Module Catalog

M.Sc. Biology

TUM School of Life Sciences

Technische Universität München

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Module Catalog: General Information and Notes to the Reader

What is the module catalog?
One of the central components of the Bologna Process consists in the modularization of university curricula, that is, the transition of universities away from earlier seminar/lecture systems to a modular system in which thematically-related courses are bundled together into blocks, or modules.
This module catalog contains descriptions of all modules offered in the course of study.
Serving the goal of transparency in higher education, it provides students, potential students and other internal and external parties with information on the content of individual modules, the goals of academic qualification targeted in each module, as well as their qualitative and quantitative requirements.

Notes to the reader:

Updated Information
An updated module catalog reflecting the current status of module contents and requirements is published every semester. The date on which the module catalog was generated in TUMonline is printed in the footer.

Non-binding Information
Module descriptions serve to increase transparency and improve student orientation with respect to course offerings. They are not legally-binding. Individual modifications of described contents may occur in praxis.
Legally-binding information on all questions concerning the study program and examinations can be found in the subject-specific academic and examination regulations (FPSO) of individual programs, as well as in the general academic and examination regulations of TUM (APSO).

Elective modules
Please note that generally not all elective modules offered within the study program are listed in the module catalog.

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[WZ2594] Research Project Secondary Plant Metabolites | Forschungspraktikum Sekundäre Pflanzeninhaltsstoffe 524 - 525
[WZ2629] Research Project Chemical Genetics | Forschungspraktikum Chemische Genetik 526 - 527
[WZ2630] Research Project Plant Growth Regulation | Forschungspraktikum Wachstumsregulation der Pflanzen 528 - 529
[WZ2685] Research Project Redox-Biochemistry in Plant-Environment Interaction | Forschungspraktikum Redox-Biochemie bei der Pflanze-Umwelt Interaktion 530 - 531
[WZ1035] Host-Parasite-Interaction | Host-Parasite-Interaction 532 - 533
[WZ1075] Herbicides and Plant Physiology | Herbizide und Pflanzenphysiologie 534 - 536
[WZ1032] Genetic Selection Supported by Markers | Marker-gestützte Selektion 537 - 538
[WZ1589] Marker-assisted Selection | Marker-assisted Selection 539 - 540
[WZ2014] Molecular Plant Breeding | Molekulare Pflanzenzüchtung 541 - 542
[WZ2371] Molecular Plant Physiology 2 | Molekulare Pflanzenphysiologie 2 543 - 545
[WZ2385] Molecular Plant Physiology 1 | Molekulare Pflanzenphysiologie 1 546 - 548
[WZ2617] Molecular Ecology, Molecular Systematics, and Biogeography of Plants | Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen 549 - 550
[WZ2657] Methods and Logic in Molecular Cell Biology and Scientific Writing | Methods and Logic in Molecular Cell Biology and Scientific Writing 551 - 552
[WZ2381] Plant Systems Biology (Lecture and Seminar) | Pflanzensystembiologie (Vorlesung und Seminar) 553 - 554
[WZ2433] Population Biology and Nature Conservation | Populationsbiologie und Naturschutz 555 - 556
[WZ2567] Phytopathology of Woody Plants | Phytopathologie von Gehölzen 557 - 558
[WZ2581] Plant Biotechnology | Pflanzenbiotechnologie 559 - 560
[WZ4020] Effects of Climate Change on Plant Physiology | Pflanzenfunktionen im Klimawandel 561 - 562
[WZ1031] Quantitative Genetics and Selection | Quantitative Genetik und Selektion 563 - 564
[WZ2689] Plant Redox-Biochemistry | Redox-Biochemie der Pflanzen 565 - 566

[MA9613] | Statistical Computing and Data Analysis (TUM School of Life Sciences) 567 - 568
[WZ1663] Secondary Plant Metabolites and Human Health | Secondary Plant Metabolites and Human Health 569 - 570
[WZ2382] Exercise in Plant Systems Biology | Übung in Pflanzensystembiologie 571 - 572
[WZ6121] Vegetation of the Earth | Vegetation der Erde 573 - 574
Specializing in Zoology/Animal Sciences | Studienschwerpunkt Zoologie/ Tierwissenschaften 575
[WZ2460] Current Topics in Neurobiology | Aktuelle Themen der Neurobiologie 575 - 577
[WZ2479] Advanced Methods and Findings in Neurophysiology | Advanced Methods and Findings in Neurophysiology 578 - 579
[ME2759] Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen 580 - 582
[WZ0404] Animal Biotechnology 2 | Biotechnologie der Tiere 2 583 - 584
[WZ2664] Animal Biotechnology 1 | Biotechnologie der Tiere 1 585 - 587
[WZ2750] Course block: Neurobiology of isolated tissue | Blockpraktikum: Neurobiologie am isolierten Gewebe 588 - 589
[WZ2753] Course block: Neurobiology of intact animals | Blockpraktikum: Neurobiologie am intakten Organismus 590 - 591
[WZ3097] Basics in Chronobiology | Basics in Chronobiology 592 - 594
[WZ2693] Cognitive Neuroscience | Cognitive Neuroscience 595 - 596
[WZ2938] Course block: Neuroscience of vision | Course block: Neuroscience of vision 597 - 598
[WZ2404] Introduction to Mammalian Cell Culture | Einführung in die Kultivierung von Säugetierzellen 599 - 600
[WZ2459] Developmental Biology and Histology of Animals | Entwicklungsbiologie und Histologie der Tiere 601 - 602
[CH0172] Practical Lab Course: Biotechnological Techniques in Mammalian Cells | Forschungspraktikum: Biotechnologische Verfahren in Säugetierzellen 603 - 604
[LS20006] Research Practical Entomology | Forschungspraktikum Entomologie 605 - 606
[WZ0003] Internship Reproductive Biotechnology | Forschungspraktikum Biotechnologie der Reproduktion 607 - 608
[WZ1331] Research Project Chronobiology | Forschungspraktikum Chronobiologie 609 - 610
[WZ1415] Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten 611 - 613

[WZ2455] Practical Course in Neurobiology of Arthropods | Forschungspraktikum Neurobiologie von Arthropoden 614 - 615
[WZ2463] Research Project Neurobiology of Birds | Forschungspraktikum Neurobiologie an Vögeln 616 - 617
[WZ2464] Research Project Neurobiology of Isolated Networks | Forschungspraktikum Neuronale Netzwerkanalyse 618 - 619
[WZ2465] Research Project Neurobiology of Ultrasound Orientation | Forschungspraktikum Neurobiologie der Echoortung 620 - 621
[WZ2474] Research Project in Molecular Physiology | Forschungspraktikum Molekulare Physiologie 622 - 623
[WZ2478] Research Project Neurophysiology | Forschungspraktikum Neurophysiologie 624 - 625
[WZ2532] Research Project Conservation Genetics | Forschungspraktikum Conservation Genetics 626 - 627
[WZ2533] Research Project Molecular Zoology | Forschungspraktikum Molekulare Zoologie 628 - 629
[WZ2545] Research Project Animal Biotechnology | Forschungspraktikum Biotechnologie der Tiere 630 - 631
[WZ2639] Research Project Neurobiology of behavior | Forschungspraktikum Neurobiologie des Verhaltens 632 - 634
[WZ2653] Research Project Neurobiology of Vertebrates | Forschungspraktikum Neurobiologie von Wirbeltieren 635 - 636
[WZ2680] Research Project in Zoological Systematics | Forschungspraktikum Zoologische Systematik 637 - 638
[WZ2687] Research Project Mapping Neural Circuits Underpinning Behavior | Forschungspraktikum Neuronale Netzwerke und Verhalten 639 - 640
[WZ2695] Research Project Wildlife Biology | Forschungspraktikum Wildbiologie 641 - 642
[WZ1085] Science of Laboratory Animals | Labortierwissenschaft 643 - 644
[WZ2690] Latest Neuroscience - Presenting Papers to Researchers and the General Public | Latest Neuroscience - Presenting Papers to Researchers and the General Public 645 - 647
[LS20005] Models in Computational Neuroscience | Models in Computational Neuroscience 648 - 649
[WZ2457] Neurobiology | Neurobiologie 650 - 651
[WZ0033] Physiology of Growth, Reproduction and Lactation | Physiologie des Wachstums, der Reproduktion und der Laktation 652 - 653
[WZ2405] Phylogeny and Zoology of Vertebrates | Phylogenie und Zoologie der Vertebraten 654 - 655
[WZ2127] Reproductive Physiology of Vertebrates | Reproduktionsbiologie der Vertebraten 656 - 657

[MA9613] | Statistical Computing and Data Analysis (TUM School of Life Sciences) 658 - 659
[WZ2458] Sensory Physiology | Sinnesphysiologie 660 - 661
[WZ2682] Sensory and Behavioral Neurogenetics | Sensory and Behavioral Neurogenetics 662 - 663
[ME2090] Viral and Nonviral Gene Transfer: Methods and Applications in Research and Therapy | Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie 664 - 665
[WZ1993] Laboratory Animal Science | Versuchstierkunde 666 - 668
[WZ1306] Zoological Field Trip to Lake Neusiedl | Zoologische Exkursion Neusiedler See 669 - 672
[WZ2456] Zoological Field Trip Mediterranean | Zoologische Exkursion Mittelmeer 673 - 675
General Education Subject | Allgemeinbildendes Fach 676
[CLA10800] Economic Thinking: Business Management | Betriebswirtschaftlich Denken 676 - 677
[SZ0207] Intensive Course Chinese - China at a glance | Blockkurs Chinesisch - China auf einen Blick 678
[WZ5297] Accounting | Buchführung, Kosten- und Investitionsrechnung 679 - 680
[CLA10555] Communication and Facilitation in Project Teams | Communication and Facilitation in Project Teams 681 - 682
[CLA20705] Diversity and Conflict Management | Diversität und Konfliktmanagement 683 - 684
[CLA30230] Ethics and Responsibility | Ethik und Verantwortung 685 - 686
[CLA31314] Introduction to Philosophical Thinking | Einführung ins philosophische Denken 687 - 688
[SZ0403] English - Academic Presentation Skills C1 - C2 | Englisch - Academic Presentation Skills C1 - C2 689 - 690
[SZ0406] English - Writing Academic Research Papers C2 | Englisch - Writing Academic Research Papers C2 691 - 692
[SZ0414] English - Intercultural Communication C1 | Englisch - Intercultural Communication C1 693 - 694
[SZ0427] English - Academic Writing C2 | Englisch - Academic Writing C2 695 - 697
[CLA11108] Leadership | Führung übernehmen 698 - 699
[SZ0502] French A1.2 | Französisch A1.2 700 - 701
[CH0136] Principles of Patent Law | Grundlagen des Patentrechts 702 - 703
[WI000404_2] Introduction to Social and Communication Psychology | Grundlagen der Sozial- und Kommunikationspsychologie 704 - 706
[SZ0608] Italian A2.2 | Italienisch A2.2 707 - 708
[SZ0707] Japanese A1.3 | Japanisch A1.3 709 - 710
[WZ0812] Cultural Competence: Choir and Orchestra | Kulturelle Kompetenz: Chor- und Orchesterarbeit 711 - 712

[CLA31900] Lecture Series Environment - TUM | Vortragsreihe Umwelt - TUM 713 - 714
[WZ3234] Life Sciences & Society. An Introduction | Lebenswissenschaften & Gesellschaft. Eine Einführung 715 - 717
[WZ5440] Make your thing: A project in the Makerspace | Mach ein Ding! Ein Projekt im Makerspace 718 - 719
[MW1535] Introduction to Patent, Trademark and Design Law for Engineers | Patent-, Marken- und Musterrecht für Ingenieure: Eine Einführung 720 - 721
[CLA11317] Interdisciplinary Lecture Series Environment: Politics and Society | Ringvorlesung Umwelt: Politik und Gesellschaft 722 - 723
[SZ0902] Russian A1.2 | Russisch A1.2 724 - 725
[SZ0904] Russian A2.2 | Russisch A2.2 726 - 727
[SZ1002] Swedish A2 | Schwedisch A2 728 - 729
[SZ1201] Spanish A1 | Spanisch A1 730 - 731
[SZ1207] Spanish A1 + A2.1 | Spanisch A1 + A2.1 732 - 733
[SZ1218] Spanish B1.1 | Spanisch B1.1 734 - 735
[WI000399] Social Psychology | Sozialpsychologie [SozPsy] 736 - 737
[CLA10813] Economic Thinking: Economics | Volkswirtschaftlich Denken 738 - 739
[CLA30622] From Invention to Patent | Von der Erfindung zum Patent 740 - 741
[CLA10029] Writer's Lab | Writer's Lab 742 - 743
[CLA10450] When Engineers Become Managers | Wenn aus Ingenieuren Manager werden 744 - 745
[CLA10626] Communicating Science | Wissenschaft in der Öffentlichkeit 746 - 747
Scientific Project Planning | Wissenschaftliche Projektplanung 748
[WZ2591] Scientific Project Planning | Wissenschaftliche Projektplanung 748 - 749

Master's Thesis | Master's Thesis

Module Description

WZ2590: Master's Thesis | Master's Thesis

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 100	**Contact Hours:** 800

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung besteht aus einer schriftlichen Master`s Thesis. Die Bearbeitungsdauer der Thesis beträgt 6 Monate. Mit der Erstellung der Master`s Thesis demonstrieren die Studierenden, dass sie in der Lage sind, eine neue wissenschaftliche Fragestellung aus ihrem jeweiligen Fachbereich zu identifizieren und zielführende Experimente zur Lösung dieser Frage zu konzipieren. Sie zeigen, dass sie eine praktischen Forschungsarbeit eigenständige durchführen und unter Berücksichtigung entsprechender wissenschaftlicher Methoden lösungsorientiert bearbeiten können.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Die Master's Thesis sollte das letzte Modul im Masterstudiengang sein, weshalb der Abschluss aller bzw. der meisten Module im Masterstudiengang vorausgesetzt werden. Details hierzu regelt die Fachprüfungsordnung. Die Anmeldung der Master´s Thesis ist frühzeitig und gemeinsam mit dem Studienplan beim Schriftführer des Prüfungsausschusses Biologie persönlich einzureichen.

Content:
Im Rahmen der Master‘s Thesis bearbeiten die Studierenden ein eigenes Forschungsthema an einem Lehrstuhl der Studienfakultät oder einem fachnahen Forschungsinstitut. Grundsätzlich kommen hier als Prüfer*in / Themensteller*in alle Hochschullehrer*innen, die Lehre im Curriculum des Studiengangs anbieten, in Frage. Details regelt die FPSO.
Die Studierenden bearbeiten selbstständig eine wissenschaftliche Fragestellung, werten ihre Ergebnisse aus und bewerten diese mit geeigneten wissenschaftlichen Methoden. Die

Vorgehensweise und Ergebnisse werden in der schriftlichen Ausfertigung der Master‘s Thesis zusammengefasst und in einem Vortag einem Fachpublikum vorgestellt.

Intended Learning Outcomes:
ach Abschluss der Master`s Thesis sind die Studenten in der Lage:
- ein neuartiges Forschungsprojekt zu identifizieren
- wissenschaftliche Fragestellungen präzise zu formulieren
- einen realistischen Zeitplan aufzustellen und einzuhalten
- ein Forschungsprojekt eigenständig durchzuführen
- die Versuche und Ergebnisse im wissenschaftlichen Kontext des gewählten Fachgebietes einzubetten
- die gewonnenen Schlussfolgerungen im Vergleich zu den in der Literatur vertretenen Ansichten zu diskutieren
- einen wissenschaftlichen Text zur Darstellung eigener Forschungsergebnisse zu verfassen, der den formalen Standards der jeweiligen Fachdisziplin entspricht
- eigene wissenschaftliche Ergebnisse einem Fachpublikum vorzustellen und zu diskutieren

Teaching and Learning Methods:
Die Studierenden wählen ihr Master`s Thesis Projekt in enger Abstimmung mit dem aufnehmenden Lehrstuhl oder Institut. Die Studierenden führen die wissenschaftlichen Arbeiten unter der Anleitung des jeweiligen Fachbetreuers eigenständig durch und dokumentieren ihre erzielten Ergebnisse gemäß den wissenschaftlichen Standards. Die schriftliche Ausarbeitung der Master’s Thesis erfolgt eigenständig durch die Studenten in enger Abstimmung und unter Rücksprache mit dem jeweiligen Fachbetreuer. Im Rahmen der Thesis ist ein Vortrag vor dem/der Prüfer*in / Themensteller *in und Fachpublikum zu halten.

Media:

Reading List:
Literatur ist von der Themenwahl abhängig. Sie wird teils durch den/die Themensteller*in, teils durch eigene Recherche zusammengestellt.

Responsible for Module:
Jeweilige Themensteller/in / Prüfer*in

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Primary Focus | Qualifizierungsschwerpunkt

Module Description

WZ2411: Immunology 2 | Immunologie 2

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 130	**Contact Hours:** 170

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of exam (in min.): 60 written + 10 oral (presentation) + practical (SL).
Regular, active participation in the courses is expected, for the internship it is required (presence check). The theoretical knowledge and basic understanding of the
connections are tested by an exam (60 min, graded). The understanding of experimental questions and methods will be evaluated by a summarizing presentation (graded) and by writing a protocol (graded) by the students. Examination, lecture and internship protocol
The mark of the written examination of the theory counts 1-fold, the common mark of lecture and practical course protocol counts 2-fold. If the overall grade is better than 4.1, the module is considered completed and passed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of the module 'Immunology 1

Content:
The module 'Immunology 2' is addressed to students who - based on the module 'Immunology 1' - want to deepen their knowledge of immunology. TThe basic knowledge about the mechanisms of immune defense is further developed by consideration of more complex immunological facts, such as the exact immunological processes in autoimmune diseases and tumor diseases. Furthermore, questions in the
immunological research and current research results are looked at. The lecture 'Special Immunology' deals with questions of current immunological research.

The practical course serves to get to know and apply immunological working methods in practice, such as
flow cytometry and various immunocyte assays.

Intended Learning Outcomes:
After completing this module, students are able to use the most important experimental methods to understand and/or apply for investigation of immunological questions. With the internship the students gain the ability to apply basic immunological methods such as isolation and cultivation of immune cells as well as the analysis of cells using flow cytometry, i.e. mastering this process. Attending the lecture enables the students to master even more complicated experimental approaches based on concrete scientific questions and to gain a deep insight into current immunological research areas. Attendance of lectures and practical training lay the foundation for the ability to apply the basic knowledge of immunology gained in the course of module 'Immunology 1' to unknown facts, evaluate immunological questions and possibly to develop own solutions.
The attendance of this module gives students the ability to further conduct immunological research in either a master's or doctoral thesis.

Teaching and Learning Methods:
The module consists of a lecture and a subsequent practical training. In the lecture current research topics are presented by the chair staff. The students are invited to study original scientific papers. During the practical training they learn immunological working methods, as well as the processing of questions from immunological research by means of group or
partner work.

Media:
Presentations via Powerpoint, script (download possibility for lecture material), internship script

Reading List:
original scientific papers (recommended by the lecturers)

Responsible for Module:
Busch, Dirk; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum der Immunologie (für Biologen) (Praktikum, 8 SWS)
Buchholz V (Kretschmer L), D'Ippolito E, Kazeroonian A, Mejias Luque R, Meyer H (Norman D, Bianca S), Schiemann M (Andrä I), Schumann K (Bernard B, Kolb S)

Spezielle Immunologie für Biologen, Biochemiker, Molekulare Biotechnologen und Mediziner (Vorlesung, 2 SWS)
Buchholz V, Busch D, Friedrich V, Gerhard M, Hochrein H, Keppler S, Kohleisen B, Mejias Luque R, Meyer H, Neuenhahn M, Prazeres da Costa C, Prodjinotho U, Rosenbaum M, Schiemann M, Schumann K

For further information in this module, please click campus.tum.de or here.

Specializing | Studienschwerpunkte

Specializing in Biochemisty and Cell Biology | Studienschwerpunkt Biochemie und Zellbiologie

Module Description

WZ2595: Applied Molecular Biotechnology | Angewandte Molekulare Biotechnologie

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 100	**Contact Hours:** 50

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90 min, schriftlich; 30 min mündlich.
Teilnahme an jedem Tag der Lehrveranstaltung wird erwartet. Die Modulprüfung wird geteilt abgehalten, da beide Prüfungselemente vom der Art her völlig verschieden sind und nicht gemeinsam bewertet werden können. Es handelt sich um eine Klausur zur Vorlesung und einen Seminarvortrag. Die schriftliche Prüfungen (90 min, benotet) dient der Überprüfung der in der Vorlesung erwähnten und im Skript zur Lehrveranstaltung dargelegten Inhalte. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, die theoretischen Hintergründe dessen zu verstehen, was sie in der Vorlesung gehört haben und das Gelernte zu verknüpfen um Fragestellungen aus dem Bereich der Vorlesung beantworten zu können. Im Seminar (30 min, benotet) werden die Studierenden ein aktuelles Literaturthema aus dem Bereich der molekularen Biotechnologie bearbeiten und in Form einer Präsentation vorstellen.

Repeat Examination:

(Recommended) Prerequisites:
Grundpraktikum in Biochemie

Content:
In diesem Modul werden Methoden zur Nutzung lebender Organismen zur Herstellung biogener Produkte vorgestellt. Hierbei wird sowohl die Nutzung von Mikroorganismen, wie auch der Einsatz

gentechnisch veränderter Pflanzen oder Tieren erläutert. Zunächst werden Methoden vorgestellt, mit deren Hilfe im Laboratorium genetische Veränderungen an Organismen vorgenommen werden können. Weiterhin werden genetische und immunologische Testverfahren vorgestellt, die es ermöglichen genetisch Veränderte Organismen zu detektieren. Darüberhinaus werden die Grundlagen der Fermentation besprochen die zur Erzeugung von Proteinen im industrielen Maßstab genutzt werden. Schließlich werden Verfahren des metabolic engeneering erklärt, die zur Veränderung ganzer Stoffwechselwege in Organismen führen können.

Intended Learning Outcomes:
Nach dieser Veranstaltung sind die Studierenden in der Lage die Erzeugung gentechnisch veränderter Mokroorganismen, Tiere und Pflanzen zu beschreiben und zu erklären, wie diese Organismen zur Erzeugung wirtschaftlich verwertbarer Produkte genutzt werden können. Die Studierenden sind weiterhin in der Lage, Risiken im Zusammenhang mit der Verwendung gentechnisch veränderter Organismen zu bewerten.

Teaching and Learning Methods:
Lehrtechnik: Vorlesung; Seminare, Projekte
Lernaktivitäten: hören der Vorlesung; Erarbeiten von Zusammenfassungen aus wissenschaftlicher Primärliteratur; Anleitungsgespräche.
Lernaktivitäten: Relevante Materialrecherche, Studium von Literatur, Zusammenfassen von Dokumenten, Produktion von Berichten / Hausarbeiten, Vorbereiten und Durchführen von Präsentationen, Konstruktives Kritisieren eigener Arbeit, Konstruktives Kritisieren der Arbeit anderer, Kritik produktiv umsetzen, Einhalten von Fristen
Lehrmethoden: Vorlesung, Präsentation, Vortrag, Einzelarbeit, Referate

Media:
Vorlesungsskript, PowerPoint, Videoaufzeichnung der Vorlesung, wissenschaftliche Fachartikel

Reading List:
Vorlesungssskript, wissenschaftliche Primärliteratur

Responsible for Module:
Dieter Langosch (langosch@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Biotechnologie (Vorlesung, 2 SWS)
Langosch D, Gütlich M

Seminar Molekulare Biotechnologie (Seminar, 2 SWS)
Skerra A [L], Skerra A, Schlapschy M, Gütlich M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2599: Analysis of High-Throughput Datasets for Biologists | Analysis of High-Throughput Datasets for Biologists

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Each participant writes a research paper-like report of approximately four pages. To do so, the students receive a set of raw data and specific question, which should be solved for this dataset. Based on the competences gained during the lecture and exercise the students should be able to solve the questions by processing the raw data and applying various forms of data analyses, e.g. clustering, enrichment analysis, Principle component analysis. The report has to be submitted within two weeks after the course.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in statistics

Content:
Lectures will give insight into how biological knowledge can be generated from modern omic technologies (transcriptomic, proteomic, metabolomic) and illustrate different ways of analyzing such data.
Practicals will consist of 1) how to use many freely available computing tools to work more powerfully and effectively 2) computer exercises that will enable the participants to apply statistical methods to the analysis of large scale biological data 3) gain knowledge on how to utilize existing biological databases in their research.

Intended Learning Outcomes:
Upon successful completion of the module students are familiar with advanced data analysis methodologies and hands-on competence on the latest available tools for the analysis of high

throughput data sets. They have basic knowledge on what information can be found and where, as well as how can the information be
accessed/retrieved.

Teaching and Learning Methods:
Lecture: Introduction into statistics, application of R software
Exercise: The theory taught in the lecture is substantiated and trained in the exercise on specific practical examples. This is done partially by each student on his own, partially in small groups of two or three.

Media:
Interactive whiteboard (Lecturer is programming on an interactive whiteboard, students mainly on their PC; complemented by black board writing and scientific publications (provided by the lecturer).

Reading List:
Current publications in statistics and data processing (provided by the lecturer one week before module starts

Responsible for Module:
Bernhard Küster kuster@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Analysis of High-Throughput Datasets for Biologists (Übung, 2 SWS)
Küster B [L], Meng C

Analysis of High-Throughput Datasets for Biologists (Vorlesung, 2 SWS)
Küster B [L], Meng C, Tester3 R
For further information in this module, please click campus.tum.de or here.

Module Description

CH3039: Bioorganic Chemistry | Bioorganische Chemie

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer Klausur (90 min), in der die Studierenden unterschiedliche Lernergebnisse abrufen sollen. Kenntnisse auf dem Gebiet der bioorganischen Chemie werden im Bezug auf wichtige biologische Fragestellungen wie die Bekämpfung von Krankheiten unter Anwendung von chemischen Werkzeugen wie die Entwicklung von selektiven Inhibitoren als Medikamente abgefragt. Dabei ist es wichtig sowohl die biologischen Herausforderungen sowie die chemischen Methoden zu kennen und aufzuzeigen. Dies wird durch z.T. praxisnahe Fragestellungen mit erforderlichen methodischen Antworten geprüft. Das Beantworten der Fragen erfordert teils eigene Formulierungen, teils Auflistungen und Zeichnungen, sowie Interpretationen und Transferieren des gelernten Wissens. Das Modul gilt mit einer Klausurnote besser oder gleich 4,0 als bestanden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in organischer Chemie, sowie Biochemie sind empfohlene Voraussetzung.

Content:
In den semesterbegleitenden Vorlesungen werden die folgenden Themen behandelt:
- Einführung in Terminologie „Bioorganische Chemie“ als interdisziplinäre Schnittstelle von Chemie, Biologie, Medizin und Analytik
- Präsentation der Meilensteine und Forschungshighlights der letzten 15-20 Jahre
- Wiederholung von Grundlagen der ribosomalen und nichtribosomalen Proteinsynthese mit dem Schwerpunkt wie die Natur Peptide herstellt
- Chemische Peptidsynthese am Beispiel der Festphase. Einführung der Boc und Fmoc Schutzgruppentechnologie, Präsentation verschiedener Kupplungsverfahren sowie geeigneter Linker

- Vorstellung der Proteinsemisynthese inspiriert durch das Protein Splicing
- Diskussion des Protein Splicings und mechanistische Analyse
- Einführung der nativen Protein Ligation sowie der dazu benötigten Strategien für die Proteinexpression sowie Peptiddesign
- Erweiterung des genetischen Codes als weiteres Beispiel für die Modifikation von Proteinen mit funktionalisierten Resten
- Einführung der 21. und 22. Aminosäure
- Vorstellung von Verfahren zur biotechnologischen Evolution der t-RNA Synthetase
- Beispiele zur Anwendung der Erweiterung des genetischen Codes
- Vorstellung von Posttranslationalen Modifikationen (PTM) und chemische Methoden diese zu detektieren
- Einführung der bioorthogonalen Ligation am Beispiel der Staudinger Reaktion, Click Chemie, und Diels Alder Reaktion mit inversem Elektronenbedarf
- Einführung von verschiedenen Enzymklassen, darunter vor allem Kinasen, Phosphatasen, Proteasen als medikamentative Angriffsziele
- Diskussion von Wirkstoffen, die diese Enzyme effektiv blockieren
- Vorstellung der chemischen Proteomik, darunter vor allem das aktivitätsbasierte Proteinprofiling
- Einführung in die Proteomforschung und Vorstellung der Massenspektrometrie
- Einführung der Photopharmakologie als neuartige Technologie zur Generierung schaltbarer Wirkstoffe

Intended Learning Outcomes:
Nach dem Bestehen des Moduls sind die Studierenden in der Lage:
- Wichtige Begriffe der bioorganischen Chemie zu kennen und einzuordnen
- Ein Verständnis dafür zu entwickeln, wie durch die interdisziplinäre Kombination verschiedener Methoden komplexe biologische Fragen beantwortet werden können
- Zu verstehen welche aktuellen Fragen die Forschung beschäftigt und welche Lösungsansätze dafür gesucht werden
- Methoden zu wählen, die im Rahmen ihrer Forschungspraktika im chemisch-biologischen Bereich dazu dienen das Projekt weiterzuentwickeln
- Aktuelle Entwicklungen auch nach dem Vorlesungsende zu verfolgen und zu verstehen
- Publikationen zu Themen auf diesem Gebiet folgen zu können und sich kritisch damit auseinanderzusetzen.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung mit begleitender Übung. Die Vorlesungsmaterialien können von der Homepage des Dozenten heruntergeladen werden. Die Vorlesung selbst erfolgt mit PowerPoint-Folien (inklusive Abbildungen und Animationen) sowie zusätzlichen Tafelanschriften. Zitate und Hinweise auf aktuelle Publikationen werden während der Vorlesung gegeben, so dass Studierende auch weiterführende Originalliteratur hinzuziehen können. Das Skript und die Tafelanschriften sind für eine erfolgreiche Teilnahme ausreichend. Der Dozent fasst zusätzlich am Anfang jeder Stunde den Stoff der letzten Vorlesung zusammen und klärt, falls notwendig, vorhandene Fragen. Am Ende jeder Vorlesung und zusätzlich bei relevanten Folien

der PowerPoint Präsentation, werden sogenannte „take home messages“ formuliert und weitere Fragen geklärt.

Media:
Das Skript steht den Studierenden auf der Homepage des Dozenten als PDF zum Download zur Verfügung. Die Vorlesungsinhalte werden mit PowerPoint Präsentationen, sowie Tafelanschriften vermittelt. Zusätzlich erfolgt der Hinweis auf weiterführende Literatur.

Reading List:
Auf Grund der Aktualität der behandelten Themen, werden Hinweise auf aktuelle Publikationen während der Vorlesung, schriftlich in der PowerPoint Präsentation mitgeteilt, so dass Studierenden auch weiterführende Originalliteratur hinzuziehen können.

Responsible for Module:
Sieber, Stephan; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Frontiers in Chemical Biology (CH3039b) (Vorlesung mit integrierten Übungen, 1 SWS)
Bach N, Sieber S

Bioorganische Chemie (CH3039a) (Vorlesung mit integrierten Übungen, 2 SWS)
Sieber S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2404: Introduction to Mammalian Cell Culture | Einführung in die Kultivierung von Säugetierzellen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (in min.): 40 oral and 150 written tests.
The manuscript for the internship serves as preparation for the internship. In addition to the practical course and lectures, seminars are held with the students in which they have to work out and present practical topics of the cultivation of mammalian cells using literature. 5 certificates (graded, 5 x 30 minutes) as well as two 20-minute presentations (graded) serve to test the theoretical skills learned in the lecture, seminar and practical course. Here students show whether they are able to structure the knowledge they have acquired and present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations. The overall grade of the module is determined by the results for the individual certificates and presentations, as well as the practical work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor degree in biology or molecular biotechnology

Content:
The lectures will provide basic knowledge about the isolation, characterization and genetic manipulation of mammalian cells. Contents are among others: Sterile working, microscopy, culture conditions, establishment and conservation of cell lines and primary cultures, determination of cell numbers, transfection methods, isolation and expansion of cell clones, application and detection of marker genes. In the lecture of the practical course, especially the background and theoretical knowledge of the experiments carried out will be taught. In the course of the practical course, basic methods for practical work with mammalian cells are taught. In the corresponding seminar the students present relevant literature concerning cell culture.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise for the cultivation and genetic manipulation of mammalian cells. Furthermore, they have learned and practiced basic cell biological working techniques. They understand cell biological questions and working techniques and can apply the acquired knowledge to more in-depth questions.
Students have also developed problem-solving skills and gained insights into cell biology and cell biological problems.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture, practical course, seminar Teaching method: Lecture; in practical course, instructional talks, demonstrations, experiments, partner work, discussion of results.
Learning activities: study of lecture notes, lecture notes, practical course script and literature; practice of laboratory skills and cell biological work techniques; cooperation with practical course partners; preparation of protocols and presentations.

Media:
Presentations using PowerPoint,
Internship script (downloadable lecture material) Publications on cell culture specific topics

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement: Sabine Schmitz; The Experimentator: Cell Culture; R. Ian Freshney: Culture of Animal Cells: A Manual of Basic Technique

Responsible for Module:
Angelika Schnieke (schnieke@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Kultivierung von Säugetierzellen (Zellkultur - Praktikum) (Praktikum, 3 SWS)
Schnieke A [L], Bauer B, Fischer K, Flisikowska T

Zellbiologische Fragestellungen (Zellkultur - Seminar) (Seminar, 2 SWS)
Schnieke A [L], Fischer K
For further information in this module, please click campus.tum.de or here.

Module Description

CH5147: Research Project Cellular Biochemistry | Forschungspraktikum Zelluläre Biochemie

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Unter Betreuung eines wiss. Mitarbeiters arbeiten die Studierenden für 6 Wochen (vollzeit) an einem eigenständigen Forschungsprojekt. Die Studierenden planen Experimente mit wiss. Fragestellung, werten diese aus und interpätieren die Ergebnisse als Grundlage für die Planung weiterführender Experimente. Das Forschungsprojekt wird in Form eines Laborjournals dokumentiert und in From einer schriftlichen Ausarbeitung wiss. dargestellt. Die Forschungsergebnisse werden im Rahmen eines Vortrags präsentiert. Die Note ergibt sich anteilig aus einer Bewertung der praktischen Arbeit (50%), wiss. Kreativität (20%), schriftlicher Dokumentation (15%) und Vortrag (15%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erforderlich sind: Gute theoretische Grundlagen in den Bereichen der Zellbioloogie, Biochemie, Molekularbiologie und Proteinchemie; Praktische Kenntnisse in molekularbiologischen, mikrobiologischen, biochemischen, spektroskopischen und zellbiologischen Grundtechniken (z.B.: PCR, Klonierung, Chromatographie, Photometrie, Mikroskopie, etc.).

Content:
Im Rahmen des Praktikums bearbeiten die Studierenden ein eigenständiges Teilprojekt eines aktuellen Froschungsvorhabens.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltung sind die Studierenden in der Lage wissenschaftliche Experimente, fragestellungsorientiert zu planen, durchzuführen, auszuwerten und zu interprätieren. Sie erlernen eine breites Spektrum von molekularbiologischen,

biochemischen, proteinchemischen und zellbiologischen Methoden in Theorie und praktischer Anwendung. Die Studierenden lernen wiss. Abläufe zu verstehen und fragstellungsorientiert anzuwenden. Sie erlernen eigenständiges, praktisches Arbeiten innerhalb eines Forschungsteams. Die Studierneden sind in der Lage ihre Arbeiten in strukturierter Art und Weise zu dokumentiere und ein Laborjournal zu führen. Sie können ihre Ergebnisse in schriftlicher und mündlicher Form wissenschaftlich darstellen und diskutieren.

Teaching and Learning Methods:
"Veranstaltungsform/Lehrtechnik: Praktikum Lehrmethode: Praktikum, Anleitungsgespräche, Demonstrationen, Experimente, Ergebnisbesprechungen.
Lernaktivitäten: Studium von aktueller Forschungsliteratur; Planung von Experimenten; Üben von labortechnischen Fertigkeiten und Arbeitstechniken; Anfertigung von Laborjournalen; Anfertigungen von wiss. Ausarbeitungen; Anfertigung einer wiss. Präsentation (Vortrag)"

Media:
"Präsentationen mittels Powerpoint,
Skript (Downloadmöglichkeit für Vorlesungsmaterial), Praktikumsskript"

Reading List:
Aktuelle Forschungsliteratur

Responsible for Module:
Buchner, Johannes; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

LS20001: Research Internship Metabolic Programming | Forschungspraktikum Metabolic Programming

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 75	**Contact Hours:** 225

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is performed during the experimental procedure. The protocol (introduction, material and methods, results and discussion, approximately 30 pages) will be used to verify skills in regards of description, evaluation and interpretation of the performed experiments in the context of metabolic programming. Furthermore, the experiments and corresponding analysis, which were performed during the practical procedures and described in the protocol, will be presented to the working group in form of a presentation (approximately 20 min) to evaluate the students ability to orally describe and critically discuss the scientific work. For the whole performance (laboratory work, protocol of 30 pages and presentation of 20 minutes; graded in a 2:2:1 ratio) one overall grade will be given.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in molecular biology, cell biology and genetics is desired.

Content:
The research project includes approximately 6 weeks of experimental work in the laboratory. The internship takes place at the chair of Metabolic Programming at the campus Freising-Weihenstephan. The topic of research depends on the recent research question of the corresponding supervisor within the fields of gene regulation, metabolism, inflammation and aging. Thereby, the research is focused around nuclear receptors, ligand-gated transcription factors, and their impact in physiology, medicine and pharmacology. By using methods from molecular biology, cellular mechanisms, which influence transcription, are investigated. This includes cell type specific and differential recruitment of cofactors, expression of regulatory transcripts and epigenetic modifications of histones and DNA. New mechanisms of gene regulation will be

identified and their relevance for transcription and physiology will be investigated. This research project will provide deeper insight into an interdisciplinary field, which links areas from human genetics and biology with cellular and molecular biology. Students will work with different methods including cloning, heterologous gene expression, protein-DNA and protein-protein interaction-assays like ChIP, reporter-analysis or CoIP, NGS, qPCR, cell culture and data analysis using bioinformatics. Furthermore, experiments with the model organism C. elegans are offered (e.g. gene knockdown with RNAi, life span and aging analysis, physiological and metabolic assays, qPCR and fluorescence microscopy). The research project might be carried out as a preparation for the final thesis.

Intended Learning Outcomes:
After successful participation in this research project, students are capable of
• analyzing recent topics of investigation in the field of molecular mechanisms of gene regulation
• creating problem-solving experimental strategies for basic questions of nuclear hormone receptor research
• applying selected experimental methods and procedures in the fields of (human) genetics, human biology, cell biology and molecular biology
• applying methods to analyze data in a highly precise and correct way and evaluate experimental outcomes
• appropriately presenting and analyzing results of experiments and data analysis
• independently transferring and applying acquired skills and techniques to other fields of research to generate, analyze and evaluate new data sets

Teaching and Learning Methods:
The internship is composed of three elements with theoretical and practical aspects: Phase 1- Developing and
planning of a scientific project, Phase 2- Implementation of a research plan devised in Phase 1, and Phase 3 – writing a scientific report about the research project. In the practical course, students are trained to identify and specify a selected basic or applied research problem related to nutrition science and biomedicine. The research internship embeds in a defined research context at the respective chair hosting the student. High intensity supervision of students by experienced scientific personnel supports the training success. Students document their research work in a dedicated lab notebook, with a focus on detailed description of applied methodologies, data acquisition and data analyses. They report to their supervisor on the progress of their work in regular meetings (examination colloquium), and at the end summarize the goals of their research project and the main findings in a 20-minute long oral presentation, using PowerPoint or equivalent presentation tools. Within this setting, the project progress is discussed, and the further development of the scientific project is planned.

Media:
Presentation: presentation software. Protocol: text document

Reading List:
Scientific literature will be provided by the supervisor.

Responsible for Module:
Uhlenhaut, Nina Henriette, Prof. Dr. rer. nat. henriette.uhlenhaut@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Metabolic Programming für Biologen (Forschungspraktikum, 15 SWS)
Uhlenhaut N [L], Greulich F, Spanier B, Strickland B
For further information in this module, please click campus.tum.de or here.

Module Description

MW1994: Research Internship Systems Biotechnology | Forschungspraktikum Systembiotechnologie [FpSysBio]

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 50	**Contact Hours:** 250

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Laborleistung erbracht, die Versuche und Messungen beinhalten mit dem Ziel der Durchführung, Auswertung und Erkenntnisgewinnung.
Die Note setzt sich aus drei Teilaspekten zusammen: - Allgemeine Bewertung (Zusammenarbeit mit dem Betreuer, Selbstständiges Arbeiten, Zuverlässigkeit, Protokollführung) 33%,
- Fachliche Bewertung (Literaturstudien, Logische Strukturierung, Schriftlicher Ausdruck, Darstellung des Wesentlichen, wissenschaftliche Durchdringung, Originalität, Bewertung der Ergebnisse) 40% und
- Praktische Fähigkeit (Technisches Verständnis, Handwerkliches Geschick, Zügigkeit der Durchführung, Ordnung am Messplatz, Umgang mit Sicherheitsrichtlinien) 27%.
Zum Bestehen der Prüfung muss ein kurzes Protokoll über die Arbeit angefertigt werden, welches aber nicht in die Note mit eingeht.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind molekularbiologische und mathematische Kenntnisse wie sie in Bachelorstudiengängen an wissenschaftlichen Hochschulen vermittelt werden.

Content:
Die Systembiologie hat sich in den letzten Jahren als interdisziplinäres Forschungsfeld etabliert und kombiniert dabei mathematisch/theoretische Ansätze mit experimentellen Methoden. Neben der Verbesserung des biotechnologischen Gesamtprozesses steht vor allem das verbesserte Verständnis der in einer Zelle ablaufenden Vorgänge im Mittelpunkt der Forschungsarbeiten. Hierfür werden biotechnologisch interessante Mikroorganismen mit gängigen

molekularbiologischen, sowie prozesstechnischen Ansätzen analysiert. Bestandteile sind die Beschreibung der Vorgänge und die jeweiligen theoretischen Grundlagen inkl. Literaturstudium, die Vorbereitung und praktische Durchführung, ggf. notwendige Berechnungen, ihre Dokumentation und Auswertung sowie die Deutung der Ergebnisse hinsichtlich der zu erarbeitenden Erkenntnisse.

Intended Learning Outcomes:
Die Studierenden können molekularbiologische und/oder modellbasierte Herangehensweisen der Biotechnologie mit starker Fokussierung auf bioprozesstechnische, biotechnologische und systembiologische Problemstellungen umsetzen. Die erlernten Methoden sind projektspezifisch, beinhalten aber in der Regel neben Klonierungsarbeiten auch biochemische Nachweismethoden, Analytik, Proteinexpression, sowie die Untersuchung und Auswertung zellulärer Prozesse und Signalwege. Der Studierende erlernt Versuche zu analysieren, durchzuführen und zu bewerten.

Teaching and Learning Methods:
Die Inhalte des Moduls werden in Zusammenarbeit mit einem Betreuer vor allem praktisch vermittelt. Die Studierenden erhalten die Möglichkeit ihnen gestellte Forschungsfragen zum großen Teil selbstständig zu bearbeiten. Die Versuche werden gemeinsam mit dem Betreuer vorbereitet und die Ergebnisse diskutiert.

Media:
Eins-zu-eins Betreuung, hands-on Erfahrung an Geräten wie HPLC, Plate reader, Cell-Counter, Äkta, Electrophoresis and Blotting Anlagen, etc

Reading List:
Wichtige Publikationen zum Thema werden bereitgestellt. Die Buchreihe 'Der Experimentator' (Springerverlag) wird als begleitende Literatur empfohlen.

Responsible for Module:
Kremling, Andreas; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0513: Research Project Cell Biology | Forschungspraktikum Zellbiologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Planung und Durchführung der Laborexperimente bilden die Grundlage zur Erlangung der fachlichen Kompetenz. Die Studierenden zeigen anhand des Laborjournals, eines zusammenfassenden Protokolls und 1-2 Präsentationen (etwa 20 min), dass Sie in der Lage sind, die wesentlichen Aspekte der Versuche in den Bereichen der Signaltransduktion von Tumorzellen strukturiert und reflektiert darzustellen. Die Gesamtnote errechnet sich aus der Präsentation (15%), dem Protokoll (25%) und der praktischen Laborarbeit (60%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
In diesem Forschungspraktikum werden einzelne Aspekte aktueller Forschungsprojekte bearbeitet. Die Themen werden auf aktuelle experimentelle Fragestellungen abgestimmt. Methodisch stehen Techniken zur Aufklärung oder Nutzung der Signaltransduktion, primär in humanen Zellkulturmodellen im Vordergrund.

Beispiele wären:
- Etablierung von Reportersystemen in Tumorzellinien
- Entwicklung von Zellchip-Assays
- Untersuchung der Zell-Wirkstoff-Interaktion
- Entwicklung funktionaler Zellassays (z.B. Invasionsassay)

Methodisch:

Zellkulturtechnologie, molekularbiologische und proteinbiochemische Methoden aus aktuellen Fragestellungen, welche am Lehrstuhl bearbeitet werden.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, experimentelle Lösungen für definierte, zellbiologische Fragestellungen zu schaffen. Die Studierenden erlangen hierbei ein vertieftes Verständnis, wie Ergebnisse vor dem experimentellen Hintergrund zu werten sind. Neben methodischen Fähigkeiten, primär in Zellkulturtechnologie und molekularbiologischen Methoden, werden selbständiges agieren und eigenverantwortliche Entscheidung gefördert.

Teaching and Learning Methods:
Lehrtechnik: Praktikum; Lernaktivitäten: Bearbeiten von zellbiologischen Fragestellungen und deren Lösungsfindung; Üben von labortechnischen Fertigkeiten; Konstruktives diskutieren und kritisieren eigener Experimente; Lehrmethode: Fragend-entwickelnde Methode

Media:
Skriptum

Reading List:
Einführende Literatur wird zum jeweiligen Praktikumsthema als Ausgangspunkt für eigene Recherchen der aktuellsten Literatur zur Verfügung gestellt.

Responsible for Module:
Karl Kramer (karl.kramer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Zellbiologie (Forschungspraktikum, 10 SWS)
Küster B [L], Kramer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2172: Functional Proteomics | Forschungspraktikum Funktionelle Proteomanalyse

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Durchführung der laborpraktischen Experimentalarbeit fließt mit einem Anteil von 60% in die Benotung ein. Die Studierenden zeigen zudem anhand eines zusammenfassenden Protokolls und 1-2 Präsentationen (20 min), dass Sie in der Lage sind, die wesentlichen Aspekte der Versuche strukturiert und reflektiert darzustellen. Die Bewertung der Präsentation und des Berichts fließen mit 15% und 25% in die Benotung der Laborleistung ein.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
BSc Abschluss ist erforderlich

Content:
Forschungspraktikum mit wechselnden, aktuellen Themen aus dem Bereich des LS fuer Proteomik und Bioanalytik.
Typische Bereiche umfassen:
a) Proteinkartierung von Zelllinien und Geweben
b) Protein-Wirkstoff-Interaktionen
c) Analyse post-translationaler Modifikationen

Methodisch:
Zellkulturtechnologie, proteinbiochemische Methoden, Massenspektrometrie, Bioinformatik mit wechselnden, aktuellen Themen aus dem Bereich des LS fuer Proteomik und Bioanalytik.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, experimentelle Lösungen für definierte, biologische und technische Fragestellungen aus dem Bereich von a) Proteinkartierung von Zelllinien und Geweben, b) Protein-Wirkstoff-Interaktionen oder c) Analyse post-translationaler Modifikationen zu schaffen. Die Studierenden erlangen hierbei ein vertieftes Verständnis, wie Ergebnisse vor dem experimentellen Hintergrund zu werten sind.

Teaching and Learning Methods:
Lehrtechnik: Praktikum; Lernaktivitäten: Bearbeiten von proteomischen Fragestellungen und deren Lösungsfindung; Üben von labortechnischen Fertigkeiten; Konstruktives diskutieren und kritisieren eigener Experimente; Lehrmethode: Fragend-entwickelnde Methode

Media:
Experimentelle Protokolle

Reading List:
Einführende Literatur wird zum jeweiligen Praktikumsthema als Ausgangspunkt für eigene Recherchen der aktuellsten Literatur zur Verfügung gestellt.

Responsible for Module:
Bernhard Küster (kuster@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Funktionelle Proteomanalyse (Praktikum, 10 SWS)
Küster B [L], Küster B, Ludwig C, The M, Wilhelm S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2252: Practical Course in Peptidchemistry and -biochemistry | Forschungspraktikum Peptidchemie und -biochemie

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The overall grade of the performance is made up of the following 3 evaluations:
1) Evaluation of the written report of the results (minutes - with 15% of the overall mark), which is summarized by the student at the end of the internship. With this, the students prove that they are able to record, evaluate, analyse and interpret the results correctly and to put them into a professional context.
2) Evaluation of a lecture (30 min - 15% of the total grade) which the student gives in front of the working group at the end of the internship. The student shows that he/she is able to prepare and convey the content of the research internship in a comprehensible way and that he/she is also able to answer questions in a qualified manner.
3) Evaluation of the work performance in the laboratory (70% of the total grade). The evaluation of practical performance is based on the student's theoretical and practical skills. The students demonstrate that they are able to set up, carry out and evaluate experiments in the field of peptide chemistry/biochemistry. They also demonstrate that they can understand and implement the theoretical background or connections with the experiments. Furthermore, the students present and discuss the results of their work in the weekly seminar of the working group in the form of a short report; this achievement is correspondingly included in the above mentioned evaluation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of organic chemistry and biochemistry required; participation in MSc lecture "Chemical Peptide and Protein Synthesis" and MSc seminar "Protein misfolding and aggregation in cell degenerative diseases" (module WZ2549) recommended

Content:
6-week research internship in a current research project of the group in the field of peptide synthesis and structure-activity relationships of biologically active peptides. The students work experimentally under supervision in the research group. The work includes peptide synthesis, peptide purification and the biochemical/biophysical characterization of synthetic peptides and their structure-activity relationships using modern methods of chemistry/biochemistry/biophysics such as solid-phase peptide synthesis, HPLC, MALDI-MS, UV/circular dichroism/fluorescence spectroscopy.

Intended Learning Outcomes:
After participation in this module, students will have a basic understanding of methods of peptide synthesis and structure-activity relationship studies of peptides. They have learned and practiced working techniques of peptide synthesis, peptide purification and their biochemical-biophysical characterization (e.g. with respect to sequence/purity, conformation, interactions, function) and are able to correctly record, evaluate, interpret, critically question, discuss and present the results of their research work.

Teaching and Learning Methods:
Instructional talks, demonstrations, experiments, partner work, literature work, data analysis/result discussions, presentation of results, practice of laboratory technical skills and working techniques, preparation of protocols.

Media:
Experimental protocols and scientific articles

Reading List:
Introductory technical literature on the respective topics and methods is provided.

Responsible for Module:
Kapurniotu, Aphrodite; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Peptidchemie und -biochemie (Praktikum, 16 SWS)
Kapurniotu A, Dalla Volta B, Naltsas D, Wunderlich H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2441: Research Project Biopolymer Chemistry | Forschungspraktikum Chemie der Biopolymere

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam for this module consists of two parts. A written project report and an oral presentation. The presentation will be split in 20 min for the speech and then another 10 min for a discussion. The summary might be written in English or in German, while the presentation will be given in English. Both parts will be graded and will be regarded as 50% of the final grade.
In the project report the students have to show that they are capable to summarize their results in a way which is regarded by an expert in that field. They have to explain the state of the research before their work begun, the scientific idea behind their work, the compilation of their results and a scientific discussion.
In the presentation they have to show that they are capable to use a fixed time frame for the demonstration of their scientific findings in front of an expert audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This internship is dedicated to master students or to bachelor students in their 5th or 6th semester. The students should have the equal knowledge of a participant of the courses biochemistry I + II and cell biology.
The courses “protein technology: membranes and membrane proteins” and “membranes and membrane proteins: exercises” are recommended but not a pre-requisite.

Content:
Students will carry out an individual research project in the field of membranes and membrane proteins. like:
- role of individual amino acids in transmembrane segments (TMS)
- Interaction between TMS and TMS

- proteolytic cleavage of TMS
- structural flexibility of TMS
- interaction of TMS with neighbouring lipid molecules

Applied technologies may include:
- cloning of vectors for a genetic screening system
- kinetics of lipid flip
- expression and purification of membrane proteins
- mass spectrometric analysis of special peptides
- computer based molecular dynamic calculations.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to carry out a defined part of a scientific research project independently. The students will be able to plan further experiments in this field and to compare their findings with the results found by other scientists. They will have learned to schedule their experiments according to their needs and to evaluate the results with the help of statistical methods. They will be able to discover errors in their own experiments and to correct these mistakes independently. They will have learned to analyze their data and to summarize the fundamental findings.

Teaching and Learning Methods:
This module is designed as a practical lab course and a scientific project. In a first talk the student will be informed about the scientific problem and the principal schedule. The students will do a literature search for relevant articles concerning their work. Under the direct supervision of a member of our group the students will learn how carry out their experiments for the first time. All further experiments as well as the evaluation of the data will be done by the student independently. During the lab course there will be several discussion meetings with selected members of our group to review the obtained findings and to consolidate the data analysis. At the end there will be a presentation for all members of our group.

Media:
Scientific primary literature, online articles. The students will have full access on any source of scientific literature that our chair may offer.

Reading List:
Scientific primary literature, online articles

Responsible for Module:
Langosch, Dieter; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum: Chemie der Biopolymere (Forschungspraktikum, 10 SWS)
Schmidt F, Ortner M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2442: Progress in Membrane Protein Biochemistry | Fortschritte in der Membranproteinbiochemie

Version of module description: Gültig ab summerterm 2011

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 30	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 2 x 60 min mündlich.
In diesem Modul halten die Studierenden zwei jeweils einstündige Seminarvorträge zu aktuellen Themen aus dem Bereich der Membran- oder Membranproteinforschung. Beide Vorträge werden bewertet und zu einer Gesamtnote gemittelt. Die Anwesenheit bei allen Terminen der Lehrveranstaltung wird vorausgesetzt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Hauptfach Biochemie im Masterstudium

Content:
Es werden neueste Forschungsergebnisse aus der eigenen Arbeitsgruppe vorgestellt und mit den Ergebnissen anderer Forschergruppen korreliert. Es werden Fachartikel aus der Primärliteratur präsentiert uns deren kritisch beurteilt.

Intended Learning Outcomes:
Nach dem absolvieren dieses Moduls haben die Studierenden die Kompetenz erworben neueste wissenschaftliche Arbeiten auf dem Gebiet der Membran- und Membranproteinforschung inhaltlich nachzuvollziehen und zu bewerten. Sie haben gelernt Forschungsergebnisse auf deren Plausibilität zu hinterfragen, auf mögliche Überinterprätationen hinzuweisen und eventuell nötige Kontrollexperimente zu reklamieren.

Teaching and Learning Methods:
Lehrtechnik: Seminare, Forschungsseminare, Projekte

Erarbeiten kritischer Zusammenfassungen aus wissenschaftlicher Primärliteratur; Anleitungsgespräche.
Lernaktivitäten: Relevante Materialrecherche, Studium von Literatur, Zusammenfassen von Dokumenten, Produktion von Berichten / Hausarbeiten, Vorbereiten und Durchführen von Präsentationen, Konstruktives Kritisieren eigener Arbeit, Konstruktives Kritisieren der Arbeit anderer, Kritik produktiv umsetzen, Einhalten von Fristen
Lehrmethoden: Präsentation, Vortrag, Einzelarbeit, Referate

Media:
wissenschaftliche Fachartikel, PowerPoint Präsentationen

Reading List:
wissenschaftliche Primärliteratur

Responsible for Module:
Dieter Langosch (langosch@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Journal Club Biopolymere (Seminar, 2 SWS)
Langosch D

Progress-Report Biopolymere (Seminar, 2 SWS)
Langosch D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2546: Research Project Biotechnology of Natural Products | Forschungspraktikum Biotechnologie der Naturstoffe

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die benotete Laborleistung umfasst die Erstellung eines Protokolls (50% der Benotung) und die Bewertung der praktischen Tätigkeit (50% der Benotung). Im Protokoll weisen die Studierenden nach, dass Sie in der Lage sind die analytischen, biochemischen und molekularbiologischen Fragestellungen zu verstehen und dadurch die gewonnen Ergebnisse in strukturierter und verständlicher Weise wissenschaftlich korrekt darzustellen und zu interpretieren. Die Benotung der praktischen Tätigkeit umfasst folgende Kriterien: Planung der Experimente, Fachwissen, Arbeitsweise, Effizienz, Belastbarkeit, Auffassungsgabe, Zuverlässigkeit, Selbständigkeit, Flexibilität, Engagement.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zur Durchführung des Praktikums sind Kenntnisse in analytischer, anorganischer und organischer Chemie sowie Biochemie und Molekularbiologie erforderlich.

Content:
Isolierung von Metaboliten, Proteinen, RNA oder DNA; Klonierung von Genen, Herstellung verschiedener Konstrukte und Transformationen für heterologe Expression oder RNAi, Agroinfiltration, Affinitätschromatographie, Expressionsanalysen, Biotransformationen, Proteinreinigung, PCR, qPCR, GC-MS, LC-MS

Intended Learning Outcomes:
Selbstständige Planung und Durchführung experimenteller Arbeiten; Auswertung und Interpretation der eigenen Ergebnisse; Selbstständiges praktisches Arbeiten mit Analysegeräten; Fehlersuche beim Auftreten von Problemen; Arbeiten im Team; Lösen von analytischen,

biochemischen oder molekularbiologischen Fragestellungen, wie beispielsweise Bestimmung von pflanzlichen Metaboliten, Quantifizierung von Allergenen und Optimierung von mikrobiellen Wirtsorganismen zur Produktion von Glukosiden.

Teaching and Learning Methods:
im Praktikum Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit, Ergebnisbesprechungen.
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Praktikumsskript und Literatur; Üben von labortechnischen Fertigkeiten und mikrobiologischen Arbeitstechniken; Zusammenarbeit mit Praktikumspartner; Anfertigung von Protokollen. Durchführung von Labortätigkeiten unter Anleitung von Post-docs und Doktoranden; Eigenes Projekt nach Absprache bzw. Mitarbeit in einem laufenden Forschungsprojekt.

Media:

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung werden die Lehrbücher der Instrumentellen Analytik, Biochemie und Molekularbiologie empfohlen

Responsible for Module:
Wilfried Schwab (schwab@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum BiNa (Forschungspraktikum, 10 SWS)
Schwab W, Hoffmann T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2561: Research Project Protein Modelling and Drug Design | Forschungspraktikum Protein- und Wirkstoffmodellierung

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 0	**Contact Hours:** 300

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Zur Leistungskontrolle ist ein Protokoll anzufertigen. Die Studierenden sollen Ihre Kenntnisse an aktuellen Fragestellungen praktisch anwenden und zeigen, dass sie in der Lage sind, die Resultate auszuwerten, zu interpretieren und prägnat darzustellen sowie Transferaufgaben zu bewältigen. Die Gesamtnote des Moduls setzt sich aus der praktischen Labortätigkeit (80%) und Protokoll (20%) zusammen.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Vorlesung "Simulation und Modellierung biologischer Makromoleküle" oder Vorlesung "Computer-aided Drug und Protein Design".
Die Veranstaltung richtet sich an Studierende der Fachrichtungen Biologie, Molekulare Biotechnologie, Bioinformatik, Biochemie, Chemie und Biophysik (Master/Bachelor 5./6. Semester).

Content:
Praktische Anwendung von Modellierungssoftware aus den Bereichen Protein-Ligand-Docking, Molekülsimulation, Proteinengineering auf aktuelle Fragestellungen. Je nach Neigung des Studierenden koennen zusätzlich auch programmiertechnische Fragestellungen bearbeitet werden.

Intended Learning Outcomes:
Die Studierenden sind mit der Handhabung und dem Anwendungsbereich verschiedener Programme aus den Bereichen Protein-Ligand Docking, Molekülsimulation und Proteinengineering

vertraut und können diese eigenständig für entsprechende wissenschaftliche Fragestellungen anwenden.

Teaching and Learning Methods:
Lehrtechnik: Praktikum. Lehrmethode: praktische Aufgaben, praktikumsbegeleitende Betreuung, Anleitungsgespräche. Lernaktivitäten: Studium von Vorlesungsmaterial und Literatur, praktisches Arbeiten am Computer, Anfertigung von Protokollen.

Media:
Praktikumsanleitungen, für theoretischen Hintergund Skript zu den Vorlesungen, projektspezifische Literatur

Reading List:
Allgemeine Literaturempfehlungen werden in den Vorlesungen und projektspezifische Literatur wird während des Praktikums gegeben.

Responsible for Module:
Antes, Iris; Prof. Dr.sc.nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ8058: Immunoinformatics | Immunoinformatik

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 50	**Contact Hours:** 40

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Eine Klausur (90 min) dient zur Überprüfung des erlernten Wissens. Im Praktikum werden die in der Vorlesung vermittelten Inhalte vertieft, wobei zur Kontrolle ein Protokoll anzufertigen ist. Die Studierenden sollen Ihre Kenntnisse aus der Vorlesung praktisch anwenden und zeigen, dass sie in der Lage sind, die Resultate aus den praktischen Übungen auszuwerten, zu interpretieren und prägnant darzustellen. Die Studierenden sollen das erworbene Wissen strukturiert und auf das Wesentliche konzentriert darstellen sowie Transferaufgaben bewältigen können. Die Klausurnote bildet zusammen mit der Note für das Praktikum die Gesamtnote des Moduls. Die Gewichtung der Noten für die Klausur und das Praktikum für die finale Modulnote ist 50:50.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
keine

Content:
Sequenz- und Strukturbasierte Vorhersagemethoden in folgenden Bereichen: MHC Klasse I und II Prozessierungspfad, Epitoperkennung, B-Cell Aktivierung, Allergenität und Immunogenität. Strukturbasierte Methoden zur Modellierung von immunologisch wichtigen Proteinen (MHC, TCR, Antikörper, etc.) und deren Bindungspartner. Anwendung der besprochenen Methoden auf medizinische Fragestellungen (z.B. Immunotherapie, Impfstoffdesign). Die Veranstaltung richtet sich an Studierende der Fachrichtungen Biologie, Molekulare Biotechnologie, Bioinformatik, Biochemie, Chemie und Biophysik (Master/Bachelor 5./6. Semester).

Intended Learning Outcomes:
Die Studenten sind mit den bioinformatischen Methoden, welche im Bereich Immunoinformatik verwendet werden, vertraut. Sie kennen die algorithmischen und anwendungsbezogenen

Unterschiede zwischen verschiedenen Methoden und haben gelernt, die passenden Algorithmen für eine gegebene Anwendung auszuwählen.

Teaching and Learning Methods:
Lehrtechnik: Vorlesung; Praktikum. Lehrmethode: Vortrag; praktische Uebungen, Partnerarbeit, praktikumsbegeleitende Betreuung, Anleitungsgespräche. Lernaktivitäten: Studium von Vorlesungsmaterial und Literatur, praktisches Üben am Computer, Zusammenarbeit mit Praktikumspartner, Anfertigung von Protokollen.

Media:
Präsentation, Skript zur Vorlesung, Praktikumsanleitungen

Reading List:
Literaturempfehlungen werden in der Vorlesung gegeben.

Responsible for Module:
Iris Antes (antes@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2138: Practical Course in Membranes and Membrane Proteins | Kompaktkurs Membranen und Membranproteine

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 50	**Contact Hours:** 40

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The test is a laboratory service consisting of practical work, a protocol and a presentation. All three parts are included in the final grade 1/3 each.

> Practical work:
The learning success consists of the transfer of the published Experiments of different working groups to a comprehensible work plan. Thereby the different laboratory equipment of the authors with the conditions in the internship laboratory. The published experiments
all build on each other and each team of authors uses different ways of presentation and the description of the results. The students must describe these coherent experiments in practice and must achieve the same results as the Authors are coming. Only if each step is executed correctly, the desired measurement. If errors occur during the execution, the Students analyze possible causes and, if necessary, alternative paths in order to reach the goal nevertheless. In contrast, the experiments on BLA-TM kinetics require special accuracy in the practical work. Even slight deviations from the specified work instructions are immediately noticeable in a large scatter of the measured value. The students must repeat the measurement in this case until the desired result is achieved with of a given statistical accuracy can be determined. The students learn how to meticulously adhere to time limits and accuracies in the test process. Any deviation from the correct test procedure can be pointed out by the supervisor to specific
errors are attributed, which are discussed with the students. Through
By repeating the tests, students can check whether they have achieved the required precision. All sources of error should then be discussed in the protocol. Biophysical measurements with synthetic liposomes require the use of the research equipment of our group. Their operation of these devices requires a accompanied familiarization as well as a deeper understanding of the underlying measuring principles. Direct support by our employees is guaranteed, that the students draw the maximum learning out of the measurements performed can.

> Protocol:
The performed practical work is documented in a protocol. A Typical protocol comprises at least 25 pages. Within the protocol the students may orient themselves on the representations of the published data, on which will their experiments were based and which they used to develop their working scheme. Here the students achieve a level of detail that is comparable to a corresponds to scientific standards. The students discuss their results, go for errors made and analyze the causes of errors. You evaluate your yields and measured values based on literature data and design strategies for their optimization.

> Lecture:
At the end of the module the students give a lecture (15 min per person) in which They represent their own contribution to the respective results. Some works will divided among the students and only the sum of all lectures results in the Overall picture of the work done. In the lecture, the students show whether they can are able to present the results of their work to a qualified professional audience and in a subsequent discussion with the emerging questions about to critically examine their work.

Repeat Examination:

(Recommended) Prerequisites:
Visit of the lecture "Protein Technology: Membranes and Membrane Proteins [WZ0443]".

Content:
Purification of a membrane protein (bacteriorhodopsin); reconstitution of bacteriorhodopsin in membranes; activity test of bacteriorhodopsin.

The practical part starts with the design of experiments for the purification of bacteriorhodopsin. The students work on the basis of the original literature on concrete working scheme. The practical part consists of four separate experiments, which differ in time requirements and complexity:
This is also included in the part to which the protocols are to be produced. In detail these are:
- Purification and reconstitution of bacteriorhodopsin (2/5)
- blaTM Kinetics (1/5)
- liposome fusion (1/5)
- Fluorescence spectroscopy on liposomes (1/5)

Intended Learning Outcomes:
After this internship, students are able to extract a membrane protein from its natural environment and reconstitute it in synthetic membranes. In addition, they have acquired knowledge in the use of research equipment to perform biophysical measurement techniques for membrane fusion.

Teaching and Learning Methods:
Teaching technique: Development of concrete instructions for action from primary scientific literature; instructional discussions, experiments, partner work, discussion of results.
Learning activities: Practice of laboratory skills and working techniques; preparation of a protocol.

Media:
scientific articles, textbooks for advanced students

Reading List:
scientific original publications

Responsible for Module:
Dieter Langosch (langosch@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

CH5148: Molecular Biotechnology with Seminar | Molekulare Biotechnologie mit Vortragsseminar

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (90 min, benotet) dient der Überprüfung der in Vorlesung erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Die Klausurnote bildet zusammen mit einer Bewertung des Vortragseminars nach ECTS gewichtet (4/6 Vorlesungen molekulare Biotechnologie; 2/6 Vortragsseminar) die Gesamtnote des Moduls. Zur Kontrolle des Verständnisses sowie der Fähigkeit zur Anwendung und Übertragung der Lehrinhalte auf Fragestellungen in der aktuellen Forschung, erarbeiten die Studenten im Vortragsseminar eigenständig eine Präsentation zu einem aktuellen Forschungsthema und besuchen draüberhinaus mehrere Vorträge aus Fachkolloqien als Studienleistung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum besseren Verständnis der Vorlesung sind grundlegende Kenntnisse in Zellbiologie und Molekularbiologie (z.B.: Zellstruktur und Aufbau, Organelle, Biochemische Stoffwechselprozesse; DNA-Rekombinationstechnik, Transkription, Translation) erforderlich.

Content:
Im Rahmen der Vorlesungen werden fortgeschrittene Kenntnisse über Prozesse der molekularen Biotechnologie vermittelt. Inhalte sind u.a.: Rekombinante Proteinsynthese, Isolierung von Proteinen, Rückfaltung von Proteinen, Produktion von biologischen Wirkstoffen wie Insulin, etc. Der Fokus liegt in allen Themenbereichen auf dem detaillierten Verständnis der molekularen Zusammenhänge innerhalb der technischen Prozesse. Im Rahmen des

Vortrags- und Hörersminars erarbeiten sich die Studierenden einerseits anhand aktueller Forschungspublikationen ein zugelostes Themengebiet und stellen dieses ihren Kommilitonen in einem 20 minütigem Vortrag vor. Andererseits, vertiefen die Studierenden durch den Besuch von 10 Vorträgen die sie sich aus dem Programm der aktuellen Fachkolloqien aussuchen, gezielt ihr Fachwissen.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden ein detailliertes theoretische Verständnis und Fachwissen über verschiedenste Methoden, Techniken und Prozesse der molekularen Biotechnologie. Sie können komplexe, zusammenhängende Produktionsprozesse von (biologischen) Wirkstoffen verstehen und nachvollziehen. Darüberhinaus sind die Studierenden in der Lage aktuelle, biotechnologische Forschungsergebnisse zu verstehen, einzuordnen und qualitativ zu interprätieren. Mit Hilfe des erworbenen Wissen sind die Studierenden ferner in der Lage publizierte Forschungsergebnisse zusammenzufassen, zu präsentieren und zu diskutieren. Darüberhinaus soll das generelle Interesse an molekularer Biotechnologie und deren Bedeutung für die Herstellung von Therapeutika geweckt werden.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Seminar, Kolloquien. Lehrmethode: Vortrag in Vorlesung; Vortrag in Hörerseminar; Referat und Diskussion im Vortragseminar; Lehrnaktivitäten: Studium von Vorlesungsskript, -mitschrift und Literatur. Rezeption von wissenschaftlicher Literatur; Vorbereiten einer wissenschaftlichen Präsentation, Diskussion wissenschaftlicher Ergebnisse.

Media:
Präsentationen mittels Powerpoint, Skript (Downloadmöglichkeit für Vorlesungsmaterial), Publikationen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage wird empfohlen: David P. Clark, Nanette J. Pazdernik, Andreas Held und Birgit Jarosch; Molekulare Biotechnologie: Grundlagen und Anwendungen; Spektrum Akademischer Verlag; ISBN-13: 978-3827421289

Responsible for Module:
Buchner, Johannes; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Vortragsseminar Biochemie (CH0449) (Seminar, 2 SWS)
Buchner J, Feige M, Hagn F, Haslbeck M, Nedialkova D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2621: Modelling of Biological Macromolecules | Modellierung biologischer Makromoleküle

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 105	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Die theoretischen Inhalte der Vorlesung werden anhand einer schriftlichen Klausur überprüft. Sie bilden die Basis für den praktischen Teil, in welchem die Studenten die erworbenen Kenntnisse auf anwendungsorientierte Fragestellungen am Computer übertragen und somit ihr Verständnis der Lerninhalte vertiefen. Diese praktischen Leistungen werden anhand von Protokollen überprüft. Gewichtung: Klausur 50%, Protokoll 50%.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Keine

Content:
Vorlesung: Anwendungsorientierte Einführung in computergestützte Methoden zur strukturellen Modellierung biologischer Makromoleküle und deren Anwendung in den Bereichen Wirkstoff- und Proteindesign: Molekulare Modelle: Molekulare Kraftfelder, Docking- und Proteinfaltungsscoringfunktionen. Algorithmen: Optimierungsmethoden, systematische Suchverfahren, stochastische Ansätze, Molekulardynamik. Praktikum: Praktische Einführung in Modellierungs-Software aus den Bereichen: Protein-Ligand-Docking, Molekülsimulation, Proteinengineering. Die Veranstaltung richtet sich an Studierende der Fachrichtung Biologie (Master).

Intended Learning Outcomes:
Vorlesung: Die Studenten sind mit den Grundzügen der Methoden zur Modellierung und Simulation biologischer Makromoleküle vertraut. Sie kennen die anwendungsorientierten Unterschiede

zwischen verschiedenen molekularen Modellen und Algorithmen und haben gelernt, die passenden Modelle/Algorithmen für eine gegebene Anwendung auszuwählen. Praktikum: Die Studenten sind mit der grundlegenden Handhabung und dem Anwendungsbereich verschiedener Programme aus den Bereichen Protein-Ligand Docking, Molekülsimulation und Proteinengineering vertraut und können diese eigenständig auf einfache wissenschaftliche Fragestellungen anwenden.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung, Praktikum, Lernaktivitäten: Erlernen von computergestützten und theoretischen Methoden in der Biologie; Eigenständiges Arbeiten am Computer; Erlernen forschungsrelevanter Fertigkeiten.

Media:
Powerpoint Presentation, schriftliche Praktikumsanleitungen

Reading List:
Aufgrund der hohen Publikations- und Forschungstätigkeit auf diesem Gebiet findet eine semesterweise Aktualisierung der Literaturliste statt. Diese wird am Anfang des Semesters an die Studenten verteilt.

Responsible for Module:
Antes, Iris; Prof. Dr.sc.nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

CH0449: Physical Biochemistry and Seminar Talk | Physikalische Biochemie und Vortragsseminar

Version of module description: Gültig ab winterterm 2010/11

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form eines bewerteten Blockpraktikums inklusive einer schriftlichen Ausarbeitung über die praktische Arbeit sowie durch einen Vortrag über einen speziellen, aktuellen Aspekt einer Forschungsfragestellung oder eine aktuelle, neue biochemische Methodik. Im Verlauf des Blockpraktikums (gesamt ca. 45 Stunden Präsenz) bewertet der Betreuer die praktischen Leistungen und die schriftliche Ausarbeitung zu Einzelversuchen. Im Verlauf des Vortragsseminars (gesamt ca. 45 Studenten) wird die Präsentation sowie die Diskussion der eigenen Thematik als auch die Beteiligung an der allgemeinen fachlichen Diskussion anderer Vorträge benotet.
Die Benotung des Blockpraktikums und des Vortragsseminars gehen zu jeweils 50% in die Gesamtnote ein.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse auf Bachelor-Niveau in Biochemie und Physikalischer Chemie.

Content:
Das Blockpraktikum vermittelt modernste Arbeitstechniken an Forschungsgeräten. In Kleingruppen werden hierbei ausgewählte Fragstellungen aus aktuellen biochemischen Forschungsprojekten mittels verschiedener Experimentserien bearbeitet. Das Praktikum vermittelt dabei Einblicke in die theoretischen, physikalischen und praktischen Grundlagen der jeweiligen Techniken (z.B: NMR an biologischen Molekülen; Elektronenmikroskopie; Analytische Ultrazentrifugation; Fluoreszenzspektroskopie; etc.) sowie die zugehörige Arbeitsweise und die Einsatzmöglichkeiten der Methodiken. Im Vortragseminar werden den Studierenden eines Jahrgangs Themen die spezifische Aspekte aktueller Forschungsthematiken oder neue, moderne Methoden und deren Anwendungen beinhalten zugelost. Die Studierenden erarbeiten auf Grundlage von aktuellen,

englischsprachigen Veröffentlichungen von Forschungsergebnissen, unter Anleitung einen Vortrag. Diesen Vortrag präsentieren und diskutieren die Studierenden vor den Kommilitonen des Jahrgangs und den betreuenden Dozenten.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, wissenschaftliche Experimente fragestellungsorientiert zu planen, anzuwenden, auszuwerten und zu interpretieren. Sie erlernen ein breites Spektrum von Methoden und deren physikalische, theoretische Grundlagen sowie deren praktische Anwendung in der Biochemie. Die Studierenden lernen wiss. Abläufe zu verstehen, fragstellungsorientiert anzuwenden und zu bewerten.
Sie erlernen eigenständiges, praktisches Arbeiten innerhalb eines Forschungsteams. Die Studierenden sind in der Lage, ihre Arbeiten in strukturierter Art und Weise zu dokumentiere. Sie können ihre Ergebnisse in schriftlicher Form wissenschaftlich darstellen, bewerten und diskutieren. Die Studierenden sind außerdem in der Lage, sich eigenständig in aktuelle wissenschaftliche Forschungsansätze anhand von englischsprachigen, wissenschaftlichen Publikationen einzuarbeiten und das Erlernte in Form eines wissenschaftlichen Vortrags zu präsentieren und zu diskutieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Blockpraktikum (4 SWS) und einem Vortragsseminar (2 SWS). Die Studierenden führen unter Anleitung von wiss. Mitarbeitern Experimentreihen an wissenschaftlichen Geräten durch und bewerten sowie interpretieren ihre Ergebnisse. Die Experimentreihen werden in Form eines Laborjournals dokumentiert und in einer schriftlichen Ausarbeitung zusammengefasst. Die Studierenden erarbeiten sich eine spezielle, aktuelle Forschungsthematik anhand von englisch-sprachigen, aktuellen Forschungspublikationen, präsentieren und diskutieren das Erlernte im Rahmen eines wissenschaftlichen Vortrags. Im Rahmen der schriftlichen Ausarbeitung im Praktikum und der Vorbereitung des Vortrags werden die Studierenden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit unterschiedlicher Forschungsthematik angeregt.

Media:
Vortrag (PowerPoint, Tafelarbeit), Diskussion, wiss. Literatur

Reading List:
Literaturhinweise erfolgen durch die Betreuer

Responsible for Module:
Buchner, Johannes; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Physikalische Biochemie (CH0449) (Praktikum, 4 SWS)
Bachmann A, Buchner J, Gemmecker G, Haslbeck M, Weinkauf S

Vortragsseminar Biochemie (CH0449) (Seminar, 2 SWS)

Buchner J, Feige M, Hagn F, Haslbeck M, Nedialkova D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0443: Membranes and Membrane Proteins | Proteintechnologie: Membranen und Membranproteine

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Prüfung (90 min, benotet)
Die Studierenden zeigen in der Klausur, dass sie die theoretischen Hintergründe der Proteintechnologie verstehen und das Gelernte verknüpfen können, um neue Fragestellungen beantworten zu können.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
keine

Content:
This advanced lecture course focuses on an in-depth treatment of different aspects of the structure and biology of biological membranes and membrane proteins. We cover a broad range of different aspects including structure of lipid bilayers, biogenesis, prediction and experimental analysis of membrane protein structure, heterologous expression, purification, molecular interactions and structure/function relationships of membrane proteins

Intended Learning Outcomes:
After this advanced lecture course students will have an in-depth knowledge of the structure and biology of biological membranes and membrane proteins. They will know abaout a broad range of different aspects including structure of lipid bilayers, biogenesis, prediction and experimental analysis of membrane protein structure, heterologous expression, purification, molecular interactions and structure/function relationships of membrane proteins.

Teaching and Learning Methods:
Das Modul besteht aus einer klassischen Vorlesung mit Präsentation und Tafelanschrieb.

Media:
Vorlesungsskript

Reading List:

Responsible for Module:
Dieter Langosch langosch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Proteintechnologie: Membranen und Membranproteine (Vorlesung, 2 SWS)
Langosch D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2016: Proteins: Structure, Function, and Engineering | Proteine: Struktur, Funktion und Engineering

Version of module description: Gültig ab summerterm 2013

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Die Studierenden zeigen in der Klausur, ob sie die vermittelten Informationen zur Struktur und Funktion von Proteinen verstanden haben und wiedergeben können. Dies umfaßt die Beschreibung, Interpretation und Übertragung der Informationen auf ähnliche Sachverhalte, unter anderem anhand konkreter Beispiele aus dem Protein-Engineering.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind theoretische und praktische Kenntnisse der Grundlagen der Biochemie.

Content:
Die Proteine bilden die funktionell vielfältigste Stoffklasse innerhalb der Biomakromoleküle. Als Enzyme, Hormone und Antikörper, Membran-, Struktur-, Transport- und Speicherproteine erfüllen sie eine Vielzahl von Aufgaben innerhalb und außerhalb der Zelle. Die Gentechnik ermöglicht heute nicht nur die Überproduktion von Proteinen in mikrobiellen Expressionssystemen oder Zellkultur; vielmehr ist durch Manipulation der kodierenden Gensequenz auch der Austausch von Aminosäuren innerhalb eines Proteins oder gar die Verknüpfung verschiedener Proteine zu einer einzigen Polypeptidkette möglich. Dieses Protein-Engineering macht sich neben biophysikalischen Methoden auch die modernen Techniken der Strukturanalyse zunutze, u.a. X-ray und NMR. Auf folgende Aspekte wird insbesondere eingegangen: Aminosäuren, Polypeptide und Proteine; selektive chemische Modifizierung; Grundlagen und Beschreibung der dreidimensionalen Struktur; Faltung und Denaturierung von Proteinen; Molekulare Erkennung; Praktische Modellsysteme des Protein-Engineerings zum Studium der Faltung, Ligandenbindung und enzymatischen Katalyse.

Intended Learning Outcomes:
Nach der Teilnahme an dem Modul verfügen die Studierenden über theoretische Grundlagen der Struktur und Funktion der Proteine. Lernergebnisse umfassen einerseits Kenntnisse über den chemischen Aufbau der Proteine aus Aminosäuren und die daraus resultierenden Reaktivitäten und andererseits die Zusammenhänge zwischen Raumstruktur, biophysikalischen Wechselwirkungen innerhalb der Polypeptidkette, mit dem Lösungsmittel Wasser sowie mit Liganden und Substraten. Damit sind die Studierenden in der Lage, das Verhalten von Proteinen unter praktischen Aspekten einzuschätzen und Strategien zu ihrer Optimierung für gegebene Anwendungsbedingungen zu entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung/Präsentation
Lernaktiviät: Literaturstudium
Lehrmethode: Vortrag

Media:
Die Vorlesung erfolgt mit graphischen Präsentationen (Projektor und PowerPoint). Die Folien werden den Studenten in elektronischer Form oder als Ausdruck rechtzeitig zugänglich gemacht.

Reading List:
Fersht, "Structure and Mechanism in Protein Science", W.H.Freeman, 1998.
Petsko, Ringe, "Protein Structure and Function", Sinauer Associates, 2004.
Whitford, "Proteins - Structure and Function", John Wiley & Sons, 2005.

Responsible for Module:
Arne Skerra skerra@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Proteine: Struktur, Funktion und Engineering (Vorlesung, 2 SWS)
Skerra A [L], Skerra A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2226: Project Seminar Membrane Proteins | Projektseminar Membranproteine

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Bewertete wissenschaftliche Ausarbeitung.
Die studierenden arbeiten selbstständig als Hausabeit einen "Forschungsantrag" aus. Dieser wird den anderen Seminarteilnehmern in Form einer Präsentation präsentiert. Sowohl die schriftliche Ausarbeitung, als auch die Präsentation werden bewertet.
Die Bewertungen der schriftl. Ausarbeitung/ der Präsentation gehen in die finale Note mit 60/40 Gewichtung ein.

Bewertungskriterien der schriftl. Ausarbeitung sind: Darstellung der Grundlagen, Originalität, technische Machbarkeit des Projekts, Übersichtlichkeit der Darstellung.
Bewertungskriterien der mündl. Präsentation sind:
Klarheit in der Präsentation, Fokussierung auf das Wesentliche der schriftl. Ausarbeitung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Hauptfach Biochemie oder Proteinbiochemie im Masterstudium

Content:
In diesem Modul wird von den Studierenden durch Weitgehend eigenständiges Ausarbeiten ein "Forschungsantrag" für ein fiktives Foschungsprojekt erstellt. Hierzu führen die Studierenden eigene Literaturrecherchen zum Thema durch und entwickeln eine Forschungsstrategie.
Dies geschieht in enger Rückkopplung mit dem Dozenten. Das Ergebnis wird in Form einer Präsentationden anderen Seminarteilnehmern präsentiert.

Intended Learning Outcomes:
Nach diesem Modul sind die Studierenden in der Lage ein eigenes kleines Forschungsprojekt schriftlich zu umreißen und einer Forschungsförderungsorganisation zur Begutachtung vorzulegen.

Teaching and Learning Methods:
Lehrtechnik: Seminare, Projekte
Erarbeiten von Zusammenfassungen aus wissenschaftlicher Primärliteratur; Anleitungsgespräche.
Lernaktivitäten: Relevante Materialrecherche, Studium von Literatur, Zusammenfassen von Dokumenten, Produktion von Berichten / Hausarbeiten, Vorbereiten und Durchführen von Präsentationen, Konstruktives Kritisieren eigener Arbeit, Konstruktives Kritisieren der Arbeit anderer, Kritik produktiv umsetzen, Einhalten von Fristen
Lehrmethoden: Präsentation, Vortrag, Einzelarbeit, Referate

Media:
wissenschaftliche Fachartikel

Reading List:
wissenschaftliche Primärliteratur

Responsible for Module:
Dieter Langosch (langosch@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Projektseminar Membranproteine (Seminar, 3 SWS)
Langosch D, Gütlich M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2549: Peptide/Protein Synthesis and Peptides in Biomedicine and Protein Misfolding Diseases | Peptid-/Proteinsynthese und Peptide in Biomedizin und Proteinmissfaltungskrankheiten

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 75	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination will be done for the lecture with a written graded exam (60 min) and an oral presentation of the student, which takes place during the seminar. The module grade is calculated from the exam grade (50%) and the grade of the oral presentation (50%).
In the written exam, students must demonstrate that they have learned and understood the basics of chemical peptide/protein synthesis, including the application of synthetic peptides in biomedicine, by means of knowledge and understanding questions.
In the oral presentation, which lasts 45 minutes in total and consists of a 30-minute presentation (PowerPoint slides) and a 15-minute discussion, the students must demonstrate that they are able to understand a relevant international scientific study in the field of the seminar and to present it in an appropriate and didactically meaningful manner. In doing so, the students have to prove that they have understood the theoretical background of the study as well as the methodological approaches and the principles of experimental techniques and that they can explain them in a comprehensible way. In the discussion the students show that they are able to enter into a scientific discourse and to represent or refute points of view in a well-founded way. For their presentations, the students prepare a 2-page handout, which will be graded according to the oral presentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic chemistry; Biochemistry

Content:
The lecture of the module provides basic knowledge of the chemical principles and methods of chemical peptide and protein synthesis. In the seminar there will be supervised presentations (in English) of scientific articles with the results of current research in the field of peptide and protein misfolding and aggregation in connection with cell regenerative diseases and a handout of each presentation will be prepared by the student.

Intended Learning Outcomes:
After the successful completion of this module, students have acquired a broad spectrum of knowledge about chemical peptide and protein synthesis and the biomedical application of synthetic peptides. Furthermore, they have acquired knowledge on protein-protein interactions, protein folding and misfolding as well as on the connection with cell degenerative diseases and the application of synthetic peptides in the above mentioned areas. Furthermore, they have learned the principles of peptide chemical, biochemical, and biophysical methods used in the above mentioned research areas.

Teaching and Learning Methods:
In the lecture basic knowledge of the chemical principles and methods of chemical peptide and protein synthesis and on the application of synthetic peptides in biomedicine by means of PowerPoint and (overhead) slide presentations as well as by blackboard writing. In addition, regular and interactive exercises will be conducted by means of whiteboards.
The seminar includes supervised student presentations of scientific articles on research in the field of peptide/protein misfolding and aggregation in connection with cell degenerative diseases and the application of synthetic peptides. The presentations are held via PowerPoint slides and are accompanied by an in-depth scientific discourse. In addition, the students will produce corresponding table templates (handouts). Lecture and seminar are accompanied by intensive literature studies.

Media:
transparencies / Powerpoint / blackboard work

Reading List:
Norbert Sebald and Hans Dieter Jakubke: Peptides: Chemistry and Biology (Wiley-VCH) and literature references in the context of the lecture and the seminar.

Responsible for Module:
Kapurniotu, Aphrodite; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Chemische Peptid- und Proteinsynthese (Vorlesung, 1 SWS)
Kapurniotu A

Proteinmissfaltung und -aggregation bei zelldegenerativen Krankheiten (Seminar, 2 SWS)
Kapurniotu A

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2580: Protein Engineering | Protein-Engineering [Protein-Engineering]

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfung: schriftlich; Prüfungsdauer: 90 min
Eine Klausur bildet den Abschluss des Moduls und dient der Überprüfung der erlernten Kompetenzen. Die Lernenden zeigen in einer Klausur, dass sie die erarbeiteten Informationen beschreiben, interpretieren und auf ähnliche Sachverhalte übertragen sowie die unterschiedlichen Informationen zu einem neuartigen Ganzen verknüpfen können. So weisen die Studierenden beispielsweise nach, dass sie die grundlegenden Ansätze des Protein-Engineerings für die Entwicklung von biomedizinischen Wirkstoffen verstanden haben, gentechnische Methoden zur Entwicklung von Proteintherapeutika beschreiben und erläutern können, Zusammenhänge zwischen Proteinstrukturen und daraus resultierenden anwendungstechnischen Möglichkeiten beurteilen können und Strategien zur Optimierung von rekombinanten Proteinen für biotechnologische oder biomedizinische Anwendungen entwickeln können. Der Lehrende gibt den Termin der Prüfungsleistung (Klausur) zu Beginn des Moduls bekannt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind theoretische und praktische Kenntnisse von Grundlagen der Proteinbiochemie.

Content:
In diesem Modul werden die wissenschaftlichen Methoden und Arbeitstechniken des Protein-Engineerings auf theoretischer Grundlage diskutiert. Schwerpunkte sind die gentechnische Produktion von Proteinen in Bakterien (cytoplasmatisch und periplasmatisch), Verfahren zur ortsgerichteten Mutagenese, Herstellung von Genbibliotheken, Selektions- und Screening-Methoden sowie Verfahren zur Bestimmung der Affinität zwischen Proteinen (z.B. Antikörpern,

Rezeptoren) und ihren Liganden oder Wechselwirkungspartnern sowie ggf. der enzymatischen Aktivität.
Des weiteren wird im Modul das Potential gentechnisch hergestellter Proteine als neue Generation von biologischen Arzneimitteln erläutert. Die pharmakologischen Eigenschaften (Affinität zu medizinisch relevanten Zielstrukturen, Effektorfunktionen, Plasma-Halbwertszeit) können durch Protein-Engineering wie auch mit proteinchemischen Methoden gezielt manipuliert werden. Anhand aktueller Fallbeispiele (Insulin, Wachstumsfaktor, humanisierte Antikörper usw.) wird die Entwicklung und Optimierung innovativer Biopharmazeutika mittels Protein-Engineering dargestellt.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an dem Modul sind die Studierenden in der Lage:
• den theoretischen Hintergrund des Protein-Engineerings zur Entwicklung von Proteinen als biomedizinische Laborreagenzien sowie als therapeutische Wirkstoffe wiederzugeben
• die Entwicklung moderner Proteintherapeutika auf molekularer Basis mittels gentechnischer Methoden nachzuvollziehen
• die Zusammenhänge zwischen Primärstruktur, Faltung und biochemischer Funktion von Proteinen aus anwendungsbezogener Perspektive zu verstehen
• die Bedeutung biophysikalischer Wechselwirkungen des biochemisch/pharmakologisch aktiven Proteins mit dem entsprechenden Liganden/Substrat zu beurteilen
• Strategien zur Optimierung von rekombinanten Proteinen für praktische Anwendungen in Biotechnologie oder Biomedizin zu entwickeln
• das ökonomische Potential von durch Protein-Engineering optimierten Biopharmazeutika zu beurteilen

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung/Präsentation; Lernaktivität: Literaturstudium; Lehrmethode: Vortrag
Die regelmäßige aktive Teilnahme an der Lehrveranstaltung wird empfohlen.

Media:
Die Vorlesungen erfolgt mit graphischen Präsentationen (Projektor und PowerPoint). Die Folien werden den Studenten in elektronischer Form oder als Ausdruck rechtzeitig zugänglich gemacht.

Reading List:
Wink, "Molekulare Biotechnologie: Konzepte, Methoden und Anwendungen", Wiley-VCH 2011.
Lottspeich et al., "Bioanalytik", Spektrum 2012.
Williamson & Williamson, "How Proteins Work", Garland 2011.
Walsh, "Biopharmaceuticals: Biochemistry and Biotechnology", John Wiley & Sons 2003.

Responsible for Module:
Arne, Prof. Dr. Skerra (skerra@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Engineering therapeutischer Proteine (Vorlesung, 2 SWS)
Skerra A

Methodische Grundlagen des Protein-Engineerings (Vorlesung, 1 SWS)
Skerra A [L], Schlapschy M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2439: Proteomics: Analytical Basics and Biomedical Applications | Proteomics: Analytische Grundlagen und Biomedizinische Anwendungen

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 105	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Type and duration of examination (in min.): Written examination 90 min.
The examination performance for the module is verified by an exam and a presentation.
In the exam it is checked that the students have mastered the theoretical basics and are proficient in
finding answers to biological questions on the basis of the spectrum of methods of proteomics and evaluate the results against the experimental background.
The presentation will be developed from one of the exercises in groups of 2-3 participants, whereby the individual groups receive different tasks. Each group presents the solutions developed in the course for the given task and the associated results. The students show that they are able to demonstrate essential aspects of their newly acquired skills and strategies in a structured and refelcted way. They must briefly explain the application of the necessary methods and discuss the context of the question. In addition to the content, the evaluation also includes formal aspects of the presentation.
The exam and the presentation are weighted in the ratio 3 (exam) to 2 (presentation). The Module is passed if the weighted average is better than 4.09.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful BSc completion

Content:
In this lecture the theoretical basics of proteome analysis are presented. These include the theory of chromatography and mass spectrometry as well as

the most important types of chromatographic separations and mass spectrometric
Peptide sequencing and quantification.
The exercise topics cover in particular: Sequencing of peptides using LC-M/MS, Spectrum interpretation, database searches and internet research. The content is continuously updated according to the latest developments in the field of proteome research.

Intended Learning Outcomes:
After attending the module course, students will know the methodological fundamentals of proteomics (e.g. sample preparation, protein and peptide fractionation, mass spectrometry, protein identification and quantification, data analysis) and will understand the theoretical background and the application area of the respective methods. They are able to work predominantly independently with proteomics methods (e.g. various chromatographic methods, mass spectrometric methods, quantification strategies, data quality testing and evaluation) and to develop answers to biological or medical questions (e.g. analysis of post-translational modifications, identification of biomarkers, analysis of protein-protein and protein-drug interactions) in order to elucidate, for example, the mechanism of action of therapeutics in the human proteome. Students can design experiments for the quantitative and qualitative detection of the proteome and evaluate the results against the experimental background. They can summarize, present and explain scientific questions in a precise manner.

Teaching and Learning Methods:
Teaching technique: Lecture, exercise and practical training; learning activities: Work on proteomic analytical questions and their solution; practicing laboratory skills; cooperation in groups of two; constructively discussing and criticizing own experiments; Teaching method: question-developing method
In the exercises (intensive course), the contents worked out in the lecture are put into practice implemented. The exercise is intended to provide practical insights into the solution of proteome analytical problems give. An essential aspect of the exercise is that the students start from to design, conduct and evaluate 7-8 experiments on their own. Thereby get an impression of the complexity of even simple appearing test protocols. Exclusively in the exercises the students have the possibility to work with specific software in the field of proteomics and thus for the extension of their subject-specific competence.

Media:
Exercise sheets, blackboard work, PowerPoint

Reading List:
current literature on the specific topics; mainly to be researched by students

Responsible for Module:
Prof. Bernhard Küster (kuster@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Intensivkurs Proteomics (Übung, 3 SWS)

Küster B [L], Küster B, Ludwig C, Meng C, The M, Wilhelm S

Proteomics - Analytische Grundlagen und biomedizinische Anwendungen (Vorlesung, 2 SWS)
Küster B [L], Wilhelm S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0227: Research Internship Chemical Biology | Research Internship Chemical Biology

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Laboratory assignment which include two presentations and a written report.
The acquisition of practical skills will be me monitored by informal continuous discussion and labbook inspection. The acquisition of data analysis, data contextualization and data presentation competence will be assessed through two oral presentations (with slides) during the weekly group seminar of the Chair (one at the beginning (10 min) to introduce the project and one in the end (20 min), following the writing up of the report) as well as the writing-up of a project report. In these presentations, students demonstrate that they can perform modern chemical biology experiments and extract their significance.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor in Biological or Chemical Sciences.

Content:
The laboratory assignments are designed to endow the students with chemical biology know-how while answering particular research questions relevant to the larger research topics investigated in the laboratory. They are tailored according to the interest and background of the students but have all in common to investigate novel small molecule tools using quantitative mass spectrometry as a readout. All projects feature affinity enrichment ("pulldowns") and mass-spectrometry data processing and analysis. Either chemical synthesis or cell culture constitute the second skillset of the projects. Possible projects can therefore be e.g.: Preparation and evaluation of novel affinity probes, Target deconvolution of cell active molecules, Proteome-wide screening.

Intended Learning Outcomes:
After the completion of the module, the students have acquired the basic experimental skills of chemical proteomics. They understand the scope and limitation of affinity-based proteome profiling. They are able to analyze and be critical of the mass-spectrometry readout that follows their pulldown experiments. Additionally they have either acquired cell culture know-how or they have been able to synthesize new chemical matter. Their report and oral presentations constitute a valuable training for their future masters thesis writing-up and defense.

Teaching and Learning Methods:
Learning by doing is the key learning method of this laboratory assignment. Experimental and data analysis methods required for the assignment are explicated and demonstrated to each student individually. Written protocols for hands-on experiments are given to the students, which first perform them under close supervision by a mentor then in autonomy. Proactive suggestions of protocols variations are encouraged, which are discussed one-to-one. Timely discussions of results allow the assignment to move forward.
Presentations of the results are learned through oral presentations, helped by powerpoint slides, and final report writing. Attendance to the weekly group seminars serves both the acquisition of presentation skills (learn by example) and the contextualization of the laboratory assignment within the field of chemical biology (theoretical learning), where members of the Chair present their own work in progress.

Media:
Hands-on experiments with protocols, powerpoint presentations, previous students reports, specialized literature.

Reading List:
Specialized literature related to the exact laboratory assignment will be provided to the students prior to the beginning of the assignment.

Responsible for Module:
Medard, Guillaume; Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Chemische Biologie (Praktikum, 10 SWS)
Medard G [L], Medard G
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2622: Simulation of Biological Macromolecules | Simulation biologischer Makromoleküle

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 105	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Die theoretischen Inhalte der Vorlesung werden anhand einer schriftlichen Klausur überprüft. Sie bilden die Basis für den praktischen Teil, in welchem die Studenten die erworbenen Kenntnisse auf anwendungsorientierte Fragestellungen am Computer übertragen und somit ihr Verständnis der Lerninhalte vertiefen. Diese praktischen Leistungen werden anhand von Protokollen überprüft. Gewichtung: Klausur 50%, Protokoll 50%.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Modellierung biologischer Makromoleküle (Modellierung und Simulation biologischer Makromoleküle 1)

Content:
Vorlesung: Weiterführende und vertiefende Behandung von Methoden zur Modellierung biologischer Makromoleküle. Dabei stehen die zugrundeliegenden Algorithmen und biophysikalischen Methoden im Vordergrund. Praktikum: Fortgeschrittene Anwendungen von Simulations- und Modellierungs-Software aus den Bereichen: Protein-Ligand-Docking, Molekülsimulation, Proteinengineering. Die Veranstaltung richtet sich an Studierende der Fachrichtung Biologie(Master).

Intended Learning Outcomes:
Vorlesung: Die Studenten sind mit den bioinformatischen und biophysikalischen Methoden, welche im Bereich computergestützte Biochemie verwendet werden, vertraut. Sie kennen die

algorithmischen und anwendungsbezogenen Unterschiede zwischen verschiedenen Methoden und haben gelernt, die passenden Algorithmen für eine gegebene Anwendung auszuwählen. Praktikum: Die Studenten sind mit der Handhabung und dem Anwendungsbereich verschiedener Programme aus den Bereichen Protein-Ligand Docking, Molekülsimulation und Proteinengineering vertraut und können diese eigenständig auch auf komplexere wissenschaftliche Fragestellungen anwenden.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung, Praktikum, Lernaktivitäten: Erlernen von computergestützten und theoretischen Methoden in der Biologie; Eigenständiges Arbeiten am Computer; Erlernen forschungsrelevanter Fertigkeiten.

Media:
Powerpoint Presentation, schriftliche Praktikumsanleitungen

Reading List:
Aufgrund der hohen Publikations- und Forschungstätigkeit auf diesem Gebiet findet eine semesterweise Aktualisierung der Literaturliste statt. Diese wird am Anfang des Semesters an die Studenten verteilt.

Responsible for Module:
Antes, Iris; Prof. Dr.sc.nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2388: Techniques in Cell Biology | Techniken der Zellbiologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (min.): 90 written tests.
Regular, active participation in the courses is expected. For the seminar this is obligatory and must be confirmed by signature. An exam (90 min, graded) serves to verify the theoretical skills learned in the lecture and seminar. The students show in the exam whether they are able to structure the knowledge they have learned and to present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations. The exam grade forms the overall grade of the module. The lecture is supplemented by a seminar, which is organized in small working groups of 3-4 persons. In addition, homework will be assigned to individual points in the lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For successful participation in the module, the basic knowledge of cell biology from the BSc program in Biology is required. In the introductory section "Signal Transduction", essential points for the module are taken up again and deepened.

Content:
In this lecture, cell biological aspects in the context of technical applications are explained using selected examples and methodological approaches to elucidate cellular signal transduction are presented. Examples for lecture topics are signal transduction, methods for elucidation of cellular signaling pathways, cell cultures, receptor tracking, cancer stem cells, in vitro differentiation, cell chips, methods of HTS/HCS, cell-free systems, synthetic cells. The topics are not fixed. Individual lecture topics are deepened in a seminar integrated in the module "Technical Cell Biology" and in the form of homework.

Intended Learning Outcomes:
After attending the module courses, students will be able to select and apply suitable strategies from the spectrum of methods used to study cellular signal transduction. In addition, they should be able to assess the effects of technical manipulations/applications on cellular responses, in particular on signaling pathways, and to consider this aspect accordingly when designing experiments.

Teaching and Learning Methods:
Teaching technique: Lecture; Seminar: Lecture.
Learning activities: study of lecture notes, lecture notes and literature; work in small groups to prepare the seminar lecture. Preparation of homework.

Media:
Presentations via PowerPoint (downloadable lecture material); blackboard work

Reading List:
There is no textbook available that covers all contents of this module. The presentation material is supplemented by specific literature references for the individual topics. As basics are recommended:
Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipurky, Darnell: " Molecular Cell Biology, 4th edition, Spektrum Akademischer Verlag, Heidelberg, Berlin, 2001.
Becker, Kleinsmith, Hardin: The world of the cell, 6th edition, Pearson Education, Inc, San Francisco, 2006.

Responsible for Module:
Karl Kramer (karl.kramer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Zellbiologisches Seminar (Vorlesung, 1 SWS)
Küster B [L], Kramer K

Techniken der Zellbiologie (Vorlesung, 2 SWS)
Küster B [L], Kramer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1024: iGEM Competition (international Genetically Engineered Machine Competition) | Wettbewerb iGEM (international Genetically Engineered Machine Competition)

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:**
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 140	**Contact Hours:** 160

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students will be graded on their ability to work in a group to accomplish a specific project and its presentation. Possible ways of assessment include the ability to perform laboratory work, work in a team, present the results in a scientific manner and contributing to the overall success by other means like organization of finances, events or general planning skills. The assessment will be adjusted to the specific work field of the student but include 1) being able to reproduce the project content, 2) show creativity and participation to lab work and project design and 3) the ability to work effectively with the rest of the team.
The professorship responsible for the academic part is based on the field of work. Students who want the module to be taken into the Transcript of Records have to apply for it at the relevant Audit Committee / Prüfungsausschuss.

Repeat Examination:

(Recommended) Prerequisites:
not necessary

Content:
The international Genetically Engineered Machine (iGEM) competition is an international Competion for students on the field of synthetic biology. It is developed and organized by the iGEM Foundation since year 2003. It is a a worldwide synthetic biology competition that was initially aimed at undergraduate university students, but has since expanded to include divisions for high school students, entrepreneurs, and community laboratories, as well as 'overgraduates'.
The module provides the participants with the basic and advanced knowledge of synthetic biology. The members of the team decide on a project, design it and realize it within a provided timeframe.

The project addresses a current world problem and try to solve it. The focus is set on the quality of the produced scientific work rather than the outcome of the competition.

Intended Learning Outcomes:
After attending the iGEM Module the students are able to design a synthetic biological project (question, hypothesis, design), perform basic laboratory work and analyze the results. The students acquire skills to plan experiments on their own, and to evaluate the state of the art of the field. The know concepts of synthetic biology. They are able to present scientific results to a generally audience.

Teaching and Learning Methods:
In addition to the weekly seminars, the members work independently forthe project. The team studies relevant literature, performs laboratory work, do their research on the topic, collects enough financial aids, works on software and hardware parts of the project and designs a website as well as a final presentation. The members get to know the new topics on a deeper level and methods in order to be able to work independently on projects.

Media:

Reading List:

Responsible for Module:
Studienfakultaet Biowissenschaften WZW

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

CH0437: Cellular Biochemistry 2 | Zelluläre Biochemie 2

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer 90-minütigen, schriftlichen Klausur erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel ein Problem der zellulären Biochemie, beispielsweise die zelluläre Proteinfaltung, erkannt wird und Wege zu einer Lösung gefunden werden können. Die Prüfungsfragen gehen über den gesamten Vorlesungs- und Übungsstoff.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkenntnisse auf Bachelor-Niveau in Biochemie und Zellbiologie.

Content:
Im Rahmen der Vorlesungen werden fortgeschrittene Kenntnisse über molekulare biochemische Prozesse in verschiedenen Organismen vermittelt. Inhalte sind u.a.: Signaltransduktion in Eukaryonten, intrazelluläre Transportprozesse, zelluläre Proteinfaltung, zelluläre Stressantworten, Chromatinorganisation und Spliceprozesse. Der Fokus liegt in allen Themenbereichen auf dem detaillierten Verständnis des mechanistischen Zusammenspiels und der Dynamik von Proteinkomplexen und ihren Interaktionspartnern. Im Rahmen der Übungen wird anhand aktueller Forschungspublikationen erarbeitet wie das vermittelte theoretische Wissen tatsächlich methodisch generiert wurde. Ebenso werden die Art der Dateninterpretation und die daraus abgeleitete Formulierung von weiterführenden wissenschaftlichen Fragestellungen und Experimenten erklärt und in Form von Gruppenarbeiten und Hausaufgaben auch praktisch geübt.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden ein detailliertes theoretische Verständnis und Fachwissen über zelluläre Prozesse in Pro- und Eukaryonten.

Sie können das komplexe molekulare Zusammenspiel verschiedener Proteine, Nukleinsäuren und anderen zellulärer Makromoleküle in diversen, zentralen biochemischen Prozessen nachvollziehen. Darüber hinaus sind sie in der Lage, aktuelle Forschungsergebnisse zu diesen Prozessen zu verstehen, einzuordnen und qualitativ zu interpretieren um daraus weitere wissenschaftliche Fragestellungen abzuleiten und zu planen. Die Studierenden können somit: Aktuelle biochemische und zellbiologische Arbeitstechniken verstehen; Fachliche Fragen auch im größeren Zusammenhang, selbst entwickeln; Zusammenhänge zwischen zellulären Prozesse im Detail verstehen; Das erworbene Wissen auf vertiefte Fragestellungen der Zellbiologie anwenden; Lösungsansätze zur Überprüfung von Hypothesen entwickeln. Weiterhin wird das Interesse an zellulärer Biochemie und deren Bedeutung für das Verständnis von molekularen Mechanismen gefördert. Nach der Teilnahme an dem Modul sind die Studierenden in der Lage, das gewählte Teilgebiet in seiner gesamten Breite zu überblicken. Das Modul bildet damit eine Basis für weitergehende Arbeiten (Forschungspraktika, Master-Thesis), in denen diese Erkenntnisse zur Planung neuer Experimente erlauben.

Teaching and Learning Methods:
Das Modul wird als Vorlesung (2 SWS) mit begleitenden Übungen (2 SWS) inkl. Gruppenarbeiten und Hausaufgaben abgehalten. Neben der Präsenzlehre steht insbesondere die Vertiefung der Inhalte in der Literatur und die inhaltlichen Auseinandersetzung mit den Themen der zellulären Biochemie im Fokus.

Media:
Präsentation, Tafelanschrift, Skript, wiss. Literatur, Diskussion.

Reading List:
Literaturhinweise erfolgen durch den Dozenten.

Responsible for Module:
Feige, Matthias; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Zellbiologie (Vorlesung) (CH0434) (Vorlesung, 2 SWS)
Buchner J (Haslbeck M), Feige M, Sattler M, Schmidt-Supprian M

Zellbiologie, Übung (CH0434) (Übung, 2 SWS)
Buchner J, Feige M, Sattler M, Schmidt-Supprian M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2389: Exercises in Cell Biology | Zellbiologische Übungen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige, aktive Teilnahme an den Übungen ist verpflichtend. Die Studierenden zeigen anhand eines Protokolls, dass Sie in der Lage sind, die wesentlichen Aspekte der Versuche strukturiert und reflektiert darzustellen. Neben dem Protokoll wird auch die Aktivität, Produktivität, Kreativität und Eigenständigkeit in den Übungen bewertet.

Repeat Examination:

(Recommended) Prerequisites:
Die erfolgreiche Teilnahme am Modul "Techniken der Zellbiologie" ist verpflichtende Voraussetzung.

Content:
Die Übung soll praxisorientierte Einblicke zur Lösung zellbiologischer Fragestellungen geben. Ein wesentlicher Aspekt der Lehrveranstaltung besteht darin, dass die Studierenden u.a. ausgehend von vorgegebenen Fragen Experimente in Eigenregie konzipieren, durchführen und bewerten. Die Übung findet in Zweiergruppen statt.

Beispiele für Übungsthemen: Echtzeitbeobachtung der Aktivierung von Oberflächenrezeptoren, Organotypischer Assay zur Charakterisierung des Invasionspotentials von Tumorzellen, Protein knock-down durch siRNA, Apoptose-Assay zum Vergleich der Resistenz von Tumorzelllinien gegenüber Therapeutika, Bewertung immuntoxischer Effekte im Phagozytose-Assay, Yeast-Screen zum Nachweis endokriner Disruptoren etc.

Generell ist der Inhalt nicht fixiert.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, überwiegend selbständig experimentelle Antworten auf zellbiologische Fragestellungen zu entwickeln. Aufbauend auf Vorkenntnissen verstehen die Studierenden wie Experimente konzipiert und die Ergebnisse vor dem experimentellen Hintergrund zu werten sind. Neben methodischen Fähigkeiten, primär in Zellkulturtechnologie und zellbiologischen Methoden, wird selbständiges agieren und eigenverantwortliche Entscheidung gefördert. Zudem gewinnen Sie einen Eindruck für die Komplexität auch einfach erscheinender Versuchsprotokolle.

Teaching and Learning Methods:
Lehrtechnik: Übung und Praktikum; Lernaktivitäten: Bearbeiten von zellbiologischen Fragestellungen und deren Lösungsfindung; Üben von labortechnischen Fertigkeiten; Zusammenarbeit in Zweiergruppen; Konstruktives diskutieren und kritisieren eigener Experimente; Lehrmethode: Fragend-entwickelnde Methode

Media:
Übungsblätter, Tafelarbeit, Power Point

Reading List:
aktuelle Literatur zu den spezifischen Themen; überwiegend von Studierenden zu recherchieren

Responsible for Module:
Karl Kramer (karl.kramer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Zellbiologische Übungen (Übung, 5 SWS)
Küster B [L], Kramer K
For further information in this module, please click campus.tum.de or here.

Specializing in Genetics | Studienschwerpunkt Genetik

Module Description

WZ0002: Applied Experimental Evolution and Bioinformatics | Applied Experimental Evolution and Bioinformatics

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:*	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students have to hand in a written report which describes the whole process from the experimental set up to results and analyses from the NGS data. The report is organized as a scientific paper. The students have to show their ability to: 1) design the experiment, 2) conduct the experimental work, 3) perform the statistical and bioinformatic analysis, 4) present the results in graphs or tables, 5) discuss critically their results.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in statistics and genetics, additional basic knowledge in bioinformatics (linux)

Content:
In the summer semester we will use Zymoseptoria tritici, a wheat pathogen, as a model organism for the course. In the winter semester, another fungal species will be chosen. 1) Introduction to fungcide resistance in agriculture, 2) Introduction to experimental evolution design, 3) Lab experiment: microbiology techniques for fungal growth (on petri plates and/or liqued culture) and fungicide treatment), 4) Preparation of NGS library sequencing, 5) presentation of published articles on fungicide resistance and resistance management, 6) NGS data analysis of full fungal genomes (quality analysis, trimming, read mapping, SNP calling and genome annotation of SNP effects), 7) data analysis and analysis of strain composition, statistics and report writing.

Intended Learning Outcomes:
Students will understand the principle of fungicide resistance and why it is an issue in modern agrculture. The aims of the courses are that students can design the statistics of their lab experiment, implement it using microbiology techniques, and implement the necessary analysis of NGS data. In detail. 1) Students can design the statistics of the lab experiment for example using programming in R. 2) The students know how to find and to access suitable NGS raw reads and reference genomes data from internet database. 3) The students will know what file system is used for genomics such as bam and VCF formats. 4) The students will acquire necessary informatics skills to use Linux and a computer cluster, and 5) necessary bioinformatics skills to handle genome data and perform SNP analysis (quality check, trimming, read mapping and SNP calling. 6) The students learn how to handle and grow different pathogens on different growth plateforms i.e. on petri plates and liqued culture and have aquired necessary molecular biology techniques and can themselves perform: fungal DNA and RNA extraction, cDNA synthesis and prepare samples for NGS sequencing. The students achieve a profound understanding of the evolutionary mechanisms driving the changes in fungi resistance to fungicide in the field. For example, they will describe how the genomes of fungal pathogens are organized and how resistance to fungicide evolves, using their own produced datasets sequenced by NGS. This knowledge can be used to advise on fungicide use in the field using modern sequencing techniques. Finally, the students will learn how to integrate NGS techniques into field diagnostic and/or experimental evolution, and will be able to design their own new studies for different crop diseases.

Teaching and Learning Methods:
Lectures with theory of experimental design, experimental work in the microbiology/DNA lab, exercise of bioinformatics and statistics on computer, powerpoint presentation of case studies (on several crop diseases and theory of fungicide treatment) and discussions.

Media:
Powerpoint, lab experiment, use of database, computer programs, published articles.

Reading List:
Milgroom, Population Biology of Plant Pathogens: Genetics, Ecology and Evolution. American Phytopathological Society Press (2015)

Responsible for Module:
Tellier, Aurélien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Übung
Applied Experimental Evolution and Bioinformatics
4
Aurelien Tellier

Aurelien Tellier
tellier@wzw.tum.de

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0630: Analysis of Epigenomic Data | Analysis of Epigenomic Data

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will be evaluated by a report which is supplemented by a short presentation:
1. Written summary report (students will prepare a 10 page, double-spaced) summary report. The report will test their ability to summarize the datasets, analysis steps, and discuss the results of the analysis in the context of a specific biological hypothesis.
2. Presentation students will prepare a 15 min. presentation based on their written report. The presentation displays their ability to present their findings in a concise way to a peer group. They discuss their approach and results in the context of the research field and defend their work in a scientific debate.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of computer systems and epigenetics.

Content:
Epigenetic modifications, such as DNA methylation or histone modifications, have a central role in the regulation of gene expression, particular in response to environmental and developmental cues. Next Generation Sequencing (NGS) technologies now allow us to measure the genome-wide patterns of various epigenetic modifications at unprecedented resolution. These technologies have opened up novel research avenues in basic and applied plant biology, including studies of development, stress response and natural variation. In this module students will be familiarized with the following NGS analysis steps:
- Introduction to Linux and R.
- Downloading NGS datasets from GEO public repository.
- Importing and manipulating NGS datasets.

- Alignment, trimming and quality filtering of ChIP-seq and WGBS sequencing reads.
- WGBS: Methylation state calling and detection of differentially methylated regions (DMRs).
- ChIP-seq: peak calling and differential enrichment analysis.
- Integration of WGBS and ChIP-seq with gene expression data.

Intended Learning Outcomes:
Upon successful completion of this module students are able to:
- Use Linux and the R computing environment.
- Distinguish epigenomic sequencing technologies such as chromatin immunoprecipitation followed by sequencing (ChIP-seq) and whole genome bisulphite sequencing (WGBS).
- Understand the structure of sequencing files.
- Manipulate and preprocess sequencing files.
- Apply software tools for analyzing ChIP-seq and WGBS data.
- Interpret the output from the data analysis.
- Query the results to answer specific biological questions.

Teaching and Learning Methods:
In the framework of this practical course students will work under close supervision on current research topics in plant epigenetics and epigenomics.

Teaching techniques:
- Computer practical.
- Individualized instructions.
- Critical discussion of analysis results with experienced supervisors and members of the research group.

Learning tasks:
- Literature studies.
- Hands-on computer-oriented tasks
- Preparation of research summaries in the form of a presentations and a written report.

Media:
Tutorials

Reading List:
Tutorials

Responsible for Module:
Frank Johannes f.johannes@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Analysis of Epigenomic Data (Forschungspraktikum, 10 SWS)

Johannes F [L], Johannes F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1582: Applications of Evolutionary Theory in Agriculture | Applications of Evolutionary Theory in Agriculture

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.
There will be an oral exam consisting with questions (30 min.). No help is allowed. The students will need to show an understanding of the concepts of Evolutionary genetics. Short calculations are possible. This exam = 2/3 of the final mark. A 20min presentation of research papers on one of the four topics will be avaluated during the seminar part of the course. This presentation counts for 1/3 of the final mark.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in statistics and genetics, additional basic knowledge of phytopathology

Content:
1) Plant pathology and epidemiology: plant disease epidemiology principles, models of disease spread, consequence for agriculture, disease management and plant breeding.
2) Host-parasite coevolution: application of population genetics to plant-pathogen interactions, and animal-parasite coevolution, importance of gene-for-gene interactions, genomic studies of coevolution in cultivated species.
3) Evolution of pesticide/fungicide resistance: adaptive fitness landscapes, Fishers geometric model, consequences for fungicide use in the field.
4) Evolution of aggressiveness of pathogens in the field: theory of aggressiveness evolution, consequence for pathogen evolution and crop yield, Muller's Ratchet

Intended Learning Outcomes:
A profound understanding of the evolutionary mechanisms acting in agriculture based on the underlying theory, basic understanding of theory for disease management and epidemiology

Teaching and Learning Methods:
interactive lecture

Media:
Powerpoint presentations, software training, lecture, exercises, literature study, mutual questions and answers

Reading List:
Madden, Hughes, and van den Bosch 2007: The Study of Plant Disease Epidemics; Hartl and Clark 2007: Principles of Population Genetics 4th Edition; Hedrick 2009: Genetics Of Populations 4th Edition; Otto and Day 2007: A Biologist's Guide to Mathematical Modeling in Ecology and Evolution

Responsible for Module:
Aurélien Tellier (aurelien.tellier@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2445: Reports from the Current Research (Developmental and Neurogenetics) | Aktuelle Forschung aus der Entwicklungsgenetik der Tiere/Neurogenetik

Version of module description: Gültig ab winterterm 2014/15

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 70	**Contact Hours:** 20

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Examination time (in min.): 30 min + 15 min short presentation.
Active participation and presence in 20 hours of reports from current research in neurogenetics. An oral examination (graded) serves to verify the acquired theoretical skills. In this examination, students show whether they are able to independently work on scientific content, structure the acquired knowledge and present the essential aspects. A short lecture on a selected topic (graded) at the end of the compulsory attendance is also expected. 70% of the total grade of the module is awarded for the oral examination, 30% for the short lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretical knowledge in genetics is required.

Content:
In this module, current topics in neurogenetics and their theoretical background are taught. These topics include the creation of animal models, behavioral biology analyses of complex neuropsychiatric diseases, the latest methods in mouse genetics, stem cell biology and systems biology approaches. Together with the student, one of these areas and the associated topic complexes (3-4) will be determined, which are also the subject of the oral examination.

Intended Learning Outcomes:
After participating in the module course, students will have the basic theoretical understanding and expertise in the creation and analysis of mouse models for neuropsychiatric diseases. The aim

is to select a specific topic/question from the multitude of topics and to deepen this theoretically in self-study and together with the supervisor. This should encourage independent work and the ability to pursue a topic. Working with relevant literature databases is learned here. Furthermore, students should learn to give a short scientific lecture.

Teaching and Learning Methods:
Internship Teaching method: during the internship instructional talks, demonstrations, experiments, team work, discussion of results.
Learning activities: internship script and literature; practicing laboratory skills and genetic work techniques; cooperation with internship partners; preparation of protocols.

Media:
laboratory work

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Larry R. Squire
Fundamental Neuroscience
Ed. by Larry R. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Daniela Vogt Weisenhorn (daniela.vogt@helmholtz-muenchen.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2659: Speciation From Population Genetics to Phylogenetics | Artbildung von Populationsgenetik zu Phylogenetik

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
There will be an oral exam consisting of questions and practical part (30 min.). No help is allowed. The students will need to show an understanding of the concepts of Population Genetics and Phylogenetics. This exam = 2/3 of the final mark. A 20min presentation of research papers on the topics of the course will be evaluated during the seminar part. This presentation counts for 1/3 of the final mark.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in Statistics and Genetics

Content:
1) Population genetics of recent speciation: speciation models, DM incompatibilities, data analysis of sister species; 2) Phylogenetics: BEST, Maximum Parsimony, Maximum Likelihood, Bayesian Methods (with/without relaxed clock) - BEAST; 3) ABC methods to analyse recent speciation; 4) Network analysis; 5) Analysis of selection over phylogenetic time scales (PAML)

Intended Learning Outcomes:
A profound understanding of the evolutionary mechanisms and the underlying theory, basic understanding of softwares for evolutionary genomics analysis

Teaching and Learning Methods:
lecture, exercises, seminars, literature study, mutual questions and answers

Media:
Powerpoint presentations, software training

Reading List:
Hartl and Clark, Principles of Population Genetics 4th Edition (2007); Hedrick, Genetics Of Populations 4th Edition (2009); Coyne, J.A. & Orr, H.A. Speciation, Sinauer Associates; Futuyma, D. 2007. Evolution: Das Original mit Übersetzungshilfen. Spektrum Akademischer Verlag.

Responsible for Module:
Aurelien Tellier (tellier@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Artbildung: von Populationsgenetik zu Phylogenetik (Vorlesung mit integrierten Übungen, 4 SWS)
Schäfer H [L], Schäfer H, Silva Arias G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2662: Modern Topics in Evolutionary Biology | Modern Topics in Evolutionary Biology

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
20min presentations with subsequent discussion of research papers on the topics of the course will be evaluated during the seminar part.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in Evolution and Genetics

Content:
1) Origin of life and early evolution; 2) Epigenetics and Evolution: return of Lamarckism? ; 3) Evolution of cooperation and society: game theory, kin selection and inclusive fitness ; 4) Ecology and evolution: levels of selection, metagenomics and holobionts ; 5) Experimental evolution in real time in the lab; 6) Origin of evolutionary innovations.

Intended Learning Outcomes:
A profound understanding of the evolutionary mechanisms and experimental tests, Development of critical analysis of articles and topics in evolutionary biology

Teaching and Learning Methods:
lecture, seminars, literature study, mutual questions and answers

Media:
Powerpoint presentations

Reading List:
Mark Ridley, Evolution, Oxford University Press 2011; Pigliucci M. and G.B. Mueller, Evolution: The extended Synthesis, MIT Press, 2010; Maynard-Smith J. and Szathmary E., The Major transitions in Evolution, Oxford University Press 1995.

Responsible for Module:
Aurelien Tellier (tellier@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Modern topics in Evolutionary Biology (Vorlesung, 2 SWS)
Tellier A [L], Tellier A

Modern topics in Evolutionary Biology (Seminar, 2 SWS)
Tellier A [L], Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

ME2759: Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 128	**Contact Hours:** 22

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Der Modul ist aufgebaut aus Vorlesungen (insgesamt 1 SWS: Einleitung somatischer Stammzellen, embryologische Entwicklung des Blutsystems, verschiedene Aspekte der adulten Stammzellen, Stammzellnische, klinische Anwendungen von blutbildenden Stammzellen). Auch werden in Seminare der Kursteilnehmer aktuelle Forschnugsbeispiele aus der Literatur vorgestellt und diskutiert (0,5 SWS).
Die Prüfungsleistung stellt sich zusammen aus: Seminarvortrag (etwa 30 min + Diskussion, 40%) und die Verfassung einer Hausarbeit (60%) zur Kontrolle des Verständnisses sowie der Fähigkeit zur Beschreibung, Interprätation und Bewertung. Das Modul ist bestanden, wenn das gemittelte Ergebnis besser als 4,1 ist.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zum besseren Verständnis dises Theorieteils sind gute Kenntnisse in Zellbiologie und Biochemie erforderlich.

Content:
Im Rahmen dieses theoretischen Moduls werden spezielle Kenntnise über somatische, und insbesondere blutbildender Stamm- und Vorläuferzellen und Stromazellen vermittelt.

Es werden 5 Vorlesungen stattfinden, und anschliessend 5, von den Studenten vorbereiteten Seminare in dem aktuelle Forschungsbeispiele präsentiert und besprochen werden sollten.

Vorlesungen
1. Einleitung in der Stammzellbiologie, somatische Stammzellen

2. Embryologische Entwicklung des Blutsystems und blutbildenden Stammzellen
3. normale Physiologie der blutbildenden Stammzellen und die Stammzellnische
4. Abnorme Physiologie der Stammzellen bei Alterung chronische Erkrankungen und Malignitäten
5. klinische Relevanz von blutbildenden Stammzellen

In den Seminaren sollen von den Teilnehmern aktuelle Forschungsergebnisse der Literatur vorbereitet, präsentiert und diskutiert werden. Dabei werden Themen wie:
1 - Stammzellidentität und Isolation
2 - Stammzellverhalten (Regeneration, Apoptose, Überleben, Proliferation, Differenzierung)
3 - Stammzellnische (Identität, Isolation, Relevanz für das Verhalten der Stammzelle)
4 - Maligne Entartungen des Blutsystems und leukämische Stammzellen
ausführlich zur Sprache kommen

Ergänzt werden die Vorlesungen und Seminare durch eine Hausarbeit (in englischer Sprache) in dem die Teilnehmer ihr Verständnisse der erworbenen Kenntnisse beschreiben, Interpretieren und bewerten.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das theoretische Verständnis und spezielle Fachwissen über blutbildenden Stammzellen. Weiterhin haben sie wesentliche Konzepte somatischer Stammzellen integriert, evaluiert und in einer Hausarbeit beschrieben. Sie haben gelernt:

• die Herkunft der somatischen Stammzellen und deren Entwicklung in Embryonen zu verstehen
• grundlegende funktionelle Verhaltensweisen blutbildender Stammzellen zu verstehen
• (Stamm)zellbiologische Fragestellungen und Arbeitstechniken aus aktuelle Forschungsliteratur zu verstehen, kritisch zu evaluieren und fachliche Fragen selbst zu entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesungen, Seminare, Hausarbeit.
Lehrmethode: Vorlesungen, Literaturrecherchen, Diskussionen, Präsentationen, Partnerarbeit (bei höheren Studentenzahlen), Ergebnisbesprechungen.
Lernaktivitäten: Studium von Literatur; Präsentation eines aktuellen Forschungsmunuscript; Anfertigung einer Hausarbeit

Media:
Original Fachliteratur, Präsentationen mittels Powerpoint, Photoshop

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Oostendorp, Robert; Apl. Prof.

Courses (Type of course, Weekly hours per semester), Instructor:
Blutbildende Stammzellen als Modell für somatische Stammzellen (Vorlesung, 1 SWS)
Oostendorp R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0404: Animal Biotechnology 2 | Biotechnologie der Tiere 2

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time: 90min. written + 20 min oral.
The module consists of lecture and seminar. Regular, active participation in the lectures is expected. A written exam (90 min, graded) serves to test the theoretical skills learned in the lectures. The students show in the written exam whether they are able to structure the knowledge they have learned and present the essential aspects. They should be able to describe, interpret, combine meaningfully and transfer the acquired information to similar situations. In the seminar, papers based on specialist literature on current topics from basic and applied research are prepared, presented and discussed (graded). The latter serves to check whether the scientific methods and facts learned in the lecture have been understood and can be transferred to new questions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is suitable for BSc students in 6 semesters or for Master students. Basic knowledge in molecular biological methods would be helpful.

Content:
The lecture will teach different approaches in regenerative medicine, including xeno-transplantation, allo- and autologous transplantation, and stem cell therapy with adult and pluripotent stem cells. Knowledge in the differentiation, de- and transdifferentiation of cells is acquired. The advantages and disadvantages of different therapeutic strategies are discussed and current examples of medical applications are given. Where relevant, ethical and social aspects are addressed. In the seminar the acquired knowledge is deepened and extended.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise about the possible use of transgenic animals in xenotransplantation as well as basic knowledge about human stem cell therapy and possibilities of tissue engineering. for applications in basic research, biomedicine or agriculture.
You should have learned,
"to what extent xenotransplantation is a realistic option for cell, tissue or organ transplantation and which genetic modification is necessary for this in the animal.
"how pluripotent stem cells can be specifically differentiated and which cells can be used for autologous or allogeneic transplantation and what limitations exist.
"They should be able to identify the best possible techniques for certain questions and possibly implement them experimentally.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture, seminar Teaching method: Lecture; at the seminar review of literature, instructions for presentation
Learning activities: study of lecture notes, lecture notes, and independent work on topics from the literature and presentation.

Media:
Presentations via Powerpoint, script (download possibility for lecture material)

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung wird empfohlen: NIH Report Regenerative Medicine (http://stemcells.nih.gov/info/2006report/), Stem Cells: Scientific Progress and Future Research Directions (http://stemcells.nih.gov/info/2001report/2001report.htm)

Responsible for Module:
Angelika Schnieke (schnieke@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biotechnologie der Tiere 2 Vorlesung (Vorlesung, 2 SWS)
Schnieke A, Flisikowska T, Fischer K

Biotechnologie der Tiere 2 Seminar (Seminar, 2 SWS)
Schnieke A, Flisikowski K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2664: Animal Biotechnology 1 | Biotechnologie der Tiere 1

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time: 90 min written + 20 min oral.
The module consists of a lecture and an internship, whereby the internship includes a term paper. Regular, active participation in the lectures is expected. A written exam (90 min, graded) serves to test the theoretical skills learned in the lectures. The students demonstrate in the exam whether they are able to structure the knowledge they have learned and to present the essential aspects. They should be able to describe, interpret, combine and transfer the acquired information to similar situations. In order to check their understanding as well as their ability to describe, evaluate and interpret the experiments carried out during the practical training, a protocol must be kept and homework must be completed. The oral presentation of the internship and the homework will be graded together. This oral examination serves to check whether the learned working techniques and their areas of application have been understood and can be applied to new questions. The final grade result of the written exam and that of the oral presentation of the minutes and the homework will be counted 3:2.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is suitable for BSc students in 5-6 semesters or for Master students. Basic knowledge in molecular biological methods would be helpful.

Content:
On the one hand, the lecture teaches the different methods of producing genetically modified mammalian cells and mammals. This includes microinjection, the use of viral vectors, transposons, RNAi, Zinc Finger nucleases, nuclear transfer, precise genetic manipulation by homologous recombination and the derivation of pluripotent stem cells in different animal species and in

humans. For each method the advantages and disadvantages are discussed and examples of application are presented (for example: generation of pharmaceutical proteins, generation of animal models for human diseases). Where relevant, ethical and social aspects are addressed. In the two-part practical course important aspects of reproduction and embryo manipulation are taught as well as basic knowledge in the construction of recombinant DNA vectors.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise in genetic engineering methods and techniques for the production of transgenic animals for applications in basic research, biomedicine or agriculture.
They should have learned,
"to understand genetic engineering questions and working techniques and to develop technical questions themselves.
"to apply the acquired knowledge to more in-depth questions.
"They should be able to identify the best possible techniques for specific problems and to implement them experimentally.

Teaching and Learning Methods:
Event type/teaching technique: Lecture, practical course Teaching method: Presentation; in practical course, instructional talks, demonstrations, experiments, partner work, discussion of results.
Learning activities: Study of lecture notes, lecture notes, practical course script and literature; practice of laboratory skills in reproductive biotechnology and embryo manipulation and vector design; cooperation with partners; preparation of protocols, homework and presentation.

Media:
Presentations via Powerpoint, script (download possibility for lecture material)

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Transgenic Animal Technology: A Laboratory Handbook
by Carl A. Pinkert;
Gene Targeting: A Practical Approach by Alexandra L. Joyner;
Animal Biotechnology by Hermann Geldermann

Responsible for Module:
Angelika Schnieke (schnieke@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biotechnologie der Tiere 1 Vorlesung (Vorlesung, 2 SWS)
Schnieke A, Bauer B, Flisikowska T

Biotechnologie der Tiere 1 Praktikum (Praktikum, 2 SWS)
Schnieke A, Flisikowska T, Flisikowski K, Bauer B, Schusser B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1696: Crop Genomics | Crop Genomics

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (90 min, Klausur) students explain without additional helping material the principles of genetic and bioinformatics strategies of genome analysis in crop plants. They demonstrate that they understand the different layers of genome analysis in crop plants, and that they are able to apply the required genomic and bioinformatics approaches in case studies and judge which methods can be applied in specific cases. They can explain the use of genomic data to analyze genotype-phenotype associations. The grade of the exam will be the final grade of the module.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of Bachelor’s courses in genetics, molecular biology, plant breeding and statistics is required. Basic knowledge in bioinformatics and skills in R programming or a computer language like Python is highly recommended.

Content:
- Genome organization in crop plants (theory)
- Next generation sequencing and genotyping technologies (theory)
- Genome sequencing and annotation (theory)
- Accessing biological sequence information from databases (theory, exercises)
- DNA sequence comparison and alignment, homology searches (theory, exercises)
- Analysis of genomic sequence data, detection of sequence variants (theory, exercises)
- Analysis of gene expression through genome-wide approaches (theory, exercises)
- Comparative genome analysis (theory)
- Genotype-phenotype association for complex agronomic traits (theory, exercises)
- Application of genomic methods in applied plant breeding programs (theory)

Intended Learning Outcomes:
Upon completion of the module students are able to evaluate molecular methods and the bioinformatic and genetic concepts of genome analysis in crops. They understand the genome organization of crop plants and can explain the concepts of next generation genome sequencing, genome annotation and functional analysis of crop plants. They will be able to access biological sequence information from databases and understand the concept of DNA sequence comparison and alignment. Students will be able to analyze plant genomics data and to use bioinformatic/ statistical approaches for the analysis of genotype-phenotype associations. Successful students can judge which approaches are appropriate for specific situations.

Teaching and Learning Methods:
Theoretical concepts are demonstrated in PowerPoint presentations. Practical application of these concepts will be through computer exercises and tutorials using experimental data sets.
In individual or group work on specific topics with presentations students show their ability to understand and solve problems using current literature and to analyze and evaluate the required methods.
Students are encouraged to attend the weekly talks of the SFB924 seminar series (dates and topics announced under http://sfb924.wzw.tum.de), which are given by national and international experts in plant molecular biology and plant genomics.

Media:
PowerPoint presentations, whiteboard. Lecture slides will be provided online in pdf format.
Computer exercises, application training (analysis of sequence data, genotype-phenotype associations)
Current literature

Reading List:
Brown: Genomes 4. Garland Science, 2017. ISBN 978-0-815-345084
Grotewold, Chappell and Kellogg: Plant Genes, Genomes and Genetics. Wiley-Blackwell, 2015. ISBN: 978-1-119-99887-7

Current literature from specific journals will be announced during the lecture.

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1588: Evolutionary Genetics of Plants and Microorganisms | Evolutionary Genetics of Plants and Microorganisms

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of an oral exam (30 min). The students are given a dataset to analyze for 30 mins of preparation time. The aim of this study is to demonstrate that the students can analyze and interpret genetic diversity data obtained as sequence of few genes or full genomes. The exam questions cover in particular the interpretation of the computed statistics. This includes, for example, analyzing published data using the program DnaSP (on their own computer provided or provided one), explaining the underlying principles of evolutionary genetics and population genetics, as well as the evaluation and interpretation of the results. The students should for example, explain how the effects of evolution influence sequence data polymorphism, and how the mathematical models of this course predict these outcomes

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in genetics and statistics.

Content:
1) Molecular evolution: Hardy-Weinberg equilibrium, neutral … evolution, mutation-drift equilibrium, natural selection, models of speciation, molecular clock, sexual reproduction and recombination. …
2) Population genetics and their application in the genome analysis of plants and microorganisms: coalescence models, application of the coalescent in genome analysis for detection of selection, analysis of population structure, inference of past demographic history. …
3) Population genetics and plant breeding: history of plant breeding, examples of domestication processes, effects of domestication on the genome.

Intended Learning Outcomes:
At the end of the module the students can 1) apply general methods for acquiring published data from internet databases. They 2) can independently analyze DNA sequences with the software DnaSP. 3) The students understand the principles of evolutionary genetics and population genetics, for example the effects and change in frequencies of mutations in populations, the role of natural selection and link to phenotyping, and the role and importance of stochastic processes in evolution. They can analyze the effects of these mechanisms in genetic data, and independently apply such analyses on full genomes. 4) The students can apply, evaluate and critically discuss the basics of population genetics theory, especially for its application to plant breeding. In principle, the students can use this knowledge also in the field of animal breeding, evolutionary ecology or human evolution. They are able to critically analyze published results in these areas, possibly further develop novel data analyses using full genomes and apply the concepts and techniques to any species.

Teaching and Learning Methods:
Teaching method: The course includes 2 SWS lectures and 2 SWS exercises. The lectures provide the theoretical and mathematical background to the theory of evolution. During exercises, the software DnaSP is used for sequence data analysis. In the exercises, the students apply the classical statistics computed from population polymorphism and also discuss their interpretation in connection to the theory.
Learning Activity: Study of scientific articles on plant breeding or human evolution and critical analysis of the published results. The exercises develop the process of problem solving and finding interpretation of the data.

Media:
Presentations with PowerPoint, software used: DnaSP, R statistics and coalescent simulators.

Reading List:
Hartl and Clark, Principles of Population Genetics 4th Edition (2007);
Hedrick, Genetics Of Populations 4th Edition (2009); Wakeley, Coalescent Theory: An Introduction (2008)

Responsible for Module:
Tellier, Aurélien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2620: Applications of Evolutionary Theory in Agriculture: Population Genomics of Crop Pathogens and Disease Management | Applications of Evolutionary Theory in Agriculture: Population Genomics of Crop Pathogens and Disease Management

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam is a research paper in the form of a written essay to be handed to the lecturer at a given date. The Essay consists of up to 7 pages (without references). The students have to answer in their essay one key question related to the evolution of pathogens in response to disease management. Several case studies (articles) will be provided as examples. The students will need to 1) analyze the methods used in the studies and the results, 2) explain the concepts of Evolutionary genetics applied to disease management, 3) describe the theoretical models used in the course which are adapted to answer the question of the essay, 4) evaluate critically the management strategy used in the studies, and 5) propose new better disease management strategies based on the knowledge of the pathogen genomics. Additional references and studies searched by the students can be added to help answer the question.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in statistics and genetics, additional basic knowledge of phytopathology

Content:
This module covers a profound overview of the evolutionary mechanisms driving the changes in crop pathogen populations and their implications for disease management.
It is built in four major blocks (four topics). They are enclosed by seminar and discussion block where students mobilize their theoretical knowledge to interpret data and propose new disease management strategies for major crops (rice, wheat, barley, banana, maize, apple, tomato).

1) Introduction to evolutionary genomics: we describe the neutral theory of molecular evolution (including genetic drift, random mutation, transposable elements insertion). How is a genome organized? What is the spatial structure of pathogen populations (between fields, regions, and continents). We describe how natural selection acts at the level of major genes and of quantitative traits, and give examples of such genes in crop pathogens. This part is mainly a lecture with small exercise to compute genetic drift using R.
2) Pathogen genomics: range of genome sizes found in pathogens. What is the effect of recombination (sexual reproduction) and accumulation of deleterious mutations by Muller's ratchet. This part is mainly lecture with small exercise on a model of sexual recombination in pathogens.
3) Disease epidemiology: disease epidemiology principles, SIR models, models of disease spread in a field (SEIR), herd immunity concept, evolution of aggressiveness. This block consists of a lecture and long exercise sessions in R where simulations of SIR and SEIR models are performed.
4) Host-parasite coevolution: introduction to models of coevolution, importance of gene-for-gene interactions in plants. We study simple dynamical systems and predict the outcome of coevolution, that is occurrence of arms race or trench warfare dynamics. This part includes a short lecture and exercise sessions with R codes simulating coevolutionary dynamics. Simulations are used to exemplify and understand the possible outcome of coevolution and to understand the implications of deploying major resistance genes in disease management.
Synthesis: what is an optimal disease management taking pathogen evolution into account? This part consists of a lecture and a seminar part (paper presentation) where the students have to propose new disease management strategies for some crop pathogens based on case studies and the theory they learned during the course.

Intended Learning Outcomes:
The students have a profound understanding of the evolutionary mechanisms driving evolutionary and genomic changes in crop pathogen populations. For example, they can describe how the genomes of pathogens change in time due to coevolution with their host, the action of humans and certain disease management strategies. Furthermore, the students are able to describe the genome evolution of pathogens and use knowledge from published full genome data analyses of crop pathogens.
The students understand the principles of disease epidemiology. They can build basic mathematical models and implement them in R to perform simulations and analyze their behavior. The students are able to describe and explain the mechanism of coevolution between hosts and their pathogens. To do so they are able to build a mathematical model of coevolution, analyze its long-term dynamics and implement it in R. Finally, the students can integrate aspects of pathogen evolution into disease management, and are able to design their own new management strategies for different crop diseases. They have basic skills in coding with the software R and are therefore able to perform basic statistics for plant pathology.

Teaching and Learning Methods:
The lectures and exercises are intermixed during the sessions. Typically, a first part of lecture introduces the concepts and the mathematical models. Then students will implement the model in R and perform simulations under different parameters. Thereby, they gain a direct understanding of the behavior and outcome of the mathematical model. The exercises are done by the whole group,

and students are encouraged to discuss their results with their colleagues, before a summary is presented by the lecturer. There is also a seminar session, where students by groups of two will present a research paper which is a case study of population genomic data of a crop pathogen. The students perform a PowerPoint presentation of this case study and afterwards will discuss it with the lecturer and the other students. The aim of the presentation is to describe, analyze and interpret population genomic data of crop pathogens, critically evaluate the results and propose new disease management strategies.

Media:
PowerPoint, computer program R, whiteboard, published articles

Reading List:
Madden, Hughes, and van den Bosch, The Study of Plant Disease Epidemics (2007);
Hartl and Clark, Principles of Population Genetics 4th Edition (2007);
Hedrick, Genetics Of Populations 4th Edition (2009);
Otto and Day, A Biologist's Guide to Mathematical Modeling in Ecology and Evolution (2007);
Milgroom, Population Biology of Plant Pathogens: Genetics, Ecology and Evolution. American Phytopathological Society Press (2015)

Responsible for Module:
Tellier, Aurélien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Applications of Evolutionary Theory in Agriculture: pathogen population genomics and disease management (Seminar, ,7 SWS)
Tellier A

Applications of Evolutionary Theory in Agriculture: pathogen population genomics and disease management (Vorlesung, 3,3 SWS)
Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0005: Fluoreszenz Lifetime Imaging - Theorie und Funktion | Fluoreszenz Lifetime Imaging - Theorie und Funktion

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The knowledge is tested in an oral examination (group examination, 45min per three students) and assessed as course achievement.
This form of examination is chosen because it particularly well permits to address the individual peculiarities of the students and of the exercise course and to scrutinize the theoretical knowledge and practical experience of the participants.

Repeat Examination:

(Recommended) Prerequisites:
Fundamentals in Confocal Laser Scanning Microscopy and molecular biology in particular of fluorophores and GFP-protein fusions respectively. The previous participation at the exercise “Confocal Laser Scanning Microscopy - Theory and Function“ is desirable but not a precondition.

Content:
The work with lifetime-measurement devices coupled to CLSMs is increasingly an important field in modern molecular biology. The subject of the exercise course is to communicate the understanding of fluorescence lifetime measurements in theory and the practical skills to use the corresponding techniques.
The exercise course introduces the peculiarities of fluorophore-protein fusions and how these are relevant and impact lifetime measurements. The students learn how the corresponding equipment is designed and combined to built up a unit with the CLSM.
The students learn the theoretical principles of lifetime measurements, of Fluorescence Lifetime Imaging (FLIM), of Förster Resonance Energy Transfer (FRET), of Anisotropy and Fluorescence Correlation Spectroscopy (FCS).

The application of FLIM in cell and molecular biological experiments in order to obtain more detailed insights is communicated. The students learn to select appropriate protein-flourophore-fusion pairs for FRET experiments in order to optimize the energy transfer between to neighboured proteins for instance.
They also acquire the knowledge to operate with a lifetime-measurement kit combined with a CLSM.
Different objects carrying different fluorophore marker protein sets (e. g. GFP-, YFP-, mRFP, mCherry fusions) are offered for analysis. Selected are proteins in the nucleus, the cytoplasm and the plasma membrane.

Intended Learning Outcomes:
The exercise course is a combination of theory and practical skills.
With the successful participation of the module the students acquire the following expertise and skills:
1. The understanding of fundamentals and methods of Fluorescence Lifetime Imaging. Aspects and questions of particular interest are for instance:
- the decay curve of a fluorophore;
- the possible changes of fluorophore-coupled protein lifetimes in different cell compartments and under different physiological conditions and the application of these phenomena in cell biology;
- the technique to assess the interaction of two different proteins in vivo with the aid of Förster Resonance Energy Transfer (FRET),
- the selection of appropriate protein-fluorophore fusions for FRET experiments considering FRET-relevant aspects like mono- and di- or multimerization or the tendency for mono- vs. multiexponential decay;
- the possibility to assess “cluster”-formation or the interaction respectively of different units of the same protein with the aid of anisotropy changes and homoFRET;
- the possibility to analyse the diffusion behaviour of proteins in different cell compartments as for instance the plasma membrane.

2. The students obtain a highly developed and special competence. They acquire the capability to operate an advance system for FLIM/anisotropy measurement of two international, co-operating companies. They also acquire the knowledge how lifetimes of fluorophores can be analysed using pulsed lasers and high-end, up-to-date detectors. The kit for measurement of lifetimes of fluorophore-protein fusions is very recent and from one of the few internationally operating companies in this field, which co-operates with one of the leading factories of Confocal Laser Scanning Microscopes (CLSMs).

3. This makes clear that the students acquire an increasingly requested but little distributed competence. This will enable them to work in a requested and advanced field of molecular biology. Obviously this represents a highly qualifying competence, which is increasingly requested for basic and applied science.

Teaching and Learning Methods:
By dealing with the relevant literature (own hand-outs and scripts or specified internet material, as for instance from the CALM webpage) the students prepare the theoretical basics of lifetime and anisotropy measurements with the aid of the available devices. The theoretical knowledge is complemented by hands-on experience at the CLSMs such that the students can independently operate these microscopes for simple tasks and understand the theory behind. From this stage onwards the students can extend and further develop their skills in order to perform own experiments (in particular in MSc. theses). The communicated methods are also interesting for BSc. and PhD students.

Media:
PowerPoint supported talks and scripts.

Reading List:
Own scripts and further available internet material will be specified.

Responsible for Module:
Ramon Angel Torres-Ruiz Ramon.Torres@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Fluoreszenz Lifetime Imaging - Theorie und Funktion (WZ0005) (Übung, 1 SWS)
Torres Ruiz R, Groß L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0067: Research Internship: Human Cytogenetics | Forschungspraktikum: Humane Zytogenetik

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of this module is performed in the form of a laboratory performance. This is to be proven by the preparation of a protocol (80% of the total grade) and a presentation (20% of the total grade).
The protocol serves to verify the ability to describe, evaluate and interpret the experiments performed in the practical course (length 15-25 pages) and should be prepared according to the IMRAD structure of a scientific publication (introduction, Mat&Meth, results, discussion).
The ability to present and interpret the experiments carried out in the practical course is demonstrated in the form of a presentation (approx. 30 min) and subsequent discussion with the supervising lecturer and specialist audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The attendance of the module “Humangenetics“ is required.

Content:
The practical course comprises 6 weeks of laboratory work. In the practical course, cytogenetic and molecular genetic laboratory methods are taught to prepare the student for independent, practice-oriented work. Among other things, students learn how to prepare cell, lymphocyte and amniotic fluid cell cultures as well as how to cultivate chorionic villi. Furthermore, the students deal with prenatal diagnostics, chromosome analyses (prenatal and postnatal) and the detection of chromosomal aberrations. Furthermore, chromosome staining techniques, fluorescence in situ hybridization (FISH) and microarray analyses will be discussed and performed. In addition, insights

into the topics of Sanger sequencing, multiplex ligation-dependent probe amplification (MLPA), whole genome amplification (WGA) and next generation sequencing (NGS) will be provided.

Intended Learning Outcomes:
Students will be able to produce cell cultures from post- and prenatal material upon completion of the lab. They will be able to describe numerical, structural chromosomal aberrations and translocations (balanced/unbalanced) and identify the associated disease patterns. Furthermore, students will be able to perform cytogenetic and molecular genetic techniques such as polymerase chain reaction (PCR), Sanger sequencing, multiplex ligation-dependent probe amplification (MLPA), array analysis, and exome sequencing. In addition, they will be able to identify and explain the characteristics of different hereditary traits (autosomal recessive, autosomal dominant, X chromosomal, mitochondrial) and create appropriate pedigrees. Furthermore, they are able to compare these with each other afterwards.

Teaching and Learning Methods:
Type of event/teaching technique: Practical course
In the practical course, students are introduced to the experimental procedure through instructional discussions, instructions and demonstrations. Subsequently, experiments are to be carried out independently and the results are to be interpreted and discussed (if necessary, with reference to relevant technical literature) during results discussions/group meetings.
By preparing a protocol, the participants should document, analyze and evaluate the results.

Media:
Depending on the chosen internship site: case-based approach, i.e. the contents are taught on the basis of cases, multimedia-supported teaching and learning programs as well as online procedures, general information (Internet).

Reading List:
Banerjee HN, Verma M. Epigenetic mechanisms in cancer. Biomark Med. 2009
Heng, Henry H.: Genome Chaos : Rethinking Genetics, Evolution, and Molecular Medicine. Stanford: Elsevier Science, 2019.
Alexey Moskalev, Alexander Aliper, Zeljka Smit-McBride, Anton Buzdin & Alex Zhavoronkov 2014

Responsible for Module:
Höfele, Julia Franziska Gertrud; Univ.-Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1817: Research Project Molecular Fungal Genetics | Forschungspraktikum Molekulare Pilzgenetik

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 40	**Contact Hours:** 260

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation in the practical course is expected. The accomplishments in the lab will be graded, including the preparation and execution of the experiments, necessary calculations, the documentation and analysis in form of a lab journal (written report) as well as the interpretation of the results. The students demonstrate with the lab journal that they are able to correctly structure and reflect the critical aspects of their experiments. The accomplishments in the lab will be extended by a final oral presentation of the research rationale & results to the other members of the group at the end of the lab course to test the communicative competences of the students.

Repeat Examination:

(Recommended) Prerequisites:
Good basic knowledge of microbiology and biochemistry, basic skills in molecular biological lab techniques, and participation in the module "Molecular Biology of Biotechnologically Relevant Fungi" are recommended but not mandatory.

Content:
In the lab course, the students will participate in ongoing research projects of the group under supervision of experienced lab members. Foci will be the molecular biology, gene regulation and physiology of filamentous fungi. In particular the handling of model organisms, their molecular, physiological and biochemical characterization and modification will be conveyed. Independent literature research will be taught and performed to deepen the knowledge basis regarding the specific topics of interest.

Intended Learning Outcomes:
This practical lab course is purposefully integrated into the daily research projects of our group and thus allows a unique learning experience of microbiological and molecular biology techniques in a real-life situation. Students will be perfectly prepared for potentially following Master or PhD thesis projects. After successful participation in this module, the students should have:
- achieved experience of real scientific project work
- acquired a broad experimental know-how including the pertinent safety regulations and the respective analytical machine handling
- reached a high level of independence in project planning and execution
- practiced good scientific record keeping and journal writing
- developed their critical interpretation skills

The lab course is supposed to furthermore strengthen the students' interest in fungi, their application in R&D as well as their relevance for society and the environment

Teaching and Learning Methods:
Teaching technique: lab course under invidual supervision; critical discussion and reflection of experimental work with supervisor and lab members. Learning activities: literature research, experimental work, generation of a written lab journal and preparation of an oral presentation to the group.

Media:

Reading List:
current literature of covered topics; mostly to be researched by students themselves

Responsible for Module:
J. Philipp Benz benz@hfm.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Pilzgenetik (Forschungspraktikum, 10 SWS)
Benz J, Karl T, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2417: Research Project Genetics 2 - Developmental Genetics | Forschungspraktikum Genetik 2 Entwicklungsgenetik

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
This is a six-week practical training with six hours regular participation every day (mo. – fri.) - working times and schedule by arrangement. Preparation, realization, interpretation and discussion of experiments. Participation in a colloquium of plant sciences. The grading will be based on the quality of the practical performance (60%) and its record (40%), which has to be written in form of an original scientific report.
In his/her practical performance the student demonstrates that he/she has acquired practical skills and techniques such that he/she is able to appropriately perform experimental work in the field of molecular biology. He/she also demonstrates to be able to operate corresponding devices and to reproducibly record the experiment carried out.
The student demonstrates that he/she is capable to evaluate the data in a meaningful scientific way, to interpret and discuss the obtained results in context of his/her theoretical knowledge and to make corresponding conclusions. He/she have the ability to process the results and summarize them in an intelligible form.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamental knowledge in Genetics, Biochemistry, Chemistry, Plant Sciences, working experience (including safety aspects) in a molecular biology lab.

Content:
Investigating a current scientific project from the field of the course supervisor. Perform work covering molecular and genetic techniques and scientific analysis (statistics where required) and train interpretation of experimental results. The focus lies on the molecular analysis of developmental processes, in particular plant embryo development and cell biology. Techniques

depending on the project treated: molecular cloning, epigenetic modifications, molecular analysis of plant mutants, use of transgenic reporters (e.g. GHFP, YFP, tagged constructs etc.) in vivo, transcriptomics, (q)RT-PCR, in situ hybridization, FISH, histology, chromosome analysis, flow cytometry, antibody staining, fluorescence and confocal laser scanning microscopy including FLIM, FLIM-FRET, FRAP, Anisotropy, protein analysis, cell culture.

Intended Learning Outcomes:
After the successful performance of this module the students are experienced in: independent scientific working, current techniques in molecular biology and data/literature investigation. They learn to include/to link knowledge published in relevant literature with the results obtained in the project investigated in the course.

Teaching and Learning Methods:
Practicum, project work. The students plan and perform their experiments as well as the literature search largely independently. They prepare a scientific evaluation of their experimental results.

Media:
Lab work, literature search, internet search.

Reading List:
There is no text book specifically designed for this training course. The students receive original literature and corresponding methodological literature/material at the beginning of the course.

Responsible for Module:
Torres Ruiz, Ramon; Apl. Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Genetik Forschungspraktikum II Entwicklungsgenetik (Forschungspraktikum, 10 SWS)
Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2468: Research Project Genetics of Eye Development | Forschungspraktikum Genetik der Augenentwicklung

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): ca. 30 min..
Anleitung zum eigenständigen wissenschaftlich theoretischen und praktischen Arbeiten Themen: Mausmutanten mit erblichen Augenerkrankungen: Molekulare Untersuchungen an Mausmutanten mit Augenerkrankungen; angewandte Methoden: PCR, Feinkartierung mit molekularen Markern, Klonierungen, in-situ Hybridisierungen an Embryonen verschiedener Genotypen, immunhistochemische Verfahren, Histologie; funktionelle Analysen (Elektroretinographie, optokinetische Trommel).

Repeat Examination:

(Recommended) Prerequisites:
Grundkenntnisse der allgemeinen und molekularen Genetik; abgeschlossenes Bachelor-Studium eines biowissenschaftlichen Fachs

Content:
Anleitung zum eigenständigen wissenschaftlich theoretischen und praktischen Arbeiten

Themen: Mausmutanten mit erblichen Augenerkrankungen:
Molekulare Untersuchungen an Mausmutanten mit Augenerkrankungen; angewandte Methoden: PCR, Feinkartierung mit molekularen Markern, Klonierungen, in-situ Hybridisierungen an Embryonen verschiedener Genotypen, immunhistochemische Verfahren, Histologie; funktionelle Analysen (Elektroretinographie, optokinetische Trommel).

Intended Learning Outcomes:
Nach der Teilnahme besitzen die Studierenden vertiefte praktische Kenntnisse der Genetik und insbesondere in der Genetik der Augenentwicklung. Sie sollten in der Lage sein, ihr erworbenes Wissen auf andere (entwicklungs)genetische Fragestellungen anzuwenden.

Teaching and Learning Methods:
Zeigen von praktischem Arbeiten im Labor

Media:
Labor: praktisches Arbeiten im Labor, Abschlussvortrag in der Arbeitsgruppe (Powerpoint-Präsentation); schriftliche Darstellung in Form eines Berichts (20-30 Seiten mit Einleitung, Methoden, Ergebnisse, Diskussion, Literaturangaben)

Reading List:
Empfohlene Literatur:
W. Buselmaier, G. Tariverdian: Humangenetik für Biologen, Springer-Verlag, 2006
J. Graw: Genetik, 4. Aufl., Springer-Verlag, 2006
G. Grupe, K. Christiansen, I. Schröder, U. Wittwer-Backofen: Anthropologie, Springer-Verlag 2005
R. Knippers: Molekulare Genetik, 9. Aufl., Thieme-Verlag 2006
E. Passarge: Taschenatlas der Genetik, Thieme-Verlag, 3. Auflage 2008
C. Schaaf, J. Zschocke: Basiswissen Humangenetik; Springer-Verlag 2008
T. Strachan & A.P. Read: Molekulare Humangenetik, 3. Aufl., Elsevier/Spektrum-Verlag 2005

Responsible for Module:
Jochen Graw (graw@helmholtz-muenchen.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2481: Practical Course in Developmental Genetics of Plants 2 | Forschungspraktikum Entwicklungsgenetik der Pflanzen 2

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Successful participation of the module is assessed by a graded presentation (20 min presentation, 10 min discussion). Students are still being supervised but perform experiments in a largely independent fashion. Advanced techniques of plant developmental genetics will be used (for example, qRT-PCR, protein purification, confocal microscopy, etc) and documented. Students work out the scientific background of the experiments and participate in the seminar series of the lab. Results will be presented and discussed in a short seminar. Language will be English.

Repeat Examination:

(Recommended) Prerequisites:
Advanced students of biochemistry, biology, molecular biotechnology and agricultural biosciences.

Content:
Students work in the lab consisting of group leader, PhD students, postdocs and technical personnel. They will address experimentally a given problem in a partly supervised and partly independent fashion. The work and results will be documented and discussed in a written lab protocol. Students regularly participate in the lab's seminar series.

Intended Learning Outcomes:
After attending the lab course students are able to perform advanced experimental techniques in plant developmental genetics and cell biology. Students also gained additional experience in the documentation and presentation of results. Furthermore, students are able to work in an independent fashion.

Teaching and Learning Methods:
Personal supervision of experimental work. Self-study of literature.

Media:
Lab work, discussions with group members, oral presentation, documentation of results.

Reading List:
Orginal research literature and reviews.

Responsible for Module:
Schneitz, Kay Heinrich; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Entwicklungsgenetik der Pflanzen 2 (Forschungspraktikum, 10 SWS)
Schneitz K, Boikine R, Freifrau von Thielmann A, Lesniewska B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2525: Research Project Experimental Genetics of Mammals | Forschungspraktikum experimentelle Genetik der Säugetiere

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
30 attendance days, 10 - 15 min presentation.
The examination consists of the practical work, a written protocol (introduction, material and methods, results, discussion and literature with a total of approx. 30 pages) and a short presentation of the work and results from the internship (approx. 10 to 15 minutes). The internship lasts 6 weeks (30 days of attendance) and is a full day. The focus of the grading is with 2/3 on the achievements during the practical work. 1/3 of the grade is made up of the written protocol and the short oral presentation (in equal parts). The most important competence that this course provides is practical experience and guided participation in a research project in current functional genome research. The students work in the normal research environment. The practical performance is judged by the quality (thoroughness, accuracy, documentation, problem solving etc.) but also by the quantity of experiments performed. In the written protocol (German or English) the students show whether they are able to structure the experiments carried out, results and the context of their work and to present the essential aspects. They should be able to describe, interpret, combine and transfer the information they have acquired to the current scientific context. In the concluding presentation (preferably in English), students should present the research question, approach and results and answer questions in a discussion. This gives students the opportunity to train their skills for scientific presentations.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
"Knowledge of molecular biology and genetics of mammals.
"Basic knowledge of molecular biology: e.g. pipetting, calculation of concentrations and units
"It is advantageous to attend the lecture on genomics and/or developmental genetics of animals
"Recommended after the completed 4th semester

"Good knowledge of English
"The internship takes place at Helmholtz Zentrum München, Ingolstädter Landstr. 1, 85764 Neuherberg

Content:
During the internship, basic knowledge about practical work in a research laboratory, in particular about functional genome research, working with mouse models or cellular systems, will be taught. Contents are among others: Phenotypic analyses of mouse models for diabetes, bone and cartilage diseases or metabolic diseases. The work in the lab is always integrated into a current research project of the Institute of Experimental Genetics. Methods of molecular biology are taught and applied by the students. Examples can be: The investigation of gene expression in animal models using microarray technologies or PCR, investigation of proteomes by mass spectrometry, in situ methods for the detection of RNA or protein expression, histological examinations, analysis of metabolites in tissue or plasma, production of DNA constructs, etc. Students will learn the context of their work in connection with an ongoing research project in functional genome research. The practical work will be instructed, but will be partly carried out independently during the course of the internship.

Intended Learning Outcomes:
After participating in the module courses, students will have initial experience of scientific work in a research laboratory. At least one molecular biological method in the field of functional genome research should be learned in depth in practice and theory. Further skills that are acquired during the practical training:
"Experience in the structured, written elaboration of scientific context, methods and results,
"Experience in oral scientific presentation.

Teaching and Learning Methods:
" Guidance talks
"Support for problem solving in practical work
"Discussion of results
" Internship
"Correction and feedback on protocol and presentation
"Feedback on the quality and quantity of practical work

Media:
" Contents are conveyed in discussions

Reading List:
"Mainly scientific publications (English only)

Responsible for Module:
Martin Hrabé de Angelis hrabe@helmholtz-muenchen.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Experimentelle Genetik der Säugetiere (Forschungspraktikum, 10 SWS)
Hrabé de Angelis M, Beckers J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2564: Research Project Hormone Signaling, Biochemical Pathways and Metabolomics | Forschungspraktikum Hormonsignaling, Biochemische Pathways und Metabolomics

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
30 days of attendance.
The examination includes the practical work, a written protocol (introduction, material and methods, results, discussion and literature) and a short presentation of the work and results from the internship (approx. 10 to 15 minutes). The internship lasts 6 weeks (30 attendance days) and is a full day. The focus of the grading is with 2/3 on the achievements during the practical work. 1/3 of the grade is made up of the written protocol and the short oral presentation (in equal parts).
The most important competence that this course provides is practical experience and participation in a research project on current topics in the fields of steroid hormone signalling, biochemical pathways and metabolomics. The students participate in normal research activities. The practical performance is judged by the quality (thoroughness, accuracy, documentation, problem solving etc.) but also by the quantity of the experiments performed. In the written protocol (German or English) the students show whether they are able to structure the experiments, results and the context of their work and to present the essential aspects. They should be able to describe, interpret and combine the acquired information in a meaningful way and transfer it to the current scientific context. In the concluding presentation (preferably in English), students should present the research question, approach and results and answer questions in a discussion. This gives students the opportunity to train their skills for scientific presentations.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Knowledge of molecular biology, cell biology and biochemistry
"Basic knowledge in laboratory practice: e.g. pipetting, calculation of concentrations and units
"It is advantageous to attend the lecture on genomics and/or developmental genetics of animals

"Good knowledge of English is desirable
"The internship takes place at Helmholtz Zentrum München, Genome Analysis Center, Ingolstädter Landstr. 1, 85764 Neuherberg

Content:
During the internship basic knowledge about practical work in a research laboratory, with emphasis on steroid hormone signalling, biochemical pathways and targeted or non-targeted metabolomics, in cellular systems or in vitro, will be taught. Contents are for example: Identification and characterization of biomarkers for metabolic diseases, characterization and inhibition of steroid hormone-metabolizing enzymes, analysis of lipid metabolism
The work in the lab is always integrated into a current research project of the Institute of Experimental Genetics. Methods of molecular biology, cell biology, protein chemistry or biochemistry are taught and applied by the students. Examples can be: The investigation of gene expression in tissues with PCR, expression analyses with western blotting, histo- and cytochemical expression analyses, development of HPLC and mass spectrometric analysis methods for metabolites, detection and quantification of metabolites in tissues or plasma by mass spectrometry, production of DNA constructs, recombinant expression of proteins, activity studies of enzymes, etc. Students will learn the context of their work in connection with an ongoing research project. The practical work will be instructed, but will be partly carried out independently during the practical training.

Intended Learning Outcomes:
After the participation in the module course, students will have experience in project-related and goal-oriented scientific work in a research laboratory. At least one molecular biological, cell biological, protein chemical or biochemical method in the field of hormone regulation, biochemical pathways or metabolomics should be learned in depth in practice and theory.
Further competences that are acquired during the practical training:
Experience in the structured, written elaboration of scientific context, methods and results
Experience in oral scientific presentation.

Teaching and Learning Methods:
" Anleitungsgespräche
" Unterstützung bei Problemlösung in der praktischen Arbeit
" Ergebnisbesprechung
" Praktikum
" Korrektur und Feedback zu Protokoll und Präsentation
" Feedback zu Qualität und Quantität der praktischen Arbeit

Media:
Inhalte werden in Gesprächen vermittelt, die Studierenden informieren sich über das Arbeitsgebiet und genutzten Techniken zusätzlich mit Hilfe von Fachliteratur oder Internetrecherchen

Reading List:
relevant publications concerning the research topic and the techniques used

Responsible for Module:
Jerzy Adamski adamski@helmholtz-muenchen.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2619: Research Project: in silico Evolutionary Genetics of Plants and Pathogens | Forschungspraktikum: in silico Evolutionsgenetik von Pflanzen und Pathogenen

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Writing a paper-like research report

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of computer system

Content:
Modern research in evolutionary biology demands the integration of sequence data with theoretical tools of simulations. This requires solid computational skills, including knowledge of various biological data resources, and usage of simulation softwares. During the course, students will 1) practice with some common data analysis methods of high throughput technology, such as next generation sequencing and whole genome sequencing, 2) learn how to make use of existing biological databases and 3) perform coalescent simulations to tests evolutionary scenarios.

Intended Learning Outcomes:
Common computational strategies to process and analyze high throughtput data, including Perl, statistical analyses with R, sequence analysis with blast, BWA, Stampy, Dnasp, and coalescent simulations with ms, msms and C++ and java codes.

Teaching and Learning Methods:
Practice sessions for computers

Media:
Case studies

Reading List:
Hartl and Clark, Principles of Population Genetics 4th Edition (2007); Hedrick, Genetics Of Populations 4th Edition (2009); Wakeley, Coalescent Theory: An Introduction (2008)

Responsible for Module:
Aurelien Prof. Tellier (tellier@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum: in silico Evolutionsgenetik von Pflanzen und Pathogenen
(Forschungspraktikum, 10 SWS)
Silva Arias G [L], Silva Arias G, Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2629: Research Project Chemical Genetics | Forschungspraktikum Chemische Genetik

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Following the regular and active participation in a six week practical course (at least 25 hours/ week) the students hand in a research report. By preparing the written report the students demonstrate the ability to summarize the key aims of the performed experiments in the field of plant chemical genetics, to present the acquired results in a concice and coherent manner and to interpret and discuss the experimental data in the context of available literature.
The final grade is an averaged grade from the written report (60%) and the level of of in-course participation (40%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology, biochemistry, genetics and chemistry. Practical experience with basic lab working techniques such as pipetting and working under sterile conditions. Completion and above average grading of the lecture(s) Crop Biotechnology and/or Plant Biotechnology.

Content:
Chemical Genetics is a novel interdisciplinary approach in which small molecules are used to identify proteins responsible for the expression of a specific phenotype (forward chemical genetics) or to affect the function of a specific protein and assess the morphological, physiological and molecular consequences in the organism (reverse chemical genetics). Chemical genetic approaches are not only useful in basic research questions, they can also directly lead to the development of drugs and agrochemicals.
Participation in the course will teach students a subset of the following techniques by participating in a research project in the lab: 1) Storage and handling of a chemical library, (2) design and set

up of a chemical genetic screen, (3) phenotype-based small molecule screen in Arabidopsis or an horticulturally relevant plant species, (4) expression marker-based small molecule screens , (5) hit confirmation and structure/function analysis using cheminformatic methods, (6) establishment of an in vitro assay to test ligand-target interaction.

Intended Learning Outcomes:
Upon completion of this module students are able to actively participate in chemical genetic research projects. They will be qualified to assess for which scientific questions a chemical genetic approach might be helpful. They are capable of independently carrying out basic chemical genetic experiments in plants and can interpret the obtained results.

Teaching and Learning Methods:
Personal supervision in experimental work, critical discussion of results, writing of a concice research report in the common publication format, oral presentation and discussion of data with lab peers.

Media:
Oral presentation, lab protocols, relevant scientific publications.

Reading List:
Plant Chemical Genomics: Methods and Protocols (2014) G. R. Hicks and S. Robert, Humana Press; Plant Chemical Biology (2014) D. Audenaert and P. Overvoorde, John Wiley & Sons.

Responsible for Module:
Tobias Sieberer (tobias.sieberer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Chemische Genetik (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Ramirez V, Sieberer T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2665: Research Procect Neurogenetics for Advanced | Forschungspraktikum Neurogenetik für Fortgeschrittene

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The services entail regular practical work on a small scientific project, a written record (introduction, material and methods, results, discussion and references with a total of 20 pages), and at the end of the practical work a short presentation (about 30 minutes) within the framework of the institute seminars. The length of the internship is 6 weeks full-time.
The final grade is calculated on the basis of the protocol and the oral presentation (2:1). The practical performance is documented in the protocol and is assessed above all on the basis of quality (thoroughness, accuracy, documentation, strategies for solving problems) and efficiency and quantity. The students show by the written record (German or English) whether they are able to present the experiments conducted, the results and the context of their work in a structured way and to represent the fundamental points. They shall be capable to described the results, interpret them, combine them logically and transfer them into the actual scientific context. In the presentation (English is preferred) the students shall be able to represent, how their results fit into the current state of research and to demonstrate their understanding in a discussion. Therefore, the students receive the opportunity to train scientific lectures..

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
The lecture of genomics and/or developmental genetics (compulsory lecture of the Bachelor degree programme) is recommended. Along with the laboratory course it is beneficial to attend the lectures of neurogenetic I and II. Good knowledge of English (laboratory language) is recommended.

Content:
Within the scope of the internship knowledge about practical work in a research lab is imparted - in particular about working in the area of neurogenetic, working with mouse models and their generation, and in the area of working with cellular models systems. Contents are: 1. modern molecular technologies for the generation of mouse models and 2. phenotypic characterisation of these mouse models (especially in the area of neuropsychiatric diseases) and therefrom derived cellular systems. The work is constantly part of a currently running research project of the Institute of Developmental Genetics. Methods applied and to be learned depend on the questioning of the research project. Examples include: cloning and testing of new vectors for the generation of animal models, gene expression analyses by means of qPCR - luciferase assays, application of viral vectors to the acute elimination of gene expression (knock-down); biochemic methods (western blots, activity measurements of proteins); histological examination of mouse models (immunohistochemically, in situ hybridisation, quantitative analyses), metabolic analyses of organs and cell cultures; mitochondrial analyses etc. The practical work is guided, however the objective during the period of internship is to achieve independency and self-responsibiltiy for the own experiment(s) conducted.

Intended Learning Outcomes:
The most important competence which shall be gained within the internship, is the practical expertise in running a small scientific project.
After participation in the modul the students have some preliminary experience in scientific work and presentation of scientific results, both in written and orally form and gain relevant competencies. Moreover, in at least one neurogenetic method they gain deeper practical and theoretical experience. Therefore, the following competencies are gained within the internship: 1. practical work in the research area neurogenetic - learning of methods (molecular, histological), 2. structured written (record) and oral (presentation) processing of the results obtained against the background of a specific scientific questioning.

Teaching and Learning Methods:
Form of event: internship; teaching method: tutorials, demonstrations, experiments, discussion of results, feedback on quantity of practical work; learning activities: study of background literature (exclusively in English), scipt of internship and literature; practicing of laboratory methods, teamwork, preparation of records; preparation of a presentation.

Media:
Presentation by means of Powerpoint, Lecture notes (download option for lecture material), script of internship

Reading List:
No course book is available which covers all aspects of this module. As basis or as a supplement the following is recommended: L. R. Squire: Fundamental Neuroscience, Ed. Larry L. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Wolfgang Wurst (wurst@helmholtz-muenchen.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Neurogenetik für Fortgeschrittene (Forschungspraktikum, 10 SWS)
Wurst W [L], Floss T, Giesert F, Hölter-Koch S, Vogt-Weisenhorn D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2683: Reseach Project Phylogenetics of Plants for Advanced Level | Forschungspraktikum Phylogenetik der Pflanzen für Fortgeschrittene

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 150	**Self-study Hours:** 300	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular presence in the lab is required to gain routine with new lab techniques. Towards the end of the practical, the students perpare a written report showing that they are able to structure their newly assembled data, to present results in a convincing way and use appropriate methods to analyse them. The grade for the module is composed of a grade for the practical lab work (40%), the written report (40%) and the final oral presentation of 20-30 min (20%) - if necessary, the calculated grade will be rounded to the better value.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
basic knowledge in Genetics/Botany/Evolutionary Biology

Content:
Participation in ongoing research projects or work on their own phylogenetic projects. During the practical work in the lab and at the computer, students will learn cutting-edge techniques and methods in modern Phylogenetics, including DNA extraction from all kinds of material (e.g., old herbarium specimens, zoological specimens, feathers, sediments, feces); PCR, sequencing, sequence analyses (editing, BLAST), alignment of sequences using different algorithms, working with GenBank and other databases, phylogeny estimation under Maximum Likelihood and Bayesian approaches, Molecular dating and biogeographic analyses.

Intended Learning Outcomes:
After having concluded this module, the students will have advanced prcatical and theoretical knowledge of modern Molecular Phylogenetics approaches from DNA extraction to Phylogenies. They will be able to design and independently run a small project, including research of scientific

literature. They have learned how to work in a scientific way including critical data analyses and presentation of results at scientific meetings.

Teaching and Learning Methods:
mainly practical work in the Molecular Ecology lab, first with some supervision, then independently following the newly learned approaches; discussion of results and problems; constructive criticism of own work; time management and working with self-set deadlines.

Media:
practical lab work, discussions, powerpoint, literature research

Reading List:
Hall, B.G. 2011. "Phylogenetic Trees Made Easy: A How-to Manual", 4. Aufl. -- papers in scientific journals (e.g. Molecular Phylogenetics and Evolution, PNAS, Curr. Biol., Journal of Biogeography).

Responsible for Module:
Hanno Schäfer hanno.schaefer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Phylogenetik der Pflanzen für Fortgeschrittene (Forschungspraktikum, 10 SWS)
Schäfer H [L], Schäfer H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2696: Research Project Molecular Mechanisms in Human Genetics | Forschungspraktikum Molekulare Mechanismen genetisch bedingter Krankheiten

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The scientific protocol to be prepared (introduction, material and method, results and discussion, length 15-25 pages) serves to verify the ability to describe, evaluate and interpret the experiments on the molecular mechanisms of genetically determined diseases performed during the practical training. In addition, the experiments or data analyses carried out during the practical training and described in the protocol are to be presented in the form of a lecture to the working group of the supervising lecturer, so that the ability to present the scientific work orally and the ability to engage in scientific, critical discussion beyond the written form can be tested. A mark is awarded for the overall performance (quality of the laboratory work, protocol, presentation).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of general and molecular genetics.

Content:
The practical course is accomplished in the specialized group paediatric nourishing medicine at the location Weihenstephan. The tasks for the internship are based on the lecturers' current research focus on gene regulation, metabolic diseases such as type 2 diabetes and pancreatitis. For both diseases a hereditary component is described. However, for most genetic associations in human diseases the molecular mechanisms are largely unknown. New disease-associated gene alterations are identified and their effects on protein function are studied. Many genetic alterations are non-coding and may have an influence on gene regulation. The precise molecular gene regulatory mechanisms - altered by human disease-associated genetic variants and epigenetic modifications - are being studied to understand how these changes in gene expression ultimately

lead to a complex phenotype such as type 2 diabetes or pancreatitis. This internship gives students a first deeper insight into a research area that combines different aspects of human genetics, human biology, cell biology and molecular biology. Students work in the context of the research group with different methods, such as cloning, heterologous expression of genes, protein-DNA interaction analyses like EMSA, reporter gene analyses, proteomics, NGS, qPCR, cell culture, as well as bioinformatic data analyses. The internship can also be used to prepare a thesis.

Intended Learning Outcomes:
By working in a research area that combines aspects of human genetics, human biology, cell biology and molecular biology, students learn to understand current research topics that deal with the analysis of molecular mechanisms of genetically determined diseases, to independently develop solutions to these problems, and to apply selected experimental laboratory or data analysis methods from these fields. The acquired skills and techniques can be transferred to other disciplines.

Teaching and Learning Methods:
Internship. Instructional talks and instructions, demonstrations, experimental work in the laboratory or data analysis, discussion of results, group meetings, technical literature, lecture, preparation of minutes.

Media:
Lecture: Presentation software. Protocol: Word processing file.

Reading List:
Current technical literature is provided by the supervisor of the internship.

Responsible for Module:
Prof. Dr. Heiko Witt

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2762: Research Project Molecular Genetics of Plant-Microbe Symbiosis 2 | Forschungspraktikum Molekulare Genetik der Pflanzen-Mikrobien Symbiose 2

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students conduct an own small research project, which requires a minimum of 40h of laboratory and/or computer work per week. The work-schedule can be adjusted with the curriculum of the students. After the practical work, a report has to be prepared and handed in a few weeks after the laboratory work has been concluded. Furthermore, the students present their work in a 15-minute presentation in English in the frame of the lab progress report seminar. The evaluation of the research course will be based on an evaluation sheet containing several categories and designed to enhance the objectivity of the grading. For transparency, the sheet will be handed to the students prior to the start of the research course. 80% of the grade will be based on the quantity and quality of laboratory work and the quality of the report (writing and figures of publication quality). 20% of the grade will be based on the quality of the oral presentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamental knowledge of molecular biology, genetics and/or plant biology is required. Students should have basic competences in molecular biology lab work such as accurate pipetting and correct preparation of solutions (including all necessary calculations of molarity etc). Proficiency in basic computer software such as Word, Excel and Power Point is a must. Basic knowledge in R, ImageJ and/or Illustrator is an advantage.

Content:
In the research course the students acquire competence and knowledge in one of the following subjects: a) Plant hormone signalling in plant symbiosis, b) transcriptional regulation of plant symbiosis, c) nutrient exchange in plant symbiosis.

Techniques and methods will depend on the individual project and may include: golden gate cloning, plant transformation, quantitative real time PCR, phenotypic analysis of roots and fungal structures by microscopy, fluorescence microscopy and analysis of subcellular compartments with fluorescent fusion proteins, handling of plants and arbuscular mycorrhiza fungi, hormone physiology, transactivation assays, protein expression and purification, protein-protein interaction techniques (yeast-2-hybrid, CoIP), genetic mapping or genotyping, data analysis using R, preparation of figures in publication quality.
Many of these techniques are transferable to other (non-plant) organisms.

Intended Learning Outcomes:
After a successful completion of the course the students have acquired competence in several laboratory techniques related to plant molecular biology and general molecular biology and genetics, writing of a laboratory book and efficient time management by running several experiments in parallel. They have learned how to design experiments with all necessary controls, how to interpret results and how to perform basic statistical data analysis using R. Furthermore, they have increased their competence in scientific writing and have learned how to display scientific data and microscopy images in publication quality.

Teaching and Learning Methods:
Combination of close practical and theoretical supervision and independent work. Reading and understanding of laboratory protocols, writing of laboratory book. Time management in the laboratory. Reading of original research articles.

Media:
The students will use lab protocols to learn and conduct experiments by themselves but under close supervision. Supervised and independent use of lab instruments and software such as DNA analysis software, ImageJ and/or Illustrator.

Reading List:
Original articles and reviews for preparation of the research course will be provided prior to the start of the research course. For prior information about the main research focus of the laboratory we recommend the review: Gutjahr and Parniske, 2013, Ann. Rev. Cell Dev. Biol., which can be downloaded using the following link:
http://www.annualreviews.org/doi/full/10.1146/annurev-cellbio-101512-122413

Responsible for Module:
Gutjahr, Caroline; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project - Molecular genetics of plant-microbe symbiosis 2c (Forschungspraktikum, 10 SWS)
Gutjahr C

Research Project - Molecular genetics of plant-microbe symbiosis 2a (Forschungspraktikum, 10 SWS)
Gutjahr C [L], Torabi S

Research Project - Molecular genetics of plant-microbe symbiosis 2b (Forschungspraktikum, 10 SWS)
Gutjahr C, Torabi S
For further information in this module, please click campus.tum.de or here.

Module Description

ME20002: Human Genetics | Humangenetik

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 117	**Contact Hours:** 33

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The learning outcomes are tested by a written exam (60 min), which may also include multiple-choice elements. Aids are not allowed in the written exam. On the basis of the questions, the students must show that they understand and know the origin and inheritance of variants/ chromosomal anomalies and certain common genetic diseases and that they have grasped the molecular basis of inheritance.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals in genetics, biochemistry, physiology.

Content:
Methods of human genetics, population genetics and genetic epidemiology, chromosomal abnormalities, genetics of
autosomal, sex-linked and mitochondrial diseases, genetics of hematological, metabolic, neurological and psychiatric diseases, prenatal and preimplantation diagnostics.

Intended Learning Outcomes:
After participation, the students possess in-depth
theoretical knowledge of human genetics and its special working methods within genetics. They know the most important methods of human genetics, their advantages and limitations. They have an overview and partly in-depth knowledge of genetic epidemiology and the inheritance processes within biological populations. They know the different hereditary diseases and their inheritance processes such as autosomal recessive or dominant, X-linked or polygenetic diseases. They have overview and sometimes in-depth knowledge of the associated metabolic

disorders or neurological or psychiatric diseases. They are able to interpret results of prenatal or preimplantation diagnostics.
They are able to apply their acquired knowledge in particular to human genetic issues.

Teaching and Learning Methods:
The lecture deals with the basics and special aspects of genetic diseases. In the seminar, individual topics are examined in greater depth, such as the use of scientific databases and the development of clinical cases.

Media:
Lecture: Classic lecture with presentation software, blackboard notes, interactive question rounds. Generally face-to-face teaching, but also digital meetings (e.g. zoom) if necessary.
Seminar: like lecture, media and teaching materials are available online and mentioned.

Reading List:
C. Schaaf, J. Zschocke: Basiswissen Humangenetik; Springer-Verlag, 3. Auflage, 2018.
J. D. Murken, T. Grimm, E. Holinski-Feder, K. Zerres: Taschenlehrbuch Humangenetik, Thieme, 9. Auflage, 2017

Responsible for Module:
Höfele, Julia Franziska Gertrud; Univ.-Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Humangenetik für M.Sc. Biologie (VO) (Vorlesung, 2 SWS)
Höfele J

Humangenetik für M.Sc. Biologie (SE) (Seminar, ,2 SWS)
Höfele J
For further information in this module, please click campus.tum.de or here.

Module Description

WZme2670: Innovative Approaches in Viral Gene Technology | Innovative Ansätze in der viralen Gentechnologie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of
a) Presentation (30 min) (1SWS = 45h), in which students with availability of aids demonstrate that they understand and are able to evaluate the most important aspects of the field. Time required for self-study approx. 2 SWS, since all students need to read all papers and need to prepare their presentation.
b) Term paper. Students must submit a self-explaining presentation, which demonstrates that basic elements of viral gene transfer / technology have been understood. Time required: 3 SWS.

The result of the exam is registered as a graded mark.

Different types of test are necessary, as only the oral presentation will provide evidence for not only the scientific understanding, but also for evaluation of the presentation and discussion skills, whereas the term paper will allow for evaluation of students' basic scientific knowledge and literature search skills. Evaluation will be as follows: seminar presentation:discussion during seminar: term paper 3:1:2. The module will be passes with grade better than 4.09.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Good basic knowledge in molecular genetics is required.
Lecture series "Viral and no-viral nucleic acids transfer - Methods and applications in research and therapy" is strongly suggested.

Content:
Due to their high efficiency viral vectors are on the one hand used in therapeutic approaches, but more often as molecular tools.
Novel approaches in viral gene technology in recent years comprise the advancement of existing, often attenuated, viruses by genetic, physical or chemical means as well as the development of novel vector types based on rarely used viruses. These approaches are persued in order to make them more specific and even more effective in vitro and in vivo.
In the field of tumor therapy oncolytic viruses gained attention, whereas with respect to regenerative approaches and in basic research replication defective viral vectors are used to generate e.g. iPS, regulate gene expression by miRNAs or edit the genome by CRISPR/Cas, etc.
With respect to safety, when using integrating viruses, it is of utmost importance to understand and influence integration mechanisms as well as sites.
As many basic researchers working in the field of molecular biology will encounter viral vectors a good knowledge of basic as well as advanced techniques is indispensable.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to understand isolated aspects of innovative approaches in gene technology with emphasis on viral gene transfer.
Students are able to:
• read publications critically (regarding scientific conclusiveness, missing controls,...),
• present data and scientific background in a concise way (power point presentation),
• get involved into active discussion during general discussion,
• to receive and to deal with critical questions posed to the presenting person.

Teaching and Learning Methods:
Seminar

In the seminar students are choosing a paper, each, from a list of very recent (English) publications in the field of gene technology provided by the instructor. Special attention will be given to viral gene therapy and viral gene delivery.
Students are giving English power point presentations consisting of background information, main data of the paper, the authors' conclusions and their own evaluation and interpretation of data and conclusions.
The presentation will be followed by active scientific discussion with all students guided by the instructor.
Suggestions for improvement of presentation will be given by the instructor and students.
This format allows for the unique chance for students to get insight into innovative technical approaches in the field and on the other to enhance their (English) presentation skills, dare to ask questions and learn how to deal with critical and questions in a rather private atmosphere.

Term paper
In contrast to the seminar, which deals with novel aspects of viral gene technology, the term paper will focus on basics supporting the understanding of techniques that were presented in the seminar.
With this respect an aspect of the paper presented during the seminar will be chosen and will be dealt with in detail (e.g. viral replication cycles, virion structure and organization, etc.). The elaboration will exceed the scientific background of the seminar presentation.
The instructor will choose the topic, to which students will perform literature research.
The elaboration of the topic will in most cases be based on older literature.
Besides the elaboration the term paper will include a reference list and an explanation how the literature search was performed.

Media:
e.g. reader, scripts, overheads, blog, whiteboard, exercise sheets, exercise portfolio, flipchart, PowerPoint, films, etc.

Reading List:
Literaturrecherche in PubMed.

Responsible for Module:
Anton, Martina; PD Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Präsentation und Diskussion innovativer Ansätze in der Gentechnologie Hausarbeit (Seminar, 3 SWS)
Anton M [L], Anton M

Präsentation und Diskussion innovativer Ansätze in der Gentechnologie (Seminar, 2 SWS)
Anton M [L], Anton M, Plank C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0004: Confocal Laser Scanning Microscopy - Theory and Function | Konfokale Laser Scanning Mikroskopie - Theorie und Funktion

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The knowledge is tested in an oral examination (group examination, 45min per three students) and assessed as course achievement.
This form of examination is chosen because it particularly well permits to address the individual peculiarities of the students and of the exercise course and to scrutinize the theoretical knowledge and practical experience of the participants.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals in microscopy and molecular biology in particular of fluorophores and GFP-protein fusions respectively.

Content:
The work with CLSMs is increasingly an important field in modern molecular biology. The subject of the exercise course is to communicate the understanding of fluorescence phenomena, of excitation and emission of fluorescent molecules in theory as well as the operational understanding of the partly complex microscopes, which allow analysing such phenomena.
The students learn the theoretical basics of this microscopy. In practical terms, they learn to choose and adjust the right hardware and the correct parameters using CLSMs. They learn how to select the appropriate protein fusion constructs for experiments in advance, in order to design an analysis with these microscopes successfully.
The knowledge how to operate CLSMs of two different international companies is advantageous for later jobs/work and alleviates the familiarization with systems of other manufactures.

The analysis of different objects with different fluorophore marker proteins (e. g. GFP-, YFP-, mRFP, mCherry fusions) impart experience and proficiency on localisation and distribution of proteins in organelles and cell compartments respectively, including polarized proteins.

Intended Learning Outcomes:
The exercise course is a combination of theory and practical skills.
With the successful participation of the module the students acquire the following expertise and skills:
1. The understanding of fundamentals and methods of Confocal Laser Scanning Microscopes (CLSMs) as for instance:
- the selection of protein-fluorophore combinations for double staining;
- avoiding bleaching effects;
- the significance of bandpass filters and dichroic mirrors;
- the correct selection of lasers, laser lines and laser power;
- the selection of different detector systems and the consideration of different detector sensitivities respectively;
- consideration of the Nyquist criterion for generation optimal images;
2. the operation of two CLSM systems from two different international companies;
3. the estimation of the capabilities of CLSMs in the cell biological analysis as for instance:
- the application and suitability of different fluorophore-protein markers for the localisation of different cell compartments and organelles respectively;
- time scans for the visualisation of cell processes like cell division;
- transport/internalisation of proteins or the response of localised proteins to cell toxins.

The acquired skills are well suited for applications in scientific investigation. They are useful for various kinds of experiments, which can be adapted and developed by the user. Provided that the acquired knowledge is actualised, the introduction to the CLSMs of the CALM unit should enable the students to understand similar microscopes faster and better and to shorten corresponding introductory trainings.

Teaching and Learning Methods:
By dealing with the relevant literature (own hand-outs and scripts or specified internet material, as for instance from the CALM webpage) the students prepare the theoretical basics of confocal laser scanning microscopy. The theoretical knowledge is complemented by hands-on experience at the CLSMs such that the students can independently operate these microscopes for simple tasks and understand the theory behind. From this stage onwards the students can extend and further develop their skills. The communicated methods are also interesting for BSc. and PhD students.

Media:
Power-Point Presentations, Hands-on instructions at CLSMs.

Reading List:
Own scripts and specified available internet material.

Responsible for Module:
Torres Ruiz, Ramon; Apl. Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Konfokale Laser Scanning Mikroskopie - Theorie und Funktion (WZ0004) (Übung, 1 SWS)
Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0637: Lab Course Methods for Analysis of Next Generation Sequencing Data | Lab Course Methods for Analysis of Next Generation Sequencing Data

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grade is based on the report by the student who will describe in 10-20 pages their analysis of a dataset they have chosen. Up to five weeks are given for data analysis and writing of the report. The report should indicate the description of methods, statistical analyses and discussion of the results. The report serves as a basic scientific document summarizing the pipeline of analysis, possible pitfalls and bias in the results, as well as a general conclusion about the chosen datasets. The datasets will be prepared by the lecturer and downloaded by the students.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in statistics and genetics

Content:
1) Introduction to NGS data.
2) Analysis of genomic NGS data: type of files, download NGS data from databases, barcoding, trimming, read quality control, perform read-mapping with a reference genome, perform SNP calling, gene annotation, statistical bias in SNP calling. Use of SAMtools and Galaxy.
3) Analysis of gene expression data from RNAseq: type of files, perform read-mapping of a transcriptome, assembly of transcriptome, annotation of genes, gene expression analysis, bias in gene expression analysis.
4) de novo genome assembly: de novo assembly of a simple genome, annotation of assembly.
5) Exercise and practice of analysis based on a dataset from initial data to statistical analysis and writing a report with discussion about the data.

Intended Learning Outcomes:
After the course the students know the different type of data generated by NGS, they know how to perform all the steps from raw data until obtaining SNPs or gene expression results. They master the analysis of genomic data up to SNP calling, and the analysis of gene expression data from RNAseq. Moreover, they know the possible bias in performing SNP calling and gene expression using different software, and understand the statistical issues with NGS data. By learning how to use different software, they know how to produce accurate data analysis from NGS sequencing data (and RNAseq data) and can write a scientific description of the pipeline of analysis. They are also confident in using the classic tools for bioinformatics of NGS data, the Linux operating system and a computer cluster.

Teaching and Learning Methods:
The lectures and exercise are intermixed during the sessions, and most sessions comprise only exercises and hands on practice. Typically, a first part of short lecture introduces the concepts and the tools with key concepts of the statistical analysis. The exercises are performed on computers under Linux and on a computer cluster. The students code and implement the analysis using different software. A Wiki page is given as a document for the course on which all command lines and exercises are documented. The wiki serves a guideline for the students to go through the pipeline of the analysis. The exercises are for the whole group, and students are encouraged to discuss their results with their colleagues, before a summary is made by the lecturer.

Media:
Software training: Linux environment, basic command line, statistical software R, SAMtools, Trimmomatic, bwa, trinity, velvet, Galaxy

Reading List:
The wiki page covers all information on software and pipeline for the course.

Responsible for Module:
Tellier, Aurélien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
NGS Datenanalyse (Übung, 4 SWS)
Tellier A [L], Ortiz Valencia E, Schäfer H, Shigita G, Silva Arias G, Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1174: Molecular Biology of Biotechnologically Relevant Fungi | Molekulare Biologie biotechnologisch relevanter Pilze

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of examination (in min.): 60 written (graded), 60 practical (lecture + exercise as ungraded course work).
Regular, active participation in the courses is expected. A written exam (60 min, graded) serves to test the theoretical skills learned in lectures and seminars. In the written exam, the students show whether they are able to structure the knowledge they have acquired and present the essential aspects of the topics discussed. In addition, they should also show that they are able to combine the interrelationships of the molecular biology of fungi in a meaningful way and transfer them to similar topics (e.g. a current but not discussed topic of fungal biotechnology). The 45-minute presentation (in English) with subsequent discussion is designed to teach independent scientific research and to demonstrate the ability to present complicated scientific relationships in a structured and logical way. The module grade is determined by the grade of the written examination. The module is passed if a grade better than 4.1 is achieved and the course work (lecture) is successfully completed, as is the successful participation in the exercises/excursions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For better understanding, basic knowledge of microbiology is advantageous.

Content:
The course is to teach basic knowledge about the diversity and physiology of fungi, and in addition covers more in-depth information on fungal biotechnological applicabilities. A focus will be the unique capability of fungi to degrade and convert plant biomass. Exemplary contents that will be discussed are: gene technology (bio-engineering), plant cell walls as substrate and their

degradation, signaling pathways of substrate perception, biotechnological applications of enzyme and small-molecule production, as well as application of fungi in the agricultural industry.
In the practical/seminar part of the course, selected topics will be discussed in more detail by student presentations and with the help of practical examples. In addition, an excursion to the Clariant Sunliquid demonstration plant in Straubing is planned, where bioethanol is being produced from fungal conversion of biomass.

Intended Learning Outcomes:
After successful participation in the module, the students will have advanced knowledge of the biotechnological applications of fungi for the production and development of natural and artificial biocompounds.
They will be able to:
• recapitulate the fungal metabolic capabilities
• comprehend and name the fundamental signaling pathways for metabolic adaptation
• using selected examples, classify the respective enzyme systems and their functions in anabolic/ catabolic reactions
• understand the molecular techniques for genome manipulation and strain development and discuss them
• critically assess the pros and cons of the presented production systems.
Moreover, the module is intended to help develop problem-solving skills as well as to foster the interest for eukaryotic microbiology, it's advantages and disadvantages, and the importance particularly of filamentous fungi for environment and industry.

Teaching and Learning Methods:
Teaching technique: Lecture - teaching method: presentation; development of general concepts on the chalkboard
In the seminar/demonstration: teaching method: talk, demonstration; learning activity: research of relevant literature, prepare and give a talk, contructive discussion of the contents

Media:
PowerPoint presentation; chalkboard work; original research papers; lab demonstrations

Reading List:
Unfortunately no text book is available that covers all the contents of the course, but the following sources are good for basics and as additional reading:
- Money, Nick, 2007, “Triumph of the Fungi: A Rotten History”, Oxford Univ. Press
- Hudler, G.W., 1998, “Magical mushrooms, mischievous molds”, Princeton University Press
- Kendrick, Bryce, 2000, “The Fifth Kingdom”, 3rd ed., Focus Pub/R Pullins Co
- Kavanagh, Kevin, 2011, „Fungi – Biology and Applications”, Wiley-VCH
- Arora, D.K., 2004, “Fungal Biotechnology in Agricultural, Food, and Environmental Applications – Mycology Series; Vol. 21”, Marcel Dekker, Inc.
- Kück, U. et al., 2009, “Schimmelpilze – Lebensweise, Nutzen, Schaden, Bekämpfung“, Springer
- Kubicek, C.P., 2013, “Fungi and Lignocellulosic Biomass“, Wiley-Blackwell

Responsible for Module:
Benz, Johan Philipp; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Biologie biotechnologisch relevanter Pilze (Vorlesung mit integrierten Übungen, 4 SWS)
Benz J [L], Benz J, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2014: Molecular Plant Breeding | Molekulare Pflanzenzüchtung

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam students have to show that they can recognize and solve a problem without additional help. The questions of the exam cover the full lecture contents.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in genetics and molecular biology

Content:
Principles of plant genetics (classical and molecular), gene mapping and genome analysis (monogenic and polygenic traits) physical mapping, genome sequencing), methods of forward and reverse genetics (map based cloning, characterization of mutants, gene isolation, functional analysis), transgenic crop plants

Intended Learning Outcomes:
General understanding of methods and concepts in genome analysis and molecular genetics of crop plants.

Teaching and Learning Methods:
Lecture.
Learning activity: textbooks, lecture slides, current literature
Teaching method: lecture with powerpoint slides.

Media:
Powerpoint presentations

Reading List:
T.A. Brown: Genome und Gene - Lehrbuch der molekularen Genetik; Spektrum Akademischer Verlag GmbH; ISBN: 978-3-8274-1843-2

Robert H. Tamarin: Principles of Genetics, McGraw Hill Higher Education; ISBN: 0070486670

Heiko Becker: Pflanzenzüchtung, UTB für Wissenschaft, Eugen Ulmer Verlag Stuttgart; ISBN: 3-8252-1744-2

Weiterführende aktuelle Fachliteratur wird jeweils am Ende der Vorlesung angegeben.

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Pflanzenzüchtung [WZ2014] (Vorlesung, 2 SWS)
Frey M, Avramova V, Mayer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2420: Molecular Genetics | Molekulare Genetik

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the exam (60 min.) the students document knowledge in molecular genetics, which reaches beyond basic background. They demonstrate the understanding of relevant scientific approaches.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Lectures and seminars in genetics, cell biology, genomics, developmental genetics of plants and animals

Content:
The lecture deals with current issues in molecular genetics based on selected examples from original work published by international groups in leading scientific journals. The students gain insight into topical questions, methods and genetic models and they learn how developing lines of investigation, based on basic knowledge, lead to new findings.
The lecture leads the students closely to modern molecular genetics. The value of this lecture lies in the fact that it aims to go beyond established textbook knowledge. Particular attention is paid to the understanding of molecular genetic processes and the strategies, which are designed to elucidate them. Mechanisms and phenomena, which are not addressed in this depth in a general lecture in genetics, as for instance exceptional alleles, epistatic interactions between genes, networks etc. represent special focuses. Further attention is paid to the strategic and experimental problems, which arise with a particular scientific question.
Depending on newly arising issues or interests additional parts called “excursus“ are implemented in the lecture, for instance if a new finding becomes relevant or an old finding becomes relevant again for a particular theme. A particular excursus is not necessarily taken up every year again.

Notably, the students are requested to discuss and question the obtained knowledge. The selected issues are intended to train the students such that they acquire competence to critically analyze work in this field.
Some selected subjects:
- Forms of alleles: amorph, hypo-, hyper-, anti-, neomorph, haploinsufficiency
- Temperature sensitive mutations
- Multiple allelism
- Penetrance
- Expressivity
- Gene interaction/forms of epistasis
- Targeted mutagenesis
- Transcription factors/-suppressors
- RNAinterference
- Epigenetics
- Gene redundancy
- Polyploidy
- Horizontal Gene Transfer

Intended Learning Outcomes:
Basic demands in the field of molecular biology are introduced. The students are trained to recognize important questions therein and to think about experimental approaches for their solution. The highlighted issues allow combining approaches from classical/formal with those of molecular genetics - one of the most efficient and powerful approaches in modern biology.
The students also learn to use knowledge about peculiarities of model organisms in this field. In particular, they learn that due to their biological and genetic peculiarities, different model organisms are suited to investigate different scientific questions. At the end of the lecture the students have knowledge about organisms as disparate as Drosophila melanogaster, Coenorhabditis elegans, Arabidopsis thaliana, Zea mays, Saccharomyces cerevisiae and others. The students are aware about important genetic insights gained through the analyses of these model organisms and their relevance for humans (e. g. “phenologues“). Since this lecture is mainly based on original work, they learn to understand the difficulties, problems and main features linked to outstanding scientific publications. At the same time they get insight into the field of current science and the work of international groups.

Teaching and Learning Methods:
PowerPoint presentations including special presentations of selected issues based on original publications. During the lecture the students are encouraged to take part in the discussion.

Media:
PowerPoint presentations and videos are provided for download (login information is given at the beginning of the lecture).

Reading List:
Bruce Alberts et al., Molecular Biology of THE CELL, 2014, 6th ed. (and higher), Garland Science New York.
Wilhelm Seyffert (Hrsg.), Lehrbuch der Genetik, 2003, 2te Auflg. (and higher) Spektrum Akademischer Verlag Heidelberg-Berlin.
Ben Lewin et al., GENES XI, 2014 (and higher), Jones & Barlett Learning, Burlington.
James D. Watson et al., Molecular Biology of the Gene 2008, 6th ed. (and higher), Pearson Education/Benjamin Cummings San Francisco.
Literature/Articles cited in the lecture.

Responsible for Module:
Torres Ruiz, Ramon; Apl. Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Genetik [WZ2420] (Vorlesung, 2 SWS)
Torres Ruiz R, Gutjahr C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2490: Neurogenetics: The Pathoetiology of the Neurological and Psychiatric Diseases | Neurogenetische Grundlagen von neurologischen und psychiatrischen Erkrankungen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students show in a graded exam (60 min, 2 graded exams/one after each semester) that they can understand and summarize basic concepts of central nervous system development. They should be able to demonstrate complex facts about the molecular basis and development of neuropsychiatric diseases in a limited time. Furthermore, they should demonstrate that they can use their acquired knowledge to analyze and evaluate case studies.

The average of the two graded exams then gives the overall grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretical knowledge in genetics (developmental genetics of animals) is desirable

Content:
1. molecular and cell biological principles of the development of the central nervous system: neurogenesis - neuronal migration - network formation - synaptogenesis - electrical maturation; 2. morphology and function of the cerebrum, cerebellum, hippcampus, basal ganglia, amygdala, spinal cord; 3. Diseases of the CNS and their molecular basis: Alzheimer's disease, Parkinson's disease, schizophrenia, depression, infections, diseases of the spinal cord, stroke, epilepsy, prion diseases, diseases of the hypothalamus

Intended Learning Outcomes:
After participating in the module course, students will have a basic theoretical understanding of the formation of the nervous system. They should be able to understand and explain the principles

of molecular regulation of these processes, have knowledge of the function and morphology of central structures of the CNS and understand the pathogenesis (molecular) of diseases of the CNS. Furthermore, the module is intended to promote interest in neurogenetics.

Teaching and Learning Methods:
Teaching method: Lecture with question-developing method
Learning activities: studying literature, learning basic processes, problem solving

Media:
Powerpoint, script on the new Moodle platform, movies

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Larry R. Squire
Fundamental Neuroscience
Ed. by Larry R. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Wurst, Wolfgang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Neurogenetik II: Grundlagen von neurologischen und psychiatrischen Erkrankungen (Vorlesung, 2 SWS)
Wurst W [L], Deussing J, Floss T, Hölter-Koch S, Vogt-Weisenhorn D, Westmeyer G

Neurogenetische Grundlagen von neurologischen und psychiatrischen Erkrankungen (Vorlesung, 2 SWS)
Wurst W [L], Deussing J, Floss T, Vogt-Weisenhorn D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1185: Plant Epigenetics and Epigenomics | Plant Epigenetics and Epigenomics

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a presentation (20 min) followed by discussion (10 min). The presentation should summarize and interpret the results obtained from analyzing published epigenomic datasets using the computational skills aquired during the Computer Practical sessions. The presentation is a means to measure the student's ability to understand a technical/ scientific subject, to analyze and evaluate facts and factors of influence, to summarize the subject and present it to an audience, and to conduct a discussion about the presented subject

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of genetics, cell biology, statistics

Content:
The course will cover:
- Components and functions of the plant epigenome: DNA methylation, histone modifications
- Measuring epigenomes: array-based and NGS based bulk and single cell technologies
- Analyzing plant epigenomic data: Array and NGS based computational tools for bulk and single cells
- Plant epigenome and environmental variation
- Plant epigenome and genetic variation
- Epigenetic inheritance in plants: Mitotic and meiotic inheritance
- Current perspectives on the agricultural and evolutionary implications of epigenetic inheritance in pl

Intended Learning Outcomes:
Students will be able to:
- Interpret the molecular components of epigenomes
- Interpret functions of epigenomes
- Identify the sources of population level epigenomic variation
- Explain modern measurement technologies
- Distinguish the conceptual background of different computational tools
- Apply computational tools to epigenomic data
- Analyze the implications of epigenetic and epigenomics
- Carry out presentation skills

Teaching and Learning Methods:
The following teaching methods will be used:
- Lectures: The goal of the lectures is to provide an in-depth overview of the main concepts, approaches and research questions in plant epigenetics and epigenomics.

- Computer tutorial: The goal of the computer tutorials is to reinforce the lecture contents with hands-on experience. The main aims are: 1) to get hands-on experience with the type of epigenomic datasets that is routinely generated in this field; 2) to get hands-on experience with software tools for the analysis of epigenomic datasets; 3) to be able to evaluate the output from these software tools, and to use the output as a way to answer concrete biological research questions.

- Seminars: The goal of the seminars is to discuss recent scientific literature in plant epigenetic and epigenomics . The aim is to demonstrate how the concepts, approaches and research questions presented in the course provide a means to decode complex scientific articles in this field.

Media:
PowerPoint presentations, software practicals

Reading List:
Hand-outs

Responsible for Module:
Johannes, Frank; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Plant Epigenetics and Epigenomics (Vorlesung, 3 SWS)
Johannes F

Plant Epigenetics and Epigenomics - Computer Practical (Praktikum, 2 SWS)
Johannes F, Hazarika R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2470: Practical Course Animal Developmental Genetics | Praktikum Entwicklungsgenetik der Tiere

Version of module description: Gültig ab summerterm 2014

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Anwesenheitspflicht und aktive Teilnahme an dem Blockpraktikum. Eine schriftliche Prüfung am Ende des Praktikums dient der Überprüfunge der im Praktikum erlernten Inhalte.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretische Kenntnisse in der Genetik sind wünschenswert.

Content:
Vermittlung der grundlegenden Schritte/Techniken/Prozesse zur Herstellung von Tiermodellen humaner Erkrankungen. Tierschutz / Kultur von embryonalen Stammzellen / Mutagenesetechniken / Generierung von Maus- und Zebrafischmodellen / Phänotypisierung von Tiermodellen / Archivierung von Tiermodellen /

Intended Learning Outcomes:
Am Ende der Veranstaltung sollen die Studenten grundlegende Kenntnisse über die Prozesse der Herstellung und Analyse von Tiermodellen humaner Erkrankungen haben. Sie sollen desweiteren die Komplexität des Prozesses verstanden haben, und Interesse an dieser Art der Forschung soll hierdurch gefördert werden.

Teaching and Learning Methods:
Lehrmethode: Präsentation; Gruppenarbeit; Experiment
Lernaktivitäten: Relevante Materialrecherche; Zusammenfassen von Dokumenten, Üben von technischen und labortechnischen Fertigkeiten; Zusammenarbeit mit anderen Studierenden

Media:
Präsentationen, Frontalpraktikum, Arbeit in Kleingruppen, Skriptum

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung wird empfohlen:
Larry R. Squire
Fundamental Neuroscience
Ed. by Larry R. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Daniela Vogt Weisenhorn (daniela.vogt@helmholtz-muenchen.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2480: Plant Developmental Genetics 2 | Plant Developmental Genetics 2

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the oral examination (30 min.) students explain without additional helping material principles of plant developmental genetics, describe experimental strategies of plant developmental genetics and evaluate the relevance of plant developmental genetics for horticulture and plant breeding. The grade of the exam will be the final grade of the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Genetics (WZ0703). Plant Developmental Genetics I (WZ0305). A basic understanding of genetics, molecular biology and cell biology is required.

Content:
- photomorphogenesis
- flowering time control
- floral meristem identity
- floral organ identity
- floral organogenesis
- gametophyte, apomixis
- fertilization process
- parental control of embryogenesis/seed development

Intended Learning Outcomes:
After successful completion of the module students are able to understand the basic concepts of plant developmental genetics and to evaluate their relevance for problems in horticulture and plant breeding.

Teaching and Learning Methods:
The lecture provides the theoretical background and concepts. During the exercises, in individual or group work on specific selected original literature with presentations students show their ability to understand the concepts and to critically analyse and evaluate the obtained scientific models.

Media:
PowerPoint presentations, chalkboard
Slides will be provided online in pdf format. Taped recordings of the lectures will be provided online as audio- and videopodcasts.
Current literature,

Reading List:
Taiz et.al. Plant Physiology and Development 2015 6th edition, Oxford University Press; Smith et al. Plant Biology 2010, Garland Science.
Current literature from specific journals will be announced during the lecture.

Responsible for Module:
Schneitz, Kay Heinrich; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Entwicklungsgenetik der Pflanzen 2 (Vorlesung, 2 SWS)
Schneitz K [L], Schneitz K

Journal Club Entwicklungsgenetik der Pflanzen (Seminar, 2 SWS)
Schneitz K, Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2581: Plant Biotechnology | Pflanzenbiotechnologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written, supervised examination (Klausur, 90min), by answering questions under time pressure and without helping material, students demonstrate that they have obtained knowledge in the areas of plant biotechnology, plant molecular biology and plant biochemistry.
The examination assesses the theoretical background and applied knowledge obtained on up-to-date aspects of current research.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A basic knowledge in genetics, genomics, plant development, biochemistry and/or botany is highly recommended

Content:
The module consists of a lecture and a seminar part.
In the lecture, state-of-the-art methods in plant biotechnology and plant molecular biology are introduced, and advantages and disadvantages are discussed. Current challenges are highlighted.
Topics of the lecture include:
- Genetically modified plants: status, regulations, cultivation, concepts;
- Generation of genetically modified plants: methods, vector systems;
- Concepts for yield improvement;
- Concepts for quality improvement;
- New potentials derived from basic research;
- Model system Arabidopsis: development of new techniques;
- Metabolic engineering.

In the seminar part different speakers from the TUM, which are active in research in plant biotechnology or plant molecular biology, introduce cutting-edge research projects that take place

on campus. The seminar part is conceived to highlight the exciting research that currently takes place and advertise opportunities for master thesis projects.

Intended Learning Outcomes:
The students have a profound knowledge in plant biotechnology, plant biochemistry and plant molecular biology. They are aware of new technological approaches and methodology applied in the fields, including plant transformation, construct and vector design, reporter systems and essential DNA, RNA and protein techniques. They are able to comment critically and reflect on technologies and aims of plant biotechnology. They have insight into latest research developments in the respective areas, in particular also in research projects that currently take place at the TUM

Teaching and Learning Methods:
Lecture: PowerPoint presentations, short movies and use of the black board. Questions to the audience will actively encourage discussion and enable students to ask questions more freely.
Seminar: Power point presentations and use of the black board. The seminar talks are followed by discussions to actively invite students to ask questions. Review papers will be provided as background reading.

Media:
Lecture: PowerPoint, black board, discussion.
Seminars: PowerPoint, black board, discussion.
PDFs of the lectures will be made available to the students. Review publications will be made available for background reading on the seminar contends.

Reading List:
Biochemistry and Molecular Biology of Plants. Buchanan, Gruissem and Jones, John Wiley & Sons, 2015

Responsible for Module:
Poppenberger-Sieberer, Brigitte; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzenbiotechnologie (Seminar, 2 SWS)
Gutjahr C, Benz J, Assaad-Gerbert F, Avramova V, Sieberer T, Schwechheimer C, Tellier A, Hückelhoven R, Johannes F, Schneitz K, Dawid C

Pflanzenbiotechnologie (Vorlesung, 2 SWS)
Poppenberger-Sieberer B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1031: Quantitative Genetics and Selection | Quantitative Genetik und Selektion

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 120.
Die Prüfungsleistung wird in einer schriftlichen Prüfung (Klausur) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel Probleme aus dem Bereich der Quantitativen Genetik, Populationsgenetik und Selektionstheorie erkannt werden, und Wege zu einer Lösung gefunden werden können. Die Prüfungsfragen gehen über den gesamten Vorlesungsstoff. Darüberhinaus können kurze Rechenaufgaben gestellt werden.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkenntnisse in Statistik
Grundkenntnisse in Genetik

Content:
" Populationsgenetik: Genetische Zusammensetzung von Populationen, natürliche Selektion und Mutation
" Quantitative Genetik: Inzucht und Heterosis, Epistasie, phänotypische und genotypische Varianzen, Ähnlichkeit zwischen Verwandten, Heritabilität, Genotyp-Umwelt Interaktion
" Selektionstheorie: Berechnung des Selektionserfolgs, Optimierung von Zuchtprogrammen

Intended Learning Outcomes:
" Verständnis für die Prinzipien der Quantitativen Genetik und Populationsgenetik und Ihre Bedeutung für pflanzenzüchterische Fragestellungen
" Verständnis für die Grundlagen der Selektionstheorie zur Optimierung von Zuchtprogrammen

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Übungen
Lernaktivität: Literaturstudium, Rechnen von Übungsaufgaben
Lehrmethode: Vortrag, Übungen, Fragend-entwickelnde Methode

Media:
Präsentationen mittels Powerpoint
Software Übungen

Reading List:
Falconer and Mackay (1996) Introduction to quantitative genetics; Lynch and Walsh (1998) Genetics and analysis of quantitative traits

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Quantitative Genetik und Selektion (Vorlesung, 4 SWS)
Schön C, Lanzl T
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2228: Seminar Current Problems in Animal Genetics | Seminar Aktuelle Probleme der Tiergenetik

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 52	**Contact Hours:** 8

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (in min.): Lecture and discussion (one day, approx. 30 - 60 min. per person).
The module Current Problems in Genetics consists of the seminar Current Problems in Genetics. The seminar is offered in the WS. Topics from the field of animal genetics are covered.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of general and molecular genetics; completed bachelor's degree in a life science subject.

Content:
The module Current Problems in Genetics consists of the seminar Current Problems in Genetics. The seminar is offered in the WS. Topics from the field of animal genetics are covered.

Intended Learning Outcomes:
After participation, the students will have in-depth knowledge in understanding current genetic literature. They should be able to use their acquired knowledge to better understand other genetic essays.

Teaching and Learning Methods:
Presentation and lecture

Media:
PowerPoint presentation

Instructions for the independent development of a complex of topics, instructions for the presentation of data.

Reading List:
After consultation with the lecturers

Responsible for Module:
Beckers, Johannes; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Aktuelle Probleme der Tiergenetik [WZ2228] (Seminar, 2 SWS)
Beckers J [L], Wurst W, Vogt-Weisenhorn D, Beckers J, Adamski J, Kieser A, Floss T, Hrabé de Angelis M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2682: Sensory and Behavioral Neurogenetics | Sensory and Behavioral Neurogenetics

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a written exam (90 min), where students are expected to remember and reproduce topics that were covered in the lecture (theories of behavioral analysis, methods, examples etc.) without additional aids. The exam will consist of multiple choice, free formulations, tables to be completed and interpretations of schemes etc. In addition, students will write an essay based on literature research on a topic that was discussed in the lecture. Topics will be assigned by the lecturer after discussion with the student. The module is passed, when the essay is successfully completed and the grade of the written exam is at least 4,0.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of neurobiology and genetics are obligatory.

Content:
LECTURE: once a week during the semester for two hours including a break, the lecture will cover the following topics:

• general introduction, deepening of knowledge in form, function, and networks of synaptic connections and nervous systems.
• the role of model animal systems in neuroscience
• illustration and deeper understanding of neuroscience research on the example of sample publications covering model system (including genetic models) such as worm, fly, fish, mouse, monkey, primate.
• Analysis and explanation of model specific methods such as automated behavioral analysis, in vivo imaging, electrophysiology, multiphoton microscopy, live microscopy, modeling

• Examples describing the role of internal state and behavioral context including the role of neuromodulation
• translation and general meaning of results obtained in model organisms
• evolution of neuronal networks and their translational meaning

EXERCISE: The exercise consists of a home assignment, independent literature research and writing of an essay. The topic will be assigned after consultation with the lecturer.

Intended Learning Outcomes:
Upon successful completion of the module, students:
• know important definitions and methods in neurogenetics and behavioral analysis, and why and how they are used in model organisms.
• understand the terms optogenetics, chemogenetics, calcium imaging, connectomics, system neuroscience, neuronal networks, phsychophysics, neuromodulation and can explain them.
• are able to interpret, analyse and develop results obtained in behavioral studies, neurophysiology and neuroanatomy.

Teaching and Learning Methods:
LECTURE: In the lecture material will be presented in a powerpoint presentation, which features many examples, pictures, schemes, videos. In addition, at the beginning of each lecture the content of the previous lecture will be summarized and open questions will be discussed. At the end of each lecture, a list of 'take home messages' will be given. EXERCISE: The exercise consists of a written essay that students will write over the course of several weeks following independent literature research at home. The topic of the essay will follow the topics covered in the lecture and will be assigned by the lecturer after consulting with the student. The aim is too deepen the student's knowledge in a topic of the lecture that is of particular interest to them. To this end, they will use online literature search tools such as Pubmed and Google, but also in person interviews or other sources that they deem informative. The lecturer will be available to discuss content and structure.

Media:
Pubmed, ejournals, video materials, online databases

Reading List:
Standard textbook: Eric Kandel (editor), Principles of Neural Sciences; various journal articles (list will be made available in class)

Responsible for Module:
Grunwald, Ilona; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2763: Transcriptional and Posttranscriptional Regulation in Eukaryotes | Transcriptional and Posttranscriptional Regulation in Eukaryotes

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written examination (60 min, Klausur) students demonstrate by answering questions under time pressure and without helping material the theoretical knowledge of components, processes and mechanisms of transcriptional and posttranscriptional regulation in eukaryotes and of methods to study them.
By comparing different techniques applied to the study of transcriptional regulation student demonstrate that they can evaluate their advantages and disadvantages for answering a given experimental question.
Their ability to analyse and evaluate a research paper and to structure the content such that they can clearly explain it to an audience, is examined during their presentation of a research paper assigned to them in a PowerPoint presentation. To demonstrate that they have acquired the ability to discuss scientific data the students generate questions about the paper to guide a discussion after their presentation.
The goals of the module have been reached and the module has been passed when the total grade of written exam and presentation (3:2) is better than 4.1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamental knowledge in genetics and molecular biology is highly recommended. The participants should have passed one or more bachelor level lectures in genetics, genomics, systems biology, developmental genetics of plants and/or developmental genetics of animals.

Content:
The development of an organism and its developmental and physiological responses to the environment are based on a precise spatio-temporal regulation of genes. The lecture and associated seminar will cover mechanisms of gene regulation. They are suitable for MSc students as well as highly motivated and advanced BSc students.

The lecture (90 mins per week) will cover:
- Transcriptional machinery
- Structure of eukaryotic chromatin
- Epigenetic modifications and chromatin remodelling
- Gene activation and repression
- Transcription factors
- Combinatorial transcription factor complexes in signal integration
- Regulation of transcription factors by posttranslational modification
- Transcription factor evolution and its role in acquisition of novel traits
- RNA molecules and RNA processing
- Regulatory RNAs
- Methods to study transcriptional regulation

The accompanying seminar (90 min per week), will include discussions on a range of original landmark papers covering different aspects of transcriptional regulation comprised in the lecture (most examples will be from plants). Furthermore, students will get advice on how to give a good presentation and will get feedback on the quality of their own presentation and advice for possible improvement.

Intended Learning Outcomes:
At the end of the module students have a profound understanding of the role and of different mechanisms of transcriptional and posttranscriptional regulation in eukaryotes. They know different techniques of how to study eukaryotic chromatin, transcription factor-DNA interactions (such as promoter deletion series for identification of cis-elements, ChIP, DIP, EMSA, microscale thermophoresis), their advantages and disadvantages. Thus, they are able to determine the correct experimental approach to address research questions in transcriptional and posttranscriptional regulation. Additionally, they are able to critically evaluate unfamiliar results in original papers related to transcriptional and posttranscriptional regulation. In the seminar, they have acquired practice in presenting original research data and gained the ability to discuss such data with their colleagues.

Teaching and Learning Methods:
LECTURE: Presentation with PowerPoint and black board. The presentation will be interrupted with questions to the students to keep their active attention and to induce reflection on the content of the lecture (Sokrates' midwife method). Short breaks will give the possibility to students to ask questions during the lecture.
SEMINAR: Students will use PowerPoint to present a research paper, which has been assigned to them. The instructor will help in guiding the discussions and will contribute questions to make

students aware of details and induce their reflection of the content. They acquire practice in presenting original research data and gained the ability to discuss such data with their colleagues.

Media:
LECTURE: Power point, black board, discussion. PDFs of the lectures will be made available to the students.
SEMINAR: Powerpoint, black board, discussion.

Reading List:
LECTURE:
Benjamin Pierce, Genetics: a conceptual approach, 2013 5th edition (or newer)
James Watson, Molecular Biology of the Gene, 2014 7th edition (or newer)
Michael Carey et al. Transcriptional regulation in Eukaryotes, 2009, 2nd edition (or newer)
Original articles used to increase the content of the lecture will be cited on the power point slides.
SEMINAR:
Original articles will be distributed to the individual speakers in the first seminar session.

Responsible for Module:
Gutjahr, Caroline; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Transcriptional and Posttranscriptional Regulation in Eukaryotes with Special Emphasis on Plants (Seminar, 2 SWS)
Gutjahr C

Transcriptional and posttranscriptional regulation in eukaryotes (Vorlesung, 2 SWS)
Gutjahr C, Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

ME2090: Viral and Nonviral Gene Transfer: Methods and Applications in Research and Therapy | Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students are required to attend the lectures on a regular basis. At the end of the semester there is a 120 minutes examination in writing. The examination will assess whether the students are able to replicate the knowledge communicated during the lectures in a structured manner. The students should be able to describe, interpret and combine the informations of the lecture series. Every question of the written exam is attributed a certain number of points. The final grade is calculated from the achieved percentage of points out of total achievable points.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in molecular biology and cell biology

Content:
The lecture series provides in depth insights into the technical/molecular basis of nucleic acid delivery into cells and applications in research and therapy.
Overview of research field / historical development / concepts and goals. Non-viral vectors / barriers for nucleic acid delivery / selected examples and applications.
Adenoviral vectors: Virus biology / vector types and construction / oncolytic adenovirus.
Retro-/lentiviral vectors: Virus biology / vector types, construction, optimization.
Immunological aspects of nucleic acid therapies.
Preclinical models / clinical studies / case discussion.

Intended Learning Outcomes:
Gene technologies are discussed controversially, especially in Germany. Frequently, opinions are adopted in the absence of actual knowledge of the chances and risks of technologies. It is the aim of this lecture to provide the students with sufficient expertise to enable them to participate as competent persons in the debate on the use of gene technologies in medicine.

Teaching and Learning Methods:
lecture course

Media:
PowerPoint, blackboard

Reading List:

Responsible for Module:
Plank, Christian; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie (Vorlesung, 3 SWS)
Anton M [L], Plank C, Anton M, Holm P, Krüger A, Knolle P, Brill T
For further information in this module, please click campus.tum.de or here.

Specializing in Medical Biology | Studienschwerpunkt Medizinische Biologie

Module Description

ME2759: Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 128	**Contact Hours:** 22

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Der Modul ist aufgebaut aus Vorlesungen (insgesamt 1 SWS: Einleitung somatischer Stammzellen, embryologische Entwicklung des Blutsystems, verschiedene Aspekte der adulten Stammzellen, Stammzellnische, klinische Anwendungen von blutbildenden Stammzellen). Auch werden in Seminare der Kursteilnehmer aktuelle Forschnugsbeispiele aus der Literatur vorgestellt und diskutiert (0,5 SWS).
Die Prüfungsleistung stellt sich zusammen aus: Seminarvortrag (etwa 30 min + Diskussion, 40%) und die Verfassung einer Hausarbeit (60%) zur Kontrolle des Verständnisses sowie der Fähigkeit zur Beschreibung, Interprätation und Bewertung. Das Modul ist bestanden, wenn das gemittelte Ergebnis besser als 4,1 ist.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zum besseren Verständnis dises Theorieteils sind gute Kenntnisse in Zellbiologie und Biochemie erforderlich.

Content:
Im Rahmen dieses theoretischen Moduls werden spezielle Kenntnise über somatische, und insbesondere blutbildender Stamm- und Vorläuferzellen und Stromazellen vermittelt.

Es werden 5 Vorlesungen stattfinden, und anschliessend 5, von den Studenten vorbereiteten Seminare in dem aktuelle Forschungsbeispiele präsentiert und besprochen werden sollten.

Vorlesungen
1. Einleitung in der Stammzellbiologie, somatische Stammzellen
2. Embryologische Entwicklung des Blutsystems und blutbildenden Stammzellen
3. normale Physiologie der blutbildenden Stammzellen und die Stammzellnische
4. Abnorme Physiologie der Stammzellen bei Alterung chronische Erkrankungen und Malignitäten
5. klinische Relevanz von blutbildenden Stammzellen

In den Seminaren sollen von den Teilnehmern aktuelle Forschungsergebnisse der Literatur vorbereitet, präsentiert und diskutiert werden. Dabei werden Themen wie:
1 - Stammzellidentität und Isolation
2 - Stammzellverhalten (Regeneration, Apoptose, Überleben, Proliferation, Differenzierung)
3 - Stammzellnische (Identität, Isolation, Relevanz für das Verhalten der Stammzelle)
4 - Maligne Entartungen des Blutsystems und leukämische Stammzellen
ausführlich zur Sprache kommen

Ergänzt werden die Vorlesungen und Seminare durch eine Hausarbeit (in englischer Sprache) in dem die Teilnehmer ihr Verständnisse der erworbenen Kenntnisse beschreiben, Interpretieren und bewerten.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das theoretische Verständnis und spezielle Fachwissen über blutbildenden Stammzellen. Weiterhin haben sie wesentliche Konzepte somatischer Stammzellen integriert, evaluiert und in einer Hausarbeit beschrieben. Sie haben gelernt:

• die Herkunft der somatischen Stammzellen und deren Entwicklung in Embryonen zu verstehen
• grundlegende funktionelle Verhaltensweisen blutbildender Stammzellen zu verstehen
• (Stamm)zellbiologische Fragestellungen und Arbeitstechniken aus aktuelle Forschungsliteratur zu verstehen, kritisch zu evaluieren und fachliche Fragen selbst zu entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesungen, Seminare, Hausarbeit.
Lehrmethode: Vorlesungen, Literaturrecherchen, Diskussionen, Präsentationen, Partnerarbeit (bei höheren Studentenzahlen), Ergebnisbesprechungen.
Lernaktivitäten: Studium von Literatur; Präsentation eines aktuellen Forschungsmunuscript; Anfertigung einer Hausarbeit

Media:
Original Fachliteratur, Präsentationen mittels Powerpoint, Photoshop

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Oostendorp, Robert; Apl. Prof.

Courses (Type of course, Weekly hours per semester), Instructor:
Blutbildende Stammzellen als Modell für somatische Stammzellen (Vorlesung, 1 SWS)
Oostendorp R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0219: Chemosensory Perception | Chemosensory Perception

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written examination (90 min) students demonstrate by answering questions without helping material the theoretical knowledge of the biology of taste, smell, and chemestetic perception as well as extra-sensory processes involving chemoreceptors. To answer the questions, own wordings are necessary and sketches of biomolecules and signaling pathways.
The successful preparation and presentation of a publication in the seminar is another requirement for passing the examination.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in molecular biology, biochemistry, cell biology and physiology is required.

Content:
The basics of aroma- and taste recognition, evaluation, and analysis on a molecular level are communicated.
In detail, the following topics are discussed:- basics of human taste recognition (molecules,anatomy, morphology and function of gustatory and olfactory structures, receptors, genetic variability and its influence on sensory sensitivity, establishment of preferences and aversions, the connection between sensory perception and food preferences, extra-sensory functions of taste and odorant receptors, oral somatosensory perception, basic taste modalities, signal transduction).

Intended Learning Outcomes:
Upon completion of the module, students understand the molecular bases of taste and smell perception. The students will be able to separate those percepts from other chemosensory cues such as chemesthesis or pheromone detection. Moreover, students are familiar with the putative

physiological relevance of extra-sensory chemosensory stimuli. The importance of the chemical senses for food preferences and consumption is known.

Teaching and Learning Methods:
The content of the lecture is presented by means of powerpoint presentations. There will be practical demonstrations on taste and smell that accompany the lecture. Students are motivated to broaden their knowledge by reading complementary literature relevant to the topic.

The seminar will give the students the chance to follow the rapid development of chemosensory research directly by reading and discussing recent publications. Students will choose a paper and critically present it to their peers. Additional literature research for a solid introduction into the field of research is requested. A handout summarizing the key findings of the presentation should be prepared. The fellow students are motivated to discuss the presentations. This will deepen the understanding of the contents presented during the lecture and enable the students to critically evaluate novel results.

Media:
PowerPoint presentations will be used. The content of the lectures will be made available for download as pdf-files.

Reading List:

Responsible for Module:
Behrens, Maik; Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Chemosensory Perception (Seminar, 2 SWS)
Behrens M

Chemosensory Perception (Vorlesung, 2 SWS)
Behrens M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2693: Cognitive Neuroscience | Cognitive Neuroscience

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will demonstrate an overview of cognitive processes in the brain during a written exam (60 min.). They can describe the cellular basis and the network architecture in the brain that lead to cognitive processing, and elaborate on the scientific status quo of cortical processing during various cognitive tasks. In addition, they can evaluate and predict the consequences of lesions and pharmacological interventions in the cortex for psychological processes and mental states. Finally, they will demonstrate an overview of the various methodological approaches to study the cognitive functions in the (human) brain.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have a basic knowledge of neurobiological processes in general, at least on the level of a physiology course, better though on the level of the "neurobiology" lecture held at the WZW (or a comparable lecture series).

Content:
computation of sensory information in the mammalian cortex; differences between cortical and non-cortical structures in the forebrain of vertebrates; Structure of the Cortex, canonical circuits, processing principles in the Cortex, Models of cortical function, malfunctions of the cortex in pathological situations, Role of the prefrontal cortex, Role of the hippocampus, Cortical processing of sensory input, Sleep, Food intake, Decision making, Cravings and Addiction, Emotions, Consciousness and Free Will. In addition, we will demonstrate options for technological interactions with the brain, and give an overview of the current approaches for analysing brain functions in the behaving organism.

Intended Learning Outcomes:
After the exam, students can sketch cortical processing, derive these computations from the underlying neurobiological foundations, and explain their functions for the organism. The students will aquire special knowledge on the role of the cortex, can integrate new information into this knowledge framework, and have an overview of pathologies and the possibilities to manipulate cognitive processes.

Teaching and Learning Methods:
Teaching mode: Lecture Teaching method: Presentation. Learning activities: Reading of basic texts, preparation and review of lecture materials, internet searches, summarizing of subjects.

Media:
The powerpoint presentations of this lecture series will be made available on Moodle. Additional information (URLs, additional texts, self-assessments etc.) will be available on Moodle as well.

Reading List:
The basic textbook for this lecture is "Neuroscience. Exploring the brain" from Bears, Connors and Paradiso, published by Lippincott, Williamsn and Wilkins. However, all other modern neurobiology textbooks are also appropriate.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Cognitive Neuroscience (Vorlesung, 2 SWS)
Fenzl T, Kreuzer M, Luksch H, Rammes G
For further information in this module, please click campus.tum.de or here.

Module Description

ME2656(2): Development of Vaccines against Infectious Diseases | Entwicklung von Impfstoffen gegen Infektionskrankheiten

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation is expected; short presentations on a given topic; preparation of a term paper is expected including a summary of the topics presented. Students will show whether they are able to structure the knowledge and to reflect the essential aspects. The module exam will be made through a lecture and homework, which are each weighted at 50%.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
basic knowledge in virology and immunology

Content:
In this module, students receive an overview of
" immunological principles of vaccinology
" vaccine formulations (antigen selection, adjuvants, DNA and vector-based vaccines)
" current aspects of vaccine development (personalized vaccines, immunosenescence)
" selected examples of innovative vaccines

Intended Learning Outcomes:
At the end of the module, students will be able to
" understand and apply general concepts of vaccinology
" understand, describe and discuss basic immunological mechanisms / modes of action of vaccines
" understand and explain vaccination strategies
" understand new aspects of vaccine development and evaluate their significance
" analyze and assess current developments in the field of vaccinology

Teaching and Learning Methods:
The module consists of a seminar and a term paper, students will be encouraged to study the literature and to discussion the topics
Teaching Technology: Seminar
Teaching Method: presentation, lecture, group work (discussion of the presented literature) individual work (housework)
Learning activities: relevant material research, study of literature, preparing and conducting presentations, writing a term paper

Media:
Power Point Präsentation

Reading List:
There is no textbook available that covers all the contents of this module; recommended basic literature: Modrow, S., Falke, D., Truyen, U., Schätzl, H. Molekulare Virologie, Springer, 3. Auflage 2010
S. J. Flint. Principles of Virology, John Wiley & Sons; Auflage: 3. Auflage 2009

Responsible for Module:
Ulrike Protzer (protzer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Entwicklung von Impfstoffen gegen Infektionskrankheiten (Seminar, 2 SWS)
Protzer U [L], Bauer T, Moeini H, Kosinska A, Protzer U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2048: Biology and Diagnostics of Pathogenic Bacteria - an Introduction | Einführung in die Biologie und Diagnostik pathogener Bakterien

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Eine Klausur (60 min, benotet) dient der Überprüfung der erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen über humanpathogene Bakterien sowie ihre Diagnostik zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung und Praktikum Allgemeine Mikrobiologie

Content:
Short overview:
Part I: Biology of pathogenic bacteria
Humans and microbes. Basic lectures from Robert Koch. Introduction to pathogenicity and virulence. Host defense systems. Defense systems of pathogens. Adhesion to the host cell. Intracellular pathogens. Bacterial toxins
Part II: Diagnostics of pathogenic bacteria
Taxonomy. Identification. Diagnostic procedure. Epidemiology.

Intended Learning Outcomes:
This lecture offers basic knowledge in the following fields: Taxonomy and identification of bacterial pathogens, mechanisms ofinteraction of pathogens with human hosts, biochemicl and molecular basis of diagnostic tools, epidemiological applications. In summary, the student shall aquire

the ability to appreciate the impact of bacterial pathogens in the fields of medicine and food biotechnology.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung
Lehrmethode: Vortrag, Fallstudien, interaktiver Diskurs mit Studenten während der Vorlesung.
Lernaktivitäten: Auswendiglernen; Lösen von Übungsaufgaben, Studium von Literatur

Media:
Tafelarbeit, PowerPoint Präsentationen, Filme.
Ausgabe von Vorlesungsfolien und Übungsfragensammlung.

Reading List:
Salyers AA, Whitt DD (2011) Bacterial pathogenesis: A molecular approach. ASM Press, Washington, 3. Auflage.
Hof H, Dörries R (2009) Medizinische Mikrobiologie. 4. Auflage.

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Biologie humanpathogener Bakterien (Vorlesung, 2 SWS)
Hall L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2451: Introduction to Mycopathology | Einführung in die Mykopathologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60 schriftlich.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (60 min, benotet) dient der Überprüfung der in der Vorlesung erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind Kenntnisse der Grundlagen der Mikrobiologie (Vorlesung Allgemeine Mikrobiologie). Zum besseren Verständnis sind gute Kenntnisse in organischer Chemie und Biochemie vorteilhaft.

Content:
Übersicht über Erkrankungen durch Pilze, Pathogenitätsfaktoren auf molekularer Ebene, Mykotoxine, Allergene bei Pilzen, Antimykotika und ihre Wirkmechanismen, Resistenzmechanismen, Materialschädigung und Lebensmittelverderb durch Schimmelpilze, Chemie der antimyzetischen Maßnahmen.

Intended Learning Outcomes:
Nach der Teilnahme an dem Modul besitzen die Studierenden einen breiten Überblick und zum Teil vertiefte theoretische Kenntnisse über filamentöse Pilze und Hefen und ihre Rolle als pathogene Mikroorganismen, Interaktionen zwischen Pathogen und Wirt, sowie die Rolle von Pilzen bei Material- und Lebensmittel-schädigenden Vorgängen. Sie sollen

" in der Lage sein, wichtige pilzliche Krankeitserreger einschließlich der durch sie verursachten Krankeitsbilder zu benennen.
" beispielhaft molekulare Mechanismen von Pathogenitätsfaktoren, Antibiotikawirkung und -resistenz zu benennen und erläutern können.
" ein Verständnis über die Möglichkeiten zurr Behandlung von Infektionen durch Pilze entwickeln.
" lernen, das erworbene Wissen auf vertiefte Fragestellungen anwenden.
Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an Mikrobiologie fördern.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung Lehrmethode: Vortrag, Demonstrationen
Lernaktivitäten: Studium von Vorlesungsskript und -mitschrift, ggf. Literaturstudium.

Media:
Präsentationen mittels Powerpoint, praktische Demonstrationen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de) Köberle, Martin, Dr. rer. nat. martin.koeberle@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Mykopathologie (Vorlesung, 2 SWS)
Liebl W [L], Köberle M
For further information in this module, please click campus.tum.de or here.

Module Description

ME2414: Research Project Pharmacology and Toxicology | Forschungspraktikum Pharmakologie und Toxikologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 75	**Contact Hours:** 225

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The internship is of continuous assessment therefore attendance is compulsory throughout. A lab book must be written to demonstrate their understanding for and the ability to describe, evaluate and interpret the practical experiments. The achievement of the learning objective should be documented by preparing an internship report in the form of a small scientific work (about 10 pages) and an oral presentation. The final grade is an averaged score from the marks of the motivation (15%), the practical work (50%), the oral presentation (15%) and the internship report (20%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modul WZ2413: Vertiefende Pharmakologie für Studierende der Biowissenschaften (Master)

Content:
Molecular and cellular mechanisms of cardiac insufficiency, leading to innovative therapies for cardiovascular disease.
Main focuses:
• Development of tissue-specific viral systems for the manipulation of non-coding RNAs.
• Cardiomyocyte reprogrammed stem cells from patients as cardiac disease models in vitro.
• Examination of the non-coding transcriptome in non-myocytic cells of the myocardium.
• Characterization of lncRNAs and circRNAs in disease context.
• Characterization of adrenoceptor variance and secreted factors that facilitate cell-to-cell communication in the myocardium.

Intended Learning Outcomes:
After the successful participation in the research internship, students are able to carry out experimental methods concerning cardiovascular basic research. They have learned to perform sterile techniques and apply new techniques in molecular biology. In addition, they are able to handle either fluorophore-assisted confocal microscopy,2-photon-microscopy, FACS, viral vector systems or electrophysiological recordings and to evaluate the results. Finally, the students will know how to create, perform and implement a scientific paper.

Teaching and Learning Methods:
Teaching Technology: lab intership
Learning Activities:
• Practice of technical and laboratory skills
• Editing problems and finding solutions
• Work with other students
• Preparation and implementation of presentations
• Production of reports
Teaching Methods
• experimental work
• Individual / group work
• Presentation
During the intership, the necessary knowledge is acquired by practicing technical and laboratory skills and editing problems and finding solutions through mediation of the Department faculty members and staff. The work will be carried out alone or in groups. Students are encouraged to substantively discuss the issues and learn how to prepare and implement presentations and scientific reports by visiting the Department's own seminars and under the guidance of Department staff members.

Media:

Reading List:

Responsible for Module:
Engelhardt, Stefan; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:

Stefan Engelhardt
TUM
Stefan.Engelhardt@tum.de

Deepak Ramanujam
TUM

Deepak.ramanujam@tum.de

Anne Dueck
TUM
anne.dueck@tum.de
For further information in this module, please click campus.tum.de or here.

Module Description

ME2436: Research Project Molecular Oncology | Forschungspraktikum Molekulare Onkologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of the examination (in min.): Minutes as academic achievement + 30 oral.
The ability to present and interpret the experiments carried out during the practical training is tested in the form of a presentation in the supervising lecturer's working group (30 min, graded, 25%). The experiments must also be documented and discussed in the form of a protocol. The protocol serves to check the ability to describe, evaluate and interpret the experiments performed in the practical course (15-25 pages, 75% graded) according to the IMRAD structure of a scientific publication (introduction, Mat&Meth, results, discussion).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The attendance of the module "Molecular Oncology" is required.

Content:
The internship will be carried out in the research group of Prof. Dr. rer. nat. Achim Krüger at the Klinikum rechts der Isar of the TUM, Institute for Experimental Oncology and Therapy Research.
The tasks for the internship are based on the current research focus.
The experiments may include current and new molecular (e.g. DNA cloning, vector construction) and cell biological (e.g. transfection and infection of mammalian cells) and biochemical (RNA and protein purification and analysis) methods as well as specific techniques in tumor biology (e.g. proliferation, migration, invasion assays, immunohistochemistry).

Intended Learning Outcomes:
After successful completion of the module, students possess basic experimental knowledge and are able to independently apply modern working techniques in biochemistry, molecular biology,

histology, cell culture, transcriptomics and proteomics. By working in the laboratory in a current field of molecular oncology, current research topics are understood and solutions to problems are developed independently. The skills and techniques learned can be easily transferred to other areas of expertise.

After completing the module, students will know the specific requirements for the preparation of a protocol in molecular oncology. They can carry out experiments, apply the methods learned, collect and evaluate data and present them in a lecture.

Teaching and Learning Methods:
Event type/teaching technique: Practical training; teaching methods in practical training: instructional talks and instructions, demonstrations, experiments, discussion of results, group meetings, technical literature, lecture, preparation of minutes

Media:
Lecture: Presentations using PowerPoint
Protocol: Text as Word file, graphics as Excel or PowerPoint files

Reading List:
Current technical literature provided by the supervisor of the internship

Responsible for Module:
Achim Krüger achim.krueger@lrz.tu-muenchen.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Onkologie (Praktikum, 10 SWS)
Krüger A [L], Krüger A
For further information in this module, please click campus.tum.de or here.

Module Description

ME2477: Research Project Molecular Virology | Forschungspraktikum Molekulare Virologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 100	**Contact Hours:** 200

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The student works experimentally in the laboratory as a member of a working group consisting of the group leader, PhD students and postdocs, technical staff and students, if applicable. He/she works under supervision on a task from the field of virology formulated for him/her at the beginning. He/she will keep a laboratory record of the experimental plan, the work performed and the results obtained. At the end the student prepares a protocol (graded), in which he/she demonstrates that he/she is able to describe the materials and methods, describe and summarize the results obtained and discuss them briefly in comparison with the relevant literature, in which the topic is introduced, the methods and materials are described, the results are presented and briefly discussed in comparison with relevant literature. He/she will participate in the regular seminars of the working group.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Knowledge of molecular biology is required. Basic knowledge in cell biology, immunology and virology is recommended.

Content:
The student works experimentally in the laboratory as a member of a working group consisting of the group leader, PhD students and postdocs, technical staff and students, if applicable. He/she works under supervision on a task from the field of virology formulated for him/her at the beginning. He/she will keep a laboratory record of the experimental plan, the work performed and the results obtained. At the end, the student prepares a protocol in which the topic is introduced, the methods and materials are described, the results are reproduced and briefly discussed in comparison with relevant literature. She/he participates in the regular seminars of the working group.

Intended Learning Outcomes:
After completing the laboratory internship, the student will be able to perform basic experimental techniques in the fields of virology, microbiology and cell biology. She/he has gained first experiences in protocol taking and presentation of scientific results.

Teaching and Learning Methods:
Direct, personal instruction for practical work in the laboratory. Private study of literature.

Media:
Internship, discussion in the working group, own oral presentation, transcript of the elaborated results in form of a short scientific paper (protocol)

Reading List:
Depending on topic, original literature and review articles

Responsible for Module:
Ulrike Prof. Dr. Protzer (protzer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Virologie (Praktikum, 2,5 SWS)
Protzer U, Bauer T, Schreiner-Gruber S, Pichlmair A
For further information in this module, please click campus.tum.de or here.

Module Description

WZme2677: Researchperiod Blood-forming Stem Cells | Forschungspraktikum blutbildender Stammzellen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 20	**Contact Hours:** 280

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Daily, active participation in the internship is expected. A presentation (30 min, graded) serves to test the theoretical skills learned in the internship. The students show in the lecture if they are able to structure the learned knowledge and present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations. The lecture grade is a sub-grade of the module (30%). To check the understanding as well as the ability to describe, evaluate and interpret the experiments carried out during the practical training, a protocol has to be kept, which is checked by a certificate (graded). The protocol forms the 2nd sub-grade of the module (70%). The examination of the cell biological working techniques learned in the practical course and their application to new questions takes place during the work (ungraded).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good knowledge of cell biology and biochemistry is required to better understand the internship.

Content:
During the internship, basic knowledge about examinations of haematopoietic stem and progenitor cells and stromal cells will be taught. Contents are among other things isolation of haematopoietic stem cells and stromal (niche) cells by means of flow cytometric methods, development of different cell culture methods for the determination of function and quality of haematopoietic stem and progenitor cells, molecular methods of the investigation of signaling pathways in rare cell types (immunofluorescence, flow cytometry), and an introduction to in vivo methods for the determination of stem cell function.

Intended Learning Outcomes:
After participating in the module courses, students will have a basic theoretical understanding and expertise of hematopoietic stem cells. Furthermore, they have learned and practiced basic cell biological working techniques. They should have learned,
- to understand (stem) cell biological questions and working techniques and to develop technical questions themselves.
- to understand the relationship between stem and progenitor cells and stroma (niche) cells.
- to apply the acquired knowledge to more in-depth questions.
- to understand the most important experiments on the basic topics of molecular cell biology and to be able to master them in terms of handling (technical and manual).
- to apply basic experimental know-how including safety and material knowledge (e.g. mastery of sterile working techniques and phenotypic identification of different cell populations), both for known trained experiments and for unknown experiments to be deduced from the literature.
The module should also help to develop problem-solving skills, and promote interest in cell biology, hematological problems and the importance of somatic stem cells.

Teaching and Learning Methods:
Event type/teaching technique: Lecture, practical course Teaching method: Lecture; in practical course, instructional talks, demonstrations, experiments, partner work, discussion of results. Learning activities: Study of literature and practical course script; practice of laboratory skills and cell biological work techniques; cooperation with practical course partners; preparation of work protocols and a summary of the entire course (with presentation of results and discussion).

Media:
Powerpoint,
script (download possibility for lecture material), practical course script

Reading List:
EThere is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Helgason, C.D., Miller, C.L. Basic Cell Culture Protocols. Methods in Molecular Biology, Springer Protocols, 4. Auflage (ISBN 978-1-62703-128-8)

Responsible for Module:
Oostendorp, Robert; Apl. Prof.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0067: Research Internship: Human Cytogenetics | Forschungspraktikum: Humane Zytogenetik

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of this module is performed in the form of a laboratory performance. This is to be proven by the preparation of a protocol (80% of the total grade) and a presentation (20% of the total grade).
The protocol serves to verify the ability to describe, evaluate and interpret the experiments performed in the practical course (length 15-25 pages) and should be prepared according to the IMRAD structure of a scientific publication (introduction, Mat&Meth, results, discussion).
The ability to present and interpret the experiments carried out in the practical course is demonstrated in the form of a presentation (approx. 30 min) and subsequent discussion with the supervising lecturer and specialist audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The attendance of the module “Humangenetics“ is required.

Content:
The practical course comprises 6 weeks of laboratory work. In the practical course, cytogenetic and molecular genetic laboratory methods are taught to prepare the student for independent, practice-oriented work. Among other things, students learn how to prepare cell, lymphocyte and amniotic fluid cell cultures as well as how to cultivate chorionic villi. Furthermore, the students deal with prenatal diagnostics, chromosome analyses (prenatal and postnatal) and the detection of chromosomal aberrations. Furthermore, chromosome staining techniques, fluorescence in situ hybridization (FISH) and microarray analyses will be discussed and performed. In addition, insights

into the topics of Sanger sequencing, multiplex ligation-dependent probe amplification (MLPA), whole genome amplification (WGA) and next generation sequencing (NGS) will be provided.

Intended Learning Outcomes:
Students will be able to produce cell cultures from post- and prenatal material upon completion of the lab. They will be able to describe numerical, structural chromosomal aberrations and translocations (balanced/unbalanced) and identify the associated disease patterns. Furthermore, students will be able to perform cytogenetic and molecular genetic techniques such as polymerase chain reaction (PCR), Sanger sequencing, multiplex ligation-dependent probe amplification (MLPA), array analysis, and exome sequencing. In addition, they will be able to identify and explain the characteristics of different hereditary traits (autosomal recessive, autosomal dominant, X chromosomal, mitochondrial) and create appropriate pedigrees. Furthermore, they are able to compare these with each other afterwards.

Teaching and Learning Methods:
Type of event/teaching technique: Practical course
In the practical course, students are introduced to the experimental procedure through instructional discussions, instructions and demonstrations. Subsequently, experiments are to be carried out independently and the results are to be interpreted and discussed (if necessary, with reference to relevant technical literature) during results discussions/group meetings.
By preparing a protocol, the participants should document, analyze and evaluate the results.

Media:
Depending on the chosen internship site: case-based approach, i.e. the contents are taught on the basis of cases, multimedia-supported teaching and learning programs as well as online procedures, general information (Internet).

Reading List:
Banerjee HN, Verma M. Epigenetic mechanisms in cancer. Biomark Med. 2009
Heng, Henry H.: Genome Chaos : Rethinking Genetics, Evolution, and Molecular Medicine. Stanford: Elsevier Science, 2019.
Alexey Moskalev, Alexander Aliper, Zeljka Smit-McBride, Anton Buzdin & Alex Zhavoronkov 2014

Responsible for Module:
Höfele, Julia Franziska Gertrud; Univ.-Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1332: Research Project Biogenic Allergens | Forschungspraktikum Biogene Allergene

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:**
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In einem etwa 6 wöchigen geblockten Laborpraktikum werden Fragestellungen zu multifaktoriellen Bildung von biogenen Allergenen und ggf. den Einfluss auf den menschlichen Organismus untersucht, wobei auf eine Einbindung in laufende Forschungsarbeiten angestrebt wird. Zur Anwendung kommen dabei auch zu größeren Teilen die jeweilige aktuelle Laborausstattung des Projektes. Am Ende des Praktikums wird ein Protokoll über das durchgeführte Projekt geschrieben und ein Vortrag darüber gehalten.

Repeat Examination:

(Recommended) Prerequisites:
Lehrveranstaltungen der mikrobiellen Ökologie im weiten Sinne oder der Pflanzenphysiologie, -biochemie, Molekularbiologie und verwandten Disziplinen

Content:
The majority of allergens in outdoor environments originate from pollen and fungi. Their allergenic potential depends on the amount and composition of allergens which are influenced by the environment. Among the major allergens are mainly stress proteins that are induced upon adverse environmental conditions such as suboptimal temperature, radiation, water regimes and interaction with air pollutants. Such scenarios are predicted to increase under ongoing climate change. Major aims of our group are to understand plant and fungal reactions to environmental conditions that induce stress. Allergenic potentials are studied using a system's approach from the organism to the molecular level. This also includes biotic factors that mediate stress responses in plants and fungi, thus potentially altering the allergen composition. Examples are microorganisms interacting with allergenic pollen, allergenic fungi reacting to other microorganisms, and microbial community composition in indoor environments that may affect immune responses of humans.

We aim at identifying factors that influence allergenic potentials such as kind and amount of allergens and interacting metabolites. Therefore, we perform experiments under controlled environmental conditions with increasing levels of complexity (single and combined stress factors) in phytotron chambers and in the greenhouse. Since results from controlled environmental conditions need to be verified in complex outdoor conditions, environmental samples are also studied. In addition, we use indoor dust samples in cohort studies to relate microbiome composition to human health data. From a microbial ecology perspective, we want to know which role biotic components and interactions play on allergenic potentials in outdoor and indoor environments.

Intended Learning Outcomes:
vertiefte Kenntnisse der Pflanzenstressbiologie, Biochemie der Allergene, und ggf. der mikrobiellen Ökologie; Anwendung theoretischen Wissens und erlernter Techniken in aktuellen Forschungsprojekten

Teaching and Learning Methods:
Interaktion Lehrende und Lernende
Anwesenheit und Mitarbeit im Labor; Verfassen eines Praktikumsberichts; Vortrag über die Arbeit: Methoden, Ergebnisse, Feedback

Media:

Reading List:
nach Absprache mit den Betreuern

Responsible for Module:
Pritsch, Karin

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1334: Research Project Urological Virotherapy | Forschungspraktikum Urologische Virotherapie

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam is a laboratory performance. It consists of the laboratory work itself, in which the quality and precision of the practical work lays the basis for the protocol of the research project. The participants use the protocol to show their ability to generate a scientific report, present and represent it in front of experts, for example the working group. The laboratory work includes – depending on the and investigated question and the presence time – about 240 hours in 6 weeks. The protocol consists of approximately 10 pages and shows the ability of the participant to process and document a scientific question academically correct as well as to evaluate and discuss the results in context of current literature, ideally obtaining a deep insight in the topic. The deadline for the submission of the protocol is within 4 weeks after the end of the practical work. In this time frame a 15 min presentation of the results from the protocol followed by 15 min of discussion needs to be done. Finally, the laboratory performance is graded, in which the quality of the laboratory work, the resulting protocol and depth of the presentation and discussion is included.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
1. Identification of viral titers of adenoviruses, 2. Cell lysis assay (proliferation assay) for the identification of lysis activity, 3. Identification of viral proteins via Western Blot analysis, 4. OD-measurement to identify the number of viral particles per ml, 5. Cultivation of HEK293 cells for viral production, 6. Real-time PCR for identification of the viral replication ability, 7. Legal requirements for S2-work

Intended Learning Outcomes:
After successful participation in the research project, the students are able to work under S2-conditions safely and process a question of a given topic in the urological virotherapy. The students can relate the topic, especially to the different aspects of the virology discussed in the seminar. They master not only the practical part of their experiments, but also the theory behind them. This makes them able to recognize malfunctions early and independent as well as develop and present constructive solutions. The students can compile the used methods and results as a scientific publication (e.g.: introduction, material and methods, results, discussion, literature), interpret and discuss them critically in the context of current literature. Furthermore, they are able to apply and evaluate methods of quantification of tumour lysis by virotherapy.

Teaching and Learning Methods:
An introduction to teaching methods/experiment will be made by trained personnel. The research project takes place in the provided S2-laboratories. A weekly seminar, in which general aspects and new results of virotherapy are presented and discussed, gives specific knowledge about this topic. The protocol and a short scientific presentation of the results are academically accompanied.

Media:
Powerpoint

Reading List:
Pubmed

Responsible for Module:
Per Sonne Holm per.holm@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2412: Immunology Research Internship | Forschungspraktikum Immunologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The practical work of the students is graded. The application of the techniques, the laboratory working methods and the keeping of a laboratory journal are evaluated. The understanding of experimental questions and methods from basic immunological research as well as the ability to process scientific data will be assessed by the students by writing a protocol (graded). The overall mark of the laboratory performance is composed of the two individual marks (mark practical work + mark internship protocol) in equal parts.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Successful completion of the module "Immunology 1"

Content:
This research internship is a work on a current project in one of the institute's research groups. The projects at the Institute represent basic immunological research in humans and mice with the aim of a greater understanding of immune responses against pathogens or misdirected immune responses in case of allergy and autoimmunity. With the help of the basic knowledge of immunology acquired in the module 'Immunology 1', specific scientific problems in this environment shall be analysed and evaluated in order to develop own solutions. During the internship the students are involved in the general seminars of the institute and the corresponding research group.

Intended Learning Outcomes:
After completion of this module, students are able to independently develop and perform experimental approaches for the investigation of selective immunological questions. Based on

the basic knowledge of immunology acquired in the module 'Immunology 1' they are able to understand and analyse specific scientific problems, plan experimental approaches and carry out the experiments independently.

Teaching and Learning Methods:
The module consists of a research internship in one of the Institute's working groups. The students work on a smaller research project. The immunological and other working methods to be applied for the project are taught by responsible supervisors. To fully understand the scientific background, students are encouraged to study original scientific papers.

Media:

Reading List:
original scientific papers

Responsible for Module:
Dirk Busch dirk.busch@mikrobio.med.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Immunologie (Praktikum, 10 SWS)
Busch D, Gerhard M, Prazeres da Costa C, Mejias Luque R, Buchholz V, Schumann K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2428: Research Internship Molecular Cell Biology of Tumorigenesis | Forschungspraktikum Molekulare Zellbiologie der Tumorentstehung

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (in min.): 20 min (oral test).
The students present the methods applied as well as the results achieved in the course of the internship in the form of a lecture in the working group seminar (20 min, graded). The experiments, their evaluation and interpretation will also be documented and discussed in written minutes, following the basic structure of a scientific article (10-20 pages, graded). The final grade is made up equally of the sub-grades for the lecture, the practical work and the practical training protocol (1:1:1).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Visit of the module "Molecular cell biology of tumorigenesis

Content:
The content of the research lab is based on the two lectures of the module "Molecular Cell Biology of Tumor Development": the development and progression of tumors is taught on a molecular genetic, biochemical and cell biological basis. Current laboratory methods from biochemistry, molecular biology, mouse genetics, tumor immunology and cell culture technology are learned and, as far as possible within the framework of the practical course, applied independently. Evaluation (including standard statistical methods) and critical interpretation of the experiments form a further part of the practical course.

Intended Learning Outcomes:
By participating in the module, students are able to perform basic cell biological, biochemical, molecular biological experimental procedures that are currently used in experimental cancer

research. In addition to practical experimental knowledge, students are also able to plan experiments in a meaningful way, to evaluate them independently and to interpret them critically. In addition, the presentation and communication of research results is learned and deepened through the practical lecture and the practical protocol.

Teaching and Learning Methods:
Form of event / teaching technique: Instructional talks and instructions, demonstrations, experiments, discussion of results, presentation of the results in the group, critical reading of English-language specialist literature, lecture, preparation of minutes.

Media:
Presentations via Powerpoint

Reading List:
There is no textbook available that covers all contents of this module. Current technical literature will be handed out by the supervisor depending on the topic of the internship. The following is recommended as a basis or supplement: 1) Biology of Cancer, Robert Weinberg, Garland Science 2006; ISBN: 0815340761
2) Textbook on Molecular Cell Biology, Alberts et al., Wiley VCH, 2007 ISBN: 3527311602
3) The Mouse in biomedical research. James G. Fox (Ed.). Academic Press, 2007. ISBN: 9780123694546
4) Mouse Models of Human Cancer. Eric C. Holland (Editor), Wiley-VCH, 2004. ISBN: 978-0-471-44460-2

Responsible for Module:
Klaus-Peter Janssen klaus-peter.janssen@lrz.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2454: Research Internship Molecular Pathology and organ-specific Carcinogenesis | Forschungspraktikum Molekulare Pathologie und organspezifische Karzinogenese

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of the examination (in min.): Protocol as study achievement + 30 min presentation.
The ability to present and interpret the experiments carried out during the practical training is tested in the form of a presentation in the supervising lecturer's working group (30 min, ungraded). The experiments must also be documented and discussed in the form of a protocol. The protocol serves to check the ability to describe, evaluate and interpret the experiments carried out during the practical training (10-20 pages, graded). The overall mark for the module consists of 20% lecture and 80% protocol.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Attendance of the module "Molecular pathology and organ-specific carcinogenesis" is required.

Content:
The internship is carried out in the working group of a lecturer participating in the lectures "Molecular Pathology" or "Organ-Specific Molecular Carcinogenesis" at the Institute of Pathology of the Technische Universität München or at the Institutes of Pathology or Radiobiology of Helmholtz Zentrum München in Neuherberg. The tasks for the internship are based on the current research focus of the lecturers and take up a partial aspect of the lectures. Basic techniques of molecular pathology and molecular biology are used in the experiments.

Intended Learning Outcomes:
In the practical training basic experimental knowledge and modern working techniques are taught. By working in the laboratory in a current field of molecular pathology or organ-specific

carcinogenesis, the students are able to understand current research topics and develop solutions to problems independently. The skills and techniques learned can also be transferred to other fields.

Teaching and Learning Methods:
Event type/teaching technique: Practical training; teaching methods in practical training: instructional talks and instructions, demonstrations, experiments, discussion of results, group meetings, technical literature, lecture, preparation of minutes

Media:
Lecture: Presentations using PowerPoint
Protocol: Text as Word file, graphics as Excel or PowerPoint files

Reading List:
Current literature provided by the supervisor of the internship

Responsible for Module:
Birgit Luber luber@lrz.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2545: Research Project Animal Biotechnology | Forschungspraktikum Biotechnologie der Tiere

Version of module description: Gültig ab summerterm 2002

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Tiere (Forschungspraktikum, 10 SWS)
Bauer B, Fischer K, Flisikowska T, Flisikowski K, Schnieke A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2681: Research Project: Challenges of Biomedicine. Social, Political and Ethical Aspects of Medical Biology. | Forschungsprojekt: Herausforderungen der Biomedizin. Soziale, politische und ethische Dimension der medizinischen Biologie.

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Realisation of an independent, supervised research project focused on social, ethical and political aspects of biomedicine at the professorship of science and technology policy.
Central Aspects: literature research and analysis; development of a research question; adressing this research question through literature analysis or empirical social science methods; writing a research report.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Modul "Challenges of biomedicine" or comparable prior experience

Content:
What role does biomedicine play in contemporary society? Which social, political and ethical questions do new forms of knowledge from the life sciences and new biomedical technologies raise? How do new molecular perspectives change our understanding of what it means to be human as well as how we think about body, illness, health and environmen? New forms of biomedical knowledge and new biotechnologies shape society in many different ways. They inspire social and economic hopes as well as controversial debates about potential risks and consequences, for example in field such as stem cell research, reproductive medicine, genetic diagnostics and gene editing, neurobiology or new epigenetic models of body-environment-interactions. New biomedical knowledge can create novels concepts of health risks and healthy behaviour, and can also generate new forms of responsibility, guilt and discrimination On the state level, discussions arise about how new technologies can and should be regulated and made

accessible.Companies are often concerned with questions related to the patentability of biomedical innovations and genetically modified organisms. In medical practice, we encounter debates about how new biomedical technologies and concepts of illness can be integrated into the daily routines of clinics and care-work and what this might imply for care-workers, doctors and patients. These are just a few aspects that show how the 21st century is characterized by complex new forms of „biopolitics“ that arise in relation to new forms of scientific knowledge and new technologies. In this modul, we will learn how to identifity and analyze social, political and ethical questions arising in the context of biomedical innovation. The objective is to help students develop an understanding of how biomedical knowledge and technologies are shaping and being shaped by contemporary society and which challenges, opportunities and tensions arise in this context.

Intended Learning Outcomes:
With the succesfull completion of the module students will aquire skills to empirically investigate questions concerning the social, political and ethical dimensions of biomedicine. They will obtain more fine-grained knowledge about the theories and methods of science and technology studies and first experiences working with social science methods. Students will thereby strenghten their compentences to not only consider the technoscientific but also the social, political and ethical aspects of biomedical innovations.

Teaching and Learning Methods:
Supervised independent scientific work in the area of Science and Technology Studies (STS)

Media:

Reading List:

Responsible for Module:
Prof. Dr. Ruth Müller

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungsprojekt: Herausforderungen der Biomedizin. Soziale, politische und ethische Dimension der medizinischen Biologie (Projekt, 2 SWS)
Müller R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2697: Research Project Analysis of High-Throuput Data in Biomedical Research | Forschungspraktikum Analyse von Hochdurchsatz-Daten in der biomedizinischen Forschung

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The scientific protocol to be prepared (introduction, material and method, results and discussion, length 15-25 pages) serves to verify the ability to describe, evaluate and interpret the data analyses performed during the practical training on the topic of high-efficiency-information data in biomedical research.
The ability to present and interpret the data analyses performed in the practical course and described in the protocol must be demonstrated in the form of a presentation in the working group of the supervising lecturer. The ability to present the scientific work orally and the ability to engage in scientific and critical discussion beyond the written form can be tested. A mark is awarded for the overall performance (quality of the laboratory work, protocol, presentation).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of general and molecular genetics and interest in programming. First programming experiences such as the course 'Methods for Analysis of Next Generation Sequencing Data' (WZ2049) are strongly recommended.

Content:
The practical course is accomplished in the specialized group paediatric nutrition medicine at the location Weihenstephan. The tasks for the internship are based on the lecturers' current research focus on pancreatitis and metabolic diseases such as type 2 diabetes. For both diseases a hereditary component is described. An essential aspect in modern genetics of human diseases is currently the integration of high-efficiency-information data such as next generation sequencing (NGS) data or proteomic data - with different phenotypic data. During the internship, students

learn to process and interpret high-efficiency-information biomedical data such as exome or whole genome data, for example with basic data analysis methods such as VCFtools or variant analysis with SnpEff. Furthermore, existing biomedical databases can be included in the analyses. This internship gives students a first insight into the interpretation of high-efficiency-information data such as NGS and illustrates its increasing importance in modern biomedical research. The internship can also be taken to prepare a thesis.

Intended Learning Outcomes:
By working in a research area of human genetics, students will understand the analysis of high-throughput data in biomedical research, develop solutions to problems, and apply selected data analysis methods - such as analysis and visualization of NGS/proteomics data with bioinformatics online tools or work with Linux, R, Python, Bash scripting - in practice. The acquired skills and techniques can be transferred to other fields of expertise.

Teaching and Learning Methods:
Internship. Exercises on the computer, literature research, working on problems and finding solutions, practice of technical skills, production of reports, constructive criticism of own work, implementing criticism productively. Teaching method; question-developing method, project work.

Media:
Lecture: Presentation software. Protocol: Word processing file.

Reading List:
Current technical literature is provided by the supervisor of the internship.

Responsible for Module:
Prof. Dr. Heiko Witt

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2756: Research Internship Molecular Pathology of Vessels | Forschungspraktikum Molekulare Pathologie der Gefäße

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:**
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 40	**Contact Hours:** 260

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Minutes and presentation, questioning about the results and background knowledge: 30-40 minutes. The student should present the achieved results in a compact and understandable way in a 10-15 minute presentation. The results are then interviewed and background knowledge that led to the results is checked. The experiments must be documented in a laboratory book. Keeping the laboratory book serves to check the ability to evaluate and correctly interpret the results. The examination is therefore oral and also written in the form of keeping the laboratory book. Protocol and presentation are charged 3:1 (P3:V1). The module is passed if the average result is better than 4.1.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in the biology of circulatory systems, Bachelor degree

Content:
The internship is supervised by the private lecturer Dipl.-Biologen Dr.rer.nat. J. Pelisek and by expert members of the research group of Prof. Mägdefessel (Vascular Biology) in the laboratory rooms of the Pathology Department of the Klinikum rechts der Isar and Biederstein. The student will be involved in the ongoing projects and will directly participate in the research of the working group. Basic techniques of molecular biology, such as immunohistochemistry, DNA and RNA isolation from human tissue, analysis of expression at the mRNA level (RT-PCR) and also at the protein level (Western blot, ELISA) will be taught.

Intended Learning Outcomes:
During the internship, the basic knowledge of modern laboratory techniques in the field of diseases of the circulatory system will be taught. The acquired skills should also be transferred to other research areas.

Teaching and Learning Methods:
Instructional talks are held, individual protocols are discussed and the experimental procedure is explained. The student should learn the techniques used in practice and provide background knowledge. Lectures, talks and presentations will take place, results will be discussed and evaluated, technical literature will be researched and individual protocols will be written.

Media:
Working with Word, Excel, PowerPoint, statistics program SPSS

Reading List:
Literature is provided by supervisors, research in PubMed is carried out.

Responsible for Module:
Pelisek, Jaroslav; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2674: Challenges of Biomedicine. Social, Political and Ethical Aspects of Medical Biology | Herausforderungen der Biomedizin. Soziale, poltische und ethische Dimension der medizinischen Biologie

Version of module description: Gültig ab summerterm 2016

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige Anwesenheit und aktive Teilnahme am Seminar, Lektüre und Vorbereitung der Basisliteratur, Gestaltung von kleineren Inputelementen für das Seminar (Referat/ Sitzungsmoderation)

Schriftliche Abschlussarbeit (Hausarbeit)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
Welche Rolle spielt die Biomedizin in der heutigen Gesellschaft? Welche sozialen, politische und ethischen Fragen werfen neues biomedizinisches Wissen und biomedizinische Technologien auf? Wie verändern neue molekulare Perspektiven unser Selbstverständnis als Menschen, sowie die Art und Weise, wie wir über Körper, Krankheit, Gesundheit und deren Umwelten nachdenken? Neue biomedizinsche Wissensformen und Technologien formen Gesellschaft vielfältig. Sie sind oft von großen gesellschaftlichen und ökonomischen Hoffnungen begleitet, aber auch von kontroversen Debatten, die nach den Risiken und Konsequenzen dieses neuen Wissens fragen. So etwa im Bereich der Stammzellforschung, der Reproduktionsmedizin, der genetischen Diagnostik, der Neurobiologie oder neuer epigenetischer Modelle von Körper-Umwelt-Interaktionen. Hier entstehen neue Konzepte von gesundheitlichem Risiko, neue individuelle und gemeinschaftliche Handlungsräume, aber auch neue Formen von Verantwortung, Schuld und möglicherweise auch neue Formen der Diskriminierung. Auf staatlicher Ebene muss

überlegt werden, wie neue Technologien reguliert, zugänglich gemacht und finanziert werden können und sollen. Privatwirtschaftliche Perspektiven fokussieren auf die Patentierbarkeit von biomedizinischen Innovationen, aber auch von biotechnologisch veränderten Lebewesen.
Im medizinschen System stellt sich die Frage wie neue biomedizinische Technologien und Krankheitskonzepte in den Klinik- und Pflegealltag eingeflochten werden können und was dies für Behandelte und Behandelnde bedeuten kann. Das 21. Jahrhundert ist damit gezeichnet von einer vielschichtigen, neuen "Biopolitik", für die Wissenschaft und Technik eine entscheidende Rolle spielen. Anhand von Beispielen aus aktuellen Debatten um biomedizinische Innovationen werden wir in diesem Modul lernen, wie soziale, politische und ethische Fragen in diesem Kontext erkannt und analysiert werden können. Ziel des Moduls ist es, ein Verständnis dafür zu entwickeln, wie biomedizinisches Wissen und biomedizinische Technologien Teil unserer Gesellschaft werden, welche Herausforderungen, Möglichkeiten und Spannungsverhältnisse sichtbar werden und welche Handlungsmöglichkeiten identifizieren werden können.

Intended Learning Outcomes:
Nach erfolgreichem Absolvieren des Moduls erwerben Studierende die Fähigkeit sich zu soziilen, politischen und ethischen Fragen an der Schnittstelle von Biomedizin und Gesellschaft kompetent zu positionieren, indem sie verschiedene gesellschaftliche und wissenschaftliche Positionen zu diesen Themen kritisch reflektieren, sowie eigene Einschätzungen artikulieren können. Studierende erwerben in diesem Sinne im Laufe der Lehrveranstaltung die Kompetenzen 1) Soziale, politische und ethische Fragen an der Schnittstelle von Biomedizin und Gesellschaft zu identifizieren; 2) Wissenschaftliche Texte, die entlang von Fallstudien die Beziehung von neum biomedizinischen Wissen/ Biotechnologien und Gesellschaft beschreiben, zu lesen, zu diskutieren und die Kernargumente zu verstehen; 3) Eigenständig aktuelle Debatten in Gesellschaft, Medien und Politik zu Biomedizin und Gesellschaft zu recherchieren; 4) Die erworbenen Analysefähigkeiten auf diese aktuellen gesellschaftlichen Debatten anzuwenden und die Beziehungen zwischen Biomedizin und Gesellschaft in den selbstrecherchierten Fallstudien kritisch zu reflektieren und zu diskutieren, sowie eigene Fragen und Einschätzungen zu formulieren.

Teaching and Learning Methods:
Lektürearbeit; angeleitete Gruppenarbeiten zur Diskussion und Vertiefung des Textverständnisses und zur Entwicklung eigener Fragen; Diskussion im Plenum; Inputelemente von Seiten der Studierenden wie Kurzreferate oder Sitzungsmoderation; eigenständige Recherchen zu Themen im Kontext der Lehrveranstaltung; schriftliche Hausarbeit als Abschluss der Lehrveranstaltung.

Media:
PowerPoint, Moodle, Flipchart, Film(ausschnitte), Reader

Reading List:
Beispiele (im Kurs werden Auszüge/Kapitel gelesen)

Dickel/Franzen/Kehl (Hg.) (2011): Herausforderung Biomedizin. Gesellschaftliche Deutung und soziale Praxis. Bielefeld: transcript.

Dumit, Joseph (2004): Picutring Personhood. Brain Scans and Biomedical Identity. Princeton: Princeton University Press.

Liebsch/Manz (Hg.) (2010): Leben mit den Lebenswissenschaften. Wie wird biomedizinisches Wissen in Alltagspraxis übersetzt? Bielefeld: transcript.

Niewöhner/Kehr/Vailly (Hg.) (2011): Leben in Gesellschaft. Biomedizin – Politik – Sozialwissenschaften. Bielefeld: transcript.

Reardon, Jenny (2005): Race to the Finish: Identity and Governance in an Age of Genomics. Princeton: Princeton University Press.

Thompson, Charis (2013): Good Science: The Ethical Choreography of Stem Cell Research. Cambridge, MA: MIT Press.

Responsible for Module:
Prof. Dr. Ruth Müller

Courses (Type of course, Weekly hours per semester), Instructor:
Herausforderungen der Biomedizin. Soziale, politische und ethische Dimension der medizinischen Biologie. (WZ2674) (Seminar, 2 SWS)
Braun M [L], Braun M, Schönwolff M
For further information in this module, please click campus.tum.de or here.

Module Description

ME2453: Molecular Pathology and Organ-Specific Carcinogenesis | Molekulare Pathologie und organspezifische Karzinogenese

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die regelmäßige Teilnahme an den Vorlesungen "Molekulare Pathologie" und "Organspezifische Molekulare Karzinogenese" ist erforderlich. Zwei Klausuren (jeweils 90 min, Single choice, benotet) dienen der Überprüfung der in den Vorlesungen erworbenen theoretischen Kompetenzen. Aufgrund des Pandemiegeschehens hat der/die Studierende auch die Möglichkeit, an einer beaufsichtigten elektronischen schriftlichen Fernprüfung (Aufsicht mit Proctorio, 90 min.) teilzunehmen (Onlineprüfung: me555o +me654o).
Diese schriftliche Prüfung wird zeitgleich parallel in Präsenz angeboten (me555+ me564)

No aids may be used in the examinations. The examination questions cover the entire lecture material. Students have the task of marking the correct answer(s) to 20 questions per exam from four given answers per question. The exams test the students' expertise and check whether they are able to combine and interpret the acquired knowledge. The two lectures can be attended in the same or different semesters. The overall grade of the module is made up of both exam grades.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The basic knowledge of molecular biology and genetics acquired during the bachelor's program should be sufficient for understanding the lectures. Attending other modules is not required.

Content:
The lecture "Molecular Pathology" teaches methodological basics of tissue analysis on the highest scientific level and deals with interdisciplinary aspects of pathological processes. Special emphasis

is placed on oncogenes and tumor suppressor genes, cell adhesion and metastasis, signal transduction, cell cycle and apoptosis, angiogenesis, environmental carcinogenesis and cancer stem cells. This will provide an understanding of the molecular mechanisms of oncogenesis. In the lecture "Organ-Specific Molecular Carcinogenesis", basic tumor classifications are explained and organ-specific carcinogenesis is explained in detail and in an understandable way for carcinomas of the stomach, colon, liver, pancreas, mamma, lung and urogenital tract. In addition, leukemias and lymphomas, brain tumors, and endocrine tumors are covered. In addition, leukemias and lymphomas, brain tumors and endocrine tumors are treated.

Intended Learning Outcomes:
After attending the two lectures, the students will have basic knowledge of molecular pathology, molecular pathological working techniques and organ-specific molecular carcinogenesis. They should have learned to understand molecular pathological questions and working techniques and to develop solutions independently, to understand molecular mechanisms of oncogenesis and to recognize interrelationships and particularities of carcinogenesis of different organs. The module should provide an insight into human pathology and arouse interest in the diagnosis and therapy of cancer.

Teaching and Learning Methods:
Course type/teaching technique: Lecture, teaching method: lecture; learning activities: study of lecture material, lecture notes and literature

Media:
Presentations via Powerpoint,
Script (download option for lecture material)

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a addition:
C. Wagener, O.Müller (Hsg.) Molecular Oncology, Georg Thieme Verlag, Stuttgart, 2010.

Responsible for Module:
Luber, Birgit; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Organspezifische Molekulare Karzinogenese (Vorlesung, 2 SWS)
Luber B [L], Luber B, Azimzadeh O, Becker K, Keller G, Kuhn P, Muckenhuber A, Nawroth R, Neff F, Pellegata N, Sarker R

Molekulare Pathologie (Vorlesung, 2 SWS)
Luber B [L], Luber B, Becker K, Azimzadeh O, Keller G, Kuhn P, Mörtl S, Pellegata N, Rosemann M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2411: Immunology 2 | Immunologie 2

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 130	**Contact Hours:** 170

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of exam (in min.): 60 written + 10 oral (presentation) + practical (SL).
Regular, active participation in the courses is expected, for the internship it is required (presence check). The theoretical knowledge and basic understanding of the
connections are tested by an exam (60 min, graded). The understanding of experimental questions and methods will be evaluated by a summarizing presentation (graded) and by writing a protocol (graded) by the students. Examination, lecture and internship protocol
The mark of the written examination of the theory counts 1-fold, the common mark of lecture and practical course protocol counts 2-fold. If the overall grade is better than 4.1, the module is considered completed and passed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of the module 'Immunology 1

Content:
The module 'Immunology 2' is addressed to students who - based on the module 'Immunology 1' - want to deepen their knowledge of immunology. TThe basic knowledge about the mechanisms of immune defense is further developed by consideration of more complex immunological facts, such as the exact immunological processes in autoimmune diseases and tumor diseases. Furthermore, questions in the
immunological research and current research results are looked at. The lecture 'Special Immunology' deals with questions of current immunological research.
The practical course serves to get to know and apply immunological working methods in practice, such as
flow cytometry and various immunocyte assays.

Intended Learning Outcomes:
After completing this module, students are able to use the most important experimental methods to understand and/or apply for investigation of immunological questions. With the internship the students gain the ability to apply basic immunological methods such as isolation and cultivation of immune cells as well as the analysis of cells using flow cytometry, i.e. mastering this process. Attending the lecture enables the students to master even more complicated experimental approaches based on concrete scientific questions and to gain a deep insight into current immunological research areas. Attendance of lectures and practical training lay the foundation for the ability to apply the basic knowledge of immunology gained in the course of module 'Immunology 1' to unknown facts, evaluate immunological questions and possibly to develop own solutions.
The attendance of this module gives students the ability to further conduct immunological research in either a master's or doctoral thesis.

Teaching and Learning Methods:
The module consists of a lecture and a subsequent practical training. In the lecture current research topics are presented by the chair staff. The students are invited to study original scientific papers. During the practical training they learn immunological working methods, as well as the processing of questions from immunological research by means of group or partner work.

Media:
Presentations via Powerpoint, script (download possibility for lecture material), internship script

Reading List:
original scientific papers (recommended by the lecturers)

Responsible for Module:
Busch, Dirk; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum der Immunologie (für Biologen) (Praktikum, 8 SWS)
Buchholz V (Kretschmer L), D'Ippolito E, Kazeroonian A, Mejias Luque R, Meyer H (Norman D, Bianca S), Schiemann M (Andrä I), Schumann K (Bernard B, Kolb S)

Spezielle Immunologie für Biologen, Biochemiker, Molekulare Biotechnologen und Mediziner (Vorlesung, 2 SWS)
Buchholz V, Busch D, Friedrich V, Gerhard M, Hochrein H, Keppler S, Kohleisen B, Mejias Luque R, Meyer H, Neuenhahn M, Prazeres da Costa C, Prodjinotho U, Rosenbaum M, Schiemann M, Schumann K
For further information in this module, please click campus.tum.de or here.

Module Description

WZme2670: Innovative Approaches in Viral Gene Technology | Innovative Ansätze in der viralen Gentechnologie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of
a) Presentation (30 min) (1SWS = 45h), in which students with availability of aids demonstrate that they understand and are able to evaluate the most important aspects of the field. Time required for self-study approx. 2 SWS, since all students need to read all papers and need to prepare their presentation.
b) Term paper. Students must submit a self-explaining presentation, which demonstrates that basic elements of viral gene transfer / technology have been understood. Time required: 3 SWS.

The result of the exam is registered as a graded mark.

Different types of test are necessary, as only the oral presentation will provide evidence for not only the scientific understanding, but also for evaluation of the presentation and discussion skills, whereas the term paper will allow for evaluation of students' basic scientific knowledge and literature search skills. Evaluation will be as follows: seminar presentation:discussion during seminar: term paper 3:1:2. The module will be passes with grade better than 4.09.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Good basic knowledge in molecular genetics is required.
Lecture series "Viral and no-viral nucleic acids transfer - Methods and applications in research and therapy" is strongly suggested.

Content:
Due to their high efficiency viral vectors are on the one hand used in therapeutic approaches, but more often as molecular tools.
Novel approaches in viral gene technology in recent years comprise the advancement of existing, often attenuated, viruses by genetic, physical or chemical means as well as the development of novel vector types based on rarely used viruses. These approaches are persued in order to make them more specific and even more effective in vitro and in vivo.
In the field of tumor therapy oncolytic viruses gained attention, whereas with respect to regenerative approaches and in basic research replication defective viral vectors are used to generate e.g. iPS, regulate gene expression by miRNAs or edit the genome by CRISPR/Cas, etc.
With respect to safety, when using integrating viruses, it is of utmost importance to understand and influence integration mechanisms as well as sites.
As many basic researchers working in the field of molecular biology will encounter viral vectors a good knowledge of basic as well as advanced techniques is indispensable.

Intended Learning Outcomes:
Upon successful completion of this module, students are able to understand isolated aspects of innovative approaches in gene technology with emphasis on viral gene transfer.
Students are able to:
• read publications critically (regarding scientific conclusiveness, missing controls,...),
• present data and scientific background in a concise way (power point presentation),
• get involved into active discussion during general discussion,
• to receive and to deal with critical questions posed to the presenting person.

Teaching and Learning Methods:
Seminar

In the seminar students are choosing a paper, each, from a list of very recent (English) publications in the field of gene technology provided by the instructor. Special attention will be given to viral gene therapy and viral gene delivery.
Students are giving English power point presentations consisting of background information, main data of the paper, the authors' conclusions and their own evaluation and interpretation of data and conclusions.
The presentation will be followed by active scientific discussion with all students guided by the instructor.
Suggestions for improvement of presentation will be given by the instructor and students.
This format allows for the unique chance for students to get insight into innovative technical approaches in the field and on the other to enhance their (English) presentation skills, dare to ask questions and learn how to deal with critical and questions in a rather private atmosphere.

Term paper
In contrast to the seminar, which deals with novel aspects of viral gene technology, the term paper will focus on basics supporting the understanding of techniques that were presented in the seminar.
With this respect an aspect of the paper presented during the seminar will be chosen and will be dealt with in detail (e.g. viral replication cycles, virion structure and organization, etc.). The elaboration will exceed the scientific background of the seminar presentation.
The instructor will choose the topic, to which students will perform literature research.
The elaboration of the topic will in most cases be based on older literature.
Besides the elaboration the term paper will include a reference list and an explanation how the literature search was performed.

Media:
e.g. reader, scripts, overheads, blog, whiteboard, exercise sheets, exercise portfolio, flipchart, PowerPoint, films, etc.

Reading List:
Literaturrecherche in PubMed.

Responsible for Module:
Anton, Martina; PD Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Präsentation und Diskussion innovativer Ansätze in der Gentechnologie Hausarbeit (Seminar, 3 SWS)
Anton M [L], Anton M

Präsentation und Diskussion innovativer Ansätze in der Gentechnologie (Seminar, 2 SWS)
Anton M [L], Anton M, Plank C
For further information in this module, please click campus.tum.de or here.

Module Description

ME2496: Molecular and Medical Virology | Molekulare und Medizinische Virologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer Klausur (90min, benotet) in der die Studierenden grundlegende und vertiefte Kenntnisse der Virologie abrufen und anwenden sollen.
Die Prüfungsleistung wird am Ende des 2. Vorlesungssemesters (SS) erbracht. Die Wiederholungsklausur findet in der vorlesungsfreien Zeit zu Beginn des darauf folgenden WS Semesters statt.
In der Prüfung soll nachgewiesen werden, dass Grundlagen der Virologie inkl. molekularer und medizinisch relevanter Aspekte verstanden und wichtige funktionelle Zusammenhänge der Virus-Wirt-Interaktion analysiert werden können.
Das Beantworten der Fragen erfordert teils eigene Formulierungen und teils Ankreuzen von vorgegebenen Mehrfachantworten. Es sind keine Hilfsmittel erlaubt.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Kenntnisse der Molekularbiologie und Grundkenntnisse in Zellbiologie und Immunologie

Content:
Allgemeine Themen der molekularen Virologie (z.B. Viruseintritt in Wirtszellen, Replikationsstrategien von RNA und DNA Viren, Expressionskontrolle, Virusassembly), Virusfamilien (z.B. Toga-, Flavi, Herpes-, Myxo, Hepatitis-, Retroviren); medizinische Aspekte der Virologie (z.B. angeborene und adaptive Immunreaktionen gegen Viren, Immunevasion, Impfungen, Emerging viruses, onkogene Transformation, virale Vektoren)

Intended Learning Outcomes:
Nach dem Besuch des Moduls versteht der Studierende die grundlegenden Prinzipien der Virologie, kennt die Merkmale bedeutender Virusfamilien und die wichtigsten Mechanismen der Virus-Wirt-Beziehung

Teaching and Learning Methods:
Vorlesungen mit Unterstützung durch PowerPoint Präsentationen, die Folien werden zum Download bereitgestellt

Media:

Reading List:
Flint et al., Principles of Virology I and II, ASM Washington
Modrow et al., Molekulare Virologie, Spektrum Verlag 2010

Responsible for Module:
Protzer, Ulrike; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare und medizinische Virologie (Teil 1 und 2) (Vorlesung, 2 SWS)
Protzer U [L], Protzer U, Baer de Oliveira Mann C, Deng L, Ebert G, Möhl-Meinke B, Pichlmair A, Vincendeau M, Wettengel J
For further information in this module, please click campus.tum.de or here.

Module Description

ME2635: Molecular Oncology | Molekulare Onkologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Klausur (90 min, freie Fragen, Benotung nach 1,0; 1,3; 1,7...) dient der Überprüfung der im Modul erworbenen theoretischen Kompetenzen, insbesondere Zell- und molekularbiologische Mechanismen der Krebsentstehung und Metastasierung. Bei den Prüfungen dürfen keine Hilfsmittel eingesetzt werden. Die Prüfungsfragen fordern die Kompetenz zur Fähigkeit zur Reproduktion (zentrale Fragestellungen des Moduls wie z.B. molekulare Signalwege, intra- und interzelluläre Kommunikationswege wiederzuerkennen und abzurufen), Assoziation (Verknüpfung von Erlerntem zu neuen Lösungen im Bereich der molekularen Onkologie) und Transfer (problemorientierte Anwendung erlernter Regulationsmechanismen bzw. Forschungsansätze auf neue verwandte oder auch andere Forschungsbereiche (Physiologie, andere Pathophysiologien) und Anwendung des erworbenen, molekularbiologischen Wissens auf vertiefte Fragestellungen, z.B. die Kompetenz aktuelle Forschungsergebnisse einordnen und bewerten zu können. Die Klausur kann bei Nichtbestehen zum Ende des Folgesemesters wiederholt werden, wobei die Gelegenheit gegeben wird, die Vorlesungsteilnahme zu wiederholen. Erst daraufhin kann dann die Vertiefung mit Hilfe der Hausarbeit erfolgen. Es geht bei der Hausarbeit um die vertiefte Ausarbeitung der in der Vorlesung behandelten Themen. Die Hausarbeiten müssen zu einem festgesetzten Termin am Ende des auf die bestandene Prüfung folgenden Semesters des Moduls abgegeben werden. Die Hausarbeit besteht aus der selbständigen Auswahl einer Originalpublikation zu jedem der 10 Themenkomplexe der Vorlesung (s.u.) und der Erstellung von je einer Reproduktions-, Assoziations- bzw. Transferfrage und den dazugehörigen Antworten, die sich aus dem Text bzw. den Abbildungen der Publikation erstellen lassen. Dieser Katalog, bestehend aus 30 Fragen und Antworten muss zu einem festgesetzten Termin als ppt File und pdf File eingereicht werden. Richtigkeit, Originalität und formale Ausführung werden in ihrer Gesamtheit als Studienleistung bewertet. Das Modul ist bestanden, wenn Klausur bestanden ist und die Studienleistung erfolgreich abgelegt wurde.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Biochemie, Molekularbiologie und Genetik sind Grundlage für das Verständnis der Vorlesungen. Der Besuch anderer Module wird nicht vorausgesetzt.

Content:
1.) Merkmale der Tumorprogression (Problematik der modernen Tumorforschung, Begriffsbestimmungen, Bedeutung des Tumor-Microenvironments, Hallmarks of Cancer, Eigenschaften transformierter Zellen im Experiment); 2.) Ursachen der Tumorentstehung (Stammzellen und Tumorbildung, wnt/ hedgehog Self-renewal, Mutationen, Reparatur, zelluläre Antwort auf Mutagene); 3.) Onkogene (Experimente von Rous, Rubin, Temin, Weinberg, Definitionen, Funktionsklassen von Onkogenen und Beispielen); 4.) Tumorsuppressorgene (Definitionen, Knudson two hit hypothesis, PTEN, Kontrollpunktze des Zellzyklus, pRB, p53, MDM2, Apoptose); 5.) Epigenetik (Definitionen, Histonmodifikationen, DNA Methylierung, pRb, CpG Islands, Beispiele, Experimente von Mary Hendrix); 6.) Umwelt der Zelle (Komponenten eines Tumors, Tumorstroma als therapeutisches target, Exrazelluläre Matrix: Komponenten und Bedeutung, Interaktionen Zelle/ECM, Zell-Zell Kontakte); 7.) Mechanismen der Metastasierungskaskade (Schritte der Kaskade, Angiogenese, angiogenic switch, Invasion, Wundheilung und Krebs, tumorassoziierte Macrophagen, epithelial-mesenchymal transition, seed and soil Hypothese, Rolle von Proteasen, Metastatische Nische; Markergene; Metastasierungsmodelle in der Maus); 8.) Proteasen/Proteolytisches Netzwerk (Physiologische und pathophysiologische Funktionen von Proteasen und Proteaseinhibitoren, Regulation von Proteasen, Spaltungsmechanismen, das proteolytische Gleichgewicht, Proteasenfamilien, Proteasen als prognostische Marker, Entwicklung von synthetischen Proteaseinhibitoren, klinische Prüfungen, Optimierung synthetischer Proteaseinhibitoren, das Cancerdegradome); 9.) Spezifische Methodik der Molekularen Onkologie (in vivo Modelle, biochemische/molekulare Nachweismethoden von Proteasen und Proteaseinhibitoren, Zymographie, knock-out Systeme, siRNA, shRNAi, virale Vektorsysteme, in vitro Migrations- und Invasionsmodelle); 10.) Vertiefung der genannten Gebiete (Diskussion von aktuellen Publikationen aus relevanten Fachzeitschriften, Erarbeitung eines vertieften Verständnisses der gelernten Mechanismen).

Intended Learning Outcomes:
Die Studierenden kennen und verstehen molekulare Mechanismen der Tumorprogression, d.h. von der Tumorentstehung bis hin zur Metastasierung. Sie können die komplexen intrazellulären und extrazellulären Regelkreise in ihrer Bedeutung für die Interaktionen zwischen Tumor und gesundem Gewebe verstehen. Anhand von experimentellen Beispielen aus der Wissenschaftsgeschichte sowie aktuellen Publikationen kennen die Studierenden den Vorgang des Erkenntnisgewinns in diesem Fachgebiet. Durch zahlreiche Hinweise im Vortrag haben die Studierenden die immer notwendigere kritische Position zum Umgang mit Forschungsergebnissen und deren Translation (z.B. in die Klinik). Mit dem in diesem Modul vermittelten Wissen (z.B. molekulare und zelluläre Mechanismen der Tumorgenese, Wirkung von Onkogenen und Tumorsuppressorgenen, sowie der Wirkung der Tumormikroumgebung) können die Studierenden relevante aktuelle Publikationen auf dem Gebiet der molekularen Tumorforschung verstehen und bewerten und bringen die theoretischen Voraussetzungen mit, die für die Aufnahme einer Projekttätigkeit in der Forschung (z.B. Master-, Doktorarbeit) notwendig sind. Die Studierenden

sind in der Lage, Originalpublikationen mit den im Modul zum Thema molekulare Onkologie erworbenen Kompetenzen zu verknüpfen und damit ihr Wissen anwendungsbezogen zu testen. Hierbei wird insbesondere die Fähigkeit geprüft, eine Originalpublikation aus der aktuellen Forschung zu analysieren, zu diskutieren und ihre wissenschaftliche Bedeutung abzuwägen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung; Eigenstudium in der Hausarbeit.
Lehrmethode: Vortrag mit Entwicklung von Tafelbildern, relativ sparsamer Einsatz von Powerpointfolien.
Lernaktivitäten: Studium von Vorlesungsmaterial, insbesondere der Mitschrift und ausgewählter Literatur; Eigenstudium und Präsentation von Fragen und Antworten zu den Themengebieten.
Durch die Wiederheranführung der Studierenden an das ihnen aus der Gymnasialzeit zuletzt bekannte problemorientierte Verständnis durch die zu erbringenden Assoziations- und Transferleistungen, verfügen sie über die inzwischen oft übliche Berufsausbildung hinaus wieder über eine Bildungserfahrung und können Forschungsprobleme in der Zukunft leichter lösen.
So ein denk- und bildungsorientiertes Studium können die Studierenden auf andere Fächer ihres Studiums übertragen, wodurch mündige und charakterstarke Universitätsabsolventen mit etwas erhöhter Wahrscheinlichkeit zu erwarten sind. Die Studierenden erfahren das Konzept des Eigenstudiums mit intensiv vertieftem Wissen.
Im Folgesemester: Eigenstudium anhand der Hausarbeit.
Die Vorlesung kann im WS oder SS besucht werden.

Media:
Entwicklung der Themen anhand von Tafelbildern unter Zuhilfenahme von Powerpointdarstellungen. Vorlesungsfolien werden als pdf vor jeder Vorlesung über die eLearning Plattform „moodle“ zur Verfügung gestellt.

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Ergänzung wird empfohlen:
Cell and Molecular Biology. G. Karp. Wiley Verlag, 4. Auflage, ISBN: 0-471-65665-8.
The Biology of Cancer. R. A. Weinberg. Garland Science, 2. Auflage, ISBN: 978-0-8153-4220-5.

Responsible for Module:
Prof. Dr. rer. nat. Achim Krüger (achim.krueger@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Onkologie I (Vorlesung, 2 SWS)
Krüger A [L], Krüger A

Molekulare Onkologie I Hausarbeit (Seminar, 2 SWS)
Krüger A [L], Krüger A
For further information in this module, please click campus.tum.de or here.

Module Description

ME2648: Molecular Oncology | Molekulare Onkologie

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the exam (90 min, free questions, grading according to 1.0; 1.3; 1.7...) the students show that they are able to structure their knowledge of the cell and molecular biological mechanisms of cancer development and metastasis and to present the essential aspects.
No aids may be used in the examination. The questions test the competence in reproduction (central questions of the module such as molecular signaling pathways, recognition and retrieval of intra- and intercellular communication pathways), association (linking
transfer (problem-oriented application of learned regulatory mechanisms or research approaches to new related or other research areas) and application of the acquired molecular biological knowledge to unknown problems. The exam can be repeated at the end of the following semester if the student fails, with the opportunity to repeat the lecture.

In addition, the module must include a scientific paper. This paper is about the in-depth, independent, elaboration of the theoretically developed topics. The topic of the term paper will only be assigned after passing the exam and the term paper must be handed in at a fixed date. In contrast to the exam, which only examines theoretical knowledge, the term paper requires the free choice of an original publication from current research on each of the 10 topics of the lecture (see below). Students must be able to work autonomously in order to promote their studies; this includes, for example, the ability to classify, discuss and evaluate current research results. In particular, the students must carry out detailed literature research. Students are also required to take responsibility for their own time management and planning. Correctness, originality and formal execution are evaluated in their entirety as a course achievement. The module is passed if the exam is passed and the study performance has been successfully completed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of biochemistry, molecular biology and genetics are the basis for understanding the lectures. Attending other modules is not required.

Content:
1.) Characteristics of tumor progression (problems of modern tumor research, definitions, significance of the tumor microenvironment, Hallmarks of Cancer, properties of transformed cells in experiment); 2) causes of tumor development (stem cells and tumor formation, wnt/ hedgehog self-renewal, mutations, repair, cellular response to mutagens); 3) oncogenes (experiments of Rous, Rubin, Temin, Weinberg, definitions, functional classes of oncogenes and examples); 4.) tumor suppressor genes (definitions, Knudson two hit hypothesis, PTEN, cell cycle control points, pRB, p53, MDM2, apoptosis); 5.) epigenetics (definitions, histone modifications, DNA methylation, pRb, CpG Islands, examples, experiments of Mary Hendrix); 6.) Cell environment (components of a tumor, tumor stroma as therapeutic target, extracellular matrix: components and meaning, cell/ECM interactions, cell-cell contacts); 7th) Mechanisms of the metastasis cascade (steps of the cascade, angiogenesis, angiogenic switch, invasion, wound healing and cancer, tumor-associated macrophages, epithelial-mesenchymal transition, seed and soil hypothesis, role of proteases, metastatic niche; marker genes; metastasis models in the mouse); 8th) proteases/ proteolytic network (physiological and pathophysiological functions of proteases and protease inhibitors, regulation of proteases, splitting mechanisms, the proteolytic balance, protease families, proteases as prognostic markers, development of synthetic protease inhibitors, clinical trials, optimization of synthetic protease inhibitors, the cancer degradome); 9th) specific methodology of molecular oncology (in vivo models, biochemical/molecular detection methods of proteases and protease inhibitors, zymography, knock-out systems, siRNA, shRNAi, viral vector systems, in vitro migration and invasion models); 10th) Deepening of the above-mentioned areas (discussion of current publications from relevant journals, development of a deeper understanding of the learned mechanisms).

Intended Learning Outcomes:
The students know and understand molecular mechanisms of tumor progression, i.e. from tumor development to metastasis. They are able to understand the complex intracellular and extracellular control loops in their importance for the interactions between tumor and healthy tissue. With the knowledge acquired in this module, the students bring with them the theoretical prerequisites necessary for starting a project activity in research (e.g. master's or doctoral thesis). They are able to link original publications with the skills acquired in the module on molecular oncology and thus test their knowledge in an application-oriented way.
In addition, they can analyze and discuss original publications from current research and weigh up their scientific significance. They can also plan extensive literature searches and carry them out successfully and independently within a tight time frame.

Teaching and Learning Methods:
The module consists of a lecture and a term paper; in the lecture, the theoretical foundations of molecular oncology are developed with the help of blackboard pictures, in dialogue with the students. A relatively economical use of PowerPoint slides is used to illustrate difficult issues.

Students deepen their knowledge through intensive study of lecture material, especially their own notes and selected literature, as well as through self-study and presentation of questions and answers on the topics. The lecture can be attended in the WS or SS.
By means of experimental examples from the history of science as well as current publications, the students recognize the process of gaining knowledge in this field. Through numerous references in the lecture, the students learn a critical position on how to deal with research results and their translation (e.g. into the clinic).
In the following, the students deepen their newly acquired knowledge by means of the term paper. In private study they look for suitable literature and analyze it in detail. They have to evaluate the plausibility of the chosen experimental approaches, as well as the quality of the presented data and the way of evaluation and presentation. In contrast to classical learning, students have to consider the decisive questions and not just learn solutions by heart.

Media:
Development of the topics on the basis of blackboard pictures with the help of PowerPoint presentations. Lecture slides are made available as pdf before each lecture via the eLearning platform "moodle".

Reading List:
There is no textbook available that covers all contents of this module. In addition to other literature it is receommend:
Cell and Molecular Biology. G. Karp. Wiley Verlag, 4th edition, ISBN: 0-471-65665-8.
The Biology of Cancer. R. A. Vineyard. Garland Science, 2nd edition, ISBN: 978-0-8153-4220-5.

Responsible for Module:
Prof. Dr. rer. nat. Achim Krüger (achim.krueger@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Onkologie I (Vorlesung, 2 SWS)
Krüger A [L], Krüger A

Molekulare Onkologie I Hausarbeit (Seminar, 2 SWS)
Krüger A [L], Krüger A
For further information in this module, please click campus.tum.de or here.

Module Description

ME2649: Molecular Oncology II | Molekulare Onkologie II

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 144	**Self-study Hours:** 120	**Contact Hours:** 24

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfung wird in Form einer Übungsleistung abgenommen. Diese Übungsleistung setzt sich zusammen aus drei Komponenten:
Benotung der mündlichen Beteiligung (nach 1,0; 1,3; 1,7...) in jeder Veranstaltung. Benotung jeder Hausaufgabe (nach 1,0; 1,3; 1,7...) (Powerpointdarstellung, insgesamt acht pro Semester); Benotung des Vortrags (nach 1,0; 1,3; 1,7..., einmal pro Semester) dient der Überprüfung der im Modul erworbenen Kompetenzen. Bei den Prüfungen dürfen alle möglichen Hilfsmittel eingesetzt werden. Die Bewertung der mündlichen Beteiligung erfolgt an Hand des Engagements und der Kenntnis der Studierenden bzw. deren Entwicklung im Laufe der Veranstaltung. Die Hausaufgaben werden bezüglich Vollständigkeit, Richtigkeit und didaktischer Qualität bewertet, die Vorträge entsprechend der didaktischen Aufbereitung. Die Leistung ist an die Teilnahme am Seminar verknüpft und kann im Folgesemester wiederholt werden, wenn der/die Studierende wieder einen Platz bekommt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bestandener Abschluss der Vorlesung Molekulare Onkologie 1

Content:
Im Seminar: Einführung in die Theorie der Wissenschaft und Aufbau einer Publikation. Bearbeiten von Abstracts von Originalpublikationen aus folgenden Themenbereichen: 1.) Merkmale der Tumorprogression 2.) Ursachen der Tumorentstehung 3.) Onkogene 4.) Tumorsuppressorgene 5.) Epigenetik 6.) Umwelt der Zelle 7.) Mechanismen der Metastasierungskaskade 8.) Proteasen/Proteolytisches Netzwerk 9.) Spezifische Methodik der Molekularen Onkologie 10.) Förderung der Tumorprogression durch TIMP-1. Entwickeln und Notieren der relevanten Methodik. Als Hausaufgabe: Entwickeln einer vergleichenden Powerpointpräsentation der

selbst vorgeschlagenen Experimente versus der tatsächlich durchgeführten. Präsentation der Hausaufgabe.

Intended Learning Outcomes:
Die Studierenden sind in der Lage selbständig die experimentelle Vorgehensweise zu entwickeln, die einer ihnen fremden Forschungsleistung (den Studierenden vorgegeben als englischsprachiges Abstract einer Originalpublikation) aus dem Gebiet der modernen molekularen Tumorforschung zugrunde liegen sollte. Die Studierenden erfassen in kurzer Zeit das Thema, die Fragestellung, das Neue in den Ergebnissen und die Relevanz der Forschungsleistung im Gebiet der molekularen Onkologie. Dabei sind sie in der Lage, ihr Wissen aus der Vorlesung Molekulare Onkologie 1 anzuwenden und mit den methodischen Kenntnissen früherer biochemischer und molekularbiologischer Vorlesungen und Praktika zu verknüpfen. Durch die Vertiefung und Anwendung dieser Vorkenntnisse erzielen die Studierenden die Fähigkeit, eigene methodische Herangehensweisen zu entwickeln und kritisch zu beleuchten. Durch den Vergleich der eigenen Vorschläge mit dem tatsächlich von den Forschern durchgeführten Experimente (Inhalt der Hausaufgabe an Hand der Gesamtpublikation) entwickeln und verbessern die Studierenden ihre wissenschaftlichen Fähigkeiten. Im Seminargespräch erinnern die Studierenden die Lehrinhalte früherer Vorlesungen und sind in der Lage den Verlauf von späteren Prüfungsgesprächen (WPP; Doktorprüfung) zu antizipieren. Sie sind zudem später in der Lage, effizient wissenschaftliche Publikationen zu bewerten (Review Prozess). Neben der Fähigkeit moderne Tumorforschung zu verstehen und zu bewerten bringen sie somit alle Voraussetzungen mit, die für die Aufnahme einer Projekttätigkeit in der Forschung (z.B. Master-, Doktorarbeit) notwendig sind.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Seminar; gemeinsames Erarbeiten der Experimentvorschläge; Eigenstudium in der Hausarbeit.
Lehrmethode: Diskussion; Befragung
Lernaktivitäten: Studium von Vorlesungsmaterial, Teilnahme an der Diskussion (Lesen und Verstehen des Abstracts, Entwickeln der Experimentvorschläge); Anfertigen eines Notizprotokolls der Diskussion; Lesen und Verstehen der Gesamtpublikation (Eigentudum); Ausarbeitung der Gegenüberstellung (Eigenstudium); Vortrag der Gegenüberstellung mit Diskussion.

Media:
Das Abstract wird als Auszug auf einem Blatt Papier ausgeteilt. Die Originalpublikation wird in ihrer Gesamtheit gleich nach dem Seminar über die eLearning Plattform „moodle“ zur Verfügung gestellt. Die Gegenüberstellung erfolgt mit Hilfe einer Powerpointdarstellung. Die Gegenüberstellungen aller Teilnehmer Vorlesungsfolien werden am Tag vor dem nächsten Seminar als pdf über die eLearning Plattform „moodle“ zur Verfügung gestellt.

Reading List:
Keine.

Responsible for Module:
Krüger, Achim; Apl. Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Onkologie II (Seminar, 2 SWS)
Krüger A [L], Krüger A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2372: Pathogenic Microorganisms | Mikroorganismen als Krankheitserreger

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Die Studierenden zeigen anhand der benoteten Klausur (90 min) ob sie in der Lage sind, Formenvielfalt und taxonomische Stellung von pathogenen Bakterien zu erläutern. Die Studierenden müssen zeigen, daß sie die Interaktion von Pathogenen mit ihren verschiedenen Wirten (Menschen und Pflanzen) im Einzelnen darstellen können. Anhand von Fallbeispielen werden diagnostische Verfahren für bakterielle Krankheitserreger geprüft. Insbesondere wird Schlüsselwissen für die Risikobeurteilung bezüglich des Vorkommens von Pathogenen im Lebensmittel- und medizinischen Bereich sowie in der Phyopathologie abgefragt und es wird erwartet, daß die Studierenden auch komplexere epidemiologische Ansätze erläutern können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modul Mikrobiologie sowie Molekulare Genetik.

Content:
Biologie humanpathogener Mikroorganismen: Übersicht über Menschen und Mikroben; Verhältnis zwischen Kommensalen und Pathogenen; Koch'sche Postulate; Übersicht über bakterielle Pathogenität und Virulenz; Abwehrsysteme des Wirtes (v.a. verschiedene Ebenen des innaten Immunsystems); Abwehrsysteme des Pathogens (Immunevasion, Adhesion an die Wirtszelle, Invasion und intrazelluläres Wachstum, bakterielle Toxine); Übersicht über pathogene Hefen und Pilze.
Erreger von Pflanzenkrankheiten: Übersicht über Pflanzen und Krankheiterreger, Übersicht über Pathogenität und Virulenz bei Pflanzenpathogenen; Abwehrsysteme des Wirtes (v.a. verschiedene Ausprägungen der Resistenz, Gen-für-Gen Hypothese, systemische Resistenz); Abwehrsysteme

von Pflanzenpathogenen; Rezeptorsysteme und innate Immunität der Pflanze; Vergleich Pflanze-Säugetier; Gentechnik und Pflanzenschutz;
Diagnostik und Epidemiologie: Taxonomie von pathogenen Bakterien; Artbegriffe; Identifizierung (physiologische, biochemische, biophysikalische und genetische Verfahren); Diagnostische Verfahren (Anreicherungen, Schnellverfahren, automatisierte Verfahren); Infektionsepidemiologie (Bedeutung von Infektionen in Deutschland, Erhebung von epidemiologischer Daten, Methoden zur Verfolgung von Kontaminationsrouten).

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul verfügen die Studierenden über sichere Grundkenntnisse hinsichtlich Formenkenntnis und Taxonomie von pathogenen Bakterien, Interaktion von bakteriellen Krankheitserregern mit humanen und pflanzlichen Wirten, diagnostischer Verfahren in mikrobiologischen Labors und epidemiologischer Anwendungen.

Die Studierenden können die Bedeutung von Krankheitserregern im lebensmittelbiotechnologischen, medizinischen und phytopathologischen Bereich einschätzen und kritisch beurteilen.
Mit dem biologisch-theoretischen Wissen aus diesem Modul sind sie in der Lage eine Forschungspraktikums im Pathogenlabor zu absolvieren.

Teaching and Learning Methods:
Die Vermittlung der Modulinhalte erfolgt durch Dozentenvortrag in der Vorlesung sowie anhand von Fallstudien, die in interaktivem Diskurs während der Vorlesung behandelt werden. Das Wissen der Studenten wird durch (i) eigenständige Nachbereitung der Vorlesungsinhalte anhand der ausgegebeben ppt Präsentationen, (ii) die Vorlesungsmitschrifte, (iii) das Studium der abgegebenen Literatur und schließlich (iv) die Lösung der ausgegebenen Übungsaufgaben nachhaltig gefestigt.

Media:
Tafelarbeit, PowerPoint Präsentationen, Filme, Vorlesungsfolien, Übungsfragensammlung

Reading List:
Salyers AA, Whitt DD (2011) Bacterial pathogenesis: A molecular approach. ASM Press, Washington, 3. Auflage.
Hof H, Dörries R (2009) Medizinische Mikrobiologie. 4. Auflage.
Buchanan et al (2002) Responses to Plant pathogens. Kapitel 11 in: Biochemistry & Molecular Biology of Plants, Buchanan B, Gruissem W, Jones R, Verlag ASPP

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in Biologie pflanzenpathogener Mikroorganismen (Vorlesung, 1 SWS)

Durner J

Einführung in die Biologie humanpathogener Bakterien (Vorlesung, 2 SWS)
Hall L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2402: Microbial Toxins in Food | Mikrobielle Toxine in der Nahrung

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden weisen in einer benoteten Klausur (60 min) nach, dass sie in der Lage sind in begrenzter Zeit und ohne Hilfsmittel ihr Fachwissen über mikrobielle Toxinbildner, deren Habitaten und Toxinen darzustellen. Zudem sollen sie grundlegende toxikologische Arbeitstechniken beschrieben sowie toxikologische Probleme mikrobieller Herkunft in ihrer Bedeutung für die Lebensmittelsicherheit einordnen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Anatomie, Physiologie und Biochemie.

Content:
Vermittlung toxikologischer und analytischer Grundlagen. Darstellung relevanter Bakterien-, Pilz- und Algentoxine: Ökologie der Toxinbildner; biochemische und pathophysiologsiche Wirkungen der Toxine; Vorkommen in der Nahrungskette ("carry over"); Prophylaxemaßnahmen, gesetzliche Reglementierungen.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen über mikrobielle Toxinbildner, deren Habitaten und deren Toxine. Weiterhin haben sie grundlegende toxikologische Arbeitstechniken (z.B. Zellkulturversuche, LC-MS/MS) erlernt und geübt. Sie sollen gelernt haben, toxikologische Probleme mikrobieller Herkunft analysieren und bewerten zu können. Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an mikrobiellen Toxinen und deren Bedeutung für die Lebensmittelsicherheit fördern.

Teaching and Learning Methods:
Vorlesung und Übungen im Labor

Media:
PowerPoint

Reading List:
Freitext

Responsible for Module:
Johann Bauer (johann.bauer@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Analytik mikrobieller Toxine (Übung, 2 SWS)
Meyer K

Mikrobielle Toxine in der Nahrung (Medizinische Mikrobiologie und Hygiene, Teil Mikrobielle Toxine) (Vorlesung, 2 SWS)
Meyer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2427: Molecular Cell Biology of Tumorigenesis | Molekulare Zellbiologie der Tumorentstehung

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
A written exam (60 min, graded, no aids) at the end of the second semester serves to test the theoretical skills learned during the module. In the written exam, the students show whether they are able to structure the knowledge they have acquired in tumor biology and present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations.
A 20-minute presentation (graded, incl. written handout) is intended to demonstrate the acquisition of the competence to independently and critically interpret current research work from the English language literature. The presentation will be given as a mid-term performance (weighting: exam 66%, mid-term performance 33%) and will be taken into account in the examination period at the end of the second semester, but not on a repeat exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The development and progression of tumors is taught on a molecular genetic and cell biological basis. General basics of molecular cell biology are also taught, especially in the first part, while the second part focuses on translational aspects. Topics:
- Tumor Viruses
- Oncogenes, tumor suppressor genes and tumor modulators
- Signal transduction and growth factors
- Cytoskeleton, cell adhesion and cell migration
- Cell cycle and cell division

- Telomer structure and chromosomal instability
- apoptosis and necrosis, as well as other forms of cell death
- Angiogenesis
- Adult stem cells and "tumor stem cells", tumor metabolism
- Embryonic development of the mouse, embryonic stem cells, knock-out and knock-in technique
- Mouse models in biomedical research: Xenotransplant models, transgenesis in mice
- Tissue-specific and inducible models: Cre/LoxP, Crispr/Cas mutagenesis
- Imaging techniques in tumor research (multiphoton microscopy, MRT, PET/CT, OCT)
- Tumor-Stroma Interactions
- Basics of tumor immunology
- Basics of "rational therapy

Intended Learning Outcomes:
After successful completion of the module, students will have in-depth knowledge of cell biology and molecular biology from all aspects of tumor biology.
They know how to move independently and confidently between clinical application and basic scientific knowledge in the field of biomedical cancer research. Students are able to independently evaluate current, English-language technical literature in the field of cancer research. Successful graduates have acquired a broad knowledge to analytically structure and experimentally solve problems in the field of cancer research, supported by practical research skills and experimental-analytical knowledge from the research internship.

Teaching and Learning Methods:
The module consists of two lectures and an tutorial. During the lecture, the learning outcomes are conveyed through lectures, supported by presentations. Students are encouraged to study the technical literature and to deal with the content of the topics. During the tutorial, moderated discussions are held to consolidate the topics learned. In addition, homework will be given during the "tutorial" to help students to understand the contents of the lecture in greater depth, for example, on the genetic basis of transgenesis in pre-clinical animal models. In addition, the students give presentations during the tutorial, including a written handout, in order to practise a technically correct verbal expression. Optionally, a research internship (at least 6 weeks per 40 hours) in the field of tumor biology can be taken.

Media:
Presentations via PowerPoint, blackboard work; Inverted Classroom at a selected lecture date per semester; films; online feedback survey via PINGO
script (download possibility for lecture material on TUMonline) set to Moodle

Reading List:
There is no textbook available that covers all contents of this module. The following is recommended as a basis or supplement: 1) Biology of Cancer, Robert Weinberg, Garland Science 2006; ISBN: 0815340761
2) Textbook of Molecular Cell Biology, Alberts et al., Wiley VCH, 2007 ISBN: 3527311602

3) The Mouse in biomedical research. James G. Fox (Ed.). Academic Press, 2007. ISBN: 9780123694546
4) Mouse Models of Human Cancer. Eric C. Holland (Editor), Wiley-VCH, 2004 ISBN: 978-0-471-44460-2

Responsible for Module:
Klaus-Peter Janssen (klaus-peter.janssen@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Zellbiologie der Tumorentstehung (Teil 1) (Übung, 1 SWS)
Janßen K [L], Janßen K, Laschinger-Bolzer M

Molekulare Zellbiologie der Tumorentstehung (Teil 1) (Vorlesung, 2 SWS)
Janßen K [L], Janßen K, Laschinger-Bolzer M

Molekulare Zellbiologie der Tumorentstehung (Teil 2) (Vorlesung, 2 SWS)
Janßen K [L], Laschinger-Bolzer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2490: Neurogenetics: The Pathoetiology of the Neurological and Psychiatric Diseases | Neurogenetische Grundlagen von neurologischen und psychiatrischen Erkrankungen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students show in a graded exam (60 min, 2 graded exams/one after each semester) that they can understand and summarize basic concepts of central nervous system development. They should be able to demonstrate complex facts about the molecular basis and development of neuropsychiatric diseases in a limited time. Furthermore, they should demonstrate that they can use their acquired knowledge to analyze and evaluate case studies.

The average of the two graded exams then gives the overall grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretical knowledge in genetics (developmental genetics of animals) is desirable

Content:
1. molecular and cell biological principles of the development of the central nervous system: neurogenesis - neuronal migration - network formation - synaptogenesis - electrical maturation; 2. morphology and function of the cerebrum, cerebellum, hippcampus, basal ganglia, amygdala, spinal cord; 3. Diseases of the CNS and their molecular basis: Alzheimer's disease, Parkinson's disease, schizophrenia, depression, infections, diseases of the spinal cord, stroke, epilepsy, prion diseases, diseases of the hypothalamus

Intended Learning Outcomes:
After participating in the module course, students will have a basic theoretical understanding of the formation of the nervous system. They should be able to understand and explain the principles

of molecular regulation of these processes, have knowledge of the function and morphology of central structures of the CNS and understand the pathogenesis (molecular) of diseases of the CNS. Furthermore, the module is intended to promote interest in neurogenetics.

Teaching and Learning Methods:
Teaching method: Lecture with question-developing method
Learning activities: studying literature, learning basic processes, problem solving

Media:
Powerpoint, script on the new Moodle platform, movies

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Larry R. Squire
Fundamental Neuroscience
Ed. by Larry R. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Wurst, Wolfgang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Neurogenetik II: Grundlagen von neurologischen und psychiatrischen Erkrankungen (Vorlesung, 2 SWS)
Wurst W [L], Deussing J, Floss T, Hölter-Koch S, Vogt-Weisenhorn D, Westmeyer G

Neurogenetische Grundlagen von neurologischen und psychiatrischen Erkrankungen (Vorlesung, 2 SWS)
Wurst W [L], Deussing J, Floss T, Vogt-Weisenhorn D
For further information in this module, please click campus.tum.de or here.

Module Description

ME2413: Pharmacology and Toxicology for Students of Life Sciences | Pharmakologie und Toxikologie für Studierende der Biowissenschaften (Vertiefung)

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module concludes with a written exam (75 min) in the form of free questions. Two to three questions are formulated for each topic, covering the essential learning content of the module from the beginnings of drug development through the various drug classes to toxic and addictive effects. A special focus is on current drug developments in pharmacology. Through regular active participation in the course and self-study on the basis of the instructional slides provided, the students are enabled to reproduce the knowledge acquired and present the essential aspects in a structured way in a limited time and without aids. Through their own formulations, the students show in the exam whether they have reached a deeper understanding of the topics. The exam is passed if at least grade 4.0 has been achieved. A possibility for repetition is given at the end of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module WZ2522: General Pharmacology for students of life sciences (bachelor)

Content:
As part of the module the knowledge in pharmacology will be extended from the bachelor's degree. The knowledge of many novel drug classes for treatment of common and serious diseases is acquired. In a historical overview, examples of drugs from nature are learned. The development and optimization of drugs is discussed from drug design to the approval of drugs. Clinical studies and the transmissibility to humans are discussed. Additional contents includes the treatment of tumors and cancer pain, allergies and autoimmunity, infectious diseases such as HIV, heart rhythm disorders and psychoses, as well as biologicals, gene therapy, toxicology and dependence on

psychotropic substances. The seminar serves to strengthen and expand the lecture content, and provides the opportunity for practical exercises.

Intended Learning Outcomes:
After completing the module, students are able to reproduce the development of a drug from target identification through lead identification and optimization up to the approval and clinical studies. The students can name different resources for drugs and classify alternative treatment methods. They are able to remember important new drug groups, their targets and mechanisms of action. For each drug class, students can reproduce the lead compounds. They are further able to remember the most common and serious side effects and drug interactions and explain their occurrence. With this knowledge they can differentiate treatment options for common and serious diseases. Finally, students are able to detect toxic and addictive effects and select appropriate antidotes and remedies.

Teaching and Learning Methods:
The module consists of a lecture and a seminar.In the lecture the necessary knowledge is mediated through lectures and presentations by department staff. Students are encouraged to study the literature and discuss the issues with each other. In the seminars, the contents of the lecture is deepened and expanded. Different learning and teaching methods are used. E. c. Students prepare and show presentations in small groups or they answer specific questions or collaborate on selected (case) examples. Occasionally, examination questions are exercised. To prepare for each seminar a relevant material research is necessary.

Media:
PowerPoint, board work, flipchart, exercise sheets, OnlineTED, movies, downloads

Reading List:
There is no textbook available that covers all the contents of this module. Current literature is provided by the respective lecturers. As a basis or to supplement is recommended:
Pharmakologie und Toxikologie: Arzneimittelwirkungen verstehen - Medikamente gezielt einsetzen von Heinz Lüllmann, Klaus Mohr und Lutz Hein (Gebundene Ausgabe - 18. Auflage von Januar 2016)

Responsible for Module:
Stefan Engelhardt (Stefan.Engelhardt@tum.de) Andrea Welling@tum.de (andrea.welling@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vertiefungsvorlesung Pharmakologie (Vorlesung, 2 SWS)
Welling A [L], Andergassen D, Avramopoulos P, Dueck A, Engelhardt S, Klug C, Laggerbauer B, Lang A, Ramanujam D, Rammes G, Thiermann H, Welling A

Seminar für Studierende der Biowissenschaften (Master) (Seminar, 2 SWS)
Welling A [L], Andergassen D, Avramopoulos P, Klug C, Laggerbauer B, Lang A, Mägdefessel L, Ramanujam D, Rammes G, Welling A, Wille T

For further information in this module, please click campus.tum.de or here.

Module Description

ME2624-2: Classical and Molecular Virology Course | Praktikum der klassischen und molekularen Virologie

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:**	**Duration:** one semester	**Frequency:** summer semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 120	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): Vortrag 45 Min.
Das Erreichen der angestrebten Lernergebnisse wird überprüft durch die täglichen praktischen Arbeiten, durch die Vorträge der Studenten (Englisch) und deren Praktikumsprotokoll (Englisch oder Deutsch; je ein Protokoll zu jeder Praktikumswoche). Es wird die Durchführung von Versuchen, deren Interpretation und auch deren Auswertung durch Zweiergruppen unter Anleitung nach Skriptvorgabe genauestens überprüft. Die Gesamtnote des Praktikums setzt sich zusammen aus Protokoll (75%) und Vortrag (25%).

Repeat Examination:

(Recommended) Prerequisites:
Ausreichendes Wissen in Molekular- und Zellbiologie sowie Immunologie (empfohlen) und Grundkenntnisse in der Virologie

Content:
Die Studierenden lernen die grundlegenden Techniken der klassischen und molekularen Virologie in der Praxis und der Theorie kennen. Zusätzlich gibt jeder Student einen Vortrag in Englisch zu praktikumsrelevanten Themen des jeweiligen Kurses. Im Eigenstudium sollen die Studenten diese Vorträge vorbereiten und zusätzlich ein schrifltiches Handout für Ihre Kollegen generieren, welches als Zusammenfassung die wichtigsten Punkte Ihrer Vorträge beinhalten soll. Die wesentlichen Techniken des Praktikums und Studienleistungen beinhalten das Erlernen von gerichtete Mutagenese viraler Genome, Anzucht und Direktnachweise von Viren, Nachweis viraler Nukleinsäuren, Analyse der Sedimentationseigenschaften viraler Partikel,Teste zum Nachweis von Antikörpern gegen Viren,Analyse der Immunreaktion Virusinfektion, Durchfluss-zytometrische

Analysen von humanen Zellen, immunohistochemische Analyse von Lebern und lymphatischen Organen und Transkriptionale Analyse von chronisch entzündeten Organen.

Intended Learning Outcomes:
Die Studierenden sollen moderne Techniken der Virologie praktisch kennen lernen und Ihre Möglichkeiten und Limitationen einzuschätzen lernen.

Teaching and Learning Methods:
Lerntechniken: Seminar, Übung, Laborlehre; Lernaktivitäten: Üben von technischen und labortechnischen Fertigkeiten, Studium von Literatur, Rechnen von Übungsaufgaben, Lernmethode: Gruppenarbeit, Presentation und Vortrag, Experiment

Media:
Skriptum, Power Point Presentation

Reading List:
Flint et al.; Principles in Virology; Modrow et al., Molekulare Virologie

Responsible for Module:
Ulrike Protzer (Ulrike.Protzer@virologie.med.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum der klassischen und molekularen Virologie (Praktikum, 8 SWS)
Baer de Oliveira Mann C, Deng L, Ebert G, Möhl-Meinke B, Pichlmair A, Schreiner-Gruber S, Vincendeau M (Ebert G)
For further information in this module, please click campus.tum.de or here.

Module Description

WZme2672: Research Project in Radiation Biology | Research Project in Radiation Biology

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The theoretical and methodological competences acquired during the project will be evaluated by a written protocol and a 45min oral presentation of the project with discussion. Both evaluation forms willl contribute 50% to the final module score. The evaluations will determine the extent to which the student has acquired the competences necessary to use and adapt appropriate scientifc methodology, to formulate and experimentally challenge a scientific hypothesis, and to interpret the research project observations and to transfer and integrate these observations into the broader context of radiation sciences.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Participation in the reseach project requires a strong understanding of the biological processes regulating cell function at the molecular level. Experience in a research laboratory environment is not a prerequisite as introductory training can be given. The ability to communicate with other team members in English would be advantageous.

Content:
After a short introduction in laboratory safety and good scientific practice you will become an active participant in the work of one of our four research teams. The research project will focus on one of the following research topics: Developing a systems biology approach to understanding the role of non-coding RNA species in the response of cells to radiation exposure. Discovery of novel drugs modifying the effects of radiation therapy of cancer using a 3D-heterotypic cell model for high throughput phenotypic screening. Understanding the effect of ionizing radiation on cancer stem cells and normal tissue stem cells. Deciphering the biological mechanisms underlying cardiovascular and neorological side effects of radiation exposre.Each of the research

groups use a combination of high throughput "omics", bioinformatics, cell and molecular biology methodologies. In addition to practical training and independent research work you will be expected to participate in our regular journal discussion meetings, research group presentations and graduate level training courses/ lectures.

Intended Learning Outcomes:
After completion of the module students will be able to create and apply a range of research strategies and methodologies to challenge a scientifc hypothesis in the radiation biology field. They will be able to evaluate and apply a theoretical understanding of the effects of radiation exposure at the cellular and molecular level to biological, political and sociological issues concerning the risks and benefits of ionizing radiation in a modern society. They will have the competence to adapt and transfer knowledge of basic radiobiological processes for the understanding of other cell and molecular biological problems.

Teaching and Learning Methods:
Majority of time will be spent in benchwork in a research laboratory as part of a team of scientists. Additional learning opportunities will include active particpation in scientific seminars, progress reporing, training courses, seminars and journal clubs. Advice in preparing the protocol and oral report will be provided. A direct supervisor will be appointed for each student to act as mentor and will be responsible for assisting with any issues arising during the project.

Media:
Research project

Reading List:
Appropriate scientific literature in English will be provided, this will include recent review articles as well as original publications.

Responsible for Module:
Michael Atkinson atkinson@helmholtz-muenchen.de, m.j.atkinson@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project in Radiation Biology 10SWS
1.)Michael Atkinson
atkinson@helmholtz-muenchen.de, m.j.atkinson@tum.de
Lehrstuhl für Strahlenbiologie
2.) Soile Tapio
soile.tapio@helmholtz-muenchen.de
Institute of Radiation Biology, Helmholtz Zentrum München
3.) Michael Rosemann
rosemann@helmholtz-muenchen.de
Institute of Radiation Biology, Helmholtz Zentrum München
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0267: Research Project: Novel Therapeutic Strategies to Treat Aging-Related Diseases | Research Project: Novel Therapeutic Strategies to Treat Aging-Related Diseases

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 50	**Contact Hours:** 250

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination assesses lab performance of the students and will consist of a written report summarizing the work experience and knowledge acquired during the internship (~20 pages). Students demonstrate with the reports that they have gained deeper knowledge of the topic and the specific lab methodology including its equipment, measurement methods and analytical tools. In addition, reports show how students performed in the lab, especially with regard to clean work at master level and in compliance with good scientific practise rules. Students know how to document this knowledge and their results and evaluations. The final grade is given for the report.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of molecular biology; previous lab experience is preferable

Content:
6-week research internship for students of the master's program Biology. Different projects in the field of pathway analysis, molecular signaling, stem cell research and drug discovery.

Intended Learning Outcomes:
Upon successful completion of this module, students gain knowledge on how cells develop an aging phenotype in normal and disease states, with a particular focus on cells derived from patients with a premature aging disorder such as Hutchinson-Gilford progeria syndrome (HGPS). On the basis of this knowledge, students are able to understand some molecular processes that drive cells to enter senescence and put all performed experiments into the correct context. To examine these mechanisms, the students perform different methods including cell culture, western

blotting, qPCR, biochemical assays, cell transfection and microscopy. Moreover, the students test specific research questions on HGPS and perform an independent project, starting by designing the experimental approaches, carrying out the experiments and analyzing the results.

Teaching and Learning Methods:
Laboratory course + literature research + presentation and discussion of research results in a weekly lab meeting + journal club

Media:

Reading List:
Lopez-Otin, C., Blasco, M.A., Partridge, L., Serrano, M., Kroemer, G., The hallmarks of aging. Cell, 2013. 153(6): p. 1194-217. Gordon LB, Rothman FG, Lopez-Otin C, Misteli T (2014) Progeria: a paradigm for translational medicine. Cell 156 (3):400-407. doi:10.1016/j.cell.2013.12.028 Gabriel, D., Roedl, D., Gordon, L.B., Djabali, K., Sulforaphane enhances progerin clearance in Hutchinson-Gilford progeria fibroblasts. Aging Cell, 2015. 14(1): p. 78-91.

Responsible for Module:
Djabali, Karima; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

ME2090: Viral and Nonviral Gene Transfer: Methods and Applications in Research and Therapy | Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students are required to attend the lectures on a regular basis. At the end of the semester there is a 120 minutes examination in writing. The examination will assess whether the students are able to replicate the knowledge communicated during the lectures in a structured manner. The students should be able to describe, interpret and combine the informations of the lecture series. Every question of the written exam is attributed a certain number of points. The final grade is calculated from the achieved percentage of points out of total achievable points.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in molecular biology and cell biology

Content:
The lecture series provides in depth insights into the technical/molecular basis of nucleic acid delivery into cells and applications in research and therapy.
Overview of research field / historical development / concepts and goals. Non-viral vectors / barriers for nucleic acid delivery / selected examples and applications.
Adenoviral vectors: Virus biology / vector types and construction / oncolytic adenovirus.
Retro-/lentiviral vectors: Virus biology / vector types, construction, optimization.
Immunological aspects of nucleic acid therapies.
Preclinical models / clinical studies / case discussion.

Intended Learning Outcomes:
Gene technologies are discussed controversially, especially in Germany. Frequently, opinions are adopted in the absence of actual knowledge of the chances and risks of technologies. It is the aim of this lecture to provide the students with sufficient expertise to enable them to participate as competent persons in the debate on the use of gene technologies in medicine.

Teaching and Learning Methods:
lecture course

Media:
PowerPoint, blackboard

Reading List:

Responsible for Module:
Plank, Christian; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie (Vorlesung, 3 SWS)
Anton M [L], Plank C, Anton M, Holm P, Krüger A, Knolle P, Brill T
For further information in this module, please click campus.tum.de or here.

Specializing in Microbiology | Studienschwerpunkt Mikrobiologie

Module Description

WZ2626: Applied Microbiology | Angewandte Mikrobiologie

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular and active student participation is expected. A written exam (60 min, graded) serves as proof of the theoretical knowledge acquired in the lecture courses. In the exam, the students demonstrate their ability to structure the body of acquired knowledge, e.g. about metabolic pathway-based compound conversion and its consequences for biotechnology and environment or about the effects of changes/manipulations in the metabolism on biosynthetic performance (see anticipated learning goals), and to summarize the important aspects of the study matter. The students should be able to describe, interpret, combine in a meaningful way the information learnt, and to transfer this knowledge to similar issues.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good background knowledge in organic chemistry and biochemistry is of advantage for a better understanding of the lecture courses.

Content:
Basic knowledge about metabolic pathways (biosynthetic and degradative capabilities) in microorganisms is repeated and extended in the lecture courses. Furthermore, advanced-level knowledge about the metabolism of microorganisms, in particular prokaryotic microorganisms, and about the application of microorganisms in biotechnological processes is tought. The contents include central metabolism and connected biotechnologically relevant biosynthetic pathways for primary and secondary metabolites, as well as for biopolymer production. Further contents are degradation pathways for sugars, polysaccharides, lignin, proteins, nucleic cids, xenobiotica. Selected examples help to illustrate the applications of organisms and/or their enzymes as well

as the optimization of microorganisms and their metabolism for improved production processes in biotechnology.

Intended Learning Outcomes:
After completion of the courses of this module the students have acquired an advanced level of theoretical understanding about the metabolic capabilities of microorganisms and their application potential in biotechnological processes.
The module should further help develop the ability to solve problems, and boost the students' interest for microbiological issues and for the important role of microorganisms for mankind and the environment.

The students are able to
" understand interconnections between metabolic pathways and conversion of compounds by microorganisms.
" understand, by virtue of selected examples, the effects of changes/manipulations in the metabolism on biosynthetic performance.
" understand, by virtue of selected examples, the effects and consequences of degradation processes in biotechnology and environment.
" apply the acquired knowledge to in-depth problems.

Teaching and Learning Methods:
Form/technique of teaching: lecture courses. Teaching method: oral lecture.
Learning activities: study of lecture handout scripts and own notes.

Media:
Presentations unsing PowerPoint,
Handout script (download option for lecture material).

Reading List:
There is no textbook available that comprehensively covers all content matter of this module.
Some aspects are covered in the following books:
Fuchs G. (Hrsg.) Allgemeine Mikrobiologie. 8. Auflage, 2007. Georg Thieme-Verlag Stuttgart.
Antranikian G. (Hrsg.) Angewandte Mikrobiologie. 2006. Springer-Verlag Berlin Heidelberg.

Responsible for Module:
Wolfgang Liebl wliebl@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Mikrobiologie - Abbauleistungen (Vorlesung, 1 SWS)
Liebl W, Ehrenreich A

Angewandte Mikrobiologie - Biosyntheseleistungen (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2559: Soil Microbiology 1 | Bodenmikrobiologie 1

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:
Microbial functions and demands on soil habitats, ecology of microbial activities; microbial material transformation processes in environmental habitats using the example of N, C, S, Fe and P and their importance for global material cycles, expression of functions in natural and managed habitats; microbiology of the rhizosphere and symbioses with plants

Teaching and Learning Methods:

Media:

Reading List:
Madigan, M.T., J.M. Martinko, P. Dunlap, D. Clark. Brock Biology of Microorganisms, Pearson Education, 12. Edition, 2009
J.C.G. Ottow, Mikrobiologie von Böden Springer, ISBN 978-3-642-00823-8, 49,95¬

Responsible for Module:
Pritsch, Karin, Dr. rer. nat. habil. karin.pritsch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Mykorrhiza (Vorlesung, 1 SWS)
Pritsch K

Bodenmikrobiologie (Vorlesung, 2 SWS)
Pritsch K, Rosenkranz M, Weikl F

Seminar Bodenmikrobiologie (Seminar, 1 SWS)
Pritsch K, Rosenkranz M, Weikl F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2560: Soil Microbiology 2 | Bodenmikrobiologie 2

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:
Madigan, M.T., J.M. Martinko, P. Dunlap, D. Clark. Brock Biology of Microorganisms, Pearson Education, 12. Edition, 2009
Zu Böden: J.C.G. Ottow, Mikrobiologie von Böden Springer, ISBN 978-3-642-00823-8, 49,95¬

Responsible for Module:
Pritsch, Karin, Dr. rer. nat. habil. karin.pritsch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2764: Diagnostics of High Consequence Pathogens in Deployable Laboratories | Diagnostics of High Consequence Pathogens in Deployable Laboratories

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** one-time
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 50	**Contact Hours:** 40

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Throughout the practical part the student's actions are monitored by the course leader and evaluated on a daily base in form of a debriefing and feedback session. In a written exam (multiple choice tests) two weeks after course end the students will demonstrate their knowledge about the biology and clinical features of high consequence pathogens including ways of infection transmission and pathomechanisms as well as aspects of practical work in a mobile laboratory

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A solid background in molecular biology and microbiology. Especially theoretical and practical experience in PCR is desirable.

Content:
The module will comprise three parts:
(i) A course-accompanying daily two hour lecture held by Dr. Stoecker. Content will be high consequence pathogens, their diagnostics and outbreak response mechanisms.
(ii) A seminar-part during which the participants will give presentations about selected biological agents.
(iii) A practical part during which the students will be trained in field diagnostics of highly contagious pathogens.

Based on the experience of several laboratory deployments in the course of the West-Africa Ebola outbreak, a training curriculum was developed which covers realistic scientific, medical, technical and operational challenges that could be encountered in a field situation.

Intended Learning Outcomes:
After completion of this course the students will:
• Have gained knowledge about biology and clinical features of high consequence pathogens including ways of infection transmission and pathomechanisms
• Have acquired practical knowledge on scientific, medical, technical and operational challenges that could be encountered in a field laboratory situation.
• be able to safely inactivate potentially contagious samples in a foldable Glovebox
• be able to select and correctly use appropriate personal protective equipment (PPE)
• have gained knowledge of how to conduct and interpret diagnostic RT-PCR-Assays
• understand how to set diagnostic laboratory results in a clinical context
• gain knowledge of how to process various samples to be expected in a field lab
• be able to plan for and execute an emergency response for small and medium potentially infectious spills

Teaching and Learning Methods:
Lecture; Seminar; Practical course
For the seminar the students will prepare PowerPoint presentations in which they give an overview about selected biological agents. They will read English scientific literature and summarize the most important points in the presentation.
Practical course: After a thorough introduction into the concept and equipment of the deployable laboratory of the Bundeswehr Institute of Microbiology, the students will work in a training field laboratory and will have to handle and process mock samples. They will receipt the samples in a safe way, inactivate them in a foldable Glovebox and perform diagnostic immunochromatographic rapid tests with them. The students will extract RNA from the samples and perform diagnostic reverse transcription real time PCR. Finally they will interpret the results and communicate them. Throughout the whole process the will have to comply with biosafety, biosecurity and diagnostic rules.
Throughout the practical part the student’s actions are monitored by the course leader and evaluated on a daily base in form of a debriefing and feedback session. In a written exam (multiple choice tests) two weeks after course end the students will demonstrate their knowledge about the biology and clinical features of high consequence pathogens including ways of infection transmission and pathomechanisms as well as aspects of practical work in a mobile laboratory

Media:
Presentations using Powerpoint,

Reading List:

Responsible for Module:
Stöcker, Kilian; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Diagnostics of High Consequence Pathogens in Deployable Laboratories (Lecture) (Vorlesung, 1 SWS)
Stöcker K

Diagnostics of High Consequence Pathogens in Deployable Laboratories (Excercise) (Übung, 2,5 SWS)
Stöcker K

Diagnostics of High Consequence Pathogens in Deployable Laboratories (Seminar) (Seminar, ,5 SWS)
Stöcker K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2048: Biology and Diagnostics of Pathogenic Bacteria - an Introduction | Einführung in die Biologie und Diagnostik pathogener Bakterien

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Eine Klausur (60 min, benotet) dient der Überprüfung der erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen über humanpathogene Bakterien sowie ihre Diagnostik zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung und Praktikum Allgemeine Mikrobiologie

Content:
Short overview:
Part I: Biology of pathogenic bacteria
Humans and microbes. Basic lectures from Robert Koch. Introduction to pathogenicity and virulence. Host defense systems. Defense systems of pathogens. Adhesion to the host cell. Intracellular pathogens. Bacterial toxins
Part II: Diagnostics of pathogenic bacteria
Taxonomy. Identification. Diagnostic procedure. Epidemiology.

Intended Learning Outcomes:
This lecture offers basic knowledge in the following fields: Taxonomy and identification of bacterial pathogens, mechanisms ofinteraction of pathogens with human hosts, biochemicl and molecular basis of diagnostic tools, epidemiological applications. In summary, the student shall aquire

the ability to appreciate the impact of bacterial pathogens in the fields of medicine and food biotechnology.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung
Lehrmethode: Vortrag, Fallstudien, interaktiver Diskurs mit Studenten während der Vorlesung.
Lernaktivitäten: Auswendiglernen; Lösen von Übungsaufgaben, Studium von Literatur

Media:
Tafelarbeit, PowerPoint Präsentationen, Filme.
Ausgabe von Vorlesungsfolien und Übungsfragensammlung.

Reading List:
Salyers AA, Whitt DD (2011) Bacterial pathogenesis: A molecular approach. ASM Press, Washington, 3. Auflage.
Hof H, Dörries R (2009) Medizinische Mikrobiologie. 4. Auflage.

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Biologie humanpathogener Bakterien (Vorlesung, 2 SWS)
Hall L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2375: Evolution of Pathogens | Evolution von Krankheitserregern

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden zeigen in einer benoteten Klausur (60 min), dass sie das in der Vorlesung und in den Übungen erworbene Wissen zu grundlegenden mikrobiellen Evolutionsprozessen (molekulare Quellen der Variabilität bakterieller Genome, Darwin'sche Selektionsprozesse, neutrale Evolution nach Kimura) auf Problemstellungen der Evolution von Krankheitserregern anwenden können.
Sie zeigen in der Klausur, daß sie in der Lage sind, in begrenzter Zeit und ohne Hilfsmittel den Erwerb und die nachfolgende Evolution von Pathogenitätsfaktoren (wie beispielsweise Toxine, Pathgenitätsinseln) sowie die molekularen Evolutionsprozesse, welche der de novo Entstehung, Adaptation sowie der Verbreitung von Antibiotikaresistenzen zugrunde liegen, kritisch modellieren und diskutieren zu können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnisse in Allgemeiner Mikrobiologie, Molekularer Bakteriengenetik und Biologie pathogener Bakterien.

Content:
Teil 1, Einführung in die Evolutionsbiologie: Methoden der Evolutionsforschung, Entstehung von Variabilität in Individuen, Fixierung von Allelen in Populationen.
Teil 2, Bakterielle Genome und Populationsstrukturen: Bakterielle Genome als Ergebnis fixierter Mutationen, Typisierung bakterieller Populationen, Infraspezifische phylogenetische Populationsanalyse.
Teil 3, Evolution von Antibiotikaresistenzen: Wirkungen von Antibiotika, Ökologie des mikrobiellen Resistoms, Mechanismen der Antibiotikaresistenz, Evolution von Antibiotikaresistenzen.
Teil 4, Ökologie als angewandte Evolutionsbiologie: Ökologische Rahmenbedingungen, Invertebraten und Vertebraten als Wirte, Wirtswechsel, Populationsökologie, Virulenzgentransfer

und Pathogenitätsinseln, Ökologie intrazellulärer Pathogene, Reduktive Evolution bei Pathogenen und Symbionten.

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss dieses Moduls kennen die Studierenden die grundlegenden Methoden der Evolutionsforschung sowie experimentell belegte Evolutionsprozesse bei Prokaryonten und sind in der Lage ihr Wissen auf molekularbiologische und epidemiologische Daten (z.B. Antibiotikaresistenzevolution, Populationen von Pathogenen) anzuwenden. Darüber hinaus sind die Studierenden in der Lage experimentell nicht reproduzierbare Konzepte aus der vergleichenden Biologie (z.B. Sequenzvarianzen, Existenz von Pathogenitätsinseln, reduzierte Genome) vor dem Hintergrund der in der Vorlesung erlernten, experimentell verifizierten Evolutionsprozesse zu interpretieren und Evolutionshypothesen zu formulieren. Diese Fähigkeit wird durch kritische Lektüre von Fallstudien aus der Literatur und deren Diskussion in der Gruppe eingeübt.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung mit begleitender Übung.
Lehrmethode: Vortrag, Fallstudien, interaktiver Diskurs mit Studenten während der Vorlesung.
Lernaktivitäten: Auswendig lernen; Lösen von Übungsaufgaben; Studium von anspruchsvoller Originalliteratur als Hausaufgabe; Präsentation in Kurzform in den Übungen; gemeinsame kritische Analyse der in den Originalarbeiten angewendeten Problemlösungsstrategien in der Gruppe.

Media:
Tafelanschrieb, Powerpoint Präsentationen, Vorlesungsfolien, Reader, Übungsfragenkatalog

Reading List:
Leider existiert kein Lehrbuch, die Qellen des unterrichteten Stoffs sind daher auf den Vorlesungsfolien zum Selbststudium angegeben. Als Unterstützung wird folgendes allgemeines Lehrbuch zur Evolutionsbiologie empfohlen: Barton et al (2007) Evolution. Cold Spring Haror, New York.

Responsible for Module:
Siegfried Scherer (Siegfried.Scherer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zur Ökologie und Evolution pathogener Bakterien (Übung, 1 SWS)
Neuhaus K

Ökologie und Evolution von pathogenen Bakterien (Vorlesung, 2 SWS)
Neuhaus K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2450: Introduction to Mycology | Einführung in die Mykologie

Version of module description: Gültig ab summerterm 2011

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular and active student participation is expected. A written exam (60 min, graded) serves as proof of the theoretical knowledge acquired in the lecture and practical courses. In the exam, the students demonstrate their ability to structure the body of acquired knowledge and to summarize the important aspects of the study matter. The students should be able to describe, interpret, combine in a meaningful way the information learnt, and to transfer this knowledge to similar issues. The grade of the exam represents the total grade of the module.

Repeat Examination:

(Recommended) Prerequisites:
Es werden Grundkenntnisse in Biologie erwartet, sowie die in den Grundvorlesungen der Biologie und Mikrobiologie vermittelten Inhalte. Zum besseren Verständnis sind Grundkenntnisse in anorganischer und organischer Chemie erforderlich.

Content:
Im Rahmen der Vorlesung werden Grundkenntnise über Pize und Hefen vermittelt. Inhalte sind u.a.: System der Pilze, Morphologie, Differenzierungsmethode, usw. Im Rahmen der Mykologischen Übungen werden grundlegende Methoden zu praktischen Arbeiten mit Pilzen und Hefen vermittelt, u.a. Identifikation von Pilzen mit Hilfe mikroskopischer und phänotypischer Methoden; Demonstrationen zu Wachstums- und Stoffwechseleigenschaften von Pilzen; Anreicherung und Isolierung aus Proben mit Hilfe geeigneter Nährmedien; Beherrschung des sterilen Arbeitens und der Mikroskopie; Herstellung von Präparaten.

Intended Learning Outcomes:
Ziele des Moduls sind es, einen Einblick in das System der Pilze und ihre Morphologie, sowie in praktische Methoden zu Ihrer Identifizierung, Differenzierung und weitergehenden Untersuchung zu geben. Lernziele sind:
" Die wichtigsten Versuche zu den grundlegenden Themen der Mykologie verstehend nachvollziehen und technisch und manuell beherrschen.
" Grundlegendes experimentelles Know-how inklusive Sicherheits- und Materialwissen (z.B. Beherrschung steriler Arbeitstechniken und phänotypische Identifzierung von Mikroorganismen) erwerben, das sowohl bei bekannten eingeübten Versuchen wie auch bei unbekannten aus der Literatur zu erschließenden Versuchen eingesetzt werden kann.
" Kritisches und kreatives Denken fördern sowie Fähigkeiten zum Lösen von Problemen entwickeln.
" Interesse an Mikrobiologie, mikrobiologischen Problemen und die Bedeutung von Mikroorganismen für Mensch und Umwelt fördern.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung mit begleitende Demonstrationen und Übungen mit Vorbesprechung zu den einzelnen Versuchen.
Lernaktivität: Üben von technischen und labortechnischen Fertigkeiten hauptsächlich durch Demonstration; Einüben der Beobachtung von Präparaten; Anfertigung von Protokollen

Media:
Präsentationen mittels Powerpoint,
Demonstrationen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Mykologie (Vorlesung, 1 SWS)
Liebl W [L], Köberle M

Mykologische Übungen (Übung, 5 SWS)
Liebl W [L], Köberle M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2451: Introduction to Mycopathology | Einführung in die Mykopathologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60 schriftlich.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (60 min, benotet) dient der Überprüfung der in der Vorlesung erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind Kenntnisse der Grundlagen der Mikrobiologie (Vorlesung Allgemeine Mikrobiologie). Zum besseren Verständnis sind gute Kenntnisse in organischer Chemie und Biochemie vorteilhaft.

Content:
Übersicht über Erkrankungen durch Pilze, Pathogenitätsfaktoren auf molekularer Ebene, Mykotoxine, Allergene bei Pilzen, Antimykotika und ihre Wirkmechanismen, Resistenzmechanismen, Materialschädigung und Lebensmittelverderb durch Schimmelpilze, Chemie der antimyzetischen Maßnahmen.

Intended Learning Outcomes:
Nach der Teilnahme an dem Modul besitzen die Studierenden einen breiten Überblick und zum Teil vertiefte theoretische Kenntnisse über filamentöse Pilze und Hefen und ihre Rolle als pathogene Mikroorganismen, Interaktionen zwischen Pathogen und Wirt, sowie die Rolle von Pilzen bei Material- und Lebensmittel-schädigenden Vorgängen. Sie sollen

" in der Lage sein, wichtige pilzliche Krankeitserreger einschließlich der durch sie verursachten Krankeitsbilder zu benennen.
" beispielhaft molekulare Mechanismen von Pathogenitätsfaktoren, Antibiotikawirkung und -resistenz zu benennen und erläutern können.
" ein Verständnis über die Möglichkeiten zurr Behandlung von Infektionen durch Pilze entwickeln.
" lernen, das erworbene Wissen auf vertiefte Fragestellungen anwenden.
Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an Mikrobiologie fördern.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung Lehrmethode: Vortrag, Demonstrationen
Lernaktivitäten: Studium von Vorlesungsskript und -mitschrift, ggf. Literaturstudium.

Media:
Präsentationen mittels Powerpoint, praktische Demonstrationen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de) Köberle, Martin, Dr. rer. nat. martin.koeberle@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Mykopathologie (Vorlesung, 2 SWS)
Liebl W [L], Köberle M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1817: Research Project Molecular Fungal Genetics | Forschungspraktikum Molekulare Pilzgenetik

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 40	**Contact Hours:** 260

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation in the practical course is expected. The accomplishments in the lab will be graded, including the preparation and execution of the experiments, necessary calculations, the documentation and analysis in form of a lab journal (written report) as well as the interpretation of the results. The students demonstrate with the lab journal that they are able to correctly structure and reflect the critical aspects of their experiments. The accomplishments in the lab will be extended by a final oral presentation of the research rationale & results to the other members of the group at the end of the lab course to test the communicative competences of the students.

Repeat Examination:

(Recommended) Prerequisites:
Good basic knowledge of microbiology and biochemistry, basic skills in molecular biological lab techniques, and participation in the module "Molecular Biology of Biotechnologically Relevant Fungi" are recommended but not mandatory.

Content:
In the lab course, the students will participate in ongoing research projects of the group under supervision of experienced lab members. Foci will be the molecular biology, gene regulation and physiology of filamentous fungi. In particular the handling of model organisms, their molecular, physiological and biochemical characterization and modification will be conveyed. Independent literature research will be taught and performed to deepen the knowledge basis regarding the specific topics of interest.

Intended Learning Outcomes:
This practical lab course is purposefully integrated into the daily research projects of our group and thus allows a unique learning experience of microbiological and molecular biology techniques in a real-life situation. Students will be perfectly prepared for potentially following Master or PhD thesis projects. After successful participation in this module, the students should have:
- achieved experience of real scientific project work
- acquired a broad experimental know-how including the pertinent safety regulations and the respective analytical machine handling
- reached a high level of independence in project planning and execution
- practiced good scientific record keeping and journal writing
- developed their critical interpretation skills

The lab course is supposed to furthermore strengthen the students' interest in fungi, their application in R&D as well as their relevance for society and the environment

Teaching and Learning Methods:
Teaching technique: lab course under invidual supervision; critical discussion and reflection of experimental work with supervisor and lab members. Learning activities: literature research, experimental work, generation of a written lab journal and preparation of an oral presentation to the group.

Media:

Reading List:
current literature of covered topics; mostly to be researched by students themselves

Responsible for Module:
J. Philipp Benz benz@hfm.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Pilzgenetik (Forschungspraktikum, 10 SWS)
Benz J, Karl T, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2082: Practical Course in Food Biotechnology | Forschungspraktikum Lebensmittelbiotechnologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The project itself and the result report represent the examination performance.
During ongoing research projects in the field of food biotechnology, a task is developed and worked on in coordination with the supervisor. The central part of this is a practical activity in the research laboratory for approx. 4 weeks (contiguous or spread over a maximum of 3 months depending on the topic) under the supervision of a scientist. A protocol will be prepared independently from the work, which contains an introduction to the topic, the presentation of the methods used, and a separate result and discussion section. The evaluation is not only based on the success of the research, but especially on the independence in the execution of the experiment and the elaboration of the protocol, the depth of understanding of the research work, the reliability of the results obtained and the cleanliness of the execution of the experiment, as well as the personal commitment. The basis for this is communication with the supervisor, practical work in the laboratory and the written protocol.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Passed examination in the module Introduction to Microbiology (mandatory), at least one of the modules Food Microbiology, Development of Starter Cultures, Food Biotechnology, Biotechnology of Natural Products (recommended)

Content:
The content of the project work is based on ongoing research. Basic topics are described in the lectures "Development of starter cultures (Vogel)", "Food biotechnology (Ehrmann)" as well as "Metabolic engineering and natural product production" and "Biomolecular food technology" (Schwab). Topics of current research can be found at www.foodscience.ws or

www.wzw.tum.de/tmw/ or www.wzw.tum.de/bina/. A specific topic is developed in each case, which is worked on under the supervision of a scientist.

Intended Learning Outcomes:
After the participation in this module course, students are able to work independently on a defined research area and to summarize this in a report.

Teaching and Learning Methods:
Independent project

Media:
An electronic report template is available for this event.

Reading List:
Scientific publications, depending on the topic.

Responsible for Module:
Rudi Vogel rudi.vogel@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Lebensmittelbiotechnologie (Forschungspraktikum, 20 SWS)
Ehrmann M, Niessen M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2258: Research Practical in Microbial Physiology and Gene Regulation | Forschungspraktikum Mikrobielle Physiologie und Genregulation

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 310	**Self-study Hours:** 160	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Gute Grundlagenkenntnisse in Mikrobiologie und Biochemie; grundlegende mikrobiologische und biochemische Arbeitstechniken.

Content:
During this research practical students work under supervision on actual reasearch projects of the groups of the Department of Microbiology. Specialized laboratory methods of microbiology, molecular biological characterization and genetic modification and/or protein purification and characterization are tought in this hands-on course. The emphasis is on molecular biology, gene regulation, and microbial physiology. Deepened knowledge in the field of the chosen topic is acquired by studying the relevant scientific literature.

Intended Learning Outcomes:
After completing this module students should have acquired the following competencies:
" Experimental experience under typical laboratory conditions via work on a real research project.
" A broad experimental know-how. The students should understand and have a good grasp of the microbiological, genetical and/or biochemical special methods, including safety and materials aspects.
" A high degree of independence with respect to the planing and execution of laboratory experimental procedures.

" The skill of writing comprehensive and meaningful laboratory protocols is exercised.
" Critical and creative thinking and reflection, and the skill to devise strategies to solve scientific questions by experimental means is trained.

Teaching and Learning Methods:
Labor" Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder." Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern." Anfertigen und Bewertung eines aussagekräftigen, nachvollziehbaren Laborprotokolls." Präsentation der Resultate in einem Kurzvortrag.

Media:

Reading List:
stark abhängig von der Aufgabenstellung, wird individuell empfohlen.

Responsible for Module:
Wolfgang Liebl (wliebl@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2376: Research Project on Pathogenic Bacteria | Forschungspraktikum Pathogene Bakterien

Version of module description: Gültig ab summerterm 2010

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:**	**Contact Hours:** 300

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
At the end of the internship the students present a protocol which is evaluated. The students demonstrate that they have learned to plan, responsibly conduct and adequately document experiments with pathogenic bacteria according to good scientific practice. Furthermore, the students show that they are able to discuss their experimental results and to classify them in a limited professional context with reference to the scientific literature. The overall grade is made up of the assessment of the work performance in the laboratory (50%) and the evaluation of the protocol (50%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor degree in molecular biotechnology or biology.

Content:
Participation in individual aspects of current microbiological research projects on molecular genetics and ecology of pathogens at the Chair of Microbial Ecology. Example would be: Translatomics and transcriptomics of Pseudomonas aeruginosa with emphasis on overlapping encoded genes, experimental transnational arrest of overlapping open reading frames; phanotypic analysis of novel putative protein-coding nucleotide sequences from pathogenic Eschrichia coli EHEC. Current research projects are described on the website of the chair.
(see . http://www.wzw.tum.de/micbio/forschung.php).

Intended Learning Outcomes:
After participation in this module, students will have a basic understanding of the application of safety-relevant microbiological methods in dealing with bacterial pathogens in the pathogen

laboratory of level R2 as well as in the genetic engineering laboratory of safety level S2 or S3**. In addition, students learn how to use advanced molecular genetic methods for the genetic modification of pathogenic bacteria. These include cloning methods and directed mutagenesis. Finally, students will learn how to use real time quantitative PCR and sequencing techniques (e.g. transcriptomics and translatomics) as well as the associated bioinformatic evaluation methods.

Teaching and Learning Methods:
Internship, tutorials, demonstrations, experiments, literature work, data analysis/review of results, presentation of results

Media:

Reading List:
Introductory textbook

Responsible for Module:
Scherer, Siegfried; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum pathogene Bakterien (Forschungspraktikum, 20 SWS)
Neuhaus K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2377: Research Project on Food Hygiene | Forschungspraktikum Molekulare Lebensmittelhygiene

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 0	**Contact Hours:** 300

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Laboratory assignment: Regular presence in the research laboratory is indispensable. Attendance times are determined by the experimental design to be carried out by the student and agreed with the supervisor. The students show through the planning of experiments, experimental performance of experiments and evaluation that they have learned advanced experimental methods of molecular food hygiene and the handling of food pathogenic bacteria. As a graded written examination, a practical course protocol in the form of a scientific publication will be prepared, which also takes relevant original literature into account. The experimental results of the research internship will be presented in an ungraded short lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module: Microorganisms as pathogens

Content:
The topic of the research package will be determined individually in consultation with the students and is part of a research pre-project on molecular food hygiene currently being worked on at the chair. The following techniques can be taught, depending on the topic: Safe working with pathogenic bacteria (S2- S3** level); mutagenesis; transcriptional analysis (qRT-PCR; microarrays, deep sequencing of transcriptomes); expression of regulatory proteins and toxins; gel mobility shifts; toxin detection and monitoring of virulence gene expression in vivo (IVIS system)

Intended Learning Outcomes:
The skills acquired by the students relate to (i) experimental microbiological and molecular biological techniques, (ii) the correct keeping of a laboratory journal, (iii) the critical interpretation

of their own results using known literature data and (iv) the presentation of research results in the form of a scientific publication. An essential learning outcome is the practice of microbiological work under the safety requirements of a pathogen laboratory.

Teaching and Learning Methods:
Teaching technique: practical training.
Teaching method: Individual teaching conversations, experiments.
Learning activities: Design of experiments, practising laboratory skills, keeping laboratory protocols, studying literature, summarising and discussing results in a research protocol, preparing and giving a presentation.

Media:
none

Reading List:
individual depending on the research topic

Responsible for Module:
Siegfried Scherer siegfried.scherer@mytum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2378: Research Project on Molecular Microbial Biodiversity and Taxonomy | Forschungspraktikum Molekulare mikrobielle Diversität und Taxonomie

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 20	**Contact Hours:** 280

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
pass/fail credit requirement: Regular attendance in the research laboratory is indispensable. Attendance times are determined by the experimental design to be carried out by the student and agreed with the supervisor. The students show through the design of experiments, the experimental performance of experiments and the evaluation that they have learned advanced experimental methods for microbial biodiversity and taxonomy. The graded step-by-step examination will be documented in the form of a scientific publication, which will also include relevant original literature. The experimental results of the research internship will be presented in an ungraded short lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Practical and theoretical knowledge in general microbiology and molecular genetics

Content:
The topic of the research package will be determined individually in consultation with the students and is part of a research project on microbial biodiversity and taxonomy currently being carried out at the chair. The following techniques can be taught, depending on the topic: Safe work with pathogenic bacteria; genome sequence analysis of bacteria (Illumina technology), culture-dependent biodiversity analysis based on Fourier transform infrared spectroscopy; culture-independent biodiversity analysis based on 16S rDNA; description of new bacterial species and genera.

Intended Learning Outcomes:
Competencies to be acquired refer to (i) experimental microbiological and molecular biological techniques, (ii) the correct keeping of a laboratory journal, (iii) the critical interpretation of one's own results including the known literature data and (iv) the presentation of research results in the form of a scientific publication. An essential learning outcome is the practice of microbiological work under the safety requirements of a pathogen laboratory.

Teaching and Learning Methods:
Teaching technique: practical training.
Teaching method: Individual teaching conversations, experiments.
Learning activities: Design of experiments, practising laboratory skills, working under time and responsibility pressure, keeping laboratory protocols, studying literature, summarising and discussing results in a research protocol, preparing and giving a presentation.

Media:
none

Reading List:
Individual depending on the research topic

Responsible for Module:
Siegfried Scherer Siegfried.Scherer@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2412: Immunology Research Internship | Forschungspraktikum Immunologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The practical work of the students is graded. The application of the techniques, the laboratory working methods and the keeping of a laboratory journal are evaluated. The understanding of experimental questions and methods from basic immunological research as well as the ability to process scientific data will be assessed by the students by writing a protocol (graded). The overall mark of the laboratory performance is composed of the two individual marks (mark practical work + mark internship protocol) in equal parts.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Successful completion of the module "Immunology 1"

Content:
This research internship is a work on a current project in one of the institute's research groups. The projects at the Institute represent basic immunological research in humans and mice with the aim of a greater understanding of immune responses against pathogens or misdirected immune responses in case of allergy and autoimmunity. With the help of the basic knowledge of immunology acquired in the module 'Immunology 1', specific scientific problems in this environment shall be analysed and evaluated in order to develop own solutions. During the internship the students are involved in the general seminars of the institute and the corresponding research group.

Intended Learning Outcomes:
After completion of this module, students are able to independently develop and perform experimental approaches for the investigation of selective immunological questions. Based on

the basic knowledge of immunology acquired in the module 'Immunology 1' they are able to understand and analyse specific scientific problems, plan experimental approaches and carry out the experiments independently.

Teaching and Learning Methods:
The module consists of a research internship in one of the Institute's working groups. The students work on a smaller research project. The immunological and other working methods to be applied for the project are taught by responsible supervisors. To fully understand the scientific background, students are encouraged to study original scientific papers.

Media:

Reading List:
original scientific papers

Responsible for Module:
Dirk Busch dirk.busch@mikrobio.med.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Immunologie (Praktikum, 10 SWS)
Busch D, Gerhard M, Prazeres da Costa C, Mejias Luque R, Buchholz V, Schumann K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2540: Research Project Microbial Physiology and Gene Regulation | Forschungspraktikum Mikrobielle Physiologie und Genregulation

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Anwesenheitszeiten ergeben sich aus der vom Studierenden durchzuführenden und mit dem Betreuer abzusprechenden Versuchsplanung. Die Studierenden zeigen durch Versuchsplanung, experimentelle Versuchsdurchführung, Ergebnisprotokollierung und -auswertung, dass sie fortgeschrittene experimentelle Methoden der bearbeiteten Forschungsthematik erlernt haben. Am Ende des Forschungspraktikums werden die experimentellen Ergebnisse in einem unbenoteten Kurzvortrag präsentiert. Als benotete schriftliche Prüfungsleistung wird ein Praktikumsprotokoll erstellt. Das Praktikumsprotokoll soll in der Form wie eine wissenschaftlichen Publikation aufgebaut sein, die Versuchsplanung und –durchführung beschreiben, die wesentlichen erhaltenen Ergebnisse unterfüttert durch aussagekräftige Abbildungen/Tabellen übersichtlich darstellen und diese unter Bezugnahme auf relevante Originalliteratur nachvollziehbar interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind gute Grundkenntnisse in Mikrobiologie und Biochemie, grundlegende mikrobiologische und biochemische Arbeitstechniken, sowie Teilnahme am Modul Organismische und Molekulare Mikrobiologie oder vergleichbare Vorkenntnisse.

Content:
Im Rahmen des Forschungspraktikums arbeiten die Teilnehmer unter Anleitung an aktuellen Forschungsprojekten der Arbeitsgruppen des Lehrstuhls für Mikrobiologie. Inhaltliche Schwerpunkte sind Molekularbiologie, Genregulation und Mikrobielle Physiologie. Es werden spezielle Methoden des praktischen Arbeitens mit Mikroorganismen, der molekularbiologischen Charakterisierung und Modifizierung, der wachstumsphysiologischen und/oder enzymatischen

Charakterisierung vermittelt. Durch Eigenstudium von fachwissenschaftlicher Literatur werden vertiefte Kenntnisse zur jeweils bearbeiteten Thematik erworben.

Intended Learning Outcomes:
Durch das forschungsnahe Praktikum unter Anleitung haben die Studierenden folgende Fähiglkeiten erworben:
- relativ eigenständiges mikrobiologisches/molekularbiologisches Arbeiten.
- Erfahrung unter Bedingungen des Laboralltags
- Ein breites experimentelles Know-how von angewandten mikrobiologischen, genetischen und/oder biochemischen Spezialmethoden inklusive Sicherheits- und Materialwissen verstehend nachvollzogen und handlungsmäßig beherrschen.
-Ein hohes Maß an Selbständigkeit im Planen und Durchführen von Experimenten.
- Fähigkeit zur Führung von aussagekräftigen, nachvollziehbaren Laborprotokollen.
- Kritisches und kreatives Denken vertieft sowie Fähigkeiten zum Lösen von Problemen erweitert.
- Kompetenz zur sorgfältigen Durchführung und Protokollierung von Laborexperimenten, kritischen Hinterfragung von Versuchsdaten und übersichtlichen schriftlichen Darstellung von Experimentalergebnissen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborpraktikum, Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder; Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern..
Lernaktivitäten: Literaturstudium, experimentelles Arbeiten; Anfertigen eines aussagekräftigen, nachvollziehbaren Laborprotokolls; Vorbereitung von Kurzpräsentationen von Ergebnissen.

Media:

Reading List:
Wissenschaftliche Fachliteratur nach Bedarf.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Mikrobielle Physiologie und Genregulation (Forschungspraktikum, 10 SWS)
Liebl W, Bimmer M, Vanderhaeghen S, Zverlov V
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2542: Research Project Microbial Diversity and Molecular Phylogeny | Forschungspraktikum Mikrobielle Diversität und Molekularphylogenie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Anwesenheitszeiten ergeben sich aus der vom Studierenden durchzuführenden und mit dem Betreuer abzusprechenden Versuchsplanung. Die Studierenden zeigen durch Versuchsplanung, experimentelle Versuchsdurchführung, Ergebnisprotokollierung und -auswertung, dass sie fortgeschrittene experimentelle Methoden der bearbeiteten Forschungsthematik erlernt haben. Am Ende des Forschungspraktikums werden die experimentellen Ergebnisse in einem unbenoteten Kurzvortrag präsentiert. Als benotete schriftliche Prüfungsleistung wird ein Praktikumsprotokoll erstellt. Das Praktikumsprotokoll soll in der Form wie eine wissenschaftlichen Publikation aufgebaut sein, die Versuchsplanung und –durchführung beschreiben, die wesentlichen erhaltenen Ergebnisse unterfüttert durch aussagekräftige Abbildungen/Tabellen übersichtlich darstellen und diese unter Bezugnahme auf relevante Originalliteratur nachvollziehbar interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind gute Grundkenntnisse in Mikrobiologie und Biochemie, grundlegende mikrobiologische und biochemische Arbeitstechniken, sowie Teilnahme am Modul Organismische und Molekulare Mikrobiologie oder vergleichbare Vorkenntnisse.

Content:
Im Rahmen des Forschungspraktikums arbeiten die Teilnehmer unter Anleitung an aktuellen Forschungsprojekten der Arbeitsgruppen des Lehrstuhls für Mikrobiologie. Es werden spezielle Methoden des praktischen Arbeitens mit Mikroorganismen und der Anwendung von Methoden zur Identifizierung, molekularbiologischen Charakterisierung und systematischen Einordnung von Mikroorganismen vermittelt. Inhaltliche Schwerpunkte sind Mikrobielle Diversität, Molekularbiologie

und Molekularphylogenie. Durch Eigenstudium von fachwissenschaftlicher Literatur werden vertiefte Kenntnisse zur jeweils bearbeiteten Thematik erworben.

Intended Learning Outcomes:
Durch das forschungsnahe Praktikum unter Anleitung haben die Studierenden folgende Kopmetenzen erworben:
-relativ eigenständiges mikrobiologisches/molekularbiologisches Arbeiten
-Erfahrung unter Bedingungen des Laboralltags
-breites experimentelles Know-how angewandter mikrobiologischen, genetischen und/oder biochemischen Spezialmethoden inklusive Sicherheits- und Materialwissen verstanden, nachvollzogen und handlungsmäßig beherrscht.
-hohes Maß an Selbständigkeit im Planen und Durchfüren von Experimenten
-Fähigkeit zur Führung von Aussagekräftigen, nachvollziehbaren Laborprotokollen
-Kritisches und kreatives Denken verstärkt sowie Fähigkeiten zum Lösen von Problemen erweitert
- Kompetenz zur sorgfältigen Durchführung und Protokollierung von Laborexperimenten, kritischen Hinterfragung von Versuchsdaten und übersichtlichen schriftlichen Darstellung von Experimentalergebnissen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborpraktikum, Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder; Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern..
Lernaktivitäten: Literaturstudium, experimentelles Arbeiten; Anfertigen eines aussagekräftigen, nachvollziehbaren Laborprotokolls; Vorbereitung von Kurzpräsentationen von Ergebnissen.

Media:

Reading List:
Wissenschaftliche Fachliteratur nach Bedarf.

Responsible for Module:
Liebl, Wolfgang; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Mikrobielle Diversität und Molekularphylogenie (Forschungspraktikum, 10 SWS)
Liebl W, Ehrenreich A, Zverlov V
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2558: Research Project Molecular Soil Microbiology | Forschungspraktikum Molekulare Bodenmikrobiologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 100	**Contact Hours:** 200

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam duration (in min.): 30 minutes (seminar lecture).
Regular, active participation in the courses is expected. The student receives his/her own scientific topic which he/she will work on during the practical course under the supervision of an experienced researcher. It is expected that the student will also evaluate the data and, through discussions with the supervisor, will be able to critically interpret the knowledge gained. This is done a) by preparing a protocol about the major outcomes of the course and b) by a seminar lecture and subsequent discussion

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Introductory lecture "Microbial Ecology and Microbiomes"; Microbiological practical courses for beginner; Basic knowledge of molecular methods such as PCR

Content:
Topics for the course are based on current work in the Research Unit for Comparative Microbiome Analysis at the Helmholtz Zentrum München. These are listed under www.helmholtz-muenchen.de/comi. A topic is selected together with the direct supervisor; the topic is set in such a way that it can be finalized in 10 weeks and that it is self-contained so that initial findings can be discussed. The methods to be used are well established; accordingly, a quick success in learning new tools is guaranteed.

Intended Learning Outcomes:
Independent processing of scientific questions; Application of learned and new methods in soil microbiology; Experimental planning based on statistical criteria including evaluation of the data sets. Ecological interpretation of molecular biological data sets.

Teaching and Learning Methods:
Practicing laboratory skills and microbiological work techniques; Discussion with doctoral students and postdocs from the Research Unit

Media:
independent lab work based on established protocols

Reading List:
Soil Microbiology and Biochemistry, Eldor A. Paul (Author), Francis E. Clark; ISBN-10: 0125468067

Responsible for Module:
Michael Schloter schloter@helmholtz-muenchen.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Bodenmikrobiologie (Forschungspraktikum, 10 SWS)
Schloter M, Schulz S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2638: Research Project in Veterinary Microbiology and Hygiene | Forschungspraktikum zur Tiermedizinischen Mikrobiologie und Hygiene

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): Protokoll.
Es wird die vollzeitliche Anwesenheit und Mitarbeit während des Prakikumszeitraums (6 Wochen) erwartet. Bei zeitlichen Überscheidungen mit anderen Lehrveranstaltungen können die Arbeitstage flexibel angepasst werden. Zur Überprüfung des Verständnisses der erlernten Methoden wird vom Studierenden ein Bericht angefertigt, dessen selbständige Anfertigung ggf. in einem Gespräch überprüft werden kann. Weiterhin können die Studierenden ihre Methodenkompetenz während der praktischen Mitarbeit im Labor nachweisen. Hierbei werden den Studierenden nach einer Einarbeitungszeit im zweiten Teil des Praktikums Aufgaben zur selbständigen Bearbeitung übertragen. Die angestrebten Lernergebnisse werden anhand des zu erstellenden Berichts vor dem Hintergrund der praktischen Mitarbeit im Labor überprüft.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zum besseren Verständnis der Methoden sind ausreichende Kenntnisse in Mikrobiologie, Chemie und Biochemie notwendig.

Content:
Im Rahmen des Praktikums werden umfangreiche Kenntnisse in mikrobiologischen Arbeitsmethoden vermittelt. Aufbauend auf grundlegenden kulturellen Techniken erlernen die Kursteilnehmer insbesondere Funktionsweise und Anwendung von modernen molekularbiologischen Nachweisverfahren. Hierzu zählen neben PCR (inkl. quantitativer RT-PCR) und PCR-SSCP auch die DNA-Sequenzierung. Weiterhin werden Grundlagen der Zellkultur sowie des Nachweises von Toxinen mikrobiellen Ursprungs und Antibiotika in biologischen Matrices mittels chemisch/physikalischer Methoden (u.a. HPLC, Massenspektrometrie) vermittelt.

Die zu bearbeitenden Themen liegen im Bereich der Hauptarbeitsgebiete des Lehrstuhls (z.Zt. Antibiotikarückstände und antibiotikaresistente Bakterien in der Umwelt, Analyse von Mikroorganismengemeinschaften, Nachweis und Vorkommen von Mykotoxinen in der Nahrung sowie deren Bedeutung für die Gesundheit von Mensch und Tier).

Intended Learning Outcomes:
Nach der Durchführung des Praktikums besitzen die Studierenden grundlegende praktische Fertigkeiten sowie theoretisches Hintergrundwissen über einen Großteil moderner mikrobiologischer Arbeitstechniken. Sie sollen gelernt haben
" mikrobiologische Fragestellungen und Arbeitstechniken zu verstehen und fachliche Fragen selbst zu entwickeln
" Zusammenhänge zwischen Stoffwechselwegen und Stoffumsetzungen durch Mikroorganismen sowie deren analytische Verwendbarkeit zu verstehen
" Grenzen der kulturellen Nachweisbarkeit von Mikroorganismen zu erkennen
" die Grundlagen molekularbiologischer Nachweismethoden von Mikroorganismen nachvollziehen und praktisch beherrschen zu können
" Arbeitstechniken zur Bestimmung von mikrobiellen Stoffwechselprodukten anzuwenden
Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an Mikrobiologie, mikrobiologischen Problemen und die Bedeutung von Mikroorganismen für Mensch und Umwelt fördern.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Praktikum. Lehrmethode: Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit, Ergebnisbesprechungen, ggf. Projekarbeit. Lernaktivitäten: Erstellung eines Protokolls.

Media:
Tafelarbeit, Arbeitsblätter und Standardarbeitsanweisungen, Versuchsbeschreibungen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Die Aneignung von Hintergrundwissen zu den angewandten Methoden wird im Rahmen des Praktikums anhand von Arbeitsblättern sowie ggf. spezifischen Literaturhinweisen gefördert.

Responsible for Module:
Johann Bauer (Johann.Bauer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2927: Research Project Molecular Microbial Enzymology | Forschungspraktikum Molekulare Mikrobielle Enzymatik

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Anwesenheitszeiten ergeben sich aus der vom Studierenden durchzuführenden und mit dem Betreuer abzusprechenden Versuchsplanung. Die Studierenden zeigen durch Versuchsplanung, experimentelle Versuchsdurchführung, Ergebnisprotokollierung und -auswertung, dass sie fortgeschrittene experimentelle Methoden der bearbeiteten Forschungsthematik erlernt haben. Am Ende des Forschungspraktikums werden die experimentellen Ergebnisse in einem unbenoteten Kurzvortrag präsentiert. Als benotete schriftliche Prüfungsleistung wird ein Praktikumsprotokoll erstellt. Das Praktikumsprotokoll soll in der Form wie eine wissenschaftlichen Publikation aufgebaut sein, die Versuchsplanung und –durchführung beschreiben, die wesentlichen erhaltenen Ergebnisse unterfüttert durch aussagekräftige Abbildungen/Tabellen übersichtlich darstellen und diese unter Bezugnahme auf relevante Originalliteratur nachvollziehbar interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind gute Grundkenntnisse in Mikrobiologie und Biochemie, grundlegende mikrobiologische und biochemische Arbeitstechniken, sowie Teilnahme am Modul Organismische und Molekulare Mikrobiologie oder vergleichbare Vorkenntnisse.

Content:
Im Rahmen des Forschungspraktikums arbeiten die Teilnehmer unter Anleitung an aktuellen Forschungsprojekten der Arbeitsgruppen des Lehrstuhls für Mikrobiologie. Es werden spezielle Methoden des praktischen Arbeitens mit Mikroorganismen, der molekularbiologischen Charakterisierung und Modifizierung und/oder der Proteinreinigung und -charakterisierung vermittelt. Inhaltliche Schwerpunkte sind Molekularbiologie und Enzymatik. Durch Eigenstudium

von fachwissenschaftlicher Literatur werden vertiefte Kenntnisse zur jeweils bearbeiteten Thematik erworben.

Intended Learning Outcomes:
Durch das forschungsnahe Praktikum sind die Studierenden in der Lage unter Anleitung relativ eigenständig mikrobiologische/molekularbiologische Arbeiten durchzuführen. Nach der Absolvierung dieses Moduls haben die Studierenden folgende Kompetenzen erworben:
" Durch die Mitarbeit an einem Forschungsprojekt Erfahrung unter Bedingungen des Laboralltags .
" Ein breites experimentelles Know-how. Die angewandten mikrobiologischen, genetischen und/oder biochemischen Spezialmethoden können inklusive Sicherheits- und Materialwissen verstanden und nachvollzogen werden und werden handlungsmäßig beherrscht.
" Es ist hohes Maß an Selbständigkeit im Planen und Durchführen von Experimenten erreicht.
" Die Fähigkeit zur Führung von Aussagekräftigen, nachvollziehbaren Laborprotokollen.
" Kritisches und kreatives Denken weiter verstärkt sowie Fähigkeiten zum Lösen von Problemen entwickelt.
- Kompetenz zur sorgfältigen Durchführung und Protokollierung von Laborexperimenten, kritischen Hinterfragung von Versuchsdaten und übersichtlichen schriftlichen Darstellung von Experimentalergebnissen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborpraktikum, Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder; Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern..
Lernaktivitäten: Literaturstudium, experimentelles Arbeiten; Anfertigen eines aussagekräftigen, nachvollziehbaren Laborprotokolls; Vorbereitung von Kurzpräsentationen von Ergebnissen.

Media:

Reading List:
Wissenschaftliche Fachliteratur nach Bedarf.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Mikrobielle Enzymatik (Forschungspraktikum, 10 SWS)
Liebl W, Zverlov V, Baudrexl M, Vanderhaeghen S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3926: Research Project Molecular Biology of Intestinal Microbiota | Forschungspraktikum Molekularbiologie intestinaler Mikrobiota

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is graded to validate the learning objective – i.e. confirmation of a small method- and research-oriented project, partly supervised and self-guided and its utilization - according to good scientific practice. This includes a corresponding achievement in the lab, documented in the form of an internship report with accompanying presentation as conclusion. --- An internship report (about 20 pages) has to be handed in and a presentation about the completed lab work has to be held with final discussion (about 20 minutes lecture time, excl. Discussion). Both, description and documentation of the experimental procedures, analysis and description of individual experiments according to good scientific practice are checked, and the communicative competence are assessed, regarding the scientific subject, questions about results or experimental approaches used for sample material, the processing of the samples, and the data evaluation. The module is passed when graded for the protocol of at least “sufficient”.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Exercises in Microbiology or similar

Content:
*DNA isolation from complex microbiomes
*Analysis of DNA
*PCR
*gel cleanings
*sterile working
*growing anaerobic bacteria
*Library making

*Sequencing using NGS

Intended Learning Outcomes:
Within a larger research project (usually microbiota of the intestines and their functional research), students are able to work on a subject-restricted project (eg with reference to specific samples, organisms or processes to be optimized) largely scientifically (laboratory and bioinformatic evaluation, usually 80:20), documented and evaluated in writing according to good scientific practice (lab book or final report), and presented in a scientific presentation (about 20 minutes in a laboratory seminar or similar). In particular, students learn to extract nucleic acids from samples (e.g., stool, skin, human and animal internal organs, bacterial cultures, etc.) quantitatively and without inhibitors. The isolated nucleic acids are enzymatically treated according to their nature (DNA, RNA), so that they lead to experimental libraries to be sequenced. Depending on the sequencing technology used (DNAseq, RNAseq, RIBOseq, etc., if appropriate using low-content samples), this includes fragmentation, tagmentation, ligation, PCR, phosphorylation, exo- and endonuclease treatment, density gradient centrifugation, etc. Students learn to accompany the process with quality control (QC) to obtain high-quality libraries and avoiding contaminations. The QC includes using conventional agarose gels, PAGE, capillary electrophoresis (BioAnalyzer or similar), dye-based assays (Qbit, etc.), etc. Furthermore, the students learn about suitable control reactions (mock, negative, positive) and how their results should be considered in data evaluation. In summary, you have an understanding of the experimental procedures for Next Generation Sequencing. To analyze the data, you will get to know bioinformatic software pipelines, which will be used depending on the question, the samples and the method of library production: IMNGS.org, Rhea, Bioconductor, usegalaxy.org, quiime2, RDP, MEGA-X, SILVA, KEGG, EcoliWiki, etc. For further discussion of the results, students are able to search in databases for literature and for gene data (eg scholar.google.com, NCBI, Genbank, and other). --- As mentioned, the focus varies according to the specific project and may also include the cultivation of bacteria under anaerobic conditions, ie. sterile and contamination-free work on an anaerobic workbench.

Teaching and Learning Methods:
Introduction into the laboratorium with a supervising scientist in a one-to-one basis, after that autonomous work in the lab after consultation. Self studies on how to conduct searches in literature and sequence data bases, data evaluation under supervision, conduction a report after consultation.

Media:
Publications of international journals about the topics

Reading List:
Current literature, for instance, Bazanella et al. (2017) Randomized controlled trial on the impact of early-life intervention with bifidobacteria on the healthy infant fecal microbiota and metabolome. Am J Clin Nutrition, 106(5): 1274–1286, https://doi.org/10.3945/ajcn.117.157529
and references therein about the methods used

Responsible for Module:
Neuhaus, Klaus; PD Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekularbiologie intestinaler Mikrobiota
10 SWS

Neuhaus, Klaus
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2557: Research Project Soil Microbiology | Forschungspraktikum Bodenmikrobiologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Ein ausführlicher Praktikumsbericht dient der Überprüfung der im Praktikum erworbenen Kenntnisse und der Durchführung der praktischen Arbeiten. Im Praktikumsbericht zeigen die Studierenden, ob sie in der Lage sind, die praktischen Arbeiten in den wissenschaftlich-theoretischen Kontext einzuordnen und die Ergebnisse ihrer Forschung adäquat darzustellen. Ferner sollen die Ergebnisse angemessen z.B. unter Einbeziehung wissenschaftlicher Publikationen aus dem entsprechenden Fachgebiet diskutiert werden. Der Praktikumsbericht wird benotet und bildet die Gesamtnote des Moduls.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Voraussetzung für die Teilnahme am Forschungspraktikum ist die erfolgreiche Teilnahme am Modul Bodenmikrobiologie 1

Content:
In Absprache mit den Betreuern werden Themen vergeben, die auch auf Initiative der Studierenden adaptiert werden können, um das Eigeninteresse an der Forschung zu fördern. Themen u.a. aus den Bereichen globaler Stoffkreisläufe (C, N), Nährstoffkreisläufe und Pflanzenernährung, Schadstoffabbau, biotische Interaktionen, werden angeboten und nach Interessenslage ausgearbeitet. Darüberhinaus wird ein Überblick über die in den Arbeitsgruppen vorhandenen Forschungsarbeiten und Techniken ermöglicht. Inhalte sind u.a.: Identifizierung und Funktion von Bodenmikroorganismen, Stoffkreisläufe in Ökosystemen, Habitate und spezifische Anforderungen zur Anpassung an Mikroorganismen, Rhizosphäre als Lebensraum, Interaktionen mit anderen Organismen (Symbiosen bzw. Pathogene), Bedeutung für die menschliche

Gesundheit; Methoden der mikrobiellen Bodenökologie: stabile Isotope, Nukleinsäureanalysen, Sequenzierungstechnologien, Microarrays, Proteomikmethoden, Biomarkeranalysen.

Intended Learning Outcomes:
Nach der Teilnahme am Forschungspraktium besitzen die Studierenden spezielle Kenntnisse über Methoden und Fragestellungen auf dem Gebiet der Bodenmikrobiologie. Die Studierenden haben praktische Erfahrung mit aktuellen Methoden bodenökologisch mikrobiologischer Arbeitstechniken gemacht. Sie haben einen Bericht über die ihnen zur Bearbeitung übertragenen Versuche erstellt und somit die Darstellung von eigenen Forschungsergebnissen einschließlich ihrer Diskussion erlernt. Ferner sollen sie gelernt haben,
" Fragestellungen und Arbeitstechniken der Bodenmikrobiologie zu verstehen, kritisch zu beurteilen und fachliche Fragen und deren Lösung selbst zu entwickeln.
" eine Forschungsfrage zu bearbeiten, in den wissenschaftlichen Zusammenhang zu stellen und zu diskutieren

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Praktikum Lehrmethode: Vortrag; im Praktikum Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit, Ergebnisbesprechungen. Im Rahmen des Forschungspraktikums werden unter Anleitung eigene Forschungsarbeiten im Labor durchgeführt.
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Praktikumsskript und Literatur; Üben von labortechnischen Fertigkeiten und mikrobiologischen Arbeitstechniken; Zusammenarbeit mit Praktikumspartner; Anfertigung von Protokollen.

Media:
Mitlernen im Labor, Dialog mit Betreuern

Reading List:
Madigan, M.T., J.M. Martinko, P. Dunlap, D. Clark. Brock Biology of Microorganisms, Pearson Education, 12. Edition, 2009
Ottow, J.C.G. . Mikrobiologie von Böden, Springer, ISBN 978-3-642-00823-8, 1. Aufl. 2011
Blum, W. E. H. : Bodenkunde in Stichworten. (Hirts Stichwortbücher) Borntraeger, Berlin/Stuttgart. 2007. ISBN 3-443-03117-X
Stahr, K., Kandeler, E., Herrmann, L., Streck, T.: Bodenkunde und Standortlehre, UTB, 2008

Responsible for Module:
Pritsch, Karin, Dr. rer. nat. habil. E-Mail karin.pritsch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Bodenmikrobiologie (Forschungspraktikum, 10 SWS)
Pritsch K (Weikl F)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1174: Molecular Biology of Biotechnologically Relevant Fungi | Molekulare Biologie biotechnologisch relevanter Pilze

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of examination (in min.): 60 written (graded), 60 practical (lecture + exercise as ungraded course work).
Regular, active participation in the courses is expected. A written exam (60 min, graded) serves to test the theoretical skills learned in lectures and seminars. In the written exam, the students show whether they are able to structure the knowledge they have acquired and present the essential aspects of the topics discussed. In addition, they should also show that they are able to combine the interrelationships of the molecular biology of fungi in a meaningful way and transfer them to similar topics (e.g. a current but not discussed topic of fungal biotechnology). The 45-minute presentation (in English) with subsequent discussion is designed to teach independent scientific research and to demonstrate the ability to present complicated scientific relationships in a structured and logical way. The module grade is determined by the grade of the written examination. The module is passed if a grade better than 4.1 is achieved and the course work (lecture) is successfully completed, as is the successful participation in the exercises/excursions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For better understanding, basic knowledge of microbiology is advantageous.

Content:
The course is to teach basic knowledge about the diversity and physiology of fungi, and in addition covers more in-depth information on fungal biotechnological applicabilities. A focus will be the unique capability of fungi to degrade and convert plant biomass. Exemplary contents that will be discussed are: gene technology (bio-engineering), plant cell walls as substrate and their

degradation, signaling pathways of substrate perception, biotechnological applications of enzyme and small-molecule production, as well as application of fungi in the agricultural industry.
In the practical/seminar part of the course, selected topics will be discussed in more detail by student presentations and with the help of practical examples. In addition, an excursion to the Clariant Sunliquid demonstration plant in Straubing is planned, where bioethanol is being produced from fungal conversion of biomass.

Intended Learning Outcomes:
After successful participation in the module, the students will have advanced knowledge of the biotechnological applications of fungi for the production and development of natural and artificial biocompounds.
They will be able to:
• recapitulate the fungal metabolic capabilities
• comprehend and name the fundamental signaling pathways for metabolic adaptation
• using selected examples, classify the respective enzyme systems and their functions in anabolic/ catabolic reactions
• understand the molecular techniques for genome manipulation and strain development and discuss them
• critically assess the pros and cons of the presented production systems.
Moreover, the module is intended to help develop problem-solving skills as well as to foster the interest for eukaryotic microbiology, it's advantages and disadvantages, and the importance particularly of filamentous fungi for environment and industry.

Teaching and Learning Methods:
Teaching technique: Lecture - teaching method: presentation; development of general concepts on the chalkboard
In the seminar/demonstration: teaching method: talk, demonstration; learning activity: research of relevant literature, prepare and give a talk, contructive discussion of the contents

Media:
PowerPoint presentation; chalkboard work; original research papers; lab demonstrations

Reading List:
Unfortunately no text book is available that covers all the contents of the course, but the following sources are good for basics and as additional reading:
- Money, Nick, 2007, “Triumph of the Fungi: A Rotten History”, Oxford Univ. Press
- Hudler, G.W., 1998, “Magical mushrooms, mischievous molds”, Princeton University Press
- Kendrick, Bryce, 2000, “The Fifth Kingdom”, 3rd ed., Focus Pub/R Pullins Co
- Kavanagh, Kevin, 2011, „Fungi – Biology and Applications”, Wiley-VCH
- Arora, D.K., 2004, “Fungal Biotechnology in Agricultural, Food, and Environmental Applications – Mycology Series; Vol. 21”, Marcel Dekker, Inc.
- Kück, U. et al., 2009, “Schimmelpilze – Lebensweise, Nutzen, Schaden, Bekämpfung“, Springer
- Kubicek, C.P., 2013, “Fungi and Lignocellulosic Biomass“, Wiley-Blackwell

Responsible for Module:
Benz, Johan Philipp; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Biologie biotechnologisch relevanter Pilze (Vorlesung mit integrierten Übungen, 4 SWS)
Benz J [L], Benz J, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2372: Pathogenic Microorganisms | Mikroorganismen als Krankheitserreger

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Die Studierenden zeigen anhand der benoteten Klausur (90 min) ob sie in der Lage sind, Formenvielfalt und taxonomische Stellung von pathogenen Bakterien zu erläutern. Die Studierenden müssen zeigen, daß sie die Interaktion von Pathogenen mit ihren verschiedenen Wirten (Menschen und Pflanzen) im Einzelnen darstellen können. Anhand von Fallbeispielen werden diagnostische Verfahren für bakterielle Krankheitserreger geprüft. Insbesondere wird Schlüsselwissen für die Risikobeurteilung bezüglich des Vorkommens von Pathogenen im Lebensmittel- und medizinischen Bereich sowie in der Phyopathologie abgefragt und es wird erwartet, daß die Studierenden auch komplexere epidemiologische Ansätze erläutern können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modul Mikrobiologie sowie Molekulare Genetik.

Content:
Biologie humanpathogener Mikroorganismen: Übersicht über Menschen und Mikroben; Verhältnis zwischen Kommensalen und Pathogenen; Koch'sche Postulate; Übersicht über bakterielle Pathogenität und Virulenz; Abwehrsysteme des Wirtes (v.a. verschiedene Ebenen des innaten Immunsystems); Abwehrsysteme des Pathogens (Immunevasion, Adhesion an die Wirtszelle, Invasion und intrazelluläres Wachstum, bakterielle Toxine); Übersicht über pathogene Hefen und Pilze.
Erreger von Pflanzenkrankheiten: Übersicht über Pflanzen und Krankheiterreger, Übersicht über Pathogenität und Virulenz bei Pflanzenpathogenen; Abwehrsysteme des Wirtes (v.a. verschiedene Ausprägungen der Resistenz, Gen-für-Gen Hypothese, systemische Resistenz); Abwehrsysteme

von Pflanzenpathogenen; Rezeptorsysteme und innate Immunität der Pflanze; Vergleich Pflanze-Säugetier; Gentechnik und Pflanzenschutz;
Diagnostik und Epidemiologie: Taxonomie von pathogenen Bakterien; Artbegriffe; Identifizierung (physiologische, biochemische, biophysikalische und genetische Verfahren); Diagnostische Verfahren (Anreicherungen, Schnellverfahren, automatisierte Verfahren); Infektionsepidemiologie (Bedeutung von Infektionen in Deutschland, Erhebung von epidemiologischer Daten, Methoden zur Verfolgung von Kontaminationsrouten).

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul verfügen die Studierenden über sichere Grundkenntnisse hinsichtlich Formenkenntnis und Taxonomie von pathogenen Bakterien, Interaktion von bakteriellen Krankheitserregern mit humanen und pflanzlichen Wirten, diagnostischer Verfahren in mikrobiologischen Labors und epidemiologischer Anwendungen.

Die Studierenden können die Bedeutung von Krankheitserregern im lebensmittelbiotechnologischen, medizinischen und phytopathologischen Bereich einschätzen und kritisch beurteilen.
Mit dem biologisch-theoretischen Wissen aus diesem Modul sind sie in der Lage eine Forschungspraktikums im Pathogenlabor zu absolvieren.

Teaching and Learning Methods:
Die Vermittlung der Modulinhalte erfolgt durch Dozentenvortrag in der Vorlesung sowie anhand von Fallstudien, die in interaktivem Diskurs während der Vorlesung behandelt werden. Das Wissen der Studenten wird durch (i) eigenständige Nachbereitung der Vorlesungsinhalte anhand der ausgegebeben ppt Präsentationen, (ii) die Vorlesungsmitschrifte, (iii) das Studium der abgegebenen Literatur und schließlich (iv) die Lösung der ausgegebenen Übungsaufgaben nachhaltig gefestigt.

Media:
Tafelarbeit, PowerPoint Präsentationen, Filme, Vorlesungsfolien, Übungsfragensammlung

Reading List:
Salyers AA, Whitt DD (2011) Bacterial pathogenesis: A molecular approach. ASM Press, Washington, 3. Auflage.
Hof H, Dörries R (2009) Medizinische Mikrobiologie. 4. Auflage.
Buchanan et al (2002) Responses to Plant pathogens. Kapitel 11 in: Biochemistry & Molecular Biology of Plants, Buchanan B, Gruissem W, Jones R, Verlag ASPP

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in Biologie pflanzenpathogener Mikroorganismen (Vorlesung, 1 SWS)

Durner J

Einführung in die Biologie humanpathogener Bakterien (Vorlesung, 2 SWS)
Hall L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2402: Microbial Toxins in Food | Mikrobielle Toxine in der Nahrung

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden weisen in einer benoteten Klausur (60 min) nach, dass sie in der Lage sind in begrenzter Zeit und ohne Hilfsmittel ihr Fachwissen über mikrobielle Toxinbildner, deren Habitaten und Toxinen darzustellen. Zudem sollen sie grundlegende toxikologische Arbeitstechniken beschrieben sowie toxikologische Probleme mikrobieller Herkunft in ihrer Bedeutung für die Lebensmittelsicherheit einordnen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Anatomie, Physiologie und Biochemie.

Content:
Vermittlung toxikologischer und analytischer Grundlagen. Darstellung relevanter Bakterien-, Pilz- und Algentoxine: Ökologie der Toxinbildner; biochemische und pathophysiologsiche Wirkungen der Toxine; Vorkommen in der Nahrungskette ("carry over"); Prophylaxemaßnahmen, gesetzliche Reglementierungen.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen über mikrobielle Toxinbildner, deren Habitaten und deren Toxine. Weiterhin haben sie grundlegende toxikologische Arbeitstechniken (z.B. Zellkulturversuche, LC-MS/MS) erlernt und geübt. Sie sollen gelernt haben, toxikologische Probleme mikrobieller Herkunft analysieren und bewerten zu können. Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an mikrobiellen Toxinen und deren Bedeutung für die Lebensmittelsicherheit fördern.

Teaching and Learning Methods:
Vorlesung und Übungen im Labor

Media:
PowerPoint

Reading List:
Freitext

Responsible for Module:
Johann Bauer (johann.bauer@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Analytik mikrobieller Toxine (Übung, 2 SWS)
Meyer K

Mikrobielle Toxine in der Nahrung (Medizinische Mikrobiologie und Hygiene, Teil Mikrobielle Toxine) (Vorlesung, 2 SWS)
Meyer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2449: Microbial Diversity and Development | Mikrobielle Vielfalt und Entwicklung

Version of module description: Gültig ab summerterm 2019

Module Level:	Language: German	Duration: one semester	Frequency: summer semester
Credits:* 5	Total Hours: 150	Self-study Hours: 90	Contact Hours: 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In einem Vortrag (20 min) mit anschließender Diskussion über spezielle Themen der mikrobiellen Vielfalt (Überblick über ausgewählte Taxa und / oder Methoden zur Charakterisierung von Mikroorganismen) zeigen die Teilnehmerinnen und Teilnehmer, dass Sie ein spezielles mikrobielles Thema selbstständig vorbereiten und einem Fachpublikum vortragen können und dazu auch tiefergehende Fragen beantworten können. Der Stoff umfasst die gesamte mikrobielle Vielfalt und geht in der fachlich Tiefe deutlich über die in der Vorlesung erreichbare Tiefe hinaus.
Die Prüfungsergebnisse zur Überprüfung der theoretischen Kompetenzen (Klausur) und die die Fähigkeit, sich eigenständig in ein sehr spezielles Thema einzuarbeiten und dies in Rede und Antwort zu vertreten (Seminar) werden (2:1) verrechnet. Das Modul ist bestanden, wenn im gewichteten Mittel die Note besser als 4,1 ist.“

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good background knowledge in organic chemistry and biochemistry is of advantage for a better understanding of the lecture courses.

Content:
In the courses of this module, basic knowledge about the phylogenetic and metabolic diversity of microorganisms and their role for the environment, mankind and biotechnology, is repeated and extended with advanced-level knowledge. The contents include for example cell-cell-communication and developmental processes in particular with prokaryotic microorganisms, systematics and phylogeny, adaptation of m icroorganisms to their habitats, the role of microorganisms in selected habitats, in global element cycles, and in selected technical processes

(e.g., wastewater treatment). In seminar presentations, changing groups of microorganisms and their properties and significance are intoduced and discussed.

Intended Learning Outcomes:
After completion of the courses of this module the students have acquired an advanced level of theoretical understanding about relationships among microorganisms, the adaptation of microorganisms to various environmental conditions, the role of their metabolic capabilities for mankind and nature, and about the processes of cell-cell-communication and cellular differentiation. They should be able to
" understand and critically discuss various methods of identification, differentiation and taxon affiliation in microbial systematics.
" understand the diversity of microbes and microbial communities in natural habitats.
" understand, by virtue of selected examples, the interconnections between metabolic pathways and the conversion of substances by microorganisms and the environment.
" apply the acquired knowledge to in-depth problems.
The module should further help develop the ability to solve problems, and boost the students' interest for microbiological issues and for the important role of microorganisms for mankind and the environment.

Teaching and Learning Methods:
Form/technique of teaching: lecture courses. Teaching method: oral lecture.
Learning activities: study of lecture handout scripts and own notes. Preparation, presentation and discussion of short lectures by students.

Media:
Presentations unsing Powerpoint,
Handout script (download option for lecture material).

Reading List:
There is no textbook available that comprehensively covers all content matter of this module.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Proseminar - mikrobielle Diversität (Seminar, 2 SWS)
Liebl W

Mikrobielle Diversität und Entwicklung (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2452: Modern Methods in Microbiological Diagnostics | Moderne Methoden mikrobiologischer Diagnostik

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden zeigen in einer benoteten Klausur (60 min), dass sie einen Einblick in das breite Spektrum der
mikrobiologischen Diagnostik gewonnen haben und einschätzen können, welche Aussagekraft verschiedene Methoden für die Identifizierung und Differenzierung diverser Mikroorganismen haben. Dafür sind keine Hilfsmittel zulässig.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind Kenntnisse der Grundlagen der Mikrobiologie (Vorlesung Allgemeine Mikrobiologie).

Content:
Übersicht über moderne Methoden der Identifizierung und Differenzierung von Pilzen und ihre Anwendungsmöglichkeiten: klassische kulturelle Methoden, molekularbiologische Methoden, physikalische-chemische Methoden, immunologische Methoden.

Intended Learning Outcomes:
Durch die Teilnahme an dem Modul gewinnen die Studierenden einen Einblick in das breite Spektrum der mikrobiologischen Diagnostik, einschließlich ihrer jeweiligen Vorzüge bzw. Einschränkungen in der Praxis. Sie lernen einzuschätzen, welche Methoden für welche Mikroorganismen geeignet sind und welche Aussagekraft welche Methoden bei der Identifizierung und Differenzierung verschiedener Keime besitzen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung Lehrmethode: Vortrag, Demonstrationen
Lernaktivitäten: Studium von Vorlesungsskript und -mitschrift, ggf. Literaturstudium.

Media:
Präsentationen mittels Powerpoint, praktische Demonstrationen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Moderne Methoden mikrobiologischer Diagnostik (Vorlesung, 2 SWS)
Köberle M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2556: Modern Methods in Microbial Ecology | Moderne Methoden der mikrobiellen Ökologie

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam duration (in min.): 60 (written exam); 30 (seminar lecture).
Regular, active participation in the courses is expected. A written exam (60 min, graded) serves to review the theoretical skills learned in the lecture. In the exam, the students should show whether they are able to structure the knowledge they have learned and to present the essential aspects. This knowledge should be further expanded in a practical course; A protocol must be presented at the end of the course to prove the ability to describe, evaluate and interpret the experiments carried out. In a seminar paper, students should critically comment on individual methods of microbial ecology using provided literature. The grade consists of the exam grade, the grade for the protocol and for the seminar (weighting 1: 1: 1)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Introductory lecture "Microbial Ecology and Microbiomes"; Microbiological practical courses for beginner; Basic knowledge of molecular methods such as PCR

Content:
Molecular methods play a very important role in microbial ecology to record the diversity of microorganisms in different environment. Further new approaches for isolating previously unknown prokaryotes are also of great importance for understanding how ecosystems work. Accordingly, the module deals with a wide range of methods that are used in modern microbial ecology. In addition to PCR-based methods, this also includes high-throughput sequencing techniques or the use of stable isotopes. In addition, also classical methods which play an important role in routine analysis, such as biomass measurements or enzyme activity determinations are presented and learned in

practice. Finally, future lines of research are discussed, especially with regard to proteomics and metabolomics

Intended Learning Outcomes:
After completing the course, the students are able to make a selection from the "method box" that best suits specific questions. The students are familiar with the advantages and disadvantages of individual methods and thus recognize the complementarity and synergies of individual approaches. Furthermore, the students are able to use corresponding methods independently, e.g. as part of a master's thesis or doctorate. In the seminar students use knowledge from current research to develop perspectives of microbial ecology for the future

Teaching and Learning Methods:
type of event / teaching technique: lecture, seminar; practical course (including demonstrations, experiments, and discussion of results)
Learning activities: Study of lecture scripts and transcripts, script of practical course and recent scientific literature; Practicing laboratory skills and microbiological working techniques; Preparation of protocols

Media:
Lecture: PowerPoint presentations and scripts, seminar: recent literature from scientific literature; practical course: script and independent lab work

Reading List:
Handbook of Molecular Microbial Ecology; ed: Frans J. de Bruijn; John Wiley & Sons; ISBN-10: 0470647191

Responsible for Module:
Michael Schloter schloter@helmholtz-muenchen.de

Courses (Type of course, Weekly hours per semester), Instructor:
Moderne Methoden der Mikrobiellen Ökologie (Praktikum, 5 SWS)
Schloter M, Schulz S

Moderne Methoden der Mikrobiellen Ökologie (Vorlesung, 2 SWS)
Schloter M, Schulz S

Moderne Methoden der Mikrobiellen Ökologie (Seminar, 2 SWS)
Schloter M, Schulz S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2691: Microorganisms in Food | Mikroorganismen in Lebensmitteln

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer benoteten Klausur mit der Dauer von 60 min erbracht, in der keine Hilfen zugelassen sind. Die Prüfung besteht aus Fragen, welche im Freitext beantwortet werden. Die Klausur dient der Überprüfung der in den Vorlesungen erworbenen Kompetenzen: Die Studierenden sollen zeigen, dass sie die Bedeutung von fermentierenden Mikroorganismen für industrielle Lebensmittelproduktion verstanden haben. Aspekte der Interaktion von Mikroben mit Produktionsanlagen sollen in der Klausur erklärt und ihre Bedeutung für die Lebensmittelhygiene diskutiert werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung und Übungen in Allgemeiner Mikrobiologie

Content:
Vorlesung Lebensmittelmikrobiologie und Hygiene: Vorlesung: Begleitflora und mikrobieller Lebensmittelverderb; Krankheitserreger in Lebensmitteln; Infektion und Intoxikation; Infektionsketten; Bedeutung von lebensmittelbedingten Erkrankungen; Beispiele für die Herstellung fermentierter Lebensmittel; Starterkulturen und Reifungskulturen; Gentechnisch veränderte Mikroorganismen in der Lebensmittelproduktion (Anwendungsbeispiele, Risiken, Gen-Ethik); Biologische Konservierungsverfahren (Enzyme, Schutzkulturen); Physikalische Konservierungsverfahren (Trocknung, Temperatur, Bestrahlung, Druck); Chemische Konservierungsmittel (Wirkungsweisen, Einsatz, Risiken); Mikrobiologische Qualitätssicherung (Risikoanalyse, HACCP-Konzept, Eigenkontrollen).
Vorlesung Mikrobiologie der Milch und Milchprodukte: Starter- und Reifungskulturen; Mikrobiologie der Milchen: Rohmilch, Past Milch, ESL Milch, UHT Milch, Kondensmilch. Milchpulver; -

Mikrobiologie der Sauermilcherzeugnisse: Sauermilchen, Kefir, Joghurt; Mikrobiologie der Käseherstellung: Frischkäse, Sauermilchkäse, Labkäse; Mikrobiologische Produktionsprobleme.

Intended Learning Outcomes:
Die Studierenden haben grundlegendes Fachwissen über zur Lebensmittelmikrobiologie erworben. Realistische Einschätzung der Bedeutung Lebensmittel verderbender Mikroorganismen sowie der Bedeutung lebensmittelbedingter Intoxikationen und Infektionen, Konservierungsverfahren und Qualitätssicherungskonzepte. Erwerb theoretischer Erkenntnisse zur Analyse von mikrobiologischen Produktionsproblemen in der Lebensmittelindustrie. Fähigkeit zur Interpretation mikrobiologischer Daten in der interdisziplinären Zusammenschau mit lebensmitteltechnologischen Prozessen und lebensmittelhygienischen gesetzlichen Vorgaben.

Teaching and Learning Methods:
Vorlesungsvorträge mit Lehrdialogen zur Vertiefung des Verständnisses.
Lernaktivitäten: Anfertigen einer Vorlesungsmitschrift, Studium vom Vorlesungsskript, Beantwortung von Übungsfragen, Nacharbeit des Stoffes mit dem Lehrbuch.

Media:
PowerPoint, Lehrfilme, Tafelarbeit, Script, Lernhilfe (Übungsfragen), Exkursionen mit Demonstrationen.

Reading List:
Madigan MT et al (2013) Brock Mikrobiologie, Kapitel über Lebensmittelmikrobiologie. Pearson
Krämer J, Prunge A (2017) Lebensmittelmikrobiologie. utb Verlag
Märtlbauer E, Becker H (2016) Milchkunde und Milchhygiene. utb Verlag

Responsible for Module:
Siegfried Scherer siegfried.scherer@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1818: Fungal Genetics Exercise | Pilzgenetische Übung

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation in the practical course is expected. In the course of the exercise, data are gathered that will be used to write a final course result protocol. The students demonstrate by writing this 10-25-page course journal that they are able to correctly structure and reflect the critical aspects of their experiments. In the course journal, also aspects such as activity/productivity, creativity and independence during the course work will be evaluated and will be part of the final grade.

Repeat Examination:

(Recommended) Prerequisites:
Skills as for example gained in the lecture "Molecular Biology of Biotechnologically Relevant Fungi" are recommended, but not mandatory.

Content:
During the theoretical part of the exercise, the course content will be taught individually and in group settings. In particular aspects such as: General developmental and cell biology of filamentous fungi; Relevance of fungi in basic and applied science; Fungi as pathogens of man, animals and plants.
During the practical part of the exercise, the focus will be on the following topics: Molecular manipulation of filamentous fungi; Cloning of transformation constructs and fungal transfection; Analysis of resulting progeny by fluorescent microscopy; Employing classical genetics techniques in crossings; Characterization of a series of unknown metabolic mutants by physiological and biochemical assays; Sugar analytic by HPAEC-PAD.

Intended Learning Outcomes:
Upon completion of the module, students will have gained basic knowlegde regarding the biology of filamentous fungi and their relevance for basic and applied science. The students will furthermore have understood how to approach scientific questions (educated experimental planning, execution, analysis and interpretation). They will have learned how to apply molecular and genetic techniques using filamentous fungi to manipulate model organisms towards the elucidation of the functioning of eukaryotic cells. These techniques are also the basic concept for current biotechnological and industrial applications.

Teaching and Learning Methods:
In this exercise, which consists of a theoretical and a practical part, lab-technical skills will be acquired and practised in group settings by way of practical teaching methods, such as experiments. These skills include: Dealing with scientific questions and solution finding by experimental approaches, and constructive discussion and critical reflection of own experiments.

Media:
Course script and Powerpoint slides

Reading List:
current literature of covered topics; mostly to be researched by students themselves

Responsible for Module:
J. Philipp Benz benz@hfm.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Pilzgenetische Übung (Übung, 5 SWS)
Benz J [L], Benz J, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2539: Seminar on Microbial Effectors | Proseminar Mikrobielle Wirkstoffe

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the oral examination (30 min) the students show that they are able to present and competently discuss a previously agreed microbiological topic on microbial active ingredients in a PowerPoint presentation in a clear and understandable way and to summarize the essential points of the topic in writing as a handout. The quality and clarity of the lecture/handout and the competence of the discussion of questions on the topic are included in the grade with a weighting of 70:30.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of the basics of microbiology (lecture General Microbiology), human biology and biochemistry is required.

Content:
In this module current topics from the field of production and mode of action of mikrob. active ingredients, for example toxins, bacteriocins, antibiotics, pathogenicity factors and pathogenicity mechanisms of bacterial pathogens.

Intended Learning Outcomes:
After completing this module, students are able to
"Gain new up-to-date knowledge on basic topics of microbiology using various pathogenic microorganisms.
"Acquire the ability to present scientific contents of microbiology in an understandable form.
" To promote critical and creative thinking and to develop skills for professional discourse.
"To promote interest in microbiology, microbiological problems and the importance of microorganisms for humans and the environment.

The acquired knowledge prepares students for independent preparation of scientific lectures and their presentation.

Teaching and Learning Methods:
Event type/teaching technique: seminar; teaching method: seminar presentations by the participants; subsequent discussion of the presentations.
Learning activities: study of literature, preparation of presentations, critical examination of contents and presentation performance through discussion with the lecturer.

Media:
Presentations using PowerPoint, handouts.

Reading List:
Individually selected primary literature.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Proseminar - mikrobielle Wirkstoffe [MID WZ2539] (Seminar, 2 SWS)
Liebl W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0407: Research Project on Beneficial Properties of the Early Life Microbiota | Research Project on Beneficial Properties of the Early Life Microbiota

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The type of assessment for this module is a laboratory assignment (Laborleistung). The goal of this module is to teach you how to design and conduct independent research in a supportive environment. Your proposal will take the form of asking a hypothesis-driven research question based on existing literature/data, that you then attempt to answer once you start the experimental component of the module. Additionally, we wish to prepare you for applying for a career in science. The project will be partly supervised and self-guided in the lab – according to good scientific practice, and this lab work and your conduct in the lab will account for 40% of the overall mark. Your internship report resulting from your lab work, should be written in the form of a scientific research paper, and should include the following sections (accounting for 50% of the overall mark)

(i) Title
(ii) Abstract
(iii) (Materials and Methods
(iv) Results
(v) Discussion.

There is a strict word limit of 6000 (+10%). This does not include figure legends or references. Your report will be assessed on the following:
• Abstract
• Introduction
• Materials and Methods
• Quality of Results
• Presentation of Results
• Data Handling
• Discussion

• Future Work Suggestions
• References
• Written Expression

You will also give a 15-minute presentation (+ 5 minutes scheduled for questions) on your research project. The goal of this exercise is to get you thinking about how to present your work to a non-expert audience. Your presentation will be assessed on the following (10% of overall mark):
• Context and communication of science
• Clarity
• Structure
• Oral delivery and visual aids
• Conclusions and answering questions

The module is passed when at least 40 out of a total of 100 points have been granted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's in Molecular Biotechnology or Biology or Biochemistry, or other relevant area

Content:
Practical work in a microbiome research lab, which may involve a combination of wet and dry lab approaches. For more info see www.halllab.co.uk.

Intended Learning Outcomes:
You will work within a larger research project – which will involves understanding how certain early life microbiota members adapt and are beneficial in the infant gut environment. You may focus on understanding complete microbial communities or drill down to examine certain microbiota members e.g. Bifidobacterium. Other aspects may involve developing and optimising cutting-edge methods for isolating microbes and also undertaking studies to probe certain aspects of beneficial microbial function e.g. production of novel anti-microbials and/or immune stimulation. For more details see www.halllab.co.uk.

Teaching and Learning Methods:
Introduction to the lab and training in appropriate methods by a Hall lab team member, followed by individual working and teamwork. Problem solving training and experimental design and data analysis will also be developed over the course of the project.

Media:
Blogs and potential for peer-reviewed scientific publication(s)

Reading List:
• Kiu R, Treveil A, Harnisch LC, Caim S, Leclaire C, van Sinderen D, Korcsmaros T, Hall LJ. Bifidobacterium breve UCC2003 induces a distinct global transcriptomic programme in neonatal murine intestinal epithelial cells. iScience. 2020. 23(7):101336
• Puengel D, Treveil A, Dalby MJ, Caim S, Colquhoun IJ, Booth C, Ketskemety J, Korcsmaros T, van Sinderen D, Lawson MAE/Hall LJ. Bifidobacterium breve UCC2003 exopolysaccharide modulates the early life microbiota by acting as a potential dietary substrate. Nutrients. 2020. 12(4), 948
• Lawson MAE/O'Neill IJ, Kujawska M, Wijeyesekera A, Flegg Z, Chalklen L, Hall LJ. Breast-milk derived human milk oligosaccharides promote Bifidobacterium interactions within a single ecosystem. ISME J. 2020: 14(2):635-648
• Dalby MJ & Hall LJ. Recent advances in understanding the neonatal microbiome. F1000Research. 2020, 9 (F1000 Faculty Rev):422.
• O'Neill I/Schofield Z, Hall LJ. Exploring the role of the microbiota member Bifidobacterium in modulating immune-linked diseases. Emerging Topic in Life Sciences. 2017; 1(4) 333-349

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project on Beneficial Properties of the Early Life Microbiota (Forschungspraktikum, 16 SWS)
Hall L (Kujawska M, Zenner C)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0408: Research Project on Microbiota-Associated Pathobionts | Research Project on Microbiota-Associated Pathobionts

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The type of assessment for this module is a laboratory assignment (Laborleistung). The goal of this module is to teach you how to design and conduct independent research in a supportive environment. Your proposal will take the form of asking a hypothesis-driven research question based on existing literature/data, that you then attempt to answer once you start the experimental component of the module. Additionally, we wish to prepare you for applying for a career in science. The project will be partly supervised and self-guided in the lab – according to good scientific practice, and this lab work and your conduct in the lab will account for 40% of the overall mark. Your internship report (dissertation) resulting from your lab work, should be written in the form of a scientific research paper, and should include the following sections (accounting for 50% of the overall mark)

(i) Title
(ii) Abstract
(iii) (Materials and Methods
(iv) Results
(v) Discussion.

There is a strict word limit of 6000 (+10%). This does not include figure legends or references. Your dissertation will be assessed on the following:
• Abstract
• Introduction
• Materials and Methods
• Quality of Results
• Presentation of Results
• Data Handling
• Discussion

• Future Work Suggestions
• References
• Written Expression

You will also give a 15-minute presentation (+ 5 minutes scheduled for questions) on your research project. The goal of this exercise is to get you thinking about how to present your work to a non-expert audience. Your presentation will be assessed on the following (10% of overall mark):
• Context and communication of science
• Clarity
• Structure
• Oral delivery and visual aids
• Conclusions and answering questions

The module is passed when at least 40 out of a total of 100 points have been granted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's in Molecular Biotechnology or Biology or Biochemistry, or other relevant area

Content:
Practical work in a microbiome research lab, which may involve a combination of wet and dry lab approaches. For more info see www.halllab.co.uk.

Intended Learning Outcomes:
You will work within a larger research project – which will involves understanding how certain microbiota members may cause disease in humans and animals. You may focus on certain microbiota members, that while at low levels do not cause harm, under certain conditions may overgrow and cause infection – i.e. pathobionts including Clostridium and Klebsiella. Other aspects may involve isolating these pathobionts from clinical samples and studying the virulence factors that these microbes may encode and produce and antimicrobial resistance determinants. For more details see www.halllab.co.uk.

Teaching and Learning Methods:
Introduction to the lab and training in appropriate methods by a Hall lab team member, followed by individual working and teamwork. Problem solving training and experimental design and data analysis will also be developed over the course of the project.

Media:
Blogs and potential for peer-reviewed scientific publication(s)

Reading List:
• Chen Y, Brook TC, Soe CZ, O'Neill I, Alcon-Giner C, Leelastwattanagul O, Phillips S, Caim S, Clarke P, Hoyles L/Hall LJ. Preterm infants harbour diverse Klebsiella populations, including atypical species that encode and produce an array of antimicrobial resistance- and virulence-associated factors. Microbial Genomics. 2020. doi.org/10.1099/mgen.0.000377
• Dalby MJ & Hall LJ. Recent advances in understanding the neonatal microbiome. F1000Research. 2020, 9 (F1000 Faculty Rev):422.
• Alcon-Giner C/Leggett RM, Heavens D, Caim S, Brook TC, Kujawska M, Hoyles L, Clarke P, Clark MD/Hall LJ. Rapid MinION profiling of preterm microbiota and antimicrobial resistant pathogens. Nature Microbiology. 2019. doi:10.1038/s41564-019-0626-z
• Kiu R, Brown J, Bedwell H, Leclaire C, Caim S, Pickard D, Dougan G, Dixon R, Hall LJ. Genomic analysis on broiler-associated Clostridium perfringens strains and caecal microbiome profiling reveals key factors linked to poultry Necrotic Enteritis. Animal Microbiome. 2019: 1(12).
• Kiu, R & Hall, LJ. An update on the human and animal enteric pathogen Clostridium perfringens. Emerging Microbes & Infections. 2018. 7:141.

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project on Microbiota-Associated Pathobionts (Forschungspraktikum, 16 SWS)
Hall L (Kujawska M, Zenner C)
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2625: Advanced Microbiology | Spezielle Mikrobiologie

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular and active student participation is expected. A written exam (60 min, graded) serves as proof of the theoretical knowledge acquired in the lecture courses. In the exam, the students demonstrate their ability to structure the body of acquired knowledge and to summarize the important aspects of the study matter. The students should be able to describe, interpret, combine in a meaningful way the information learnt, and to transfer this knowledge to similar issues.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good background knowledge in organic chemistry and biochemistry is of advantage for a better understanding of the lecture courses.

Content:
One of the lecture courses deals with the broad variety of specialized metabolic pathways in particular in prokaryotic microorganisms. Contents are the diversity and variations of central metabolism, specialized fermentation and anaerobic respiration pathways, different possibilities of carbon dioxide fixation and of phototrophic metabolism etc. A second lecture course deals with molecular microbial genetics, including genome biology of bacteria and archaea, replication and segregation of chromosomes and plasmids, DNA repair, mutation, transposition, gene transfer, recombination, regulation of gene expression, genetics and multiplication of bacteriophages and archaeal viruses etc. Links are drawn in the lecture courses between the metabolic pathways discussed and their importance for the environment and for mankind, as well as between the molecular genetics mechanisms active in cells and molecular biology methods used in experimental research.

Intended Learning Outcomes:
After completion of the courses of this module the students have acquired a good overview and advanced-level theoretical understanding about metabolic pathways and molecular genetics mechanisms in microorganisms. They should be able to
" understand interconnections between metabolic pathways and conversion of compounds by microorganisms.
" understand the relevance of different metabolic pathways for the energetics and product formation of the respective microorganisms.
" correlate, by virtue of selected examples, specialized metabolic pathways with the natural growth conditions of the corresponding microorganisms.
" understand the interrelation between mutant generation, mobile genetic elements, gene transfer etc. and the properties of microorganisms.
" understand molecular mechanisms for genetic variability / stability.
" apply the acquired knowledge to in-depth problems.
The module should further help develop the ability to solve problems, and boost the students' interest for microbiological issues and for the important role of microorganisms for mankind and the environment.

Teaching and Learning Methods:
Form/technique of teaching: lecture courses. Teaching method: oral lecture.
Learning activities: study of lecture handout scripts and own notes.

Media:
Presentations unsing Powerpoint,
Handout script (download option for lecture material).

Reading List:
There is no textbook available that comprehensively covers all content matter of this module.
Some aspects are covered in the following book:
Fuchs G. (Hrsg.) Allgemeine Mikrobiologie. Georg Thieme-Verlag, Stuttgart.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare mikrobielle Genetik (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A

Mikrobieller Stoffwechsel für Fortgeschrittene (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A
For further information in this module, please click campus.tum.de or here.

Specializing in Ecology | Studienschwerpunkt Ökologie

Module Description

WZ1172: Applied River Restoration | Angewandte Fließgewässerrenaturierung

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Current information regarding the limited activities with physical presence due to the CoViD19-pandemic:
In case the framework requirements (hygienie, distance rules etc.) for examinations with physical presence are not met, the planned examination format can be changed to a digital (remote) examination according to §13a APSO. The decision on this change will be communicated as soon as possible, however latest 14 days before the actual examination date, by the responsible examiner in coordination with the examinations board.
Under regular conditions the examination will be a 90 minutes written test and contains both parts of the Module "Applied River Restoration" and Applied River Restoration Planning". In this exam it is intended that the students show their ability to solve problems in a limited time frame. The questions cover all lecture topics. For answering the questions, the students require their own wording or a sketchily illustration of certain restoration related issues.
It is expected that the students participate in the lectures regularly and actively.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in this field; it can be advantageous to participate in other lectures with the topic of aquatic ecology, but is not necessary if there is any basic knowledge in the field of river restoration.

Content:
The Module consists out of a given Lecture during the summer semester and a practical planning part during the winter semester. The main topic is to learn about important factors driving the

degradation of rivers and streams as well as methods to restore riverine ecosystems and their ecosystem services. How to measure the success of river restoration and important ecosystem services? Which factors contribute to successful river restoration? To further deepen the acquired knowledge and to improve the knowledge transfer into practice, the latest restoration problems will be solved in ad-hoc planning sessions and a field trip will be organised.

Intended Learning Outcomes:
After the course, the students should be able to evaluate the effects of anthropogenic disturbance as well as restoration techniques in rivers, and to develop target oriented solutions for river restoration. The students are able to critically evaluate holistic approaches for river restoration. Additionally, the students are able to analyse important limiting factors determining the success of the restoration of communities, species or their life stages. The students are further able to apply important methods for the assessment of river restoration.

Teaching and Learning Methods:
The course combines a lecture "Applied River Restoration" with integrative planning practice "Applied River Restoration Planning". The lecture contents will be presented using power-point. To teach the integrative planning practice an ad-hoc planning session will be held at a seperate date during the Winter Semester solving rescent restoration problems. The task of the ad-hoc planning session can be solved in groupes up to a maximum of 4 persons. Additionally, the students will be encouraged to independently screen the respective literature in this field. To further deepen the acquired knowledge a field trip will be organised.

Media:
Power-point, white-board, flip-chart, Video, descriptions of case studies, digital plans

Reading List:
Jungwirth et al. 2003. Angewandte Fischökologie an Fließgewässern. 1st Edition, UBT Stuttgart, Germany.; Hauer & Lamberti 2007. Methods in Stream Ecology, 2nd Edition, Elsevier, Holland.; Woodward G., 2011. Advances in Ecological Research, Elsevier, London, UK. Boon & Pringle 2009.; Assessing the conservation value of fresh waters. Cambridge University Press, UK.; The River Restoration Centre 2002. Manual of River Restoration Techniques. The River Restoration Centre, Silsoe, Beds, UK. Jähnig et al. 2011. Fließgewässer-Renaturierung heute und morgen. Schweizerbart Science Publishers, Stuttgart, Germany.; the most recent literature will be provided in the lectures.

Responsible for Module:
Pander Joachim (joachim.pander@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Applied River Restoration (Vorlesung, 2 SWS)
Geist J [L], Pander J

Applied River Restoration Planning (Übung, 3 SWS)

Pander J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1647: Remediation of Contaminated Sites - Lecture and Exercises | Altlastensanierung - Vorlesung und Übungen

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer schriftlichen Klausur (120 min). Anhand der Klausur zeigen die Studierenden, dass sie gesetzliche Regelungen, die sich mit Altlasten beschäftigen, verstehen, das Gefährdungspotential einer Altlast im Hinblick auf die Art der Schadstoffe und den Emissionspfad bewerten können, die verschiedenen Untersuchungsmethoden verstehen sowie eine geeignete Probenahmestrategie und analytisches Untersuchungsprogramm bewerten können.

Das Modul "Altlastensanierung - Vorlesung und Übungen" ist das Alternativmodul zu "Altlastensanierung - Vorlesung und Seminar". Je nach verfügbaren Plätzen behält sich der Modulverantwortliche vor, die Studierenden dem einen oder anderen dieser beiden Module zuzuordnen. Es kann nur eines von beiden Modulen absolviert werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Einführung in die Bodenkunde 1 und 2 müssen erfolgreich absolviert sein (Ausschlusskriterium).

Content:
Vorlesung: Bundesbodenschutzgesetz, Vorgehensweise bei der Erkundung von Altlasten; branchentypische Kontaminationen (Altablagerungen - Altstandorte, Rüstungs- und Militäraltlasten); Bewertung von Kontaminanten (Hauptkontaminanten - Prioritätskontaminanten, Stofftransport, Exposition); Gefährdungspotential, ökotoxikologische Tests; Untersuchung von Altlasten (Untersuchungsmethoden, Probenahmestrategie, analytisches Untersuchungsprogramm); Sanierungsziele; Sicherungsmaßnahmen; Dekontaminationsverfahren; Rekultivierung und Renaturierung (Böden auf Altstandorten, Bergbaufolgelandschaften).

Übungen: Besuch von Altlastenbetrieben im Raum München: Biologische ex-situ Sanierung organisch belasteter Böden; Beprobung kontaminierten Bodenmaterials in Haufwerken; Immissionsschutzvorgaben für altlastenbearbeitende Betriebe; Sortierung und (Zwischen-) Lagerung kontaminierter Böden vor der Entsorgung in geeigneten Deponien; LAGA Deponieklassen zur Klassifikation kontaminierter Böden; Verwertungsmöglichkeiten für kontaminiertes Material; innovative in-situ Sanierungs- und Sicherungsmaßnahmen; Verhältnis von Investitions- und Betriebskosten bei langfristigen Sanierungsmassnahmen; Sicherungsmaßnahmen in Bergbaufolgelandschaften; spezifische Probleme in Braunkohlentagebaufolgelandschaften; Evaluation von Rekultivierungs- und Renaturierungsmaßnahmen; gesetzliche Hintergründe: Bundesbodenschutz-, Kreislaufwirtschafts- und Wasserschutzrecht.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, gesetzliche Regelungen, die sich mit Altlasten beschäftigen, zu verstehen, die richtige Vorgehensweise bei der Untersuchung von Altlasten und Altlastenverdachtsflächen sowie bei der Sanierung von Altlasten anzuwenden, das Gefährdungspotential einer Altlast im Hinblick auf die Art der Schadstoffe und den Emissionspfad zu bewerten, die verschiedenen Untersuchungsmethoden zu verstehen sowie eine geeignete Probenahmestrategie und analytisches Untersuchungsprogramm zu bewerten, unterschiedliche Sanierungstechniken und Rekultivierungsmaßnahmen zu bewerten und in Abhängigkeit von der jeweiligen Altlast die geeignete anzuwenden. Zudem sind die Studierenden in der Lage, verschiedene altlastenbearbeitende Betriebe und Altlastenstandorte zu bewerten sowie die angewandten Sanierungsverfahren kritisch, im Hinblick auf Sanierungserfolge und Umweltauswirkungen, zu analysieren.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung und einer Übung. In der Vorlesung werden den Studierenden die gesetzliche Regelungen, die sich mit Altlasten beschäftigen, die richtige Vorgehensweise bei der Untersuchung von Altlasten und Altlastenverdachtsflächen sowie bei der Sanierung von Altlasten, das Gefährdungspotential einer Altlast im Hinblick auf die Art der Schadstoffe und den Emissionspfad, die verschiedenen Untersuchungsmethoden sowie eine geeignete Probenahmestrategie und analytisches Untersuchungsprogramm, unterschiedliche Sanierungstechniken und Rekultivierungsmaßnahmen vermittelt.

In den Übungen wird mit den Studierenden während des Besuchs ausgewählter belasteter Standorte und Sanierungseinrichtungen verschiedene altlastenbearbeitende Betriebe und Altlastenstandorte bewertet sowie die angewandten Sanierungsverfahren kritisch, im Hinblick auf Sanierungserfolge und Umweltauswirkungen, analysiert.

Media:
Präsentationen

Reading List:
Präsentationen; vertiefende Bücherliste auf Anfrage

Responsible for Module:
Kögel-Knabner, Ingrid; Prof. Dr. rer. nat. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Remediation of Contaminated Sites - Regeneration of contaminated soils (Vorlesung, 2 SWS)
Bucka F

Altlastensanierung - Kontaminierte und rekultivierte Böden (Übung, 2,1 SWS)
Bucka F, Heister K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6415: Applied Limnology | Angewandte Limnologie (V+Ü)

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is an oral examination (30 min).
In the examination the students show that they can independently evaluate unknown waters and, if necessary, develop approaches for the restoration or rehabilitation of the water bodies.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module General Limnology is recommended.

Content:
The module includes the following contents:
The eutrophication of water bodies: historical development, causes, biological consequences, extent, prevention; methods of water body qualification: Vollenweider model, chemical, physical and biological models; water body restoration, fall axe games, water body aeration, P-precipitation, sediment conditioning, biomanipulation, water body acidification: history, extent, chemical and biological consequences, countermeasures, practical introduction to bioindication with macrophytes, application of the macrophyte index for the assessment of running waters and lakes.

Intended Learning Outcomes:
After successful participation in the module event, students are able to independently evaluate unknown waters and, if necessary, develop approaches for the restoration or rehabilitation of the water bodies.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. In the lecture the necessary basics from different areas of applied limnology are presented. In the exercise the theoretical basics are deepened in

cooperation with other students by applying the macrophyry index to evaluate different types of water bodies.

Media:
Power-Point, Flipchart, Tafelarbeit, Digitale Mikrophotographie

Reading List:
Will be announced in the courses

Responsible for Module:
Uta Raeder (uta.raeder@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Limnologie (Vorlesung, 1 SWS)
Raeder U, Hoffmann M

Makrophyten als Bioindikatoren zu Bewertung der Wasserqualität I (Übung, Limnologie) (Übung, 3 SWS)
Zimmermann S, Hoffmann M, Raeder U

Makrophyten als Bioindikatoren zu Bewertung der Wasserqualität II (Übung, Limnologie) (Übung, 3 SWS)
Zimmermann S, Hoffmann M, Raeder U
For further information in this module, please click campus.tum.de or here.

Module Description

LS50012: Movement Ecology | Bewegungsökologie von Wildtieren

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung erfolgt als Projektarbeit. Diese umfasst einen Berichtvon 10-15 Seiten und einer Abschlusspräsentation (15 Minuten) sowie einer Kurzpräsentation eines Fachartikels aus dem Bereich Bewegungsökologie (5 Minuten) während der Übung. Die Projektarbeit beinhaltet die im Rahmen der Übung erarbeitete Fragestellung, eine Zusammenfassung der verwendeten Daten, die angewendeten Auswertemethoden, die erzielten Ergebnisse und eine Diskussion der Ergebnisse.
Die Studierenden demonstrieren die Fähigkeit einfache Studien zur Bewegungsökologie von Wildtieren mit Hilfe von technologischen Hilfsmitteln zu planen und auszuwerten.
Die Arbeit ist als Gruppenarbeit angelegt, wobei als Prüfungsleistung die individuellen Beiträge der Studierenden deutlich erkennbar sein müssen.
Die Beurteilung ergibt sich zu 60% aus der schriftlichen Arbeit und zu 40% aus den mündlichen Präsentationen (davon 30% für die Abschlusspräsentation, 10% für die Kurzpräsentation). Anhand der Präsentation wird auch die Fähigkeit überprüft die erzielten Ergebnisse in knapper und anschaulicher Form darstellen zu können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Für das Verständnis des Moduls sind grundlegende ökologische Kenntnisse erforderlich.

Content:
Das Modul setzt sich aus einem Vorlesungs- und einem Übungsteil zusammen. Im Vorlesungsteil werden
theoretische Grundlagen der Bewegungsökologie vermittelt, die im Übungsteil im Rahmen eines 4-tägigen

Forschungsaufenthalts im Nationalpark Berchtesgaden (mit Übernachtung in der TUM Forschungsstation Friedrich N. Schwarz am Rossfeld) praktisch angewendet werden.
Das Modul vermittelt:
• theoretische Grundlagen der Bewegungsökologie (z.B. Ursachen und Folgen von Tierwanderungen)
• Grundkenntnisse verschiedener Bewegungsmechanismen und -strategien
• Kenntnisse über die häufigsten Methoden um Tierbewegungen zu untersuchen (Radio-, GPS-Telemetrie)
• Analyse von räumlich-zeitlichen Daten z.B. Bewegungsdistanzen, Streifgebietsgrößen und Lebensraumnutzung
• Darstellung, Diskussion und Präsentation der Ergebnisse

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage die Grundlagen der Bewegungsökologie von Wildtieren zu erklären und dieses Wissen einzusetzen, um eigene einfache Studien in diesem Bereich zu planen sowie die Studien anderer zu bewerten. Diese Studien können sowohl der Grundlagenforschung als auch ökologischer und naturschutzfachlicher Planungen (z.B. Radiotelemetrie bei Fledermäusen, GPS-Telemetrie für Greifvögel im Zusammenhang mit Windkraftwerken) dienen. Das Modul vermittelt den Studierenden im Bereich Bewegungsökologie sowohl theoretische Grundlagen als auch praktische Erfahrung im Umgang mit Telemetriemethoden. Sie haben einen Überblick über die häufigsten technologischen Hilfsmittel, um Wanderbewegungen von Tieren zu untersuchen (z.B. Radiotelemetrie, GPS-Telemetrie), und kennen sowohl die wissenschaftlichen als auch die rechtlichen und ethischen Grundlagen, um diese Methoden bei Wildtieren einzusetzen. Darüber hinaus beherrschen die Studierenden einen Grundstock an analytischen Methoden um räumlich-zeitliche Daten auszuwerten. Damit können sie beispielsweise Bewegungsdistanzen, Streifgebietsgrößen und Lebensraumnutzung berechnen, die Ergebnisse graphisch darstellen und diskutieren.

Teaching and Learning Methods:
Das Modul setzt sich aus einer Vorlesung und einer begleitenden Übung zusammen. In den Vorlesungen werden die theoretischen Grundlagen in Form von Vorträgen und Präsentationen vermittelt. Die Studierenden sollen zum Studium des Vorlesungsskriptes und der Fachliteratur angeregt werden. In den Übungen werden einige Methoden demonstriert und das Wissen praktisch angewandt. Anhand bestehender Telemetriedaten sollen die Studierenden kleine Projekte planen und die Daten der Fragestellung entsprechend am Computer auswerten. Bei Kurzexkursionen im Nationalpark Berchtesgaden werden laufende Telemetrieprojekte vorgestellt und Herausforderungen bei der Feldarbeit (Fang, Telemetrie) besprochen.

Media:
PowerPoint, Tafelarbeit, Übungen am Computer, Gruppenarbeit und Gruppendiskussion.

Reading List:
Wird in der Lehrveranstaltung bekannt gegeben.

Responsible for Module:
Loretto, Matthias-Claudio, Ph.D. matthias.loretto@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Bewegungsökologie von Wildtieren (VO) (Vorlesung, 1 SWS)
Loretto M

Bewegungsökologie von Wildtieren (UE) (Übung, 3 SWS)
Loretto M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0351: Biodiversity in Dynamic Forests and Protected Areas Management | Biodiversität dynamischer Wälder und Schutzgebietsmanagement

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung erfolgt in Form einer Projektarbeit im Umfang von 10-15 Seiten ergänzt um eine 5- bis 10-minütige Präsentation. Dabei bearbeiten die Studierenden entweder Themen aus dem Bereich Biodiversität dynamischer Wälder oder Schutzgebietsmanagement. Das Thema wird den Studierenden vom Dozierenden zugeteilt. Die konkreten Bestandteile der Arbeit sind:
• Formulierung der Zielsetzung
• Erhebung von Daten (Anhand von Fachliteratur, Interview mit Nationalparkmitarbeitern, eigene Datenerfassung)
• Auswertung der Daten
• Interpretation der Ergebnisse
Die Projektarbeit erfolgt in Form einer Gruppenarbeit, wobei als Prüfungsleistung die individuellen Beiträge der Studierenden bewertet werden. Diese individuellen Beiträge müssen in der Präsentation und der schriftlichen Auswertung deutlich erkennbar gemacht werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Für das Verständnis des Moduls sind grundlegende ökologische Kenntnisse erforderlich.

Content:
Im Rahmen des Moduls werden Grundkenntnisse zur Artenvielfalt in Wäldern mit einem Fokus auf unterschiedliche Waldentwicklungsphasen vermittelt. Die wichtigsten Erfassungsmethoden für Tiere, sowie grundlegende Kenntnisse der Arten sollen im Rahmen angeleiteter Übungen vermittelt werden, bei denen die Studierenden in Gruppen ausgewählte Artengruppen in unterschiedlichen Waldentwicklungsphasen selbst erfassen. Desweiteren werden die grundlegenden

Herausforderungen dargestellt, denen sich Schutzgebietsmanager gegenübersehen, ebenso wie mögliche Lösungen. Dieses Themenfeld können die Studierenden in Gruppen im Interview mit Mitarbeitern des Nationalparks Berchtesgaden erörtern.

Intended Learning Outcomes:
Nach dem Besuch des Moduls sind die Studierenden in der Lage,
• die wichtigsten Erhebungsmethoden zu verschiedenen terrestrischer Artengruppen anzuwenden.
• typische Tierarten in Bergwäldern zu bestimmen.
• die Treiber der Artenvielfalt in dynamischen Wäldern zu beschreiben.
• Herausforderungen im Schutzgebietsmanagement zu analysieren.
• Strategien im Schutzgebietsmanagement zu entwerfen.

Teaching and Learning Methods:
Das Modul setzt sich aus zwei Vorlesungsteilen mit je einer begleitenden Übung zusammen. In den Vorlesungen werden die theoretischen Grundlagen in Form von Vorträgen und Präsentationen vermittelt. In den Übungen werden diese Grundlagen im Feld demonstriert und anschließend von den Studierenden selbst angewendet. Die Übung zum Schutzgebietsmanagement umfasst Exkursionen und Interviews mit Mitarbeitern des Nationalparks Berchtesgaden.

Media:
PowerPoint Präsentationen, Vorlesungsskripten, Fachliteratur

Reading List:
Primack & Sher 2016: An Introduction to Conservation Biology, Sinauer; Wohlgemuth et al. 2019: Störungsökologie, utb;

Responsible for Module:
Seibold, Sebastian; PD Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Walddynamik und Biodiversität (Vorlesung, 1,5 SWS)
Seibold S [L], Loretto M, Seibold S

Schutzgebietsmanagement (Übung, 1,5 SWS)
Seibold S [L], Loretto M, Seibold S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2047: Soil Protection | Bodenschutz

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of an oral examination (20 min.) and a presentation (15 min.). The oral examination and presentation are graded at a ratio of 2:1. On the basis of the oral examination, students show that they understand processes that influence the behaviour of substances in soils. They also show that they are able to analyze the influence of acidification, salinization, heavy metals, radionuclides as well as organic pollutants in soils and that they understand different remediation techniques and can evaluate them depending on the type of contamination. In the seminar lecture (presentation) the students show that they can delve deeper into a specific topic of soil protection and present the contents to the other students in a consistent and understandable way. In addition, they should demonstrate that they can competently respond to questions, suggestions and discussion points from the audience in relation to the respective topic area.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Introduction to soil science 1 and 2 must be successfully completed (exclusion criterion).

Content:
The module includes the following contents: Soil functions, pathways of action, toxicology, legal basics, determination of soil pollution, soil components (clay minerals, oxides, organic material), ion exchange, adsorption, precipitation and coprecipitation, acidification, salinization, behavior of trace elements in soils (availability, mobility), inorganic pollutants (heavy metals), radionuclides, organic pollutants (e.g. PAK, PCB, dioxins and pesticides), remediation and securing procedures.

Intended Learning Outcomes:
After attending the module course, students will be able to understand processes that influence the behaviour of substances in soils (e.g. sorption), to evaluate the influence of acidification and salinization on the behaviour of substances in soils, to analyse the behaviour of heavy metals, radionuclides and organic pollutants in soils and to understand and evaluate different remediation techniques depending on the type of contamination. They are able to independently familiarize themselves with specific questions of soil protection and to present hazards, protection methods and remediation techniques to an audience and to explain them in more detail in the discussion.

Teaching and Learning Methods:
The module consists of a lecture and a seminar. In the lecture, students are introduced to the processes that influence the behaviour of substances in soils. The lecture gives a broad overview of the different groups of pollutants and shows their behaviour in soils. For the seminar, students choose a more limited topic from the context of soil protection, in which they independently delve deeper. The students give a lecture on their topic, which is discussed by all students in the plenum under the guidance of the lecturer.

Media:
Presentations

Reading List:
Lecture: presentations, in-depth book list on request; seminar: special literature lists for the individual topics

Responsible for Module:
Kögel-Knabner, Ingrid; Prof. Dr. rer. nat. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Bodenschutz - Organische und anorganische Schadstoffe in Böden (Vorlesung, 2 SWS)
Bucka F

Bodenschutz - Nutzungsabhängige Funktionsfähigkeit von Böden (Seminar, 2 SWS)
Schweizer S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2416: Soil Research Course with Colloquium | Bodenkundliches Forschungspraktikum mit Kolloquium

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 50	**Contact Hours:** 100

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time: 30 min.
Examination

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Introduction to soil science 1 and 2 must be successfully completed (exclusion criterion).

Content:
Performance of field and laboratory work, evaluation as well as written and oral presentation of the data, discussion of scientific lectures.

Intended Learning Outcomes:
Students are able to independently carry out smaller research tasks. They are able to evaluate research results and present them in written and oral form. They are confident in discussing research results.

Teaching and Learning Methods:
Research internship: work in the field and/or laboratory, initially under supervision, then increasingly independently. Colloquium: lectures with detailed discussion.

Media:
Individual explanations in the research internship; presentations in the colloquium.

Reading List:
Is specified for each individual case.

Responsible for Module:
Prof. Dr. Ingrid Kögel-Knabner (koegel@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Bodenkundliche Übungen für Fortgeschrittene (Übung, 4 SWS)
Kögel-Knabner I

Bodenkundliche Übungen für Fortgeschrittene (Übung, 4 SWS)
Kögel-Knabner I
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2510: Diatoms as Bioindicators and Scanning Electron Microscopy | Bioindikatoren mit Diatomeen und Rasterelektronenmikroskopie

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 105	**Contact Hours:** 135

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlagen der Limnologie und der Botanik (BSc Studium)

Content:
Aufbau von Kieselalgen, Systematik und Taxonomie der Kieselalgen (Diatomeen), Kieselalgen als Indikatororganismen zur Bestimmung der Gewässerverschmutzung, physikalische Grundlagen und praktische Einführung in die Licht- und in die Rasterelektronenmikroskopie, Herstellen von Diatomeenpräparaten für die Licht- und die Elektronenmikroskopie, Einführung in die Bestimmung von Diatomeen am Lichtmikroskop, qualitative und quantitative Auswertung von Diatomeenpräparaten aus verschiedenen Gewässern, Bestimmung der Gewässertrophie anhand des Diatomeenindex, Studium der Feinstruktur von Diatomeenschalen am Rasterelektronenmikroskop.

Intended Learning Outcomes:
Nach der Modulveranstaltung sind die Studenten in der Lage, Diatomeenproben aus unterschiedlichen Gewässern zu analysieren und die Qualität der Gewässer entsprechend der EU-Wasserrahmenrichtlinie zu bewerten. Die Studenten können eigenständig Monitoringprogramme auf der Basis des Diatomeenindex für unbekannte Fließgewässer und Seen entwickeln.
Zudem verfügen die Studenten nach der Modulveranstaltung über ein vertieftes Wissen in der Rasterelektronenmikroskopie und sind in der Lage, selbständig an einen REM zu arbeiten.

Teaching and Learning Methods:
Die Modulveranstaltung wird in Form eines Praktikums angeboten. Die Grundlagen der Rasterelektronenmikroskopie werden in Form einer integrierten Vorlesung mit anschaulichen physikalischen Experimenten und anhand von praktischen Übungen am REM erarbeitet. Die Studenten üben die labortechnischen Fertigkeiten zur Herstellung von Diatomeenpräparaten und erlernen die mikroskopische Auswertung dieser Präparate. In Kleingruppen erfolgt die statistische und graphische Auswertung. In Ko-Produktion wird erlernt, einen Bericht in Form eines Gutachten über das Untersuchungsgewässer termingerecht zu erstellen.

Media:
PowerPoint, Flipchart, Tafelarbeit, Digitale Mikrophotographie

Reading List:
The Diatoms: Applications for the environmental and earth sciences, Stoermer & Smol; Aufwuchs-Diatomeen in Seen und ihre Eignung als Indikatoren der Trophie, Hofmann; Bacillariophyceae. In: Ettl, H., Süßwasserflora von Mitteleuropa. (begründet von A. Pascher) Krammer & Lange-Bertalot Band 2(1-4); The Diatoms. Biology and morphology of the genera, Round, Crawford & Mann; The biology of diatoms, Werner; Diatomeen im Süßwasser-Benthos von Mitteleuropa, Hofmann, Werum, Lange-Bertalot

Responsible for Module:
Raeder, Uta, Dr. rer. nat. uta.raeder@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Bioindikation mit Diatomeen und Rasterelektronenmikroskopie MSc Bio (Limnologie) (Übung, 9 SWS)
Raeder U, Jacob P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2526: Soils of the World: Properties and Protection | Böden der Welt: Eigenschaften und Schutz

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 120	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.
Prüfungsleistung

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Einführung in die Bodenkunde 1 und 2 müssen erfolgreich absolviert sein (Ausschlusskriterium).

Content:
1. Eigenschaften, Verbreitung, Genese und Nutzungsmöglichkeiten sämtlicher Bodentypen der Erde, dargestellt gemäß der internationalen Bodenklassifikation WRB.
2. Das Welternährungsproblem, was ist Bodendegradation?, Steigerung der Nahrungsmittelproduktion auf fruchtbaren Standorten, marginale Standorte (stark erosionsgefährdet, semiarid, stark verwittert), Agroforstwirtschaft (Definitionen, Effekte von Bäumen auf den Boden, Erosionsschutz, Wasserhaushalt, Nährstoffhaushalt, die Rolle der Wurzeln).
3. Bodenbeschreibungen nach den international verbindlichen Guidelines der FAO, Klassifikation nach dem internationalen System WRB und anschließende ökologische Interpretation.

Intended Learning Outcomes:
Die Studierenden kennen sämtliche Bodentypen der Erde mit ihren wichtigsten Eigenschaften. Sie haben ihre Genese und die Gründe für ihr Auftreten in den verschiedensten Teilen der Welt verstanden. Die Studierenden verstehen die Zusammenhänge zwischen der natürlichen Boden(un)fruchtbarkeit und der Gefährdung der Böden durch Landnutzung. Sie kennen die Produktionsmöglichkeiten auf Standorten unterschiedlicher Fruchtbarkeit und deren geschichtliche

und kulturelle Implikationen. Sie sind in der Lage, die spezifischen Erfordernisse bei der Nutzung verschiedener marginaler Standorte zu beurteilen. Sie verfügen über ausreichende Kenntnisse hinsichtlich der Möglichkeiten des Bodenschutzes durch den Einsatz von Bäumen. Die Studierenden können die FAO-Guidelines for Soil Description im Gelände anwenden und die wichtigsten Bodeneigenschaften anhand dieser Guidelines beschreiben. Sie sind in der Lage, Böden nach WRB zu klassifizieren. Sie sind ferner in der Lage, aus Beschreibung und Klassifikation die Fruchtbarkeitseigenschaften der Böden und ihr Gefährdungspotential abzuleiten.

Teaching and Learning Methods:
Vortrag und Präsentation (Vorlesung); interaktive Bodenansprache, Bodenklassifikation und Bodenbewertung (Geländeübungen); Literaturstudium, Nachdenken

Media:
Vorlesung: Präsentationen, Tafelanschriebe; Geländeübung: Skripten

Reading List:
IUSS Working Group WRB (2007): World Reference Base for Soil Resources 2006. Erstes Update 2007. Deutsche Ausgabe (2008). Übersetzt von P. Schad; herausgegeben von der Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover.

Blanco, H., Lal, R. (2008): Principles of soil conservation and management.

Montgomery, D.R. (2007): Dirt The erosion of civilizations.

Diamond, J. (2005): Collapse How societies choose to fail or survive (auch auf deutsch).

Young, A. (1997): Agroforestry for soil management. 2nd edition. FAO (2006): Guidelines for Soil Description, 4th edition. Prepared by R. Jahn, H.-P. Blume, V.B. Asio, O. Spaargaren and P. Schad. FAO, Rom.

Responsible for Module:
Dr. Peter Schad (schad@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Böden der Welt (Vorlesung, 2 SWS)
Schad P

Bodenansprache und Bodenklassifikation nach internationalen Standards (Übung, 2,8 SWS)
Schad P

Bodendegradation und Bodenschutz in den Tropen und Subtropen (Vorlesung, 2 SWS)
Schad P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4223: Biodiversity | Biodiversität

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Aufgrund des Pandemiegeschehens hat der/die Studierende auch die Möglichkeit, an einer beaufsichtigten elektronischen schriftlichen Fernprüfung (Aufsicht mit Proctorio, 60 min.) teilzunehmen (Onlineprüfung: WZ4223o). Diese schriftliche Prüfung wird zeitgleich parallel in Präsenz angeboten (WZ4223).

Die Modulprüfung ist eine schriftliche Prüfung (Klausur; 60 min). Anhand der Klausur zeigen die Studierenden, dass sie wichtige Begriffe, Methoden und Theorien der Biodiversitätsforschung mit eigenen Worten erklären, verschiedene Landnutzungsszenarien bewerten sowie deren Einfluss auf die Biodiversität und Ökosystemleistungen verstehen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Das Modul umfasst folgende Inhalte:
Die Herkunft, Mechanismen der Erhaltung, Bedrohung, und Nutzen für den Menschen von Biodiversität

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, wichtige Begriffe, Methoden und Theorien der Biodiversitätsforschung mit eigenen Worten zu erklären. Sie können verschiedene Landnutzungsszenarien bewerten, deren Einfluss auf die Biodiversität und Ökosystemleistungen verstehen und Konzepte zur Überprüfung dieses Einflusses entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung mit integrierten Übungen. Anhand der Vorlesung werden den Studierenden wichtige Begriffe, Methoden und Theorien der Biodiversitätsforschung sowie die Einflüsse verschiedener Landnutzungsszenarien auf die Biodiversität und Ökosystemleistungen vorgestellt.
In den integrierten Übungen werden anhand aktueller Literatur die Bewertung verschiedener Landnutzungsszenarien, deren Einfluss auf die Biodiversität und Ökosystemleistungen und Konzepte zur Überprüfung dieser Einflüsse diskutiert.

Media:
Abhängig von Themen und Dozenten

Reading List:
Abhängig von Themen und Dozenten

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Biodiversität (Vorlesung mit integrierten Übungen, 4 SWS)
Hof C [L], Hof C, Heinen R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1216: Introduction in Ecological Modelling | Einführung in die ökologische Modellierung

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden verfassen einen Bericht (ca. 10-20 Seiten), in dem die Modellentwicklung und Modellauswertung dokumentiert wird und der durch eine kurze Präsentation ergänzt wird (15 Min.). Das konzeptionelle Modell wird dargestellt und die Ergebnisse der in der Implementierung simulierten Szenarien vorgestellt, interpretiert und fachlich diskutiert. Mit dem Bericht weisen die Studierenden nach, dass sie sich durch die Modellentwicklung ein tiefergehendes Verständnis des betrachteten Systems erarbeiten und komplexere ökologische Sachverhalte in Simulationsmodellen darstellen können. Sie zeigen zudem, dass sie Modelle in einer graphischen Simulationsumgebung oder in einer Programmiersprache (z.B. R oder Python) implementieren können und die Modellbeschreibung schriftlich dokumentieren und die Ergebnisse interpretieren können. Anhand der Präsentation zeigen die Studierenden, dass Sie die Fragestellung, die Modellbeschreibung und die erarbeiteten Ergebnisse des Projekts in geeigneter Weise aufbereiten und einer Zuhörerschaft zu präsentieren können und in der Gruppe diskutieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine.

Content:
Ökologische Simulationsmodelle helfen uns, ökologische Zusammenhänge und die Funktionsweise von Ökosystemen (oder Teilen davon) besser zu verstehen. Das erklärt ihr breites Anwendungsfeld, z.B. für Resourcenmanagement, Forstwirtschaft und Natur- und Artenschutz. In diesem Modul werden tiefergehende Kenntnisse zur ökologischen Modellierung erarbeitet. Dabei analysieren und strukturieren die Studierenden ausgewählte einfache Ökosystemprozesse,

erstellen für diese ein konzeptionelles Modell und implementieren dieses Modelle anschließend in einer graphischen Simulationsumgebung (z.B. Vensim) oder in einer Programmiersprache (z.B. R oder Python). Das Modul beinhaltet eine allgemeine, übergreifende Einführung in Modellierungsprinzipen, die Vorstellung der jeweils behandelten Ökosystemprozesse und Fragestellungen sowie die Einführung in den Umgang mit der jeweiligen Modellierungs- und Simulationsumgebung. Behandelte Themen umfassen:
- Artverbreitungsmodelle (Species Distribution Models)
- Modelle der Populations- und Habitatdynamik
- Ausbreitungsmodelle

Intended Learning Outcomes:
Nach Teilnahme an diesem Modul sind die Studierenden in der Lage, komplexere ökologische Sachverhalte in Simulationsmodellen darzustellen. Sie sind somit in der Lage, sich durch Modellierung ein tiefergehendes Verständnis des betrachteten Systems zu erarbeiten. Die Studierenden können Systeme und relevante Prozesse in Form eines konzeptionellen Modells abbilden und anschließend mittels einer graphischen Simulationsumgebung (z.B. Vensim) oder in einer Programmiersprache (z.B. R oder Python) umsetzen. Die Studierenden können die Modellbeschreibung in Form einer Präsentation und eines Berichtes dokumentieren und die Ergebnisse im Bericht interpretieren. Sie können die Fragestellung, die Modellbeschreibung und die erarbeiteten Ergebnisse des Projekts in geeigneter Weise aufbereiten und einer Zuhörerschaft präsentieren und in der Gruppe diskutieren. Die Studierenden sind in der Lage, Fähigkeiten und Grenzen der Modellierungsansätze zu erkennen.

Teaching and Learning Methods:
Das Modul setzt sich aus einer Vorlesung mit integrierten Übungen zusammen. In der Vorlesung werden die theoretischen Grundlagen zur Modellierung (Was sind Modelle, wozu werden sie verwendet, wie erstellt man ein Modell? Weiterhin Grundbegriffe der verwendeten Programmierung) von den Dozenten in Form von Vorträgen und Präsentationen vermittelt. In der Übung werden von den Studierenden folgende Aufgaben als Einzelarbeit durchgeführt:
- Literaturrecherche und Formulierung der wissenschaftlichen oder management-relevanten Fragestellungen
- Recherche der nötigen Hintergrundinformationen
- Entwicklung eines konzeptionellen Modells
- Implementierung des Modells in einer Simulationsumgebung oder in einer Programmiersprache
- Durchführung von Modellsimulationen
- Szenarienanalyse
- Auswertung der Ergebnisse und graphische Darstellung
- Ergebnisse in einem Kurzvortrag präsentieren und diskutieren
- Dokumentation des Modells und der Modellergebnisse in einem Bericht

Media:
Vorlesung mit Powerpoint und Tafelarbeit, Übungen am Computer. Modellentwicklung in Gruppenarbeit. Literaturrecherche.

Reading List:
Smith & Smith (2007) Introduction to Environmental Modeling, Oxford University Press.
Soetaert & Herman (2009) A Practical Guide to Ecological Modelling, Springer.
Bossel, H. (1992). Modellbildung und Simulation: Konzepte, Verfahren und Modelle zum Verhalten dynamischer Systeme. Vieweg, Braunschweig, Wiesbaden, Germany.
Weitere Fachliteratur für Fallbeispiele.

Responsible for Module:
Anja Rammig Anja.Rammig@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die ökologische Modellierung (Vorlesung mit integrierten Übungen, 4 SWS)
Rammig A [L], Hof C, Krause A, Rammer W, Rammig A, Wagner T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2484: Nutritional Physiology of Insects | Ernährungsbiologie der Insekten

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Das Modul wird mit einer Projektarbeit (wissenschaftliche Ausarbeitung) abgeschlossen. In der Projektarbeit beschreiben die Studierenden den Versuchsaufbau, seine Durchführung und Auswertung der Ergebnisse. In der Diskussion zeigen die Studierenden, dass sie mit den verwendeten Methoden und Auswerteverfahren vertraut sind und interpretieren die Ergebnisse im ökologischen Kontext. Sie zeigen, dass sie Versuchsergebnisse strukturiert darstellen und interpretieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Tierökologie und Forstentomologie, gute Kenntnisse in Entomologie sowie in Chemie und Biochemie

Content:
- Entwicklung von Versuchsplänen
- Haltung von Insekten unter Laborbedingungen
- Kriterien für die Beurteilung der Nahrungsqualität,
- Erstellen von Massenbilanzen für die Nahrungsverwertung,
- Berechnung Verwertungsindices,
- Ermittlung von Fraßpräferenzen,

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss des Moduls sind die Studierenden in der Lage:
- Fraßpäferenzversuche mit prädatorischen Insekten zu verstehen.
- Verfahren zur Bilanzierung der Nahrungsverwertung von Insekten zu kennen.

- Einfluss der Nahrungsqualität auf die Fitness von Einzelindividuen und von Populationen prädatorischer Insekten zu verstehen.
- Fachliteratur im Bereich der Ernährungsphysiologie hinsichtlich ihrer ökologischen Bedeutung beurteilen zu können.
- Daten aus Fütterungsversuchen unter zu Hilfenahme von statistischen Methoden zu analysieren.
- Methoden zur Laborhaltung von Insekten zu entwickeln.

Teaching and Learning Methods:
In einer einleitenden Vorlesung wird den Studierenden die Bedeutung der Nahrungsqualität für die Fitness von Insekten dargestellt und auf die Probleme nahrungsanalytischer Untersuchungen mit Prädatoren hingewiesen. Im Selbststudium machen sich die Studierenden mit der Biologie und Ökologie der im Praktikum verwendeten Prädatoren vertraut. In gemeinsamer Diskussion werden Versuchspläne erstellt. Im Praktikum führen die Studierenden in Gruppen selbstständig Fütterungsversuche durch und werten die Ergebnisse statistisch aus. Die Ergebnisse werden im Seminar vorgestellt und in einem Protokoll niedergeschrieben.

Media:
Powerpoin Präsentation, Skriptum, Tafelarbeit, Folien

Reading List:
Dettner/Peters " Lehrbuch der Entomologie" Gustav Fischer; Chapman "The insects" Cambridge Univ. Books; Nation " Insect physiology and biochemistry" CRC

Responsible for Module:
Dr. Axel Gruppe – Lehrstuhl für Zoologie

Courses (Type of course, Weekly hours per semester), Instructor:

Axel Gruppe
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2732: Environmental Monitoring and Data Analysis | Environmental Monitoring and Data Analysis

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 80	**Contact Hours:** 70

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Aufgrund des Pandemiegeschehens hat der/die Studierende auch die Möglichkeit, an einer beaufsichtigten elektronischen schriftlichen Fernprüfung (Aufsicht mit Zoom, 180 min.) teilzunehmen (Onlineprüfung: WZ2732o). Diese Prüfung wird zeitgleich parallel in Präsenz angeboten (WZ2732).

Upon completion of the module, the students have a profound understanding of key aspects of environmental monitoringand are able to choose appropriate as well as to efficiently run environmental measurements, to reproducibly analyze acquired data and to clearly communicate results of environmental measurements.
This ability should be demonstrated by writing a research paper following standards of reproducible research based on different aspects of environmental monitoring and data analysis with R. For the research paper, either available data or data measured during the module should be used and be analyzed in respect to defined hypotheses; developed R code has to be provided too.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in R is recommended.

Content:
1 Environmental monitoring including principles, techniques and management issues used in environmental monitoring and assessment; Observing, recording, communicating and archiving collected data and providing it to project stakeholders in order to identify sustainable and responsible environmental practices.
Optional: short course Aerobiology, GAW program, visit of companies

2 Environmental data analysis
Introduction to data analysis with R; Principles of reproducible research and implementation with R; Pipelines for environmental data analysis from obtaining data via cleaning and transforming to modelling and visualization with modern R; Coverage of data retrieval from different storage types for climate, proxy, phenology, and other data (text-based, netCDF, data bases); Modeling and visualization as complementary strategies for hypothesis-driven data analysis, based on published research from different fields of environmental sciences.

Intended Learning Outcomes:
After this module, the students can plan, implement and run environmental measurements. They are able to efficiently analyze environmental data sets, including download and import of data sets and visualization and modelling with R.

Teaching and Learning Methods:
Course 1 consists of a practical course in the laboratory and in the field where students will work in small teams on applied case studies and exercises related to environmental / meteorological monitoring. Course 2 then offers combined lecture and exercise sessions at the PC lab on how to efficiently analyze those environmental data sets of course 1.

Media:
PowerPoint Presentation, Field work, Interactive documents for data analysis

Reading List:
Beginner level tutorials for Swirl (http://swirlstats.com/)

Responsible for Module:
Responsible for Module: Prof. Dr. Annette Menzel - Professur für Ökoklimatologie Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, 08161/ 71-4740, menzel@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental monitoring and data analysis; ecological data analysis (Vorlesung mit integrierten Übungen, 3 SWS)
Menzel A [L], Buras A, Krause A, Meyer B

Environmental monitoring and data analysis; ecological monitoring (Vorlesung mit integrierten Übungen, 2 SWS)
Menzel A [L], Lüpke M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4032: Entomology | Entomologie

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is completed with a report. In it, students should demonstrate that they know the most important insect groups and their ecological role, know about their biology and can apply this knowledge to concrete entomological questions on the interactions of plants and insects in the context of a scientific experiment. Learned knowledge should be reproduced in a structured way and the research question should be analyzed scientifically. The report should demonstrate that the essential aspects have been grasped and can be reproduced in written form. The report comprises 15-20 pages and is structured like a publication, i.e. it includes an abstract, introduction, materials and methods used, results and a concluding discussion as well as a list of references used.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of Zoology, Ecology and Physiology is mandatory

Content:
The module covers the (chemical) ecology, behavior, diversity and evolution of important insect groups, their species-specific resource use, their natural counterparts as well as theories on ecosystem processes/functions and services. Furthermore, based on chemical ecology, the basics of biological control of insect pests are presented as well as the possibilities of their practical application.

Intended Learning Outcomes:
After successful participation in the module course, students know important insect groups and their role in natural and human-influenced ecosystems. They are able to deduce and evaluate their impact on plants (including crops) and ecosystem processes based on ecology, behavior, diversity,

evolution and ecosystem function. This competence allows them to assess their role in ecosystems also under the influence of global change and alternative land use. In addition, they understand the most important ecological and physiological principles of biological control.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. In the lecture, the necessary knowledge is imparted by the lecturers in the form of lectures and presentations and discussed together with the students. The students are encouraged to deal with the content of the topic and to study the scientific literature as well as the lecture notes. In the exercises, important insect groups are observed, determined and their behavior as well as resource use are studied within the framework of an experiment in small groups.

Media:
Power Point presentation, on-site demonstration, documentaries, pictures and collection material

Reading List:
Miller und Miller, Insect-Plant Interactions, Springer; Chinery, Insects of Britain and Western Europe, A&C Black; Gullan, The Insects: An Outline of Entomology

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Entomologie - Grundlagen von Interaktionen zwischen Pflanzen und Insekten (Vorlesung, 2 SWS)
Leonhardt S [L], Leonhardt S, Rüdenauer F

Entomologie - Bestimmung,Verhalten und biologische Bedeutung von Insekten (Übung, 3 SWS)
Leonhardt S [L], Leonhardt S, Rüdenauer F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0259: Field Assessment of Soil Quality | Feldmethoden zur Erfassung des Bodenzustands

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 58	**Contact Hours:** 42

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Anwesenheitspflicht im Gelände, schriftliche Prüfung

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Einführung in die Bodenkunde 1

Content:
Ansprache der Böden in der Umgebung von Freising nach KA5 (Beschreibung des Bodens im Feld nach der deutschen Klassifikation inkl. Ableitung bodenphysikalischer und bodenchemischer Kennwerte anhand von Tabellenwerken), Erfassung des Bodenwassergehalts im Feld (Meßverfahren und Einflußgrößen), Messung der potentiellen Bodenerosion im Feld und Vergleich mit aktuellen Messdaten (Erosionsmessstelle und Berechnungen)

Intended Learning Outcomes:
Nach der Teilnahme an der Veranstaltung ist die/der Studierende in der Lage Ergebnisse feldbodenkundlicher Erhebungen zu verstehen und zu bewerten. Zudem ist sie/er hinsichtlich möglicher Fehlerquellen wie räumlicher Heterogenität oder der Ungenauigkeit von aus Tabellenwerken abgeleiteten Kennzahlen sensibilisiert und somit für die praktische Anwendung im einfachen Rahmen vorbereitet. Im Hinblick auf die Bestimmung des Bodenwassergehalts hat die/der Studierende die wichtigsten Einfllußgrößen und Messmethoden im Feld verstanden und kann die ermittelten Messwerte analysieren und bewerten. Die Schätzung des Bodenabtrags durch Wasser kann die/der Studierende selbstständig durchführen und bewerten. Messwerte aus Feldananlagen zur Erosionsmessung kann die/der Studierende analysieren und bewerten.

Teaching and Learning Methods:
Hier steht, was Sie vorbereiten und was Sie ins Gelände mitbringen müssen:http://www.wzw.tum.de/bk/pdfs/uebungen/feldmethoden10.pdf

Media:
Verschiedene Skripte, Nationale Klassifikationsrichtlinie, Feldexkursion mit Gelände- und Bodenansprache

Reading List:
Ad-hoc-AG Boden (2005): Bodenkundliche Kartieranleitung. 5. Auflage. 438 S., Hannover.

Responsible for Module:
Dr. Markus Steffens (steffens@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2283: Research Project Biomolecular Limnology | Forschungspraktikum Molekularbiologische Limnologie

Version of module description: Gültig ab summerterm 2011

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.
Die Prüfung wird Form eines Berichtes erbracht, der den Aufbau einer Veröffentlichung hat (Einleitung, Material und Methoden, Ergebnisse, Diskussion). In die Note geht die Bewertung eines Vortrags mit 20% ein.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der Limnologie und der Molekularbiologie

Content:
Der Inhalt des Forschungspraktikums richtet sich nach den jeweils aktuellen Forschungsprojekten an der Limnologischen Station in Iffeldorf in molekularbiologischer Richtung. Diese werden auf der Homepage der Limnologischen Station vorgestellt (http://www.limno.biologie.tu-muenchen.de).
Es werden sowohl Themen zur Evolution und Populationsgenetik höherer Organismen als auch mikrobiologische Themen aus dem Bereich der Limnologie angeboten.

Intended Learning Outcomes:
Die Studenten erlernen die Grundlagen molekularbiologischen Arbeitens wie PCR, Gensequenzierung, AFLP sowie verschiedene statistische Verfahren zur Auswertung von molekularbiologischen Analysen. Sie erfahren konstruktive Kritik und üben sich darin diese konstruktiv umzusetzen.

Teaching and Learning Methods:
Das Modul besteht aus einer sechswöchigen selbständigen Mitarbeit in einem molekularbiologischen Projekt in der Limnologie. Es wird jeweils eine eigenständige Fragestellung bearbeitet. Mit dem Betreuer wird die Vorgehensweise (experimental design) diskutiert, wobei eigene Kreativität erforderlich ist. Die Studenten üben sich im Umgang mit konstruktiver Kritik und erlernen Zeitmanagement sowie das termingerechte Verfassen der schriftlichen Ausarbeitung.

Media:
Fallbeschreibungen, ISI-Web of Knowledge Literaturrecherche, Internet-Datenbankrecherchen,

Reading List:
Lehrbücher zur Molekularbiologie, aktuelle Veröffentlichungen

Responsible for Module:
Arnulf Melzer (arnulf.melzer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum in molekularbiologischer Limnologie (Forschungspraktikum, 10 SWS)
Bauer F [L], Bauer F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2332: Research Project Organismic Limnology | Forschungspraktikum Organismische Limnologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.
Die Prüfung wird Form eines Berichtes erbracht, der den Aufbau einer Veröffentlichung hat (Einleitung, Material und Methoden, Ergebnisse, Diskussion). In die Note geht die Bewertung eines Vortrags mit 20% ein.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlagen der Limnologie und der organismischen Biologie (BSc Studium)

Content:
Der Inhalt des Forschungspraktikums richtet sich nach den jeweils aktuellen Forschungsprojekten an der Limnologischen Station in Iffeldorf in organismischer Richtung. Diese werden auf der Homepage der Limnologischen Station vorgestellt (http://www.limno.biologie.tu-muenchen.de)

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studenten in der Lage, selbständig eine klar umrissene wissenschaftliche Fragestellung aus dem Bereich der organismischen Limnologie zu bearbeiten. Sie sind fähig, eine Hypothese zu formulieren und diese anhand der Durchführung und der Auswertung von wissenschaftlichen Experimenten bzw. Freilanderhebungen zu überprüfen. Die Studenten erfahren konstruktive Kritik und üben sich darin diese konstruktiv umzusetzen.

Teaching and Learning Methods:
Das Modul besteht aus einer sechswöchigen selbständigen Mitarbeit an einem organismisch orientierten Projekt in der Limnologie. Es wird jeweils eine eigenständige Fragestellung bearbeitet. Mit dem Betreuer wird die Vorgehensweise (experimental design) diskutiert, wobei eigene Kreativität erforderlich ist. Die Studenten üben sich im Umgang mit konstruktiver Kritik und erlernen Zeitmanagement sowie das termingerechte Verfassen der schriftlichen Ausarbeitung.

Media:
Fallbeschreibungen, ISI-Web of Knowledge Literaturrecherche, Internet-Datenbankrecherchen

Reading List:
Lehrbücher zur Limnologie, aktuelle Veröffentlichungen

Responsible for Module:
Arnulf Melzer (arnulf.melzer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum in organismischer Limnologie (Forschungspraktikum, 10 SWS)
Raeder U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2383: Research Project in Animal Ecology | Forschungspraktikum Tierökologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): Anfertigung eines Praktikumsberichts und 20 min Präsentation der Ergebnisse mit anschließender Diskussion.
Das Modul wird mit einem Praktikumsbericht und einer mündlichen Ergebnispräsentation abgeschlossen. Die Studierenden zeigen, dass sie Experimente zieloriientiert planen und effizient und exakt durchführen könne. Der Praktikumsbericht belegt, dass sie mit Aufbau und Diktion einer wissenschaftlichen Publikation vertraut sind. Souveränität in Vortrag und Diskussion stellen sie bei der mündlichen Ergebnisdiskussion unter Beweis. Sie sollen den größeren Zusammenhang erkennen, in den ihre bearbeitete Fragestellung eingebttet ist.. Die Note setzt sich aus gleichen Anteilen zusammen aus Bewertung (1) der experimentellen Planung und Umsetzung, (2) Benotung des Ergebnisberichts und (3) der mündlichen Präsentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelorabschluß

Content:
Die Studierenden bearbeiten einzeln eine eng umrissene Fragestellung aus einem laufenden Forschungsprogramm des Lehrstuhls.

Intended Learning Outcomes:
Die Studierenden erwerben umfassende Kompetenzen im wissenschaftlichen Arbeiten .
Sie recherchieren die einschlägige Originalliteratur, adaptieren publizierte Methoden für die eigene Fragestellung, entwerfen einen zielorientierten Versuchplan und setzen ihn effizient um. Sie erweitern ihre methodischen Erfahrungen. Sie dokumentieren die Ergebnisse längerer

Versuchsreihen. Sie erkennen die Bedeutung, aber auch Grenzen ihrer Ergebnisse und üben sich in der Frustationstoleranz bei experimentellen Fehlschlägen. Sie vertiefen bisherige Kenntnisse der statistischen Auswertung. Das Forschungspraktikum soll ein Beitrag zu einer Publikation werden.

Teaching and Learning Methods:
Lehrmethode: Anleitungsgespräche, Diskussion, Lernmethode: Arbeiten mit Originalliteratur, Adaptation von Methoden für eigene Fragestellung, Entwerfen von zielorientierten Versuchplänen und ihre effiziente Umsetzung, adäquate methodische Erfahrungen, Protokollieren von Versuchen, die sich über längeren Zeitraum erstrecken, selbstkritische Bewertung der Ergebnisse und Frustationstoleranz bei experimentellen Fehlschlägen, Arbeiten mit Statistikprogrammen, Abfassen eines wissenschftlichen Textes im Sinne einer Publikation

Media:
Powerpoint Präsentation, Skriptum, Tafelarbeit

Reading List:
Arbeiten mit der zur Einführung genannten und in der selbständigen Recherche gefundenen Literatur.

Responsible for Module:
Reinhard Schopf (schopf@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2390: Methods in Fish Biology and Aquatic Ecology | Forschungspraktikum Methoden der Aquatischen Ökologie und Fischbiologie - molekular

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 80	**Contact Hours:** 220

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (min.): 30.
The overall mark for the internship is based on the practical achievements, the written summary in the form of a report and a scientific presentation of the results in a lecture with subsequent discussion.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Thematic interest; the introductory practical course "Methods of Aquatic Systems Biology" is useful, but not mandatory. Depending on the specialisation, basic knowledge of molecular biology is required

Content:
Methods and mode of operation in the fields of aquatic ecology and fish biology with a focus on molecular biological topics (e.g. molecular genetics, isotope chemistry).
During the six-week practical activity and the approx. 2-week preparation/postprocessing, important working methods and methods of research in molecular aquatic ecology and fish biology are taught and deepened. In addition to experimental design, representativeness of sampling and detection of measurement errors, the main focus is on comprehensive and critical data interpretation, preparation of a scientific research report and presentation and discussion of the results in the style of a scientific conference paper.

Intended Learning Outcomes:
Understanding of the use of molecular biological methods (e.g. genetic methods, isotope analyses) in aquatic systems biology including experimental design, data mining and analyses, interpretation and presentation

Teaching and Learning Methods:
Practical activity, practice, individual support and feedback. Case studies: involvement in current research projects (partly in cooperation with partner institutions); at the beginning of the internship short presentation on the project presentation; at the end of the internship report writing and final presentation

Media:
Practical exercises / field and laboratory work, laboratory book

Reading List:
Mühlhardt: The Experimentator Molecular Biology/Genomics; Barker: Laboratory manual for beginners; further subject-specific literature will be provided according to the thematic focus; scientific literature research is part of the internship

Responsible for Module:
Jürgen Geist geist@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Methods in Aquatic Ecology and Fish Biology I + II - molekular (Praktikum, 10 SWS)
Geist J, Beggel S, Stoeckle B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2397: Research Project: Methods of Aquatic Ecotoxicology for Advanced Students | Forschungspraktikum Methoden der aquatischen Ökotoxikologie für Fortgeschrittene

Version of module description: Gültig ab summerterm 2011

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Methoden der aquatischen Ökotoxikologie für Fortgeschrittene
(Forschungspraktikum, 10 SWS)
Beggel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2406: Methods in Fish Biology and Aquatic Ecology - Organismic | Forschungspraktikum Methoden der Aquatischen Ökologie und Fischbiologie - organismisch

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 80	**Contact Hours:** 220

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (min.): 30.
The overall mark for the internship is based on the practical achievements, the written summary in the form of a report and a scientific presentation of the results in a lecture with subsequent discussion.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Thematic interest in ecological-organismic questions; it is useful, but not mandatory, to take the introductory practical course "Methods of Aquatic Systems Biology". Attending the lectures Aquatic Ecology and Conservation and/or Fish Biology and Aquaculture is advantageous, but not mandatory.

Content:
Methods and mode of operation in the fields of aquatic ecology and fish biology with a focus on organismic or ecological topics (e.g. microscopy techniques, electrofishing, bioindication, macrozoobenthos identification, sediment sampling and analyses etc.)

Intended Learning Outcomes:
Aquisition of practical experience and competence in experimental design and experimental handling in aquatic ecology / fish biology; experience in problem solving, statistical data mining and analyses, as well as in presentation of results; Aquisition of methodological competence in field biological and laboratory experiments (e.g. microscopy techniques, electrofishing, bioindication, macrozoobenthos identification, sediment sampling and analyses etc.)

Teaching and Learning Methods:
Practical activity, practice, individual support and feedback.
Case studies: involvement in current research projects; at the beginning of the internship a short lecture to introduce the project; at the end of the internship reporting and final presentation in the seminar Solution of scientific problems in fish biology & aquaculture required.

Media:
Practical exercises / field and laboratory work, laboratory book

Reading List:
Hauer & Lamberti: Methods in Stream Ecology, Jungwirth et al. Applied fish ecology in running waters, Further subject-specific literature will be provided during the internship; scientific literature research is part of the internship

Responsible for Module:
Jürgen Geist geist@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Methods in Aquatic Ecology and Fish Biology I + II - organismisch (Praktikum, 10 SWS)
Geist J, Beggel S, Pander J, Stoeckle B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2574: Research Project Terrestrial Ecology | Forschungspraktikum Terrestrische Ökologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige und aktive Teilnahme an dem Forschungspraktikum wird erwartet. Der Bericht über die Arbeit dient der Notenfindung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Das Praktikum vermittelt die Arbeitsweise der Terrestrischen Ökologie. Die Studierenden lernen eine Forschungsarbeit im Gebiet durchzuführen, von der Gestaltung der Forschungsfrage über die Wahl der geeigneten Methodik, der Durchführung und Analyse der Arbeiten bis hin zum Schreiben eines Berichts. Der Bericht entspricht dem Format einer wissenschaftlichen Veröffentlichung. Das Praktikum ist in eines der aktuellen Forschungsprojekte am Lehrstuhl eingebettet.

Intended Learning Outcomes:
Nach der Teilnahme an dem Praktikum haben die Studierenden die Vorbereitung, Planung und Durchführung einer wissenschaftlichen Arbeit in der Terrestrischen Ökologie gelernt. In Abhängigkeit der konkreten Fragestellung sind die Studierenden nach der Lehrveranstaltung in der Lage, die entsprechenden Methoden selbständig anzuwenden.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Anleitungsgespräche, Demonstrationen, Experimente, Ergebnisbesprechungen.

Lernaktivitäten: Üben von labortechnischen Fertigkeiten und ökologischen Arbeitstechniken; Anfertigung von Protokollen.

Media:

Reading List:
wird in der Veranstaltung vorgestellt und selbst erarbeitet.

Responsible for Module:
Wolfgang Weisser (wolfgang.weisser@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Terrestrische Ökologie (MSc. Biologie) (Forschungspraktikum, 16 SWS)
Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2633: Focus Ecology | Fokus Ökologie

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam comprises a written test (60 min) in which the students proof that they are skilled to use the software package R. They are able to solve statistical problems and can evaluate ecological data sets using R.
In a short presentation the participants introduce one of the invited scientists to the seminar group and show their ability to summarize the scientific career of the guests in a condensed way. The unit is successfully absolved when the written exam is passed and the biographical presentation of one of the guests had been given.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module WZ2370 Statistical Analysis of Biological Data Using R.

Content:
The module consists of a seminar addressing recent findings of various ecological disciplines and a practical course in statistics. Both units are elementary for students aiming on a specialization in ecology. Scientists and students are meeting in the seminar to discuss the presentations of invited guest speakers. The talks are motivating the participants to shape their own career and are providing insight to various projects and institutions in ecology. Sound knowledge in statistics is an essential prerequisite for planning and evaluating ecological experiments. The software package R is freely available and offers the whole range of statistical analysis on an advanced level.

Intended Learning Outcomes:
Having successfully completed the module the students have got an overview on new developments and recent challenges in the field of ecology. They are able to take part at scientific discussions and can estimate the quality of presentations regarding its contents and style. They are trained to summarize the steps of a scientific career and know the criteria to assess the effort of scientists.
They can plan experiments and evaluate the data using the software package R. They understand the statistical tools described in publications and are able to estimate the significance of ecological findings.

Teaching and Learning Methods:
Presentations of invited scientists are inspiring the participants and sharpening their critical attitude. Group discussions in preparing and in analyzing the talks help the participants to define and to defend their own position. The statistical methods used in the R course can be applied to the results presented in the talks of the seminar. The range and peculiarity of ecological experiments are reflected in numerous practical exercises in its statistical evaluation.

Media:
Diverse types and styles of presentation due to the interdisciplinary international guest speakers in the seminar, media from presentations by MS Power Point to chalk on the board are involved. Installation and application of the freeware package R for training the evaluation of exemplified data sets from ecological experiments.

Reading List:
Michael Crawley: The R Book. 2nd ed., Wiley 2012.
Garr Reynolds: Presentation Zen. 2nd ed., New Riders 2011.
N. Schulenburg: Exzellent präsentieren. Springer 2018.

Responsible for Module:
Häberle, Karl-Heinz; Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
"Hot topics" in der Ökologie (Seminar, 2 SWS)
Häberle K

Seminar Angewandte Ökologie und Planung (Seminar, 2 SWS)
Kollmann J, Häberle K, Annighöfer P, Egerer M, Geist J, Grams T, Schäfer H, Kögel-Knabner I, Leonhardt S, Menzel A, Pauleit S, Pretzsch H, Rammig A, Rötzer T, Seidl R, Tellier A

R für Fortgeschrittene (Übung, 4 SWS)
Meyer S, Weißer W

R für Fortgeschrittene (Focus Ökologie) (Übung, 4 SWS)
Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2684: Reseach Project Molecular Ecology and Evolutionary Biology of Plants for Advanced Level | Forschungspraktikum Molekulare Ökologie und Evolutionsbiologie der Pflanzen für Fortgeschrittene

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 150	**Self-study Hours:** 300	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular presence in the lab is required to gain routine with new lab techniques. Towards the end of the practical, the students perpare a written report showing that they are able to structure their newly assembled data, to present results in a convincing way and use appropriate methods to analyse them. The grade for the module is composed of a grade for the practical lab work (40%), the written report (40%) and the final oral presentation of 20-30 min (20%) - if necessary, the calculated grade will be rounded to the better value.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
basic knowledge in Genetics/Botany/Evolutionary Biology

Content:
Participation in ongoing research projects (e.g., evolution of morphological characters and biogeography of the gourd family, phylogenetic analyses of invasive potential in island floras) or work on their own projects with ecological questions that can be addressed using molecular/ phylogenetic methods. During the practical work in the lab and at the computer, students will learn cutting-edge techniques and methods in Molecular Ecology, including ancestral trait reconstruction, phylogenetic comparative methods, and analyses of community assembly, invasion biology, and consequences of climate change using molecular approaches.

Intended Learning Outcomes:
After having concluded this module, the students will have advanced prcatical and theoretical knowledge of modern Molecular Ecology and Phylogenetics approaches. They will be able to

design and independently run a small project, including research of scientific literature. They have learned how to work in a scientific way including critical data analyses and presentation of results at scientific meetings.

Teaching and Learning Methods:
mainly practical work in the Molecular Ecology lab, first with some supervision, then independently following the newly learned approaches; discussion of results and problems; constructive criticism of own work; time management and working with self-set deadlines.

Media:
practical lab work, discussions, powerpoint, literature research

Reading List:
Beebee, T. & Rowe, G. 2008. An Introduction to Molecular Ecology, 2nd ed.-- Hall, B.G. 2011. "Phylogenetic Trees Made Easy: A How-to Manual", 4. Aufl. -- papers in scientific journals (e.g.: Ecology Letters, Molecular Ecology, New Phytologist)

Responsible for Module:
Hanno Schäfer hanno.schaefer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum
Molekulare Ökologie und Evolutionsbiologie der Pflanzen für Fortgeschrittene
10 SWS

Hanno Schäfer
Professur fuer Biodiversität der Pflanzen
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For further information in this module, please click campus.tum.de or here.

Module Description

WZ4189: Fisheries and Aquatic Conservation | Fisheries and Aquatic Conservation

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Current information regarding the limited activities with physical presence due to the CoViD19-pandemic:
In case the framework requirements (hygienie, distance rules etc.) for examinations with physical presence are not met, the planned examination format can be changed to a digital (remote) examination according to §13a APSO. The decision on this change will be communicated as soon as possible, however latest 14 days before the actual examination date, by the responsible examiner in coordination with the examinations board.

The examination consists of a 60 min. written exam (Klausur). In addition, the students need to prepare a 10-15 min. presentation in the practical exercise. Gradings from the examination and the presentation are weighed in the ratio 2:1.
The examination means to measure the student's ability to assess anthropogenic influence on aquatic ecosystem functioning, evaluate the socioeconomic importance of fisheries and aquaculture , explain factors affecting susceptibility to and recovery from overexpoitation and recall fisheries management tools for wild populations as well as of the underlying biological principles such as fish population dynamics. In the written examination students demonstrate by answering questions under time pressure and without helping material their theoretical and practical (e.g. application of methods) knowledge about fisheries management. For answering the questions, the students require their own wording.
In the practical excercise the students prepare a presentation in form of a broschure, poster, video or podcast. For the presentation, the student is expected to demonstrate that he or she is capable of preparing a certain topic within a given time frame in such a way as to present or report it in a clear and comprehensible manner to specific target audiences in the context of fisheries and aquatic conservation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in aquatic biology, social sciences, conservation biology and management; this course can be selected
independently from other courses in the fields of Fish Biology and Limnology at TUM

Content:
The module combines the theoretical background and the practical implementation of fisheries management and aquatic conservation. The key aspects are:
1. Introduction to fish, shellfish and fisheries management,
2. The socioeconomic importance of fisheries and aquaculture,
3. The functioning of aquatic ecosystems and the impacts of fisheries on aquatic ecosystem health,
4.Factors affecting susceptibility to and recovery from overexploitation,
5. Fisheries Management Tools for wild populations,
6. Aquaculture,
7. Aquatic Biodiversity Conservation,
8. Case study and knowledge transfer/communication excercise

Intended Learning Outcomes:
At the end of the module students understand the importance of aquatic resources for mankind and the variables which influence ecosystem functions as well as the principles of aquatic biodiversity conservation. They are able to analyze the effects of natural and man-made disturbances in aquatic ecosystems (e.g. overexploitation) based upon an interdisciplinary understanding of methodological aquatic
and fisheries biology, human dimensions, socioeconomic factors and management skills. In addition, students are able to objectively integrate knowledge from different disciplines (e.g. fish biology, conservation biology, commercial fishing techniques, aquatic habitat assessment and management) to evaluate sustainable resource management.

Teaching and Learning Methods:
The module combines a lecture "Fisheries Management" with an accompanying practical excercise " Applied Aquatic Conservation". The lecture contents will be presented using lectures based on power-point presentation, group work and interactive role plays in order to combine activating teaching methods with classic presentation techniques. In the accompanying practical excercise to the lecture the students will apply the gained theoretical knowledge by conducting case studies or participating research experiments with various content in the field of freshwater ecology and aquatic conservation. The content of the practical work is incorporated into running research projects at the chair (e.g. habitat restoration, artificial breeding programmes, habitat assessment, conservation genetics). Additionally, the students learn to independently screen the respective literature in this field and learn methods in science communication.

Media:
Form of presentation: lecture, case study, movie segment and practical excercise
material: lecture notes, flip-chart/board, plus different materials for methodological/technical training

Reading List:
1. King (2007) Fisheries Biology, Assessment and Management
2. Helfman (2007) Fish Conservation: A guide to understanding and restoring global aquatic biodiversity and fishery
resources
3. Moyle & Cech (2004) Fishes An introduction to Ichtyology
4. Primack (2008) A primer of conservation biology

Responsible for Module:
Geist, Jürgen; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Fisheries Management (Vorlesung, 2 SWS)
Geist J

Applied Aquatic Conservation (Übung, 2 SWS)
Geist J [L], Bayerl H, Geist J, Pander J, Stoeckle B, Zingraff-Hamed A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6303: Research Internship Restoration Ecology | Forschungspraktikum Renaturierungsökologie

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (min.): 20 minutes (oral exam) and evaluation of the internship report.
The grade of the module results from a lecture and a written paper after completion of the research work. The module comprises 10 cp.

Repeat Examination:

(Recommended) Prerequisites:
Advanced knowledge of renaturation ecology; basic knowledge of test design and statistics.

Content:
The module is an elective module of the Master's programme in Biology or Master's programme in Nature Conservation and Landscape Ecology and Master's programme in Environmental Planning and Engineering Ecology. The following topics are covered: After an introduction to the theoretical basics of the scientific work, an independent sub-project within a current research project of the Chair of Renaturation Ecology is chosen. The project is supported by guidance in experimental design, statistical analysis, literature search, written elaboration and oral presentation.

Intended Learning Outcomes:
After participation in the module courses, the student is able to independently plan, carry out and communicate smaller research projects within renaturation ecology.

Teaching and Learning Methods:
Discussion and practical guidance in close contact with a research assistant of the chair.

Media:
Discussion and practical guidance

Reading List:
Ford, E.D. (2000) Scientific Method for Ecological Research. Cambridge University Press, Cambridge, 564 S.
Gibson, D.J. (2002) Methods in Comparative Plant Population Ecology. Oxford University Press, Oxford, 344 S..
Further literature:
Special scientific literature according to the technical orientation of the project.

Responsible for Module:
Johannes Kollmann jkollmann@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Renaturierungsökologie (Forschungspraktikum, 2 SWS)
Kollmann J [L], Albrecht H, Kollmann J, Le Stradic S, Teixeira Pinto L, Wagner T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6329: Research Course in Ecoclimatology | Forschungspraktikum Ökoklimatologie

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** irregularly
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 30	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination is carried out in the form of a written paper (approx. 10-15 pages). The students show that they can evaluate scientific data and present the results in writing. They show that they can apply the research and evaluation of scientific literature to their own work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of physics and mathematics

Content:
The module includes the following contents:
- Independent and autonomous work on a selected small research topic
- the research in the university area at the department of ecoclimatology
- the scientific working techniques, including measurements, observations, statistical analysis
- written elaboration and graphically appealing presentation of own results.

Intended Learning Outcomes:
After successful completion of the module, students are able to evaluate scientific data and present the results in writing and orally. They can apply the research and evaluation of scientific literature to their own work.

Teaching and Learning Methods:
The module is held in the form of a research internship. During the internship, students work independently and on their own responsibility on a selected small research topic. In this way the students learn about research in the university area at the Department of Ecoclimatology as well as

the scientific working techniques including measurements, observations, statistical evaluations and apply these to their own topics.

Media:

Reading List:
Additional reading of various textbooks for meteorology, climatology, forest meteorology; will be announced at the beginning of each course

Responsible for Module:
Menzel, Annette; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Ökoklimatologie (Forschungspraktikum, 8 SWS)
Menzel A [L], Lüpke M, Menzel A
For further information in this module, please click campus.tum.de or here.

Module Description

BV470020T2: Fundamentals of Geographic Information Systems | Grundlagen Geoinformationssysteme

Version of module description: Gültig ab summerterm 2020

Module Level: Bachelor/Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The expected learning outcome is verified by two written partial exams. Successful completion of the exercises is expected.

Note in view of the limitations on university operations as a result of the CoViD19 pandemic: If the basic conditions (hygiene, physical distance rules, etc.) for a classroom-based examination cannot be met, the planned form of examination can be changed to a written or oral online examination in accordance with §13a APSO. The decision about this change will be announced as soon as possible, but at least 14 days before the date of the examination by the examiner after consultation with the board of examiners of the respective study program.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Computer Science

Content:
The module covers the following basic concepts and applications of Geoinformatics:
- Fundamentals of Geoinformatics
- Geodetic reference systems and GIS
- Geospatial data
- Data modeling and GIS-data-models
- Geospatial database systems
- GIS analyses
- Web-GIS
- Digital Height Models

- 3D GIS
- 3D City and Landscape Models in GIS
- Dimension time in GIS
- Exercises covering the topics mentioned above using a GIS software package.

Intended Learning Outcomes:
At the end of the module students are able to
- remember and to understand basic terms and definitions in the Geoinformatics domain,
- recognize the benefits of GIS for different application domains,
- understand concepts and paradigms for modeling and analyzing geospatial data in GIS and to apply those concepts for solving spatial problems,
- implement the basic concepts of geospatial data modeling and analysis using specific GIS software.

Teaching and Learning Methods:
The module consists of lectures and exercises.
The lecturers give oral presentations during the lectures in order to provide the necessary know-how. Students prepare and present summaries of lectures as part of several means of active collegiate collaboration. The theoretical concepts provided by the lectures are deepened in the exercises by solving practical problems with GIS software packages and geospatial data. As part of several means of active collegiate collaboration, students prepare for a specific exercise topic and then act as tutor for the specific topic.

Media:
- presentations
- blackboard
- e-learning platform Moodle
- GIS software

Reading List:
to be announced during the lectures

Responsible for Module:
Andreas Donaubauer (donaubauer@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zu Geoinformationssysteme 1 (Übung, 1 SWS)
Donaubauer A

Übungen zu Geoinformationssysteme 2 (Übung, 1 SWS)
Donaubauer A

Geoinformationssysteme 1 (Vorlesung, 1 SWS)
Donaubauer A

Geoinformationssysteme 2 (Vorlesung, 1 SWS)
Donaubauer A [L], Donaubauer A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6318: Geological Fundamentals of Bavarian Landscapes | Geologische Grundlagen der Naturräume Bayerns

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer schriftlichen Klausur (60 min). Anhand der Klausur zeigen die Studierenden, dass sie wichtige endogene und exogene geologische Prozesse verstehen, die wichtigsten gesteinsbildenden Minerale und die wichtigsten Gesteine mit ihren jeweiligen Eigenschaften kennen, die Erdgeschichte mit ihren wichtigsten stratigraphischen Einheiten verstehen, die wichtigsten geologischen Einheiten Bayerns kennen und ihre spezifische Genese und ihre charakteristischen Eigenschaften als Grundlage regionaler Landnutzungs- und Wirtschaftsstrukturen verstehen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine; Grundlagen in anorganischer Chemie sind hilfreich

Content:
Geologische Grundlagen:
- Endogene Dynamik: Aufbau der Erde, Plattentektonik, Plutonismus, Subvulkanismus, Vulkanismus; - Exogene Dynamik: Verwitterung, Transport, Sedimentation; Mineralogie und Gesteinskunde: Gesteinsbildende Minerale und ihre Eigenschaften, wichtige Gesteine; Stratigraphie; Erdgeschichte.

Geologische Einheiten Bayerns (Bildung, typische Merkmale, regionale Verteilung): Grundgebirge, Mesozoische Schichtstufenlandschaft; Tertiäre Molasse, Süddeutsche Pleistozänlandschaft, Bayerische Alpen, Holozäne Sedimente

Intended Learning Outcomes:
Nach erfolgreichem Abschluss des Moduls verstehen die Studierenden wichtige endogene und exogene geologische Prozesse, können wichtige Relief- und Landschaftsformen als Produkte dieser Prozesse interpretieren und erkennen diese Landschaftsformen im Gelände. Sie kennen die wichtigsten gesteinsbildenden Minerale und die wichtigsten Gesteine mit ihren jeweiligen Eigenschaften und sind in der Lage, die landschaftsbildenden Gesteinstypen im Gelände wiederzufinden. Die Studierenden verstehen die Erdgeschichte mit ihren wichtigsten stratigraphischen Einheiten. Sie kennen die wichtigsten geologischen Einheiten Bayerns, können sie im Gelände identifizieren, verstehen ihre spezifische Genese und ihre charakteristischen Eigenschaften als Grundlage regionaler Landnutzungs- und Wirtschaftsstrukturen.

Teaching and Learning Methods:
Das Modul besteht aus Vorlesungen und Übungen. In der Vorlesung werden unter Einsatz von Powerpoint und Tafelskizzen die wichtige endogene und exogene geologische Prozesse, die wichtigsten gesteinsbildenden Minerale, die wichtigsten Gesteine mit ihren jeweiligen Eigenschaften, die Erdgeschichte mit ihren wichtigsten stratigraphischen Einheiten, die wichtigsten geologischen Einheiten Bayerns und ihre spezifische Genese und ihre charakteristischen Eigenschaften als Grundlage regionaler Landnutzungs- und Wirtschaftsstrukturen vermittelt.

In den Übungen werden einfache Versuche zur Erkennung von Gesteinen und Mineralen durchgeführt. Zudem üben die Studierenden im Rahmen einer mehrtägigen Geländeübung durch selbstständige Ansprache und Präsentation die geologischen Großeinheiten mit typischen Landnutzungsmustern und Wirtschaftsstrukturen, Geotopen und charakteristischen Gesteinen.

Media:
Powerpoint-Präsentationen, Tafelskizzen, Handstücke von Mineralen und Gesteinen, Geologische Karten, einfache chemische und physikalische Testutensilien (HCl, Ritzgegenstände); verschiedene Skripte, mehrtägige Geländeübung (erfasst alle geologischen Großeinheiten Bayerns)

Reading List:
Bahlburg, H. & Breitkreuz, C. (1998): Grundlagen der Geologie. Ferdinand Enke Verlag Stuttgart; Grotzinger, J.; Jordan, T.H.; Press, F.; Siever, R. (2003): Allgemeine Geologie. 5. Auflage 2008, Spektrum Verlag; Maresch, W. & Medenbach, O. (1982): Steinbachs Naturführer Mineralien. Mosaik Verlag. Bayerisches Geologisches Landesamt (1996/98): Geologische Karte 1:500.000 mit Erläuterungen.
Bayerisches Geologisches Landesamt (2003): Sonderband GeoBavaria - 600 Millionen Jahre Bayern
München
Medenbach, O. & Sussiek-Fornefeld, C. (1987): Steinbachs Naturführer Gesteine. Mosaik Verlag, München; Grotzinger, J. Jordan, T.H., Press, F.& Siever, R. (2003): Allgemeine Geologie. 5. Auflage 2008, Spektrum Verlag.

Responsible for Module:
Prof. Dr. Jörg Prietzel (prietzel@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Geologie und Gesteinskunde, Teil 2 (Vorlesung, 1 SWS)
Prietzel J

Geologie als wichtiger Faktor der Naturräume Bayerns: Großlandschaften und Geotope (Übung, 2,8 SWS)
Prietzel J

Einführung in die Geologie und Gesteinskunde, Teil 1 (Vorlesung, 1 SWS)
Prietzel J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1171: Climate change related challenges in sewage treatment biology and engineering ecolgy | Klimabedingte Herausforderungen für Abwasserbiologie und Ingenieurökologie

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung erfolgt in Form einer 60-minütigen schriftlichen Prüfung. Anhand der Prüfung zeigen die Studierenden, dass sie zentrale Faktoren und Prozesse des Gewässerschutzes verstehen, die Ingenieurökologie im Hinblick auf biologische Abwasserreinigung und deren Zusammenhänge mit der Gefährung aquatischer Biodiversität verstehen, biologische und naturnahe Abwasserreinigungssystemen bewerten können, wichtige Analysemethoden in der Abwasserreinigung verstehen sowie den Einfluss des Klimawandels und Anpassungsmaßnahmen verstehen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Thematisches Interesse; Grundkenntnisse der biologischen Abwasserreinigung wären hilfreich, das Belegen anderer Lehrveranstaltungen aus dem Bereich der Aquatischen Ökologie wird empfohlen

Content:
Das Modul umfasst folgende Inhalte:
- Grundlagen des Gewässerschutzes (Gesetzgebung, Wasserrahmenrichtlinie, Geschichte und Entwicklung der biologischen Abwasserreinigung, Hygiene),
- Grundlagen Klimawandel (Klimapolitik in Bayern, EU, global, Klimaanpassungsforschung, Mitigation und Adaptation),
- Biologie der Abwasserreinigung (Mikroskopisches Bild, Nährstoffkreisläufe),

- Ingenieurökologie (Verfahren der technischen Abwasserreinigung, Abhilfemaßnahmen bei Betriebsstörungen anhand biologischer Indikatoren, Verfahren der naturnahen Abwasserreinigung, innovative Verfahren, wie Hygienisierung, Bioakkumulation, Biofiltration, Membranbelebung),
- Strategien und Methoden zum Schutz aquatischer Ökosysteme in Kläranlagen (Nährstoffe, Arzneimittelreste);
- Analytik und Untersuchungsmethoden bei der biologischen Abwasserreinigung

Intended Learning Outcomes:
Nach erfolgreichem Abschluss dieses Moduls sind die Studierenden in der Lage,
- zentrale Faktoren und Prozesse des Gewässerschutzes zu verstehen;
- Ingenieurökologie im Hinblick auf biologische Abwasserreinigung und deren Zusammenhänge mit der Gefährung aquatischer Biodiversität zu verstehen;
- biologische und naturnahe Abwasserreinigungssystemen zu bewerten;
- nachhaltige Schutzkonzepte für Gewässer zu entwickeln und zu bewerten;
- wichtige Analysemethoden in der Abwasserreinigung zu verstehen;
- den Einfluss des Klimawandels und Anpassungsmaßnahmen zu verstehen.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung, einem Seminar und zwei Tagesexkursionen.
In der Vorlesung werden die zentralen Faktoren und Prozesse des Gewässerschutzes, die Ingenieurökologie im Hinblick auf biologische Abwasserreinigung und deren Zusammenhänge mit der Gefährung aquatischer Biodiversität sowie der Einfluss des Klimawandels und Anpassungsmaßnahmen in Form von Vorträgen mit Powerpoint vorgestellt.
Im Seminar werden mit den Studierenden aktuelle Themen zu Klimaschutz, Ingenieurökologie und Abwasserbiologie besprochen und diskutiert. In den Exkursionen bekommen die Studierenden vor Ort einen Einblick in technisch-biologische Großkläranlagen mit Labor (Mikroskopisches Bild), in naturnahe Abwasserreinigungsanlagen sowie in die Kanalisation München.

Media:
Power-Point Präsentation, Tafel, Fallbeispiele, Exkursion / Demonstrationen

Reading List:
Mudrack & Kunst: Biologie der Abwasserreinigung; Hacker & Johannsen: Ingenieurbiologie; Schönborn: Fließgewässerbiologie; Shilton eds.: Pond Treatment Technology; Janke: Umweltbiotechnik; Wissing: Abwasserreinigung in Pflanzenbeeten; BayLfU eds., Informationsbericht 1/99: Das Mikroskopische Bild bei der aeroben Abwasserreinigung, Schönwiese: Klimatologie; Handouts

Responsible for Module:
Geist, Jürgen; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Methoden der technischen und naturnahen Abwasserreinigung (Exkursion, 1 SWS)
Gschlößl T

Aktuelle Themen zu Klimaschutz, Ingenieurökologie und Abwasserbiologie (Seminar, 1 SWS)
Gschlößl T

Ingenieurökologie und Klimawandel in aquatischen Systemen (Vorlesung, 2 SWS)
Gschlößl T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4225: Concepts and Research Methods in Ecology | Konzepte und Forschungsmethoden der Ökologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module takes place in the form of a written examination (180 minutes). This includes multiple-choice questions, open questions, case studies and scenarios. In the written exam, students demonstrate that they have understood the terms, concepts and mechanisms presented, the basic principles of biogeochemical cycles, and the role of human land use and climate change for species. Furthermore, the application of the model introduced in the course to a concrete applied problem of species conservation will be assessed and questions on the application of the model to the analysis of land use scenarios will be answered. Finally, open-ended questions and different scenarios will demonstrate that students can analyse and evaluate the influence of climate change and land use change on the future composition of species communities.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic course in the area of ecology (animal ecology, plant ecology/vegetation science, eco-climatology) as well as basics of evolution.

Content:
Part A is dedicated to the fundamentals of ecology and evolution in a changing world and includes sessions about population, community and functional ecology, evolution, and the roles of plant ecophysiology, microbiology, and global changes in the biogeochemical cycles. It includes a small group project based on a game and aiming at thinking forest management in a global changes context. Part B is dedicated to understanding the ecological impacts of human activities on biodiversity and is largely based on modeling approaches. It includes a small group project based

on simulations and aiming at thinking landscape planning to support biodiversity in Germany in the face of climate change.

Intended Learning Outcomes:
After successful completion of the module, students will be able to define important terms in population ecology, community ecology and global ecology and discuss the role of ecology in solving applied problems. Students are able to describe basic ecological and evolutionary terms, concepts and mechanisms, e.g. dispersal, speciation, evolution of traits, microbiome, population dynamics, niche theory, natural selection as well as competition, predation and mutualism in their own words. Furthermore, they understand the basic principles of biogeochemical cycles influenced by human land use and climate change, and they can discuss the causes and consequences of the current biodiversity crisis.
Students are further able to use a simple ecological modelling software (e.g. range shifter) and are able to implement different mechanisms such as resource availability, dispersal and species interactions in this model and analyse the consequences for the species composition of an ecological community. They understand the structure of publicly available data sets on human land use, climate change and species occurrence, and are able to use the model to analyse the consequences of land use change for species occurrences, and tp evaluate the results in terms of species conservation in the landscape.

Teaching and Learning Methods:
The module is divided into two parts (A and B). It begins (during the introductory session) and concludes (during the final session, before the exam) self-assessment, which allows students and teachers to classify learning progress during the course. The results of the first self-assessment are used to guide course participants through the material covering the basics needed for the course. This allows course participants to fill potential gaps in basic knowledge.
The module is build to engage students through diversified active learning activities. Session are build following a recurrent structure: Inputs are done in the form of lectures followed by applied sessions including exercises, reading of scientific articles followed by discussions and/ or debates, games, and two small management-oriented projects. Important concepts are presented in the lectures, while the active learning activities are oriented toward deepening chosen topics and consolidating the understanding of the relationships linking the different important concepts presented in the lectures.

Media:
Moodle, Online recording of the lectures (and associated Powerpoint presentations), interactive material

Reading List:
The results of the self-assessment, organized by topics, allow targetting potential basic knowledge gaps necessary to the course and identify the strength of the students in the different topics. From there, adequate material is proposed to the students to fill in their basic knowledge gaps and harmonize the knowledge levels of students with different backgrounds.

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zu Konzepte und Forschungsmethoden der Ökologie (Übung, 4 SWS)
Mimet A [L], Grams T, Layritz L, Meyer B, Mimet A, Rosenkranz M, Schäfer H, Weißer W

Konzepte und Forschungsmethoden der Ökologie (Vorlesung, 2 SWS)
Mimet A [L], Mimet A, Weißer W, Grams T (Layritz L, Meyer B), Layritz L, Meyer B, Rosenkranz M, Schäfer H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2469: Limnology of Running Waters | Limnologie der Fließgewässer

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination is an oral examination (30 min). By means of the examination, students show that they can typify and evaluate the quality of unknown watercourses by means of measurement results of physical and chemical conditions as well as by the mapped flora and fauna. The students show that they are able to assess the ecological status of a watercourse based on the EU Water Framework Directive and develop development plans for running waters.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module 'General Limnology' is recommended.

Content:
The module includes the following contents:
1. physical-chemical conditions: Temperature, flow, boundary layer phenomena, substrate distribution, oxygen, hydrocarbon, nutrients.
2. biological conditions: Epiphytes, macrophytes, plankton, consumers, macroinvertebrates, fish.
3. colonization of the three riverine habitats: pelagial, benthal, hyporheic interstitial.
4. adaptation strategies and developmental biology of running water organisms, river typology, saprobity and trophy in running waters, River Continuum Concept.
5. practical exercises, hydrophysical measurements, hydrochemical analyses, mapping of flora and fauna, application of biological indices, river structure quality mapping.

Intended Learning Outcomes:
After successful participation in the module course, the students are able to typify and evaluate the quality of unknown watercourses by means of independent measurements of physical and chemical conditions as well as by mapping the flora and fauna. The students are able to assess

the ecological status of a water body according to the EU Water Framework Directive and to develop development plans for running waters.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. In the lecture the necessary basics from different areas of stream limnology are taught. In the exercise the theoretical basics for the evaluation of rivers and streams are deepened in cooperation with other students by applying different physical and chemical methods and biological indices.

Media:
PowerPoint, flipchart, blackboard work, digital microphotography

Reading List:
Introduction to Limnology, Schwoerbel; Running water biology

Responsible for Module:
Uta Raeder (uta.raeder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Limnologie der Fliessgewässer (Vorlesung, 1 SWS)
Raeder U

Limnologie der Flüsse und Bäche (Übung) I (Übung, 3 SWS)
Raeder U, Hoffmann M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2565: Limnic Microbiology | Limnische Mikrobiologie

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time: 30 min.
The examination will be the form of a report, which has the structure of a publication (introduction, material and methods, results, discussion). The grade is based on a 20% evaluation of a presentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of microbiology and limnology

Content:
Microorganisms (bacteria, viruses and protozoa) in lakes with varying degrees of trophicity are studied. The focus is on cyanobacteria and their interactions with cyanophages (viruses that infect cyanobacteria) and protozoa. The students will get an insight into the basics of aquatic food-webs. Methods used are FISH (fluorescence in situ hybridization) and a number of other epifluorescence methods, as well as culture experiments. In the accompanying seminar, the methodological basics of the experiments carried out during the practical training as well as alternative methods for the analysis of aquatic ecosystems will be covered. The results of the experiments will be analyzed by the students at the end and summarized in a practical training report.

Intended Learning Outcomes:
After participating in the module, students will have a deeper insight into the microbial food-webs of aquatic ecosystems. With the methods learned, they can independently assess the interactions of microorganisms in aquatic ecosystems. They are able to plan microbiological experiments independently and to apply FISH and other epifluorescence methods to environmental samples and to analyze and evaluate the corresponding experimental results.

Teaching and Learning Methods:
Performing experiments, individually and in groups, practicing laboratory skills, lectures, presentations, independent study of literature

Media:
Presentations, script, case descriptions, ISI web of knowledge literature research

Reading List:
general textbooks on microbiology and limnology, current publications

Responsible for Module:
Katrin Zwirglmaier (katrin.zwirglmaier@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2671: Living Landscapes - Extended Ecological Excursion | Lebendige Landschaften - mehrtägige ökologische Exkursion

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 95	**Contact Hours:** 55

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time (min.): 30 minutes for oral test and paper.
Exam oral (presentation 30 min. + discussion) and written (summary of the presentation (2-3 pages for excursion guide and excursion protocol of an excursion day), weighting written - oral 50:50

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Flower determination exercises, soil science, stand climatology

Content:
Excursion to destinations that change from year to year: Composition of a landscape of different vegetation units, identification of dominant plant species of common and characteristic vegetation types of the excursion goal, dependence of vegetation on climate and soil, strategies of nature conservation, land use forms of the excursion goal, vegetation composition as a result of competition and fascination, morphological adaptation of plants to site conditions (e.g. drought, salt)

Intended Learning Outcomes:
Enhancement of botanical knowledge of species, recognition of ecological interrelationships, recognition of growth-limiting factors, recognition of conflicts between forms of land use and nature conservation, combination of observation and background knowledge, handling of identification literature to identify plant and animal species.

Teaching and Learning Methods:
educational hikes, field surveys, field ecological measuring methods

Media:
Powerpoint presentation, demonstration of learning objects (plants, animals, soil, rocks) in the field

Reading List:
natural history travel guides for the respective excursion country and - goal, technical literature suitably the respective seminar topic, generally: Walter/Breckle "ecology of the earth", Schultz "manual of the Ökozones

Responsible for Module:
Häberle, Karl-Heinz; Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ4018: Laboratory Methods for Soil Characterization | Labormethoden zur Bodencharakterisierung

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 70	**Contact Hours:** 80

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Das Modul wird mit einem Prüfungsparcours abgeschlossen. Die Prüfungsgesamtdauer beträgt pro Prüfungskandidat 90 Minuten. Der Prüfungsparcours setzt sich aus einer schriftlichen Prüfung und einer anschließenden Präsentation zusammen. Im schriftlichen Teil der Prüfung zeigen die Studierenden, dass sie die theoretischen Grundlagen zur Charakterisierung von chemischen und physikalischen Eigenschaften von Böden kennen und Zusammenhänge zwischen chemischen und physikalischen Bodeneigenschaften erklären können. In der anschließenden Präsentation stellen die Studierenden die ausgewerteten Messerergebnisse ihrer Laboruntersuchungen vor und weisen damit nach, dass sie ihre Messwerte der Bodenprofile schlüssig auswerten, interpretieren und vorstellen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Bodenkunde werden vorausgesetzt (Beispielsweise erworben im Modul "Natürliche Ressourcen: Boden und Standort" im Bachelorstudiengang Forstwissenschaft und Ressourcenmanagement)

Content:
1. Methoden der Probenahme im Gelände; Probenvorbereitung für die Laboranalytik; Vorstellung der wichtigsten Labormethoden zur Charakterisierung chemischer und physikalischer Eigenschaften von Böden; Interpretation entsprechender Messdaten von Bodeneigenschaften im Hinblick auf Standortseigenschaften 2. Durchführung und Auswertung ausgewählter Laborversuche zur chemischen und physikalischen Charakterisierung von Böden

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an der Modulveranstaltung können die Studierenden verschiedene Labormethoden zur Charakterisierung der chemischen und physikalischen Eigenschaften von Böden anwenden. Sie sind in der Lage die entsprechenden Messwerte zu interpretieren und hieraus Aussagen zu Standortseigenschaften- und Ökologie abzuleiten. Darüber hinaus sind sie in der Lage ihre Messerergebnisse in geeigneter und schlüssiger Form auszuwerten und zu präsentieren.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung und einem Seminar. In der Vorlesung wird das nötige Wissen zur Charakterisierung von Böden von den Dozentinnen und Dozenten durch Vorträge und Präsentation vermittelt. Im Seminar werden von den Studierenden in Gruppenarbeit Bodenproben im Gelände entnommen und diese unter Anleitung im Labor untersucht. Die Ergebnisse der Untersuchung werden in der Modulprüfung präsentiert.

Media:
PowerPoint, Tafelarbeit, Folien, Messgeräte

Reading List:
Schlichting, Blume, Stahr, Bodenkundliches Praktikum. Blackwell Wissenschafts-Verlag (1995)

Responsible for Module:
Prof. Dr. Axel Göttlein – Professur für Waldernährung und Wasserhaushalt

Courses (Type of course, Weekly hours per semester), Instructor:
Chemische und physikalische Boden- und Standortscharakterisierung (Vorlesung, 2,3 SWS)
Göttlein A

Bodenkundliche Laborübungen (Übung, 3 SWS)
Prietzel J, Schweizer S, Göttlein A, Kolb E, Laniewski R, Leemhuis S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2229: Multi-day Botanical Excursion and Seminar on Evolution and Biogeography of Island Floras | Mehrtägige botanische Exkursion und Seminar zur Evolution und Biogeographie von Insel-Floren

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
To pass the course, students have to give a seminar talk and contribute a chapter (c. 10 printed pages) for the excursion guide. The two deliverables both contribute 50% to the final mark. In addition, a herbarium of flowering plants, ferns and/or mosses containing 50 different dried and identified species from the excursion's destination has to be delivered (unmarked).

Repeat Examination:

(Recommended) Prerequisites:
Basic botanical knowledge and some experience with identification keys (e.g. through successful participation in the Basic botany course part 1 & 2 or similar practicals).

Content:
About a quarter of the described plant species worldwide is found on islands. During a multi-day trip to an island/archipelago we will explore the diversity of such a hotspot and its evolutionary and biogeographical origins. The preparation seminar during the summer semester will allow the students to get accustomed to the species and ecosystems in the island and they will prepare short descriptions, species lists and identification keys, which will combine into a nature travel guide. The manuscript for the travel guide will be tested during the actual trip at the end of the summer semester and corrected/ammended if necessary. Back in Germany, the manuscript should be ready for publication. The students thus not only get to know the flora, fauna and vegetation of an island, they also learn how to present scientific contents to a lay readers. The list of the island destinations includes (but is not limited to) Azores, Cape Verdes, Balearic islands, Sardinia and Corsica.

Intended Learning Outcomes:
After taking part in the modul the students will have a profound knowledge about plant and animal diversity of the visited island region including evolutionary history of these lienages. They have a deeper knowledge of island biogeography and will be able to perform biogeographic analyses for various groups of organisms. They know how to identify plants and animals in the field and how to analyze animal-plant relationships in an ecological context (e.g., pollination, seed dispersal, herbivory relationships). Moreover, they gained the skill to present complex natural science topics in a simplified way for the general public.

Teaching and Learning Methods:
seminars, literature study, team work with other students, preparation of scripts, preparation and presentation of talks, travel guide writing

Media:
script, powerpoint, free speach

Reading List:
for each of the selected island destinations a literature list will be compiled every year

Responsible for Module:
Schäfer, Hanno; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Exkursion
Mehrtägige botanische Exkursion zur Evolution und Biogeographie von Insel-Floren Europas und angrenzender Gebiete
4 SWS

Seminar
Seminar zu Insel-Floren Europas und angrenzender Gebiete
2 SWS

Hanno Schäfer
FG Biodiversität der Pflanzen
hanno.schaefer@tum.de
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2617: Molecular Ecology, Molecular Systematics, and Biogeography of Plants | Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Seminarvortrag: 30%; schriftliche Pruefung 70%

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
In der Vorlesung werden die Grundlagen der Molekularen Ökologie, Molekularen Systematik und Biogeographie knapp wiederholt, um dann schwerpunktmässig auf neuere Entwicklungen einzugehen: DNA Extraktion und Sequenzierung von sehr altem Material ('ancient DNA' - Mumien, Neandertaler-Knochen, etc.) und komplexen Mischungen (Kot, Mageninhalt, Sedimenten, Bodenproben), Pyrosequenzierung, DNA-Barcoding, Molekulare Uhren, Rekonstruktion von biogeographischen Szenarien mit Hilfe phylogenetischer Datensätze, phylogenetische Analyse von Pflanzengesellschaften. Im Seminar sollen die Studierenden Ergebnisse ausgewählter, aktueller Studien aus dem Bereich Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen in einem Kurzvortrag in eigenen Worten darstellen. Im Anschluss daran erfolgt eine gemeinsame Diskussion, die u.a. der Themenfindung für zukünftige Forschungsprojekte (inkl. Master-und Doktorarbeiten) dienen soll.

Intended Learning Outcomes:
Verständnis der Entstehung von Pflanzenarten und Pflanzengesellschaften

Teaching and Learning Methods:
Vorlesung: Vor- und Nachbearbeitung; Seminar: Literaturrecherche, Zusammenfassung von Forschungsergebnissen aus der Literatur und Präsentation im Rahmen eines Referates mit anschliessender Diskussion.

Media:
Skriptum, PowerPoint (Folien können heruntergeladen werden), Filme

Reading List:
Coyne, J.A. & Orr, H.A. Speciation, Sinauer Associates; Beebee, T. & Rowe, G. 2008. An introduction to molecular ecology, Oxford University Press; Futuyma, D. 2007. Evolution: Das Original mit Übersetzungshilfen. Spektrum Akademischer Verlag.

Responsible for Module:
Hanno Schäfer (hanno.schaefer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen (Vorlesung, 2 SWS)
Schäfer H

Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen (Seminar, 2 SWS)
Schäfer H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6324: Molecular Ecology and Restoration Genetics | Molecular Ecology and Restoration Genetics

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 150	**Self-study Hours:** 80	**Contact Hours:** 70

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a presentation and a mid-term exam. The methods to investigate population characteristics and the implications for restoration activities are prerequisite for individual research projects. The ability to apply the correct methodology to given scientific questions will be tested in context of a presentation in the seminar. Major goal is also to test the ability to summarize own results or those of other studies in a presentation (20 minutes, Powerpoint) clearly and in a way easy to follow by other seminar attendants. The presentation will be followed by a discussion of the findings (20 min) which will also include subjects and methods of the lecture. Both parts will form the basis for the module grade. The lab experiment, which consists of application of the methods learned (and tested in the discussion following the presentation) will be evaluated on grounds of a written report as a voluntary exam. In case this mid-term-exam is passed, the grade for the modul will improve by 0,3, a downgrading is not possible. This report will also test for the desired learning of good scientific practice, since it depends on writing a lab book.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module introduces the conceptual framework of molecular ecology. It covers the different methods available to investigate relevant population characteristics. Examples are genetic structure, local adaptation and signature for selection. In particular, implications for restoration activities are discussed.

Intended Learning Outcomes:
At the end of the module students will be able to understand and interpret molecular studies in ecology with focus on restoration and invasion biology. In this context they will know how to set up, conduct and document experiments in a molecular lab. The candidates will have the ability to present complex content in this field to peers/colleagues.

Teaching and Learning Methods:
The module consists of a lecture course, a practical course and a seminar (with excursion). In the weekly lecture course presentation of various topics will be given that students need to recapitulate at home and do further literature research. The one week practical course consists of excersicing laboratory technical skills and working on an individual experiment in the molecular laboratory.
In the seminar these will be connected with recent research on biological invasions employing molecular ecologial analyses.students will prepare and give a presentation on recent research prepared by them and discuss the findings with peers.

Media:

Reading List:

Responsible for Module:
Christian Bräuchler (c.braeuchler@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ6417: Nature Conservation | Naturschutz

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Klausur (60 min) fragt ab, ob die Studierenden die grundlegenden Herausforderungen des Biodiversitätsschutzes und die Konzepte zum Schutz der Natur verstehen und komprimiert wiedergeben können (siehe Lerning outcomes). Weiterhin fragt die Klausur ob, ob die Studierenden Lösungen zu konkreten Naturschutzsproblemen auch unter zeitlichem Druck präzise aufzeigen können. Die Beantwortung der Fragen erfordert eigene Formulierungen. Hilfsmittel: Büromaterial, Taschenrechner.Die Klausur bestimmt die Gesamtnote des Moduls.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Ökologie und Landschaftsplanung

Content:
Das Modul gliedert sich in eine Vorlesung und ein Seminar.
In der Vorlesung, die die im Bachelorstudiengang auf verschiedene Lehrveranstaltungen verteilten naturschutzfachlichen Grundlagen zusammenfasst und vertieft, haben aktuelle und internationale Aspekte des Naturschutzes eine besondere Bedeutung.

Folgende Themen werden in der Vorlesung behandelt:
- Kulturwissenschaftliche Grundlagen und Geschichte,
- Naturwissenschaftliche Grundlagen,
- Aufgaben des Naturschutzes,
- Objekte, Methoden und Konzepte des Naturschutzes,
- Planungswissenschaftliche Grundlagen: Rechtliche Instrumente im nationalen und internationalem Rahmen,

- Umsetzung und Management: Nationale und internationale Konflikte und Synergien, Naturschutz und Gesellschaft, Naturschutz im Spiegel aktueller Entwicklungen (z.B. Invasive Arten, Klimawandel)

Zweiter Teil des Moduls ist ein Seminar, in dem die Studierenden aktuelle Themen aus dem Bereich des Naturschutzes erarbeiten und präsentieren. Dieser Teil kann auch zur konkreten Vorbereitung des Masterprojektes
genutzt werden.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen (Vorlesung und Seminar) sind die Studierenden in der Lage a) die Treiber des aktuellen Biodiversitätsverlustes zu verstehen, b) die verschiedenen Motivationen für einen Schutz der Natur zu verstehen, c) aktuelle Methoden der Naturschutzbiologie sowie Schutzstrategien auf konkrete Beispiele anzuwenden, d) den Forschungsbedarf und das nötige Wissen bei einem Naturschutzproblem zu analysieren, e) wissenschaftliche Texte zu aktuellen Naturschutzproblemen zu verstehen, f) verschiedene mögliche Lösungen zu einem Naturschutzproblem zu entwickeln und zu bewerten

Teaching and Learning Methods:
Die Inhalte der Vorlesung werden durch die Dozenten vorgetragen, um einen Überblick über die Ursachen und Strategien der Überwindung des Biodiversitätsverlustes zu bekommen. Im Seminar werden Informationen zu aktuelle Themen des Naturschutzes von den Studierenden aus der Literatur recherchiert. Die Literatur wird zur Verfügung gestellt. Die Ergebnisse der Literaturanalyse werden den Mitstudierenden präsentiert und gemeinsam mit dem Dozenten ausführlich diskutiert.

Media:
Vorlesung: Power-Point-Präsentation, Skript; Seminar: Texte

Reading List:
Wird zu Beginn der Veranstaltung zur Verfügung gestellt.

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Naturschutz (Vorlesung, 2 SWS)
Weißer W

Seminar Naturschutz (Seminar, 2 SWS)
Weißer W, Schäffer N, Mimet A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0409: Ecosystem Dynamics | Ökosystemdynamik

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung erfolgt als Projektarbeit im Umfang von 10-15 Seiten und einer Abschlusspräsentation (15 Minuten). Die Projektarbeit beinhaltet die im Rahmen der Übung erarbeitete Fragestellung, die erhobenen Daten, die angewendeten Simulationsmethoden, sowie die erzielten Ergebnisse. Die Studierenden demonstrieren damit die Beherrschung der im Modul erlernten Datenerhebungs- und Analysemethoden. Die Arbeit ist als Gruppenarbeit angelegt, wobei als Prüfungsleistung die individuellen Beiträge der Studierenden deutlich erkennbar sein müssen. Die Beurteilung ergibt sich zu 70% aus der schriftlichen Arbeit und zu 30% aus der mündlichen Präsentation. Anhand der Präsentation wird auch die Fähigkeit überprüft die erzielten Ergebnisse in knapper und anschaulicher Form darstellen zu können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine.

Content:
Das Modul setzt sich aus einem Vorlesungs- und einem Übungsteil zusammen. Im Vorlesungsteil werden theoretische Grundlagen der Ökosystemdynamik vermittelt, die im Übungsteil im Rahmen eines 4-tägigen Forschungsaufenthalts im Nationalpark Berchtesgaden (mit Übernachtung in der TUM Forschungsstation Friedrich N. Schwarz am Rossfeld) praktisch angewendet werden. Das Modul vermittelt:

• theoretische Grundlagen der Ökosystemdynamik (Landschaftsökologie, Störungsökologie)
• Grundkenntnisse der dynamischen Ökosystemmodellierung

• Empirische Datenerhebung im Gebirge
• Praktische Anwendung der Daten in Ökosystemmodellen in der Projektion von zukünftiger Ökosystemdynamik
• Analyse und Präsentation der Ergebnisse
• Angewandte Ökosystemdynamik anhand von Bespielen verschiedener Ökosysteme im Nationalpark Berchtesgaden

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage selbständig im Feld empirische Daten zur Ökosystemdynamik zu erheben, und zu verarbeiten. Darüber hinaus beherrschen sie einfache Anwendungen von Ökosystemmodellen und die Auswertung von Simulationsergebnissen in Hinblick auf die Veränderung von Ökosystemen. Das Modul vermittelt den Studierenden sowohl theoretisches Wissen als auch praktische Erfahrungen zum Thema Ökosystemdynamik. Die Studierenden haben gelernt die zeitlichen und räumlichen Veränderungen in Ökosystem zu verstehen, sowie die wichtigsten Triebfedern der Ökosystemdynamik. Dabei greifen grundlegende Aspekte quantitativer ökologischer Forschung ineinander, und zwar die Datenerhebung, die Verarbeitung der erhobenen Daten, und deren vorausschauende Nutzung im Rahmen von Ökosystemsimulationen. Diese integrative Sichtweise vermittelt den Blick auf die Schnittstellen zwischen den Disziplinen und die Studierenden haben gelernt verschiedene Methoden zu kombinieren um die Dynamik von Ökosystemen erfolgreich zu quantifizieren.

Teaching and Learning Methods:
Im Vorlesungsteil werden theoretische Grundlagen der Ökosystemdynamik und der Ökosystemmodellierung in Form von Vorträgen und Präsentationen vermittelt. Im Übungsteil wird das Wissen praktisch angewandt. Dazu werden Daten auf einer Testfläche im Nationalpark Berchtesgaden durch die Studierenden erhoben, die dann direkt im weiteren Verlauf der Übung am Computer genutzt und analysiert werden. Durch Kurzexkursionen werden den Studierenden unterschiedliche Aspekte der Ökosystemdynamik in diversen Ökosystemen (Wald, Alm, alpines Grasland) vermittelt.

Media:
PowerPoint, Flipchart, Tafelarbeit, Übungen am Computer, Gruppenarbeit und Gruppendiskussion.

Reading List:
Wird in der Lehrveranstaltung bekannt gegeben.

Responsible for Module:
Rammer, Werner; Dr. nat. techn.

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen der Ökosystemdynamik (Vorlesung, 1 SWS)
Rammer W [L], Rammer W, Seidl R

Ökosystemdynamik Übungen (Übung, 3 SWS)
Rammer W [L], Rammer W, Seidl R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2395: Aquatic Ecology and Conservation | Ökologie und Schutz von Gewässersystemen

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 180	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Current information regarding the limited activities with physical presence due to the CoViD19-pandemic:
In case the framework requirements (hygienie, distance rules etc.) for examinations with physical presence are not met, the planned examination format can be changed to a digital (remote) examination according to §13a APSO. The decision on this change will be communicated as soon as possible, however latest 14 days before the actual examination date, by the responsible examiner in coordination with the examinations board.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Thematic interest; attending other courses in the field of aquatic ecology is not required

Content:
Importance of aquatic ecosystems for humans, ecosystem functions, characteristics of the water habitat, gas balance, nutrients and their dynamics, bioindication methods, hazard factors of aquatic biodiversity, ecology and hazard of running waters, ecology and hazard of standing waters, aquatic ecotoxicology; strategies for the protection of aquatic biodiversity; investigation methods and working methods in aquatic systems biology; the exercises serve to deepen, apply and illustrate with concrete case studies

Intended Learning Outcomes:
Understanding of central factors and processes in aquatic ecosystems and their interrelationships with the threat to aquatic biodiversity; ability to assess anthropogenic and natural disturbances

of aquatic ecosystems; ability to critically evaluate and develop holistic protection concepts for waters; knowledge of important measurement and investigation methods in aquatic systems biology

Teaching and Learning Methods:
Lecture, tutorial; can be combined with an excursion

Media:
Power-Point presentation, blackboard, flip-chart, leaflet, case studies, practical exercises / demonstrations

Reading List:
Pullin AS Conservation Biology; Cambridge University Press; Primack R.B. A primer of conservation biology; Sinauer Ass.; Gleick PH The world's water Report on Festwater Resources; weitere Literatur wird bekannt gegeben

Responsible for Module:
Jürgen Geist (geist@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Aquatic Ecology and Conservation V (Vorlesung, 2 SWS)
Geist J

Lösung wissenschaftlicher Probleme in Gewässerökologie und Aquakultur (Seminar, 2 SWS)
Geist J, Beggel S, Kühn R

Einführung in die Methoden der Aquatischen Systembiologie (Übung, 5 SWS)
Geist J [L], Dobler A, Geist J, Pander J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2415: Ecotourism and Nature Conservation | Ökotourismus und Naturschutz

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (min.): 90 min.
The students attend 2 lectures. The theoretically acquired knowledge is actively deepened in a field exercise. However, the number of participants for the exercises is limited; practice areas are available first to students of the MSc SRM. The non-participation can be compensated for by additional work.

Repeat Examination:

(Recommended) Prerequisites:
English language skills, B.Sc.

Content:
In the lecture "Biodiversity and Protected Habitats" the students first get an overview of the spatial distribution of the vegetation zones of the earth. They learn which zones contribute qualitatively and quantitatively to global biodiversity. Instructions for the protection of biodiversity are presented. In the lecture "Ecotoursim and Nature Conservation" the focus is on alternative holiday activities in connection with the protection of biodiversity. Terms, concepts and the current state of implementation are presented. In the corresponding exercises the students learn what "soft tourism" and "ecotourism" mean in terms of nature and environmental protection

Intended Learning Outcomes:
Recognition of the importance of new strategies for global nature conservation and environmental protection, which also takes into account the socio-economic components.

Teaching and Learning Methods:
Freitext

Media:
Freitext

Reading List:
Will be presented at the event

Responsible for Module:
Fischer Anton a.fischer@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ4027: Plant Ecophysiology - Research at the Plant-Environment Interface | Ökophysiologie der Pflanzen - Forschung an der Schnittstelle zwischen Pflanze und Umwelt

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 80	**Contact Hours:** 70

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is performed in the form of a laboratory test. For this purpose the students prepare a protocol, whereby individual students are responsible for certain sections of the protocol. Usually the protocol is divided into 2-4 sections and comprises 8-15 pages. The students should show that they are able to implement an independently developed experiment in the field of plant ecology. Typically, experimental manipulations of environmental conditions such as ambient temperature, CO2 concentration, soil moisture (or similar) are introduced and the plant reaction is recorded. Furthermore, students should demonstrate that they are able to document and interpret the results of the experiment according to scientific standards. The protocol will be completed by a presentation in which the students demonstrate that they are able to present and communicate their experiment and its results to an audience in a suitable way. The protocol will be completed after feedback on the presentation by the staff of the chair and involved lecturers and has to be completed within 4-6 weeks after the end of the course.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
- Experimental treatment of plant-ecological questions, typically related to climate change
- Familiarization with current research topics;
- Testing hypotheses in an experiment in the field of plant ecology, typically by manipulating environmental factors such as temperature, CO2 concentration or soil moisture.
- Reaction of plants to their abiotic and biotic environment

- Plant strategies for stress management of e.g. drought, ozone, increased CO2 concentration, increased temperature, pathogen infestation, nanoparticles,...

Intended Learning Outcomes:
After successful participation in the module, students are able to
- implement scientific work in plant ecology within the framework of a current research project
- independently develop hypotheses and test them by experiment
- to evaluate, interpret and present data that you have collected yourself
- plant ecology research methods on e.g. photosynthesis, water balance, use of stable isotopes in ecological research, resource allocation, competition, facilitation,... to use for hypothesis evaluation
- to assess plant response to changing environmental factors in the context of climate change

Teaching and Learning Methods:
The module consists of seminar and exercise. In the seminar the theoretical basics of different research projects are taught in a lecture by means of presentations and short excursions to experimental plots. In the exercise, students work in groups to develop and work on their own research question within a research project presented in the seminar. This is done in close cooperation with doctoral students, post-docs and lecturers working on the projects. Typically, the environmental conditions of the plants, such as ambient temperature, CO2 concentration or soil moisture, are manipulated in the experiment and the plant reaction is quantitatively recorded. The results of the project are recorded and presented in the protocol.

Media:
Presentation, measuring instruments, tours, test areas

Reading List:
- "Experimental Plant Ecology" by von Willert, Matyssek and Herppich, Thieme-Verlag
- "Biology of trees" by Matyssek, Fromm, Rennenberg and Roloff, UTB Ulmer Verlag
- "Plant Ecology" by Schulze, Beck, Müller-Hohenstein, Spektrum-Verlag
- "Climate Change Biology" by Hannah, First/second edition, Academic Press

Responsible for Module:
Apl. Prof. Dr. Thorsten Grams – Lehrstuhl für Ökophysiologie

Courses (Type of course, Weekly hours per semester), Instructor:
Realisierung von Forschungsprojekten - Von der Idee bis zur Auswertung (Übung, 3 SWS)
Grams T [L], Grams T, Häberle K (Buras A)

"Hot topics" in der Pflanzenökologie (Seminar, 2 SWS)
Grams T [L], Grams T, Häberle K, Rammig A (Buras A)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6300: Ecosystem Management and Applied Restoration Ecology | Ökosystemmanagement und angewandte Renaturierungsökologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Compilation of a review of a selected ecological topic with reference to restoration aspects (20-30 pages) based on at least 8 current, international publications. Presentation of the results in form of a scientific talk followed by discussion. (weight: 70%, review, 30% presentation)

Repeat Examination:

(Recommended) Prerequisites:
Basics of scientific writing, experience with literature search and scientific presentation, general knowledge of ecological concepts,vegetation ecology, landscape ecology and basics of restoration ecology. Number of participants is restricted to 12. Admission according to respective previous knowledge and experience.

Content:
Topic of the seminar are current issues and questions of restoration ecology and ecosystem management for specific ecosystems and habitats in a global context. The seminar covers basic ecological aspects, processes and dynamics of the respective system, biotic, abiotic and anthropogenic factors as well as possible approaches and measures for protection and management. All topics are closely linked to current research projects of the institute.

Intended Learning Outcomes:
The seminar is based on the professional requirements and needs on master students and graduates for their scientific practice on international levels. Students intensively look into specific, up-to-date aspects of the chosen topic, learn to find and analyze scientific literature, to sum up the researched findings in form of a scientific review paper and to present their results by a short scientific presentation.

Teaching and Learning Methods:
After the assignment of the seminar topics students will be supervised individually or in groups. Weekly consultations will be offered with focus on review writing, presentation requirements and literature interpretation

Media:
Presentation and Review

Reading List:
Topics and starting literture will be provided during a separate preliminary meeting

Responsible for Module:
Wagner, Thomas; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Ökosystemmanagement und angewandte Renaturierungsökologie (Projekt, 4 SWS)
Wagner T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6340: Advances Ecological Field Course: : Habitat Dynamics, Vegetation and Arthropods of Alpine Rivers | Ökologischer Feldkurs für Fortgeschrittene: Habitatdynamik, Vegetation und Arthropodenfauna von Alpenflüssen

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung besteht aus einem schriftlichen Bericht (20–30 S.), der in Form und Inhalt an eine wissenschaftliche Veröffentlichung angelehnt ist und die fachgerechte Durchführung der ökologischen Felduntersuchungen dokumentiert. Anhand des Berichts zeigen die Studierenden, dass sie das untersuchte Alpenfluss-Ökosystem, die wichtigsten Ökosystemprozesse, die diese bestimmenden Faktoren sowie die Auswirkungen der Habitatdynamik auf Pflanzen und Tiere analysieren und entsprechende Fragestellungen wissenschaftlich bewerten können.

Repeat Examination:

(Recommended) Prerequisites:
Grundkenntnisse der Biodiversität und Ökologie von Pflanzen, Tieren und Gewässern; Grundlagen der ökologischen Statistik und Modellierung; Grundkenntnisse im wissenschaftlichen Schreiben

Content:
Das Modul hat die folgenden Inhalte:
• Ökosystemprozesse von Alpenflüssen;
• raumzeitliche Dynamik von Habitaten;
• Vegetation und Wasserführung;
• Effekte der Habitatdynamik auf Tier- und Pflanzenpopulationen;
• intakte und degradierte Referenzsysteme (z.B. Tagliamento, Durance, Inn, Isar, Lech);
• Feldmethoden: hydrologische Messverfahren, Aufnahmen von Vegetation und Arthropoden, UAV zur Erfassung von Habitaten und Vegetation;
• Auswertung mit GIS sowie Modellierung in R bzw. Python.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an dem Modul können die Studierenden:
• das untersuchte Ökosystem, seine Standortfaktoren und deren Dynamik verstehen;
• wichtige Ökosystemprozesse und die sie bestimmenden Komponenten und Faktoren analysieren;
• typische Pflanzengesellschaften und ausgewählte Gruppen der Arthropodenfauna sowie deren Anpassungen an die Habitatdynamik mit geeigneten Methoden bewerten;
• wissenschaftliche Erhebungen und Experimente selbständig durchführen;
• Daten aufbereiten, statistisch untersuchen und beurteilen;
• Ergebnisse in Form eines an eine wissenschaftliche Veröffentlichung angelehnten Berichts entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar und einer Übung. Im Vorbereitungsseminar präsentieren die Studierenden die Methodik und den aktuellen Stand der Forschung zu den wichtigsten Aspekten des besuchten Alpenflusssystems, und identifizieren unter Anleitung des Dozenten und in Diskussion mit der Gruppe geeignete Fragestellungen inkl. tier- und pflanzenökologischer Feldexperimente. In der Übung führen die Studierenden betreut durch den Dozenten eigene Untersuchungen im Exkursionsgebiet durch, sie bereiten die gewonnenen Daten auf und stellen die Ergebnisse in einem Abschlussbericht dar.

Media:
Feldübungen, Powerpoint, Wandtafel

Reading List:
Egger G, Michor K, Muhar S & Bednar B (2009) Flüsse in Österreich. Lebensadern für Mensch, Natur und Wirtschaft. Studienverlag, Innsbruck.
Kollmann J, Kirmer A, Hölzel N, Tischew S & Kiehl K (2019): Renaturierungsökologie. Springer Spektrum Verlag, Berlin.
Patt H (2015): Fließgewässer- und Auenentwicklung. Grundlagen und Erfahrungen. Springer, Berlin.
Bestimmungsliteratur für Pflanzen und Arthropoden (Flora Helvetica mit Schlüssel, Bährmann: Bestimmung wirbelloser Tiere), zusätzlich bebilderte Bestimmungsbücher; Weitere Literatur entsprechend der jeweiligen Thematik nach Bekanntgabe im Vorseminar.

Responsible for Module:
Kollmann, Johannes; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Ökologischer Feldkurs: Vegetations- und tierökologische Übungen (Übung, 6 SWS)
Wagner T [L], Wagner T, Holzschuh R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2398: Practical Ecotoxicology | Praktische Ökotoxikologie

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer wissenschaftlichen Ausarbeitung (ca. 10-15 Seiten) erbracht. Die Arbeit wird im Stil einer wissenschaftlichen Veröffentlichung verfasst und dient der Kontrolle des Verständnisses sowie der Fähigkeit zur Beschreibung, Auswertung und Interpretation der im Praktikum erzielten Ergebnisse. Die Studierenden zeigen in der Ausarbeitung, dass sie die Risikobewertung von Umweltstressoren mittels komplexer Testsysteme (Mesokosmenstudie, Aquarienversuche) sowie die Planung, den Aufbau, die Durchführung und die Auswertung ökotoxikologiescher Testverfahren verstehen. Sie zeigen zudem, dass sie Zooplankton- und Makroinvertebratenproben qualitativ und quantitativ auswerten, ökosystemare Zusammenhänge erkennen und die verschiedenen Effektarten und deren Auswirkungen auf die verschiedenen Trophieebenen benennen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
förderlich wären Lehrveranstaltungen zu ökotoxikologischen und/oder limnologischen Themen

Content:
Das Modul beinhaltet:
- Mesokosmenstudien
- Aquarienversuchen
- Untersuchungsmethoden zur ökotoxikologischen Bewertung von Umweltstressoren
- Erfassung physikalischer und biologischer Parameter und deren qualitative und quantitative Auswertung
- Auswertung der erhobenen Daten mit gängigen statistischen Auswertungsmethoden (uni- und multivariate Statistik) und Bestimmung der verschiedenen Bewertungsendpunkte(NOEC).

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an dem Modul verstehen die Studierenden die Risikobewertung von Umweltstressoren mittels komplexer Testsysteme (Mesokosmenstudie, Aquarienversuche). Sie verstehen die Planung, den Aufbau, die Durchführung und die Auswertung ökotoxikologiescher Testverfahren. Sie kennen die Taxonomie von Zooplankton und Makroinvertebraten und sind in der Lage, Zooplankton- und Makroinvertebratenproben qualitativ und quantitativ auszuwerten. Sie sind in der Lage, ökosystemare Zusammenhänge zu erkennen und die verschiedenen Effektarten und deren Auswirkungen auf die verschiedenen Trophieebenen zu benennen. Sie kennen und verstehen die gängigen ökotoxikologischen statistischen Auswertungsmethoden (multivariat und univariat) und die Bestimmung ökotoxikologischer Endpunkte.

Teaching and Learning Methods:
Das Modul wird in Form eines Praktikums abgehalten. In einführenden Vorlesungen werden die Grundlagen mittels Vorträgen vermittelt.
Der eigentliche Schwerpunkt dieses Moduls sind die anschließenden praktischen Tätigkeiten in Freiland und Labor unter Anleitungsgesprächen, während denen die Studierenden durch selbstständiges Arbeiten die erlernten Methoden in Teamarbeit anwenden.

Media:
Folien, Lehrmaterial

Reading List:
Fent (2007): Ökotoxikologie, Georg Thieme Verlag
Orginalliteratur

Responsible for Module:
Geist, Jürgen; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktische Ökotoxikologie (Praktikum, 5 SWS)
Geist J [L], Beggel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2433: Population Biology and Nature Conservation | Populationsbiologie und Naturschutz

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is an oral examination (20 min). Based on the oral examination, students demonstrate that they understand the population biology of plants and their mechanisms of action and are able to evaluate selected current research topics in this field.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of ecosystem connections and processes

Content:
The course introduces the population biological basics and mechanisms of action of plants. The topics covered are: Variation and inheritance in plant populations; evolutionary and ecological genetics; intraspecific interactions; population dynamics; age structure of populations; regional population dynamics and metapopulations; competition and coexistence; evolution of the life history of plants reproductive systems, reproduction, growth, senescence and death. These topics are linked to nature conservation and landscape planning.

Intended Learning Outcomes:
After participating in the module courses, students will have a basic knowledge of the population biology of plants and the mechanisms of action of plants, they will be able to evaluate current research topics in this field and apply the topics in nature conservation and landscape planning.

Teaching and Learning Methods:
Lectures with PPT presentations, which are followed up by self-study of the script, textbook and voluntary homework. In the seminar, the topics of the lecture are scientifically deepened by independently selecting, reading, understanding and reproducing original articles.

Media:
PPT presentations, script, textbook, original articles

Reading List:
Silvertown, J. & Charlesworth, D. (2001): Plant Population Biology. - Blackwell Publishing, Malden.

Further literature:
Crawley, M.J. (Ed.) (1997): Plant Ecology. - Blackwell Science, Oxford.
Rockwood, L.L. (2006): Introduction to Population Ecology. - Blackwell Publishing, Malden.
Townsend, C.R., Begon, M. & Harper, J.L. (2008): Essentials of Ecology. - Blackwell Publishing, Malden.
Urbanska, K.M. (1992): Population biology of plants. - UTB 1631, Stuttgart.

Topic-specific literature for the seminar will be announced at the beginning of the event.

Responsible for Module:
Johannes Kollmann (jkollmann@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Populationsbiologie und Naturschutz (Seminar, 2 SWS)
Kollmann J, Le Stradic S, Teixeira Pinto L

Einführung in die Populationsbiologie der Pflanzen (Vorlesung, 2 SWS)
Kollmann J, Teixeira Pinto L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4020: Effects of Climate Change on Plant Physiology | Pflanzenfunktionen im Klimawandel

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is normally concluded with an oral examination. In this exam, students should demonstrate that they understand the interrelationship between climate change, plant functions and interactions with biotic and abiotic factors. The participants show that they are able to derive possible risks and potentials of climate change for cultivated as well as natural plant systems (with a focus on woody plants). The duration of the examination is 20 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
not specified

Content:
1. (Woody) Plant systems as components of biogeochemical cycles, global C sink strength and functional biodiversity on different spatio-temporal scales; reaction of plants to increased CO2 concentration, chronic O3 load, elevated temperatures, drought, flooding, high N deposition; consequences of land-use change, cultivation of energy plants, and land degradation.
2. Change of susceptibility or resistance of woody plants due to climate change (increased CO2, O3, N input) to drought and heat.
3. Climate change and the risk for and mitigation by ecosystems. Significance for the C-source/sink ratio on different spatio-temporal scales. International agreements to reduce greenhouse gas emissions.
4. Effects of climate change on the interactions between plants and insects.

Intended Learning Outcomes:
After successful participation students are able to understand mechanistically the effect of global change scenarios on plants and their biotic network. In addition, they are able to assess, analyze and interpret possible uses, development potentials of and risks for plant systems and their interactions with insects.

Teaching and Learning Methods:
The module consists of three lectures and a seminar. In the lectures the present knowledge is presented and discussed. Causes and effects of "global change" scenarios on plants (Lecture 1) will be deepened by evolutionary and ecological aspects of the life form tree (Lecture 2) and the acquired knowledge will be used to estimate future risks for plant-insect interactions (Lecture 3). In the seminar students make enquiries in small groups on current topics and present their results in the form of a scientific poster.

Media:
PowerPoint, showcases, illustrative material, internet enquiries, discussions.

Reading List:
Larcher "Ecophysiology of Plants", UTB Ulmer, 1994.
Lambers, Chapin, Pons "Plant Physiological Ecology", Springer, 1998.
Schlesinger/Bernhardt "Biogeochemistry - An Analysis of Global Change", Academic Press, 2020.
Schoonhoven, van Loon, Dicke „Insect-Plant Biology“, Oxford Univ. Press, 2005.
Smagghe/Diaz (eds.) “Arthropod-Plant Interactions”, Springer, 2012.

Responsible for Module:
Häberle, Karl-Heinz; Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzen in der Umwelt von morgen (Vorlesung, 1 SWS)
Grams T

Seminar "Global Change" (Seminar, 1 SWS)
Grams T, Häberle K, Leonhardt S, Neumann A, Rammig A, Rüdenauer F

Erfolgsmodell Baum (Vorlesung, 1 SWS)
Häberle K

Pflanze-Insekten-Interaktionen im Globalen Wandel (Vorlesung, 1 SWS)
Leonhardt S, Rüdenauer F
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2370: Statistical Analysis of Biological Data Using R | Statistische Auswertung biologischer Daten unter Anwendung von R

Version of module description: Gültig ab winterterm 2011/12

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 180.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (180 min, benotet) dient der Überprüfung der in Vorlesung und Übung erlernten theoretischen und praktischen Kompetenzen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine

Content:
The aim of this course is to give a practical introduction to the methods, techniques, and computation of statistics using the free statistical software R. The course is addressed to B.Sc. students of biology, forestry, landscape planning with little or no experience in statistics and should enable them to design and analyze experiments. After an introduction, students will learn the usage of the powerful statistic program R which can be downloaded from the Internet, is free of charge.
Contents:
Basic Statistics, Linear Regression, Non-Parameter Statistics ANOVA, Multiple Regression, General Linear Modeling (GLM)

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, biologische Experimente so zu planen, das die gewonnen Datensätze dann auch statistisch korrekt ausgewertet werden können.

Teaching and Learning Methods:
Nach einer Einführungsvorlesung wird im Kurssaal anhand von biologischen Datensätzen die Benutzung des Statistikprogrammes R geübt.

Media:
Powerpoint, Wandtafel, Übungen am Computer

Reading List:

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in R (Übung, 4 SWS)
Meyer S, Weißer W

Einführung in die Versuchsplanung (Vorlesung, 2 SWS)
Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2571: Advanced Methods in Experimental Design | Spezielle Methoden der Versuchsplanung

Version of module description: Gültig ab summerterm 2012

Module Level:	Language: German	Duration: one semester	Frequency: summer semester
Credits:* 5	Total Hours: 150	Self-study Hours: 35	Contact Hours: 115

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Klausur

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Spezielle Verfahren in R (Übung, 2 SWS)
Meyer S

Übung Terrestrische Ökologie II (Übung, 5 SWS)
Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2573: Advanced Conservation Science | Spezielle Fragen des Naturschutzes

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird schriftlich in Form einer 60 minütigen Klausur erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel die grundlegenden Prinzipien des Naturschutzes wiedergegeben und angewandt werden können. Weiterhin wird überprüft, ob die Studierenden die biologischen Mechanismen für den Einfluss von menschlicher Landnutzung auf die Biodiversität verstanden haben und auf konkrete Vorschläge für eine nachhaltige Landnutzung übertragen können. Die Bearbeitung der Klausur erfordert vorrangig eigenständig formulierte Antworten, gegebenenfalls auch das Ankreuzen von vorgegebenen Mehrfachantworten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundvorlesung Ökologie

Content:
Das Modul gibt eine vertiefte Einführung in die Naturschutzwissenschaften, insbesondere in die grundlegende Motivationen und Herausforderungen des Naturschutzes im Rahmen der menschlichen Landnutzung.
Inhalte Vorlesung Naturschutz: 1) Motivationen für Naturschutz in der Gesellschaft, 2) biologische Mechanismen des Aussterbens von Arten, 3) Rolle der Agrarwirtschaft für die Änderung der biologischen Vielfalt, 4) Ökosystemleistungen in der Landwirtschaft, 5) Aktuelle Ansätze des Flächenmanagements und der nachhaltigen Agrarproduktion mit Schwerpunkt auf Lösungen, die die biologische Vielfalt und Ökosystemleistungen berücksichtigen.
Inhalte Seminar Naturschutz: 1) vertiefte Diskussion von Argumenten grundlegender Fragen zum Konflikt zwischen Produktion und Schutz der Natur anhand von wissenschaftlichen Artikeln,

2) Vertiefte Diskussion aktuelle Lösungsansätze zur nachhaltigen Agrarproduktion anhand von aktuellen wissenschaftlichen Artikeln.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen verstehen Studierende die wichtigsten naturschutzrelevanten Fragestellungen für eine nachhaltige Agrarwissenschaft. Sie können die wichtigsten biologischen Mechanismen zum Zusammenhang zwischen Agrarproduktion und Biodiversitätsschutz beschreiben und die vorgestellten Lösungsansätze auf in Vorlesung und Seminar vorgestellte Fallstudien anwenden. Sie sind in der Lage, bei vorliegenden Daten eine Produktionsmethode im Hinblick auf die Erhaltung und Nutzung der Biodiversität zu analysieren und die Nachhaltigkeit zu bewerten.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung: Präsentation mit zwischengeschalteten Diskussionen und Eigenarbeit, Seminar: eingeständige Aneignung der Inhalte einer wissenschaftlichen Arbeit, Vorstellung der Arbeit durch eine/n Studierende/n im Seminar, die/der zu Beginn einer Stunde ausgesucht wird, angeleitete Diskussion der wissenschaftlichen Arbeit. Vorlesung und Seminar finden im gleichen Semester statt und nehmen aufeinander Bezug.

Media:
Präsentationen mittels Powerpoint, selbsterstelltes Skript, WiKi-Moodle, wissenschaftliche Papiere auf Englisch

Reading List:
wird in der Vorlesung vorgestellt.

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Spezielle Fragen des Naturschutzes (MSc Agrarsystemwissenschaften und MSc Biologie) (Vorlesung, 2 SWS)
Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2482: Animal Ecology | Tierökologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 87	**Self-study Hours:** 42	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Animals and the abiotic environment, population and sexuality, communication systems, space-time patterns of populations, growth and population dynamics, intra und interspecific competition. part R. Gerstmeier: Ecosystem I, Ecosystem II, Zoogeography, Climate change and invasive animals

Intended Learning Outcomes:
Students are able to evaluate parameters of the abiotic environment and understand criteria of habitat selection. They understand communications systems within and between species and gain knowledge to discuss special patterns of population distribution in time and space, including climate change aspects.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Roland Gerstmeier (r.gerstmeier@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2575: Terrestrial Ecology 1 | Terrestrische Ökologie 1

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Als Prüfungsleistung für das Modul dient eine 10-15seitige wissenschaftliche Ausarbeitung, in der die Studierenden die in der Übung erarbeitete Fragestellung vor dem Hintergrund der in der Vorlesung vermittelten Konzepte einführen, die in der Übung verwendete Methodik beschreiben, und die in der Übung erzielten Ergebnisse vor dem Hintergrund der Konzepte der Ökologie der Lebensgemeinschaften analysieren und bewerten sollen.
Anhand der wissenschaftlichen Ausarbeitung zeigen die Studierenden, dass sie die Konzepte und Methoden der Ökologie der Lebensgemeinschaften kennen und die Spezifika interspezifischer Interaktionen in eigenen Worten wiedergeben können. Sie zeigen, dass sie aus einer Beobachtung einer ökologischen Lebensgemeinschaft heraus grundlegende Hypothesen zum Funktionieren der Gemeinschaft entwickeln und selbst erhobene Daten zu Lebensgemeinschaften analysieren und interpretieren können.

Repeat Examination:

(Recommended) Prerequisites:
Modul „Ökologie“ (Grundvorlesung Ökologie)
Modul „Versuchsplanung“ (Grundkenntnisse der Versuchsplanung sowie statistischer Auswertungen in der Software R).

Content:
Das Modul umfasst folgende Inhalte:
- organismische Interaktionen und ihrer Rolle für die Strukturierung von Lebensgemeinschaften. Dabei liegt der Fokus auf positiven (Mutualismus) und negative (Prädation, Konkurrenz) Interaktionen.
- Methoden, wie die Struktur von Lebensgemeinschaften im Freiland untersucht
- Eigenschaften von Artengemeinschaften im Freiland

- Standardmethoden der Terrestrischen Ökologie
- eigene Beobachtungen im Freiland
- Analyse selbst erhobener Daten

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen kennen die Studierenden die Konzepte und Methoden der Ökologie der Lebensgemeinschaften. Die Studierenden können in eigenen Worten die Spezifika interspezifischer Interaktionen wiedergeben und sie verstehen, welche Faktoren Lebensgemeinschaften strukturieren. Die Studierenden sind in der Lage, aus einer Beobachtung einer ökologischen Lebensgemeinschaft heraus grundlegende Hypothesen zum Funktionieren der Gemeinschaft zu entwickeln und sie können Experimente entwickeln, um diese Hypothesen zu testen. Mit Hilfe der vermittelten Analysemethoden sind die Studierenden in der Lage, selbst erhobene Daten zu Lebensgemeinschaften zu analysieren und zu interpretieren.

Teaching and Learning Methods:
In einer Vorlesung werden theoretische Konzepte der Ökologie der Lebensgemeinschaften vermittelt. Die Vorlesung enthält Elemente eines Seminars, in dem die Studierenden mit dem Dozenten die Konzepte und ihre Anwendbarkeit auf Umweltprobleme diskutieren. In der Übung (Terrestrische Ökologie 1) werden ökologische Methoden im Freiland eingeübt, wobei die Studierenden die Fragestellung sowie die Methoden aus der Literatur mit Hilfestellung selbst erarbeiten.

Media:
Präsentationen (Powerpoint) vom Dozenten und Studierenden, selbst erstelltes Skript, Protokoll, wissenschaftliches Paper.

Reading List:
Peter J. Morin, Community Ecology, Blackwell Science, Oxford, U.K. 424 pages [Signatur UB: 1003/BIO 130f 2012 L 153(2)]

Responsible for Module:
Wolfgang Weisser (wolfgang.weisser@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Ökologie der Lebensgemeinschaften (Vorlesung, 2 SWS)
Weißer W

Grundpraktikum Terrestrische Ökologie I (Praktikum, 4 SWS)
Weißer W [L], Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2333: Underwater Ecology | Unterwasserökologie

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung wird in Form eines Berichtes (15-20 Seiten) erbracht. Anhand des Berichts zeigen die Studierenden, dass sie Lebensräume, Flora und Fauna sowohl des Mittelmeeres als auch heimischer Gewässer kennen und diese tauchend kartieren können. Sie zeigen, dass sie sowohl die komplexen ökologischen Zusammenhänge als auch Wechselwirkungen in marinen und limnischen Ökosystemen verstehen. Zudem zeigen sie, dass sie diese vergleichend bewerten und Entwicklungsvorschläge kreieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der Limnologie, Botanik und Zoologie

Content:
Das Modul umfasst folgende Inhalte:
. Lebensräume des Mittelmeeres,
. Flora und Fauna des Mittelmeeres,
. Kartierung von Flora und Fauna mariner Standorte in der Region der Insel Cres (Kroatien),
. Lebensräume einheimischer Seen,
. Flora und Fauna einheimischer Seen,
. Artenverbreitung von Makrophyten (Wasserpflanzen) entlang der vertikalen Gradienten abiotischer Faktoren in Seen
. Tauchkartierungen

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an dem Modul kennen die Studierenden Lebensräume, Flora und Fauna sowohl des Mittelmeeres als auch heimischer Gewässer und können diese tauchend

auch unter Zeitdruck und unter extremen Bedingungen kartieren. Sie verstehen sowohl die komplexen ökologischen Zusammenhänge als auch Wechselwirkungen in marinen und limnischen Ökosystemen. Zudem sind sie in der Lage, diese vergleichend zu bewerten und Entwicklungsvorschläge zu kreieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar und zwei Übungen. Die Studierenden bereitenim Seminar durch Literaturrecherche ein ausgewähltes Thema hinsichtlich mediterraner Lebensräume vor und stellen dies den restlichen Kursteilnehmern vor. Anschließend kartieren sie in der ersten Übung die marine Unterwasserflora und -fauna in ausgewählten Abschnitten. An heimischen limnischen Standorten wird in der zweiten Übung ebenfalls in Gruppenarbeit die Artenverbreitung von Makrophyten entlang der vertikalen Gradienten abiotischer Faktoren in Seen erarbeitet, wobei das Arbeiten unter Zeitdruck und unter extremen Bedingungen erlernt wird. Schließlich werden die Ergebnisse der Untersuchungen der verschiedenen Standorte in einem Bericht zusammengefasst und einander gegenübergestellt.

Media:
PowerPoint-Präsentation, Tafelarbeit, Flipchart, Film, digitale Photographie

Reading List:
Biologische Meereskunde, Sommer; Fauna und Flora des Mittelmeres, Riedl; Das Mittelmeer, Fauna Flora Ökologie, Hofrichter; Bestimmungsschlüssel für die aquatischen Makrophyten (Gefäßpflanzen, Armleuchteralgen und Moose) in Deutschland, van de Weyer; Süßwasserflora von Mitteleuropa, Pteridophyta und Anthophyta (Bd 1+2), Casper & Krausch; Süßwasserflora von Mitteleuropa, Charales, Krause; A treatise on Limnology, Bd 3 Limnological Botany, Hutschinson; Biology of aquatic vasuclar plants, Scouthorpe;

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Lebensräume des Mittelmeeres/Forschungstaucherausbildung Block 1 (Limnologie) (Seminar, 2 SWS)
Zimmermann S, Leidholdt J

Flora und Fauna des Mittelmeeres (Limnologie) / Forschungstaucherausbildung Block 2 (Übung, 4 SWS)
Zimmermann S, Leidholdt J

Artenverbreitung von Makrophyten entlang der vertikalen Gradienten abiotischer Faktoren in Seen/ Forschungstaucherausbildung Block 3 (Limnologie) (Übung, 4 SWS)
Zimmermann S, Leidholdt J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4044: Causes and Impacts of Climate Change | Ursachen und Auswirkungen von Klimaänderungen

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Überprüfung des Lernergebnisses erfolgt durch eine Übungsleistung sowie eine Klausur. Die Übungsleistung umfasst vier benotete Hausaufgaben verteilt über das Semester zu den Teilbereichen Teststatistik, Korrelationsanalyse, multivariate Statistik und Modellierung. Die Aufgaben sind von den Studierenden eigenständig zu Hause zu bearbeiten um sicherzustellen, dass sie die zu Grunde liegende Statistik und die damit einhergehende Umsetzung in einer Programmiersprache sicher beherrschen. Die Studierenden demonstrieren mit diesen Übungsaufgaben, dass sie ein vertieftes Verständnis für statistische Fragestellungen haben, in der Lage sind, angemessene statistische Methoden und Tests auszuwählen, in der Programmiersprache „R“ umzusetzen und die Ergebnisse korrekt zu interpretieren. Da die in der Übung vermittelten Kompetenzen (Programmieren und korrekte Anwendung statistischer Methoden) stark aufeinander aufbauen, ist es notwendig den Kenntnisstand der Studierenden in regelmäßigen Abständen zu prüfen um bei Fehlern frühzeitig korrigierend eingreifen zu können. Im Rahmen der 90 minutigen Übung ist eine umfangreiche Evaluierung der Kompetenzen für jeden Studierenden einzeln nicht möglich, weshalb dies anhand der Hausaufgaben stattfindet. Die benotete Übungsleistung trägt darüber hinaus dazu bei, dass sich die Studierenden bereits vor der Klausurvorbereitung am Ende des Semesters intensiv mit dem statistischen Hintergrund der Vorlesung auseinandersetzen. In der 60minütigen, schriftlichen Klausur am Ende des Semesters zeigen die Studierenden, dass sie ohne Hilfsmittel und unter Zeitdruck in der Lage sind, Fragen zu Ursachen und Auswirkungen von Klimaänderungen zu bearbeiten sowie den Zusammenhang zwischen der Vorlesung und den statistischen Übungsinhalten herzustellen. Darin sollen die Studierenden nachweisen, dass sie die Ursachen und Auswirkungen des Klimawandels kennen sowie die zukünftigen sozioökonomischen und ökologischen Folgen des Klimawandels mit adäquaten statistischen Mitteln (z.B. Modellen) beschreiben können. Die Gesamtnote setzt sich zusammen aus der schriftlichen Klausur (60%) und der Übungsleistung (insgesamt 40%/10% je Hausaufgabe).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorausgesetzt werden Grundkenntnisse der Ökoklimatologie (Beispielsweise erlangt im Modul Ökoklimatologie des Bachelorstudiengangs Forstwissenschaft und Ressourcenmanagement).

Content:
Das Modul vermittelt den Studierenden im Rahmen der Vorlesung die Ursachen sowie die zu erwartenden regionalen und globalen Auswirkungen des Klimawandels in den Bereichen Klimatologie, Ökologie, Forstwirtschaft und Phänologie. Die im Rahmen der Übung vermittelten statistischen Methoden umfassen Test-Statistik, Korrelationsanalyse, multivariate Statistik, Modellierung und Grundkenntnisse der Statistik-Software ‚R'.

Intended Learning Outcomes:
Die Studierenden besitzen ein vertieftes Wissen der Ursachen und Auswirkungen des erwarteten Klimawandels auf die Teilbereiche Klimatologie, Ökologie, Forstwirtschaft und Phänologie. Darüber hinaus sind sie in der Lage Auswirkungen von Klimaänderungen in natürlichen Systemen festzustellen, sowie künftige Veränderungen und ihre ökologischen und sozioökonomischen Folgen abzuschätzen. Die Studierenden können entsprechende Datenreihen statistisch adäquat analysieren und interpretieren.

Teaching and Learning Methods:
Das Modul setzt sich zusammen aus der Ringvorlesung ‚Auswirkungen von Klimaänderungen in natürlichen Systemen' mit verschiedenen eingeladenen Spezialisten welche den rezenten Wissenstand zur Thematik vermitteln. Damit thematisch verknüpft sind praktische Übungen am Computer, welche es den Studierenden erlauben die statistischen Hintergründe des in der Ringvorlesung vermittelten Wissens zu erarbeiten und zu verstehen. Die Inhalte der Vorlesung werden im Vortrag und durch Präsentationen vermittelt. Studierende sollen zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt werden. Der Übungsteil setzt sich aus einem Theorie-Teil – welcher die notwendigen Statistik-Kenntnisse vermittelt – und einem Praxis-Teil – welcher die eigenständige Anwendung dieses Wissens in der Programmiersprache ‚R' umfasst – zusammen. Um das im Rahmen der Übung vermittelte Wissen adäquat zu prüfen, sollen die Studierenden vier benotete Hausaufgaben (jeweils eine zu jedem der thematischen Teilbereiche Test-Statistik, Korrelationsanalyse, multivariate Statistik und Modellierung) anfertigen.

Media:
PowerPoint, Statistiksoftware R

Reading List:
IPCC (2013/2014) Climate Change Fifth Assessment Report (AR5), Newmann et al. (2001) Climate Change Biology. Verschiedene Lehrbücher zur Statistik werden in der Vorlesung vorgestellt.

Responsible for Module:
Prof. Dr. Annette Menzel – Professur für Ökoklimatologie

Courses (Type of course, Weekly hours per semester), Instructor:

Annette Menzel, Nicole Estrella, Allan Buras, Anton Fischer, Thorsten Grams, Thomas Rötzer, Stefan Raspe
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6122: Field Course in Vegetation of the Earth | Übungen zur Vegetation der Erde

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination takes the form of a written report (20-40 p.) summarizing the results of the exercise. Based on the report, students show that they are able to assess and evaluate the biogeography, biodiversity, land use and threats to the excursion area. They can then derive appropriate measures for sustainable land use, nature conservation and renaturation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Lecture "vegetation of the earth"

Content:
The module includes the following contents:
- Flora, fauna and vegetation of the excursion region
- Ecological and biogeographical factors that determine this biodiversity
- Land use and degradation in the region
- Protection and renaturation of ecosystems

Intended Learning Outcomes:
After successful participation in this module students are able to analyse and evaluate the biogeographical conditions, the ecosystem structure, land use and endangerment of vegetation under the local conditions of the excursion area. They can apply their knowledge of the decisive ecological factors, can determine the essential (e.g. dominant) plant species and understand their site requirements. They are able to assess the effects of human use on vegetation and protected habitats and develop appropriate measures of sustainable land use, nature conservation

and renaturation with intercultural competence. They can carry out biodiversity surveys, site measurements and small independent experiments under difficult terrain conditions.

Teaching and Learning Methods:
The module consists of one exercise. In the exercise, the students present, individually or in groups of two, topics relevant for the professional preparation of the subsequent excursion (field exercise over 2-3 weeks) in 5-14 one-hour sessions with seminar character. The seminar reports will be made available to all participants in written form. In the field exercise, selected vegetation zones and ecosystems are visited and analyzed on site. Local colleagues from partner universities and other experts will be involved. Likewise, large protected areas (e.g. national parks) will be visited using the example of the respective countries and the establishment and management will be discussed with the local nature conservation administration. In student projects the local biodiversity is recorded, ecological factors are measured and own experiments are conducted.

Media:
Site inspections, handouts, presentations, script, herbarium

Reading List:
Pfadenhauer, J. S. & Klötzli, F. A. (2015) Vegetation of the earth: foundations, ecology, distribution. Springer publishing house.
Schultz, J. (2016) The ecological zones of the earth. UTB.
In the preparation phase for each exercise, students are provided with a list of relevant literature on the country of excursion.

Responsible for Module:
Prof. Dr. rer. nat. Johannes Kollmann johannes.kollmann@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0322: Ecological Colloquium: Scientific Foundations and Applications in Practice | Ökologisches Kolloquium: Wissenschaftliche Grundlagen und Anwendungen in der Praxis [SciTravels]

Overview of current research topics from local to global

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a presentation (approx. 20 min.; 25% of the grade) and is supplemented by a written report (report of approx. 10 pages; 75% of the grade). In the presentation, students should demonstrate that they can independently research and professionally present their findings. Through the written report, students should demonstrate that they can communicate specialized knowledge about ecology, conservation, biodiversity, sustainability, and resource use in writing. Students should also demonstrate that they can evaluate current problems and research questions as well as transdisciplinary connections between research, planning, nature conservation and environmental protection, politics and society in this subject area.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Depending on the topic, basic knowledge of landscape- , vegetation- , wildlife- , forest- or soil ecology, as well as climatology and land use is necessary.

Content:
The module consists of a seminar and an exercise.

In the seminar, selected topics on ecology, nature conservation, biodiversity and sustainability research are presented in a series of guest lectures by internationally or nationally renowned scientists.

In the exercise, the results are presented and discussed by students in relation to the other contributions.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to,
- understand sophisticated technical knowledge on diverse topics in the field of ecology, nature conservation and sustainable resource production and use;
- evaluate the quality of presentations by internationally or nationally recognized experts on selected topics in ecology, nature conservation, biodiversity and sustainability research according to methods and techniques, content and form;
- conduct research on the biography and professional focus of researchers, and
- present the results of their analysis and research efficiently and appropriately in a written report and to present and critically discuss them in a presentation.

Students will thus be able to critically evaluate current problems and research questions as well as transdisciplinary connections between research, planning and management, conservation and environmental protection, politics and society.

Teaching and Learning Methods:
The students prepare for each lecture by reading the publications of the guest scientists and important related studies in the field. During the lecture, they assess how the subject matter is prepared and presented by the guest scientists. Based on the publications of the scholars and the lecture, the students analyze the methods and techniques used by the scientists to communicate their subject matter. By critically analyzing publications and lectures, students learn how established scientists present and communicate their scientific content to the public. By comparing and discussing several guest lectures as part of the exercise, students learn techniques for communicating specialized knowledge effectively both orally and in writing. The combination of presentations and written reports of students corresponds to the profile of requirements that graduates are often confronted with in the professional fields of ecosystem management, nature conservation, landscape planning and public relations.

Media:
Seminar: PowerPoint presentations, script;
Exercise: original scientific articles, students' own presentations.

Reading List:
Topic-specific literature for the seminar will be announced.

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forum Naturschutz (Übung, 2 SWS)
Kollmann J

Weihenstephaner Kolloquium zur Angewandten Ökologie und Planung (Kolloquium, 2 SWS)
Kollmann J, Häberle K, Annighöfer P, Egerer M, Geist J, Grams T, Kögel-Knabner I, Leonhardt S, Menzel A, Pauleit S, Pretzsch H, Rammig A, Rötzer T, Schäfer H, Seidl R, Tellier A

Seminar Angewandte Ökologie und Planung (Seminar, 2 SWS)
Kollmann J, Häberle K, Annighöfer P, Egerer M, Geist J, Grams T, Schäfer H, Kögel-Knabner I, Leonhardt S, Menzel A, Pauleit S, Pretzsch H, Rammig A, Rötzer T, Seidl R, Tellier A

Wissenschaftl. Reisen: von Beobachtungen und Grundlagen zur angewandten Forschung (Übung, 1 SWS)
Leonhardt S [L], Annighöfer P, Egerer M, Leonhardt S

Wissenschaftl. Reisen: von Beobachtungen und Grundlagen zur angewandten Forschung (Seminar, 2 SWS)
Leonhardt S [L], Annighöfer P, Egerer M, Leonhardt S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2572: Experimental Design (Advanced Course) | Versuchsplanung (Fortgeschrittenenkurs)

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Written report for experimental design course, written practical assessment (exam) for R practical course

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic mathmatics and use of microsoft office.

Content:
The module contains:
. importance of a good experimental design,
. how to avoid pseudoreplication,
. different types of experimental design and suitable types of analyses.
. introduction into the free software package R and at the same time introduces descriptive statistics, simple and multivariate regression, ANOVA, GLM, and parameter free methods.
Experimental design and critical analysis of peer-reviewed papers, use of the R software for analyses.

Intended Learning Outcomes:
At the end of the course, students will be able to design and conduct good ecological experiments and analyse the data using the R statistical software. Students will be able to critically analyse a peer-reviewed paper in the area of interest of the student.

Teaching and Learning Methods:
The module uses lectures and practicals to teach experimental design and statistics. The lecture course uses group work and discussions alongside traditional lectures. In the practical part, students learn the basics of statistical tests and analyse ecological data using the statistical program R on the computers.

Media:
PowerPoint, Wandtafel, Übungen am Computer

Reading List:

Responsible for Module:
Weißer, Wolfgang; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
R für Fortgeschrittene (Übung, 4 SWS)
Meyer S, Weißer W

Versuchsplanung (Fortgeschrittenenkurs) (Vorlesung, 2 SWS)
Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4230: Wildlife Management | Wildtiermanagement

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:**	**Duration:** two semesters	**Frequency:**
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
DDie Prüfungsleistung wird in Form einer schriftlichen Prüfung erbracht. Die Prüfungsdauer beträgt 60 Minuten. Darin soll nachgewiesen werden, dass die Studierenden die wichtigsten Grundlagen des Wildtiermanagements verinnerlicht haben, wesentliche Instrumente und deren Einsatzgebiete verstehen und in der Lage sind, diese auf konkrete Problemstellungen anzuwenden.

Repeat Examination:

(Recommended) Prerequisites:
Vorausgesetzt werden grundlegende Kenntnisse über Biologie und Ökologie wichtiger Wildtiere in Europa (Beispielsweise erlangt im Modul "Tier- und Wildökologie" des Bachelorstudiengangs Forstwissenschaft und Ressourcenmanagement)

Content:
1. Was ist Wildtiermanagement?
2. Konzepte des Wildtiermanagements
3. Einstellung Mensch - Wildtier (Human dimension)
4. Urbane Gebiete als Lebensraum für Wildtiere
5. Methoden im Wildtiermanagement
6. Aktuelles Wildtiermanagement in Bayern
7. Räuber-Beute-Systeme
8. Trophische Kaskaden und Landscape of Fear

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Modul verstehen die Studierenden, dass Wildtiermanagement immer auf den drei Säulen, Tier, Mensch und Habitat basiert. Sie sind in

der Lage die Grundprinzipien des Wildtiermanagements zu erfassen, Probleme mit Wildtieren zu analysieren und Managementkonzepte zu entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesungen in der die theoretischen Grundlagen in Form von Vorträgen und Präsentationen vermittelt und durch Diskussion von Fallbeispielen vertieft werden. Ergänzt wird die Vorlesung durch eine Exkursion, in der aktuelle Themen des Wildtiermanagements in Bayern aufgegriffen, Lösungsansätze aufgezeigt und mit den Studierenden diskutiert werden.

Media:
PowerPoint

Reading List:
Conover 2001: Resolving Human- Wildlife Conflicts. Adams, Lindsey, Ash 2005: Urban Wildlife Management. König 2008: Fears, Attitudes and opinions of suburban residents with regards to their urban foxes.

Responsible for Module:
PD Dr. Andreas König koenig@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Exkursion zum Wildtiermanagement (Exkursion, 1 SWS)
König A

Wildtiermanagement (Vorlesung, 2 SWS)
König A, Peters W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6121: Vegetation of the Earth | Vegetation der Erde

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung wird in Form einer mündlichen Prüfung (20 min) erbracht. In der Prüfung zeigen die Studierenden, dass sie die wichtigsten Vegetationstypen und Vegetationszonen der Erde analysieren und beispielhafte Arten, Gattungen, Familien und Lebensformen nennen können. Sie demonstrieren zudem, dass sie die globale Differenzierung der Vegetation anhand funktionaler ökologischer Eigenschaften, evolutionärer Prozesse und biogeographischer Rahmenbedingungen analysieren können. Zusätzlich belegen sie, dass sie die Vegetation zur Klassifikation der standörtlichen und nutzungsbedingten Verhältnisse verwenden können. Eine mündliche Prüfung eignet sich zur Erfassung der genannten Studienleistungen, da die Studierenden hier zeigen können, ob sie die komplexen Zusammenhänge der historischen und aktuellen Landnutzung und der Vegetationsgefährdung bewerten und geeignete Maßnahmen für Naturschutz und Renaturierung entwickeln können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Botanik, der Vegetationsökologie, Geographie, Geologie, Bodenökologie und Klimatologie

Content:
Das Modul umfasst folgende Inhalte:
• Entwicklung, Verbreitung, Gliederung und Ökologie der wichtigsten Vegetationstypen der Erde
• Charakteristische Arten, Gattungen, Familien und Lebensformen
• Steuernde Ökosystemprozesse und die entsprechenden ökologischen Eigenschaften der Vegetationstypen
• Klima-, boden- und nutzungsbedingte Anpassungen von Pflanzen
• Auswirkungen von Landnutzung und anderen anthropogenen Einflüssen

• Optionen für Naturschutz und Renaturierung

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss dieses Moduls können die Studierenden die wichtigsten Vegetationstypen und Vegetationszonen der Erde unterscheiden und mit beispielhaften Arten, Gattungen, Familien und Lebensformen von verschiedenen Kontinenten kennzeichnen. Die Studierenden können die globale Differenzierung der Vegetation anhand funktionaler ökologischer Eigenschaften, evolutionärer Prozesse und biogeographischer Rahmenbedingungen analysieren. Umgekehrt können die Studierenden anhand der regionalen Vegetation die standörtlichen und nutzungsbedingten Verhältnisse klassifizieren, und zwar unter Verwendung der vorherrschenden Ökosystemprozesse und spezifischer Anpassungsstrategien der Pflanzen. Darüber hinaus sind sie in der Lage, die historische und aktuelle Landnutzung sowie Gefährdung der regionalen natürlichen Vegetation zu bewerten und entsprechende Maßnahmen des Naturschutzes und der Renaturierung zu entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung mit Powerpoint-Präsentationen, in der den Studierenden die biogeographischen Muster und die sie bedingenden ökologisch-evolutionären Prozesse der Vegetation der Erde vorgetragen werden.

Media:
PowerPoint, Handzettel, Tafelanschrieb, Pflanzenmaterial zur Anschauung

Reading List:
Pfadenhauer, J. S. & Klötzli, F. A. (2015) Vegetation der Erde: Grundlagen, Ökologie, Verbreitung. Springer-Verlag
Schultz, J. (2016) Die Ökozonen der Erde. UTB

Responsible for Module:
Wagner, Thomas; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Vegetation der Erde (Vorlesung, 4 SWS)
Wagner T [L], Wagner T, Albrecht H, Le Stradic S, Teixeira Pinto L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2333: Underwater Ecology | Unterwasserökologie

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung wird in Form eines Berichtes (15-20 Seiten) erbracht. Anhand des Berichts zeigen die Studierenden, dass sie Lebensräume, Flora und Fauna sowohl des Mittelmeeres als auch heimischer Gewässer kennen und diese tauchend kartieren können. Sie zeigen, dass sie sowohl die komplexen ökologischen Zusammenhänge als auch Wechselwirkungen in marinen und limnischen Ökosystemen verstehen. Zudem zeigen sie, dass sie diese vergleichend bewerten und Entwicklungsvorschläge kreieren können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der Limnologie, Botanik und Zoologie

Content:
Das Modul umfasst folgende Inhalte:
. Lebensräume des Mittelmeeres,
. Flora und Fauna des Mittelmeeres,
. Kartierung von Flora und Fauna mariner Standorte in der Region der Insel Cres (Kroatien),
. Lebensräume einheimischer Seen,
. Flora und Fauna einheimischer Seen,
. Artenverbreitung von Makrophyten (Wasserpflanzen) entlang der vertikalen Gradienten abiotischer Faktoren in Seen
. Tauchkartierungen

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an dem Modul kennen die Studierenden Lebensräume, Flora und Fauna sowohl des Mittelmeeres als auch heimischer Gewässer und können diese tauchend

auch unter Zeitdruck und unter extremen Bedingungen kartieren. Sie verstehen sowohl die komplexen ökologischen Zusammenhänge als auch Wechselwirkungen in marinen und limnischen Ökosystemen. Zudem sind sie in der Lage, diese vergleichend zu bewerten und Entwicklungsvorschläge zu kreieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar und zwei Übungen. Die Studierenden bereitenim Seminar durch Literaturrecherche ein ausgewähltes Thema hinsichtlich mediterraner Lebensräume vor und stellen dies den restlichen Kursteilnehmern vor. Anschließend kartieren sie in der ersten Übung die marine Unterwasserflora und -fauna in ausgewählten Abschnitten. An heimischen limnischen Standorten wird in der zweiten Übung ebenfalls in Gruppenarbeit die Artenverbreitung von Makrophyten entlang der vertikalen Gradienten abiotischer Faktoren in Seen erarbeitet, wobei das Arbeiten unter Zeitdruck und unter extremen Bedingungen erlernt wird. Schließlich werden die Ergebnisse der Untersuchungen der verschiedenen Standorte in einem Bericht zusammengefasst und einander gegenübergestellt.

Media:
PowerPoint-Präsentation, Tafelarbeit, Flipchart, Film, digitale Photographie

Reading List:
Biologische Meereskunde, Sommer; Fauna und Flora des Mittelmeres, Riedl; Das Mittelmeer, Fauna Flora Ökologie, Hofrichter; Bestimmungsschlüssel für die aquatischen Makrophyten (Gefäßpflanzen, Armleuchteralgen und Moose) in Deutschland, van de Weyer; Süßwasserflora von Mitteleuropa, Pteridophyta und Anthophyta (Bd 1+2), Casper & Krausch; Süßwasserflora von Mitteleuropa, Charales, Krause; A treatise on Limnology, Bd 3 Limnological Botany, Hutschinson; Biology of aquatic vasuclar plants, Scouthorpe;

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Flora und Fauna des Mittelmeeres (Limnologie) / Forschungstaucherausbildung Block 2 (Übung, 4 SWS)
Zimmermann S, Leidholdt J

Lebensräume des Mittelmeeres/Forschungstaucherausbildung Block 1 (Limnologie) (Seminar, 2 SWS)
Zimmermann S, Leidholdt J

Artenverbreitung von Makrophyten entlang der vertikalen Gradienten abiotischer Faktoren in Seen/ Forschungstaucherausbildung Block 3 (Limnologie) (Übung, 4 SWS)
Zimmermann S, Leidholdt J
For further information in this module, please click campus.tum.de or here.

Specializing in Plant Sciences | Studienschwerpunkt Pflanzenwissenschaften

Module Description

WZ1596: Analysis of Bioactive Compounds in Fruits and Vegetables | Analysis of Bioactive Compounds in Fruits and Vegetables

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular participation in the laboratory training is expected. Each participant will give a presentation (15 min) about a practical experiment followed by a colloquium (15 min). These will show the competence regarding the theoretical aspects of plant analysis. In both the colloquium and the presentation (equal value), the students will show being able to sort and to demonstrate the steps of different analytical methods. A protocol about a laboratory experiment has to be prepared by each participant. This serves as a control tool for testing theoretical knowledge as well as the ability of the students to describe experimental results including their evaluation and interpretation. This written protocol is a subject of the colloquium.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
basic chemistry and biochemistry; recommended is participation of one of the following lectures: "Control and oprimization of secondray plant metabolites" or "Secondary plant metabolites and human health"

Content:
The course introduces into analysis and bioactivity of secondary plant metabolites. Different classes of bioactive substances will be covered, e.g. phenylpropanoids, flavonoids, carotenoids or terpenoids. A practical part deals with the isolation, identification and quantification of natural components and testing the bioactive (mainly antioxidative) capacity of the isolated substances

Intended Learning Outcomes:
The participants will have profound competence in analytics of secondary metabolites from plants including extraction, identification of structures, quantification. They will be able choose the appropriate methods fo the respective analyses and will be able to adapt them to new demands. Finally, they are able to evaluate the experimental results.

Teaching and Learning Methods:
lecture, laboratory training, demonstration of experiments, personal advice, discussion of results with the supervisor and within the students teams, preparation of the experiments by reading the scriptum and literature in advance, carrying out a practicl project in a team and preparing a protocoll

Media:
lecture with powerpoint presentation, scriptum, practical laboratory training

Reading List:
C. Santos-Buelga, G. Williamson (Eds.), Methods in Polyphenol Analysis. The Royal Society of Chemistry, Athenaeum Press, 2003;
W. Feucht, D. Treutter: Phenolische Naturstoffe. Obst- u-. Gartenbauverlag München, 1989;
Goldberg, G. (ed.): Plants: Diet and Health; Blackwell Publishing, 2003

Responsible for Module:
Dieter Treutter (dieter.treutter@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung, Übung, Analysis of bioactive compounds in fruits and vegetables, 4SWS
Dieter Treutter (dieter.treutter@mytum.de) Susanne Rühmann (susanne.ruehmann@tum.de) Ionela Regos (regos@wzw.tum.de)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2424: Biotic Plant Stress Physiology | Biotische Stressphysiologie der Pflanzen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 80	**Contact Hours:** 70

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur 90 min, benotet) dient der Überprüfung der in Vorlesung und Übung erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Die Klausurnote bildet zusammen mit der Leistung im Seminarvortrag die Gesamtnote des Moduls.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlagen in den Pflanzenwissenschaften

Content:
Vorlesung/Seminar: Definition, Symptomatik und Physiologie von Stress in Kultur- und Modellpflanzen. Auswirkungen verschiedener biotischer und abiotischer Umwelteinflüsse auf Entwicklung, Hormonhaushalt, Physiologie und Ertragsfähigkeit von Pflanzen. Lösungsansätze zur Resistenz/Toleranz gegen verschieden Stressfaktoren. Praktikum: Symptomatik von biotischem und abiotischem Stress an höheren Pflanzen. Messung und Beeinflussung physiologischer Stressparameter in exponierten Pflanzen mit unterschiedlichen Resistenzeigenschaften. Voraussetzungen zur physiologischen Selektion resistenter Genotypen. Verstehen und Anwenden von stressphysiologischen Meßgrößen. Verstehen und Anwenden von stressphysiologischen Meßgrößen. Methoden: Chlrorphyllfluoreszenz, Gaschromatographie, Enzymatik, etc.

Intended Learning Outcomes:
Ausbildung zum Stressphysiologen, der in der Lage ist, Stressparameter in Pflanzen zu messen und zu verstehen, um pflanzliche Leistungsfähigkeit unter verschiedenen Umweltbedingungen bewerten zu können.

Teaching and Learning Methods:
Vorlesung, Übung, Seminar

Media:

Reading List:

Responsible for Module:
Ralph Hückelhoven (hueckelhoven@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biotische Stressphysiologie der Pflanzen (Seminar, 1 SWS)
Schempp H [L], Hückelhoven R, Schempp H, Engelhardt S, Vlot-Schuster A, Durner J, Lindermayr C, Rosenkranz M, Stegmann M

Biotische Stressphysiologie der Pflanzen (Vorlesung, 2 SWS)
Schempp H [L], Hückelhoven R, Vlot-Schuster A, Schempp H, Engelhardt S, Durner J, Lindermayr C, Rosenkranz M, Stegmann M

Biotische Stressphysiologie der Pflanzen (Übung, 2 SWS)
Schempp H [L], Schempp H, Vlot-Schuster A, Stegmann M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1696: Crop Genomics | Crop Genomics

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (90 min, Klausur) students explain without additional helping material the principles of genetic and bioinformatics strategies of genome analysis in crop plants. They demonstrate that they understand the different layers of genome analysis in crop plants, and that they are able to apply the required genomic and bioinformatics approaches in case studies and judge which methods can be applied in specific cases. They can explain the use of genomic data to analyze genotype-phenotype associations. The grade of the exam will be the final grade of the module.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of Bachelor’s courses in genetics, molecular biology, plant breeding and statistics is required. Basic knowledge in bioinformatics and skills in R programming or a computer language like Python is highly recommended.

Content:
- Genome organization in crop plants (theory)
- Next generation sequencing and genotyping technologies (theory)
- Genome sequencing and annotation (theory)
- Accessing biological sequence information from databases (theory, exercises)
- DNA sequence comparison and alignment, homology searches (theory, exercises)
- Analysis of genomic sequence data, detection of sequence variants (theory, exercises)
- Analysis of gene expression through genome-wide approaches (theory, exercises)
- Comparative genome analysis (theory)
- Genotype-phenotype association for complex agronomic traits (theory, exercises)
- Application of genomic methods in applied plant breeding programs (theory)

Intended Learning Outcomes:
Upon completion of the module students are able to evaluate molecular methods and the bioinformatic and genetic concepts of genome analysis in crops. They understand the genome organization of crop plants and can explain the concepts of next generation genome sequencing, genome annotation and functional analysis of crop plants. They will be able to access biological sequence information from databases and understand the concept of DNA sequence comparison and alignment. Students will be able to analyze plant genomics data and to use bioinformatic/ statistical approaches for the analysis of genotype-phenotype associations. Successful students can judge which approaches are appropriate for specific situations.

Teaching and Learning Methods:
Theoretical concepts are demonstrated in PowerPoint presentations. Practical application of these concepts will be through computer exercises and tutorials using experimental data sets.
In individual or group work on specific topics with presentations students show their ability to understand and solve problems using current literature and to analyze and evaluate the required methods.
Students are encouraged to attend the weekly talks of the SFB924 seminar series (dates and topics announced under http://sfb924.wzw.tum.de), which are given by national and international experts in plant molecular biology and plant genomics.

Media:
PowerPoint presentations, whiteboard. Lecture slides will be provided online in pdf format.
Computer exercises, application training (analysis of sequence data, genotype-phenotype associations)
Current literature

Reading List:
Brown: Genomes 4. Garland Science, 2017. ISBN 978-0-815-345084
Grotewold, Chappell and Kellogg: Plant Genes, Genomes and Genetics. Wiley-Blackwell, 2015. ISBN: 978-1-119-99887-7

Current literature from specific journals will be announced during the lecture.

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1332: Research Project Biogenic Allergens | Forschungspraktikum Biogene Allergene

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:**
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In einem etwa 6 wöchigen geblockten Laborpraktikum werden Fragestellungen zu multifaktoriellen Bildung von biogenen Allergenen und ggf. den Einfluss auf den menschlichen Organismus untersucht, wobei auf eine Einbindung in laufende Forschungsarbeiten angestrebt wird. Zur Anwendung kommen dabei auch zu größeren Teilen die jeweilige aktuelle Laborausstattung des Projektes. Am Ende des Praktikums wird ein Protokoll über das durchgeführte Projekt geschrieben und ein Vortrag darüber gehalten.

Repeat Examination:

(Recommended) Prerequisites:
Lehrveranstaltungen der mikrobiellen Ökologie im weiten Sinne oder der Pflanzenphysiologie, -biochemie, Molekularbiologie und verwandten Disziplinen

Content:
The majority of allergens in outdoor environments originate from pollen and fungi. Their allergenic potential depends on the amount and composition of allergens which are influenced by the environment. Among the major allergens are mainly stress proteins that are induced upon adverse environmental conditions such as suboptimal temperature, radiation, water regimes and interaction with air pollutants. Such scenarios are predicted to increase under ongoing climate change. Major aims of our group are to understand plant and fungal reactions to environmental conditions that induce stress. Allergenic potentials are studied using a system's approach from the organism to the molecular level. This also includes biotic factors that mediate stress responses in plants and fungi, thus potentially altering the allergen composition. Examples are microorganisms interacting with allergenic pollen, allergenic fungi reacting to other microorganisms, and microbial community composition in indoor environments that may affect immune responses of humans.

We aim at identifying factors that influence allergenic potentials such as kind and amount of allergens and interacting metabolites. Therefore, we perform experiments under controlled environmental conditions with increasing levels of complexity (single and combined stress factors) in phytotron chambers and in the greenhouse. Since results from controlled environmental conditions need to be verified in complex outdoor conditions, environmental samples are also studied. In addition, we use indoor dust samples in cohort studies to relate microbiome composition to human health data. From a microbial ecology perspective, we want to know which role biotic components and interactions play on allergenic potentials in outdoor and indoor environments.

Intended Learning Outcomes:
vertiefte Kenntnisse der Pflanzenstressbiologie, Biochemie der Allergene, und ggf. der mikrobiellen Ökologie; Anwendung theoretischen Wissens und erlernter Techniken in aktuellen Forschungsprojekten

Teaching and Learning Methods:
Interaktion Lehrende und Lernende
Anwesenheit und Mitarbeit im Labor; Verfassen eines Praktikumsberichts; Vortrag über die Arbeit: Methoden, Ergebnisse, Feedback

Media:

Reading List:
nach Absprache mit den Betreuern

Responsible for Module:
Pritsch, Karin

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1333: Research Project: Plants as Holobionts | Forschungspraktikum Pflanzen als Holobionten

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:**
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfung ist eine Laborleistung. Sie setzt sich zusammen aus einem praktischen Laborteil mit etwa 240 Zeitstunden. In diesem werden nach wissenschaftlichem Standard Daten gewonnen, die dann auszuwerten sind. Um die angestrebte Forschungskompetenz nachzuweisen ist im Anschluss an das Praktikum ein Bericht anzufertigen, der den Standards einer wissenschaftlichen Publikation nahekommt.
Die Ergebnisse des Berichts sind während der Erstellung des Berichts oder nach Abschluss des Berichts vorzutragen (20 Minuten plus anschließende Diskussion). Die Note ergibt sich aus der Gesamtleistung, die sowohl in der Qualität der Laborarbeit als auch im Bericht erbracht wurde.

Repeat Examination:

(Recommended) Prerequisites:
Lehrveranstaltungen der mikrobiellen Ökologie im weiten Sinne oder der Pflanzenphysiologie, -biochemie, Molekularbiologie und verwandten Disziplinen

Content:
Verschiedene Methoden der Molekularbiologie (z.B. Proteomik, DNA-/RNA-Analysen, Metabolitanalysen, biochemische Tests, stabile Isotopenanalyse). Datensammlung, Datenauswertung und Dateninterpretation mit Hilfe von fortgeschrittene statistischer Analytik sowie Berichtsanfertigung.

Intended Learning Outcomes:
Vertiefte Kenntnisse der Pflanzenbiologie und –ökologie, insbesondere Fähigkeit zur Charakterisierung von mikrobiellen Pflanzen-Mikroorganismen- Gemeinschaften mit modernen molekularbiologischen Methoden (z. B. Hochdurchsatzsequenzierung, Biostatistik unter

Anwendung von R), und der mikrobiellen Ökologie (FUNguild zur funktionellen Charakterisierung von DNA-Sequenzen von Pilzen) sowie weitere funktionelle Methoden zur Charakterisierung mikrobieller Gemeinschaften (stabile Isotopen- Techniken, biochemische Tests wie z. B. Enzymaktivitätsbestimmungen).
Absolvierende des Moduls können das vorhandene Grundlagenwissen mit den aktuellen Publikationen zu diesem Thema eigenständig verknüpfen und das so neu generierte Wissens in der praktischen Forschung anwenden. Sie können eigenständig die Daten erfassen, auswerten und im Kontext der aktuellen wissenschaftlichen Literatur interpretieren. Sie haben ein vertieftes Wissen von Pflanzen in ihrer Wechselwirkung mit assoziierten Mikroorganismen und können komplexe Interaktionen auf biochemischen als auch auf ökologischen Niveau interpretieren und Anwendungen für den Menschen ableiten. Sie können in aktuellen Forschungsprojekten Teilprojekte weitgehend selbständig bearbeiten.

Teaching and Learning Methods:
Interaktion Lehrende und Lernende
Anwesenheit und Mitarbeit im Labor; Verfassen eines Praktikumsberichts; Vortrag über die Arbeit: Methoden, Ergebnisse, Feedback

Media:

Reading List:
nach Absprache mit den Betreuern

Responsible for Module:
Pritsch, Karin

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1415: Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 240	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studien-/Prüfungsleistung ist eine Laborleistung, d.h. die Studierenden sollen eine oder mehrere Forschungsfragen weitgehend selbständig bearbeiten. Zur Durchführung liegen zum Teil vorgegebene Protokolle vor. Die Studierenden führen teilweise Freiland als auch Laborarbeiten durch und werden dabei jeweils in die Arbeitsmethoden und Geräten eingewiesen, so dass Sie die Methoden meist vollkommen selbständig, in einigen speziellen Fällen unter Anleitung, nutzen können. Im Rahmen des Forschungspraktikums erheben sie Daten, die sie auswerten und präsentieren. Hierbei wird erwartet, dass sie die erhaltenen Ergebnisse in Bezug zu den Fragestellungen und selbst entwickelten Hypothesen setzen und in einen breiteren wissenschaftlichen Kontext stellen.
Im Anschluss an das Praktikum wird der Kompetenzgewinn in Form eines benoteten, wissenschaftlichen Standards genügendem Protokolls schriftlich abgeprüft, welches innerhalb von 4-6 Wochen nach Abschluss des Praktikums vorzulegen ist. Dabei handelt es sich um eine 20-50 Seiten umfassende schriftliche Arbeit, die zunächst auf das zu bearbeitende Thema unter Aufführung bereits publizierter wissenschaftlicher Vorarbeiten hinführen, die Forschungsfragen und -hypothesen erläutern, dann die verwendeten Methoden (inklusive Statistik) im Detail aufführen, alle Ergebnisse darstellen und zuletzt in Bezug auf bestehende Literatur diskutieren soll. Mit dem Protokoll weisen die Studierenden nach, dass Sie eine zwar thematisch begrenzte, aber anspruchsvolle Fragestellung der Insekten-Pflanzen Interaktion mit Fokus auf die damit verbundenen Verhaltensphysiologischen Grundlagen innerhalb begrenzter Zeit erfolgreich bearbeiten und entsprechend den wissenschaftlichen Gepflogenheiten darstellen und abschließen können. Um auch die notwendige Fähigkeit zur Vermittlung der Ergebnisse zu prüfen und benachbarte Themen, die nicht Kernbestandteil des Protokolls sind, abzuprüfen, muss im Rahmen der Laborleistung und nach Abschluss von Datenaufnahme und -auswertung ein Vortrag (20 min) innerhalb der Arbeitsgruppe gehalten werden. Es wird empfohlen, den Vortrag 2-3 Woche vor Protokollabgabe zu halten.

Die Leistungen von Protokoll und Vortrag werden mit einer Note bewertet, wobei das Protokoll einen etwa doppelt so hohen Anteil wie der Vortrag hat.
Die Kontaktzeit mit dem Betreuenden sind ungefähr 60 Stunden. Die restlichen 240 Stunden bestehen aus eigenständiger Arbeit in Feld, Labor und Bibliothek. Davon entfallen etwa 40 Stunden auf die Erstellung des Protokolls und des Vortrags.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Ökologie, Botanik und/oder Entomologie sind nötig, beispielsweise auf dem Niveau der Module "Allgemeine Ökologie", "Grundkurs/Allgemeine Botanik" und/oder "Grundkurs/Allgemeine Zoologie". Abhängig vom finalen Projektthema sind grundlegende Kenntnisse der Biodiversität, Ernährungsökologie, Physiologie oder Neurobiologie wünschenswert, beispielsweise auf dem Niveau der Vorlesungen/Seminare "Diversität und Evolution der Farn- und Samenpflanzen", "Vegetation der Erde", "Funktion und Interaktion von Insekten in Waldökosystemen", "Bienenkunde", "Cognitive Neuroscience" oder "Sinnesphysiologie".

Content:
Innerhalb dieses Forschungspraktikums können Themen aus dem Bereich der Ökologie von Insekten behandelt werden. Beispielhaft wären die Themen „Einfluss Pestiziden auf das Lern- und Sammelverhalten von Bienen“ oder "Nährstoffperzeption bei verschiedenen Bienenarten"; dies beinhaltet in der Regel eine Kombination aus Verhaltensversuchen und Freiland- oder Käfigbeobachtungen. Weiterhin können Verhaltensversuche auch mit chemischen Analysen (z.B. GCMS) kombiniert werden. Auch Experimente mit anderen Insekten (Schmetterlinge, Fliegen, Käfer, Ameisen) sind möglich. Der Schwerpunkt in diesem Forschungsmodul liegt auf der Untersuchung der Physiologie des Verhaltens, welche Interaktionen zwischen bestimmten Insektenarten und bestimmten Pflanzenarten zur Grunde liegt. Die Studierenden werden, soweit wie möglich, die Versuche selbstständig durchführen und auswerten. Das genaue Thema ist nach Absprache mit den jeweiligen Dozenten zu vereinbaren.

Intended Learning Outcomes:
Nach erfolgreichem Abschluss des Moduls sind die Studierenden in der Lage, Versuche zu den verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten sowie deren Auswertung weitgehend oder vollständig eigenständig durchzuführen. Dazu gehört das Designen von Feldexperimenten, die systematische Datenaufnahme im Feld, die Konditionierung von Bienen anhand bestehender Laborprotokolle und die statistische Auswertung von Versuchsergebnissen mit Hilfe des "open software" Programms R. Darüber hinaus erlernen sie die Fähigkeit, in wissenschaftlich strukturiertem Format zu schreiben und ihre Ergebnisse in Bezug zu den erhaltenen Fragestellungen und selbst entwickelten Hypothesen zu setzen sowie in einen breiteren wissenschaftlichen Kontext zu stellen.

Teaching and Learning Methods:
Lehrmethode: Gespräch, Anleitung an Spezialgeräten, wie z.B. Mikromanipulatoren, bis eigenständiges Arbeiten möglich ist; Anleitung zu Arbeiten im Freiland, bis eigenständige Feldarbeit durchgeführt werden kann; Diskussionen von Zwischenergebnissen in Lehrstuhlseminar; ggf Anleitung zur Erstellung einer wissenschaftlichen Arbeit.
Lernmethode: Arbeit in Freiland und Labor; systematische Datenerfassung und Auswertung; graphische Darstellung von Ergebnissen, Niederschrift und Vortrag; Studium der Literatur und der grundständigen Lehrbücher.

Media:
Anleitungen zu Freilandarbeiten und Laborversuchen, Protokolle zu Konditionierung und Auswertungen, Arbeitsgruppen-Seminare und Gespräche, mündliche statistische Einführung, R-Skripte, wissenschaftliche Literatur, Bücher, Datenbanken

Reading List:
Wissenschaftliche Literatur wird innerhalb des Praktikums ausgegeben und soll zusätzlich in eigenständiger Literaturrecherche erarbeitet werden.
Beispiel für Standartwerk zum Thema:
Nickolas M. Waser & Jeff Ollerton (2006): Plant-Pollinator Interactions: From Specialization to Generalization
Stephen J. Simpson & David Raubenheimer (2012) The Nature of Nutrition

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten (Praktikum, 10 SWS)
Leonhardt S [L], Leonhardt S, Rüdenauer F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2273: Practical Course in Phytopathology | Forschungspraktikum Phytopathologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 100	**Contact Hours:** 200

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
A detailed internship report (preferably in English) in conjunction with an accurately kept laboratory book serves to verify the knowledge acquired during the internship and the performance of the practical work. In the internship report, students show whether they are able to place the practical work in the scientific-theoretical context and whether they are able to adequately present and interpret the results of their research. Furthermore, the results should be discussed appropriately, e.g. by including scientific publications from the relevant subject area. A concluding presentation about the project in English rounds off the internship.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of molecular plant sciences and cell biology

Content:
Insight into the problem-oriented work with modern methods of life sciences (co-immunoprecipitation, qRT-PCR, GoldenGate cloning, etc.) Acquisition of a profound understanding and ability to apply research methods in the agrobiosciences. Insights into the scientific approach to questions from relevant research projects, e.g. MAMP recognition, molecular evolution of plant defence, plant susceptibility factors. Learning how to present research results.

Intended Learning Outcomes:
After participating in the module course, students are able to create experimental solutions for current problems in phytopathological research. By working on and participating in current research projects, students gain a deeper understanding of how results are to be evaluated against the experimental background. In addition to methodological skills, primarily in molecular biological,

protein biochemical and bioinformatics methods, independent action and autonomous decision-making are encouraged. The performance of laboratory experiments forms the basis for the acquisition of technical competence.

Teaching and Learning Methods:
Practical laboratory work; instructional talks, demonstrations, experiments, literature work, data analysis/result discussions, presentation of results, practice of laboratory technical skills and working techniques, preparation of protocols.

Media:
Protocols and scientific literature

Reading List:
Introductory technical literature on the respective topics and methods is made available in the form of publications.

Responsible for Module:
Ralph Hückelhoven hueckelhoven@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Agrobiowissenschaften Pflanze/Phytopathologie (Forschungspraktikum, 10 SWS)
Hückelhoven R, Hausladen J, Engelhardt S, Ranf-Zipproth S, Schempp H, Stam R, Stegmann M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2380: Research Project Plant Systems Biology | Forschungspraktikum Pflanzensystembiologie

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Following this six week practical training, each participant writes a research report (20 - 30 pages) and presents(20 - 30 min.) his results at the progress report meeting of the department in German or English language. Besides scientific criteria also the graphic representation of the results figures following publication quality guidelines (Adobe Photoshop, Adobe Illustrator) will be paid attention to. The students can decide themselves on a date for handing in the report, to ensure that sufficient time is available for compiling it.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of plant biology, morphology and cell biology is recommended. Basic techniques for working in the molecular biology laboratory is strongly recommended such as clean pipetting.

Content:
The practical training teaches profound skills in one of the following techniques: (I) gene expression analysis (evaluation of microarray data, quantitative real time PCR, reporter gene analysis in intact organisms), (II) cell biology (confocal microscopy, analysis of different cell compartments using GFP-fusion proteins etc.) or (III) biochemistry (expression and purification of recombinant proteins from bacteria, functional assays). The participants are being introduced into current topics in molecular plant biology, that are being worked on in the department.

Intended Learning Outcomes:
Following participation in the practical course, students will have detailed practical and technical knowledge to answer systems biology problems in biology, specifically but not exclusively in plant biology.

Teaching and Learning Methods:
Form of studies/study techniques: Study of the lecture script, lecture comments and appropriate literature. Preparation of a written report with publication quality figures. Working with time pressure. Meeting deadlines.

Media:
Working with the handout. Basic skills in using one of the two softwares, Adobe Photoshop or Adobe Illustrator. Working independently on a fluorescence microscope or other state-of-the-art equipment.

Reading List:
Plant Physiology (Taiz/Zeiger) 5th edition. Molecular Biology of the Cell (Alberts).

Responsible for Module:
Schwechheimer, Claus; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum I, II, III und IV (PlaSysBiol PR I, II, III, IV) – M.Sc. (Forschungspraktikum, 10 SWS)
Schwechheimer C [L], Schwechheimer C, Hammes U, Denninger P, Bassukas A, Graf A, Sala J, Schröder P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2384: Research Project 2 Molecular Biology of Plant | Forschungspraktikum 2 - Molekularbiologie der Pflanzen

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (in min.): 30 oral tests + graded test report.
To check the comprehension as well as the ability to describe, evaluate and interpret the experiments carried out during the practical training, a protocol has to be kept, which is checked and graded. In a colloquium, students demonstrate their ability to structure the acquired knowledge and to present the essential aspects of molecular biology of plants. They should be able to describe, interpret and combine the acquired information in a meaningful way and apply it to similar situations. The overall grade of the module consists of the protocol grade and the colloquium grade (1:1).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For a better understanding of the contents imparted during the internship, a profound knowledge of the biological and molecular basics is required; in addition, in-depth experimental experience in plant sciences and a completed bachelor thesis are prerequisites

Content:
Das Praktikum führt die Teilnehmer vertieft an aktuelle Themen und Methoden der molekularen Pflanzenbiologie heran. Die Teilnehmer arbeiten dabei zusammen mit Wissenschaftlern Hand in Hand an aktuellen Forschungsprojekten des Lehrstuhls. Das Praktikum wird für verschiedene Themenbereiche angeboten. Themenbereiche sind die Streßphysiologie der Pflanzen, der pflanzliche Xenobiotika-Metabolismus, pflanzliche Peroxisomen und Zellteilung. Die Festlegung des Themas erfolgt nach Absprache.

Streßphysiologie: Gegenwärtig werden am Lehrstuhl die pflanzliche Reaktion auf Trockenstreß, Salzstreß und Starklichtstreß untersucht. Aktuell spielen in diesem Zusammenhang die Wurzel-Sproß-Kommunikation unter Streßbedingungen und Abscisinsäure-vermittelte Signaltransduktion bzw. Anpassungsreaktionen in Wildtyp und speziellen Mutanten eine wichtige Rolle. Techniken: In vivo-Imaging Verfahren (Detektion von Luciferaseaktivität mit zellulärer Auflösung, Thermokamera, Calcium-Imaging), transiente Expression im Protoplastensystem, Konfokalmikroskopie, SDS-PAGE, Western Blot, Klonierung.

Programmierter Zelltod: Gegenwärtig wird in der Arbeitsgruppe Gietl die Funktion der KDEL-Cystein Endopeptidasen in Entwicklung und Pathogen-Abwehr, sowie ihr Transport innerhalb der Zelle untersucht. Techniken: Pflanzenanzucht; Inokulierung mit biotrophen, semi-biotrophen und nekrotrophen Pilzen, Beurteilung des Befallsstadiums; Untersuchung von Reporterlinien bzw. ko-Mutanten; Mikroskopie, Konfokalmikroskopie; Proteinuntersuchungen (Hochregulierung der KDEL-Cystein Endopeptidasen, Immunpräzipitation, Aktivitätsmessung.

Xenobiotika-Metabolismus: Fremdstoffe (Xenobiotika) werden in der Pflanze modifiziert und vielfach an hydrophile Substanzen wie Zuckermoleküle und Glutathion konjugiert. Im Rahmen des Praktikums werden grundlegende analytische Methoden wie HPLC, Hefetransformation, Klonierungen und Enzymassays verwendet. An der Glutathionkonjugation beteiligte Pflanzenenzyme werden in Hefe als Modellsystem exprimiert und ihre Funktion bei der Pestiziddetoxifikation untersucht.

Zellteilung: Die Arbeitsgruppe Assaad untersucht Zellteilung, Zellwandbildung, Membranverkehr und Allokationsentscheidungen in Arabidopsis thaliana. Mit Methoden der Molekulargenetik, Zellbiologie und Biochemie wird die Regulierung des Wachstums in Antwort auf unterschiedliche Stressbedingungen untersucht. Zum Einsatz kommen Techniken wie Mutantenanalyse, Kartierung, positionelle Klonierung, Live Imaging und Immunolokalisierung anhand von Konfokalmikroskopie und Immunopräzipitation.

Intended Learning Outcomes:
By participating in the research internship, students acquire in-depth theoretical knowledge and a specific understanding of
"questions of molecular plant biology
"Modern working techniques of plant physiology
You will then be able to apply the acquired knowledge to in-depth questions, to competently apply modern working techniques of plant physiology and to experiment with plants, especially with Arabidopsis

Teaching and Learning Methods:
The internship introduces the participants to current topics and methods of molecular plant biology. The participants work hand in hand with scientists on current research projects of the chair. The internship is offered for different topics. Topics are stress physiology of plants, plant xenobiotic metabolism, plant peroxisomes and cell division. The topic will be determined by arrangement.

Stress Physiology: Currently, the department is investigating the plant response to drought stress, salt stress and high intensity light stress. Currently, root-sprout communication under stress conditions and abscisic acid-mediated signal transduction or adaptation reactions in wild type and special mutants play an important role in this context. techniques: In vivo imaging techniques (detection of luciferase activity with cellular resolution, thermal camera, calcium imaging), transient expression in the protoplast system, confocal microscopy, SDS-PAGE, western blot, cloning.

Programmed cell death: Currently, the Gietl group is investigating the function of KDEL-cysteine endopeptidases in development and pathogen defense, as well as their transport within the cell. Techniques: Plant growth; inoculation with biotrophic, semi-biotrophic and necrotrophic fungi, assessment of the stage of infestation; investigation of reporter lines or co-mutants; microscopy, confocal microscopy; protein studies (upregulation of KDEL-cysteine endopeptidases, immunoprecipitation, activity measurement.

Xenobiotic metabolism: Foreign substances (xenobiotics) are modified in the plant and often conjugated to hydrophilic substances such as sugar molecules and glutathione. During the practical course basic analytical methods such as HPLC, yeast transformation, cloning and enzyme assays are used. Plant enzymes involved in glutathione conjugation are expressed in yeast as a model system and their function in pesticide detoxification is investigated.

Cell division: The Assaad group studies cell division, cell wall formation, membrane traffic and allocation decisions in Arabidopsis thaliana. Using methods from molecular genetics, cell biology and biochemistry, the regulation of growth in response to different stress conditions is studied. Techniques such as mutant analysis, mapping, positional cloning, live imaging and immunolocalization using confocal microscopy and immunoprecipitation are applied.

Media:
Presentations via PowerPoint, blackboard writing,
Internship script (PowerPoint presentations can be downloaded)

Reading List:
Weiler and Nover: General and molecular botany. Thieme publishing house.
Peter Schopfer and Axel Brennicke: Plant Physiology. Spektrum Akademischer Verlag.
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag
Bob Buchanan, Wilhelm Gruissem and Russell L. Jones: Biochemistry & Molecular Biology of Plants. John Wiley & Sons
Professional articles from scientific journals (adapted to the chosen working topic).

Responsible for Module:
Erwin Grill (Erwin.Grill@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum II: [WZ2384] (Forschungspraktikum, 10 SWS)

Grill E (Doch I, Liebthal M, Röder J, Sühnel M, Yang Z), Assaad-Gerbert F (Wiese C), Christmann A (Groß L)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2400: Practical Course: Computing for Highthroughput Biology | Forschungspraktikum Computeranwendungen für Hochdurchsatz-Biologie

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the course, students work on large-scale genomic data sets. The scientific problem, the applied methods, the results and the interpretation and discussion of the results will be documented in a scientific report (ca. 20 pages) which will be graded.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of computer systems. Familiarity with UNIX/Linux and basic programming skills in R or Python are an advantage.

Content:
Agricultural biosciences demand computational skills and in depth knowledge of biological data. During the course, students will practice with some common data analysis methods of high throughput technology, such as next generation sequencing, gene expression analysis, high-throughput genotyping in individual projects. They will gain knowledge on how to utilize existing biological databases in their research and how to interpret their own results in the context of current literature.

Intended Learning Outcomes:
In individual research projects, students will become familiar with computational strategies for the analysis of high dimensional data. Upon completion of this module, students are able to handle large datasets and process them with appropriate tools using programming languages like R or Python. They will be able to analyze datasets and use suitable tests for evaluating the plausibility of the data and to do quality filtering. They will be able to apply custom pipelines for data analysis.

Depending on the specific project this will include the use of public databases, text manipulation with R or Python, gene expression analysis with bioconductor R, sequence analysis with blast, vmatch, Clustalw, BWA, genome visualization with GBrowse and Next Generation Sequencing workflows. Students will be able to test the significance of the results and to interpret them in the context of current literature.

Teaching and Learning Methods:
The advisors will provide experimental data from current research projects or from public datasets. In computer exercises, students will learn to write programming scripts for handling and analyzing the data. Results will be discussed with the advisors and interpreted using current literature.

Media:
Case studies, computer exercises.

Reading List:
Project-specific current literature will be provided for each project.

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Computeranwendungen für Hochdurchsatz-Biologie (Forschungspraktikum, 10 SWS)
Avramova V, Lanzl T, Urzinger S, Mayer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2401: Research Project 'Molecular Plant Breeding' | Forschungspraktikum Molekulare Pflanzenzüchtung

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a project report (approx. 15-20 pages), which is to be submitted at the end of the module and is graded. The report contains a short introduction to the topic, the scientific research questions, the applied material and methods, the results and a discussion of the results in the context of current literature.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in molecular genetics and plant breeding. Previous practical experience with molecular techniques and/or handling of plants is an advantage.

Content:
The individual projects that students will work on encompass current topics of plant breeding and address different aspects of ongoing research projects. The projects cover the acquisition of scientific methods and comprise molecular genetic laboratory and/or modern phenotyping methods for agronomic traits. Depending on the individual project, different molecular techniques are applied (e.g. DNA extraction from plant material, PCR, DNA cloning and sequencing, analysis of molecular markers, gene expression analysis). We also offer topics related to drought stress in field or greenhouse experiments with a strong focus on application in crop plants, where physiological and agronomic traits are assessed. In projects with a focus on phenotyping, students will learn how to plan and conduct field or greenhouse experiments and how specific phenotypes are measured. During the project, the appropriate scientific analysis and interpretation of the data will be addressed, which includes e.g. statistical data analysis, mapping of genes/QTL, characterization of genes, literature work.

A list of current projects is available at www.wzw.tum.de/plantbreeding. Upon agreement own topics can be suggested.

Intended Learning Outcomes:
In the research project "Molecular Plant Breeding" the students will learn to design experiments in the lab or greenhouse/field in individual case studies. They gain experience in planning and conducting the experiments, organizing the work and analyzing experimental data. Upon successful completion of the research project, students are able to scientifically analyze, interpret, discuss and present their obtained results in the context of current literature.

Teaching and Learning Methods:
Depending on the individual project, the students will gain and practice laboratory skills and/or knowledge on handling of plants in greenhouse/field experiments through hands-on lab practicals and/or hands-on phenotyping methods. Through instruction by their advisor, they will learn to define specific scientific questions related to their individual topic, to find solutions to solve these questions and to discuss the results. By preparing an oral presentation and a final written report, students learn how to adequately describe their experiments, how to structure the results and how to discuss the results in view of current literature.

Media:
Experimental studies related to current research projects, current literature

Reading List:
Project-specific current literature will be provided for each project.
General:
- Grotewold, Chappell and Kellogg: Plant Genes, Genomes and Genetics. Wiley-Blackwell, 2015. ISBN: 978-1-119-99887-7
- Brown: Genomes 4. Garland Science, 2017. ISBN 978-0-815-345084
- Abraham Blum: Plant Breeding for Water-limited Environments, Springer Science + Business Media S.A.; ISBN-10:1441974903

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Pflanzenzüchtung (Forschungspraktikum, 10 SWS)
Avramova V, Eggels S, Mohler V, Polzer C, Urzinger S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2594: Research Project Secondary Plant Metabolites | Forschungspraktikum Sekundäre Pflanzeninhaltsstoffe

Research Project Secondary Plant Metabolites

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Two presentations of the participants (15 min each, graded) on the planning and the results of a laboratory project and a final colloquium (15 min, graded) are designed to review the learned skills. The students show in the colloquium and in the presentations, whether they are able to structure the acquired knowledge and represent the essential aspects. They should have the ability to describe, interprete, combine useful and be able to transfer the compiled information to similar situations. The overall grade of the module is determined in equal parts of presentations and colloquium. To check the understanding and ability to description, analysis and interpretation of the experiments, a record must be kept, which also provides the basis for the second presentation.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basics in organic chemistry and biochemistry, knowledge on bioactive compounds

Content:
Students have to work on an analytical project on secondary metabolites or on managing the bisoynthesis of secondary metabolites in plants for improving quality or resistance. A further possible experimental field is the profiling of bioactive compounds in plant foods. Depending on the research project the following methods will be used: chromatography, spectroscopy, enzymatic assays, transcriptome analyses.

Intended Learning Outcomes:
After the course the participants have advanced knowledge in analysis of secondary metabolites in plants including the characterizaton of the molecule structure and the metabolite quantification.

The participants have advanced knwoledge on biosynthesis of secondray metabolites and on its elicitation and where applicable on pathogen action. They are furthermore able to organize a chemical analysis project independently on the basis of literature. After the experiment they are able to critically evaluate the data in comparison with the relevant scientific literature.

Teaching and Learning Methods:
Teaching Techniques: lecture, practical method of teaching: lecture, practical instructions in the discussions, demonstrations, experiments, pair work, discussions of financial performance.
Learning Activities: Study of Lecture notes-complicity, Lecture notes and literature; practicing laboratory skills, preparation of protocols.

Media:
Presentations using PowerPoint, script (download option for lecture material), laboratory exercises, practical work on projects

Reading List:
Current scientific and project-related literature, journals, according to the instructions by the supervisor

Responsible for Module:
Dieter Treutter (dieter.treutter@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2629: Research Project Chemical Genetics | Forschungspraktikum Chemische Genetik

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Following the regular and active participation in a six week practical course (at least 25 hours/ week) the students hand in a research report. By preparing the written report the students demonstrate the ability to summarize the key aims of the performed experiments in the field of plant chemical genetics, to present the acquired results in a concice and coherent manner and to interpret and discuss the experimental data in the context of available literature.
The final grade is an averaged grade from the written report (60%) and the level of of in-course participation (40%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology, biochemistry, genetics and chemistry. Practical experience with basic lab working techniques such as pipetting and working under sterile conditions. Completion and above average grading of the lecture(s) Crop Biotechnology and/or Plant Biotechnology.

Content:
Chemical Genetics is a novel interdisciplinary approach in which small molecules are used to identify proteins responsible for the expression of a specific phenotype (forward chemical genetics) or to affect the function of a specific protein and assess the morphological, physiological and molecular consequences in the organism (reverse chemical genetics). Chemical genetic approaches are not only useful in basic research questions, they can also directly lead to the development of drugs and agrochemicals.
Participation in the course will teach students a subset of the following techniques by participating in a research project in the lab: 1) Storage and handling of a chemical library, (2) design and set

up of a chemical genetic screen, (3) phenotype-based small molecule screen in Arabidopsis or an horticulturally relevant plant species, (4) expression marker-based small molecule screens , (5) hit confirmation and structure/function analysis using cheminformatic methods, (6) establishment of an in vitro assay to test ligand-target interaction.

Intended Learning Outcomes:
Upon completion of this module students are able to actively participate in chemical genetic research projects. They will be qualified to assess for which scientific questions a chemical genetic approach might be helpful. They are capable of independently carrying out basic chemical genetic experiments in plants and can interpret the obtained results.

Teaching and Learning Methods:
Personal supervision in experimental work, critical discussion of results, writing of a concice research report in the common publication format, oral presentation and discussion of data with lab peers.

Media:
Oral presentation, lab protocols, relevant scientific publications.

Reading List:
Plant Chemical Genomics: Methods and Protocols (2014) G. R. Hicks and S. Robert, Humana Press; Plant Chemical Biology (2014) D. Audenaert and P. Overvoorde, John Wiley & Sons.

Responsible for Module:
Tobias Sieberer (tobias.sieberer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Chemische Genetik (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Ramirez V, Sieberer T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2630: Research Project Plant Growth Regulation | Forschungspraktikum Wachstumsregulation der Pflanzen

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 108	**Contact Hours:** 192

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Following the regular and active participation in a six week practical course (at least 32 hours/ week) the students hand in a research report. By preparing the written report the students demonstrate the ability to summarize the key aims of the performed experiments in the field of plant growth regulation, to present the acquired results in a concice and coherent manner and to interpret and discuss the experimental data in the context of available literature.
The grading will be also based on the level of active participation and experimental/ intellectual skills during the lab work. The final grade is an averaged grade from the written report (60%) and the level of of in-course participation (40%).

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology and physiology, genetics and plant development. Practical experience with basic lab working techniques such as pipetting and working under sterile conditions. Completion and above average grading of the lecture(s) Crop Biotechnology and/or Plant Biotechnology.

Content:
As primary resource of biomass plants grow by continuous formation of modular organs. The net growth is the result of different growth parameters including the rate of organ formation, the size of the single organs and the overall amount of formed organs. Moreover it is strongly dependent on environmental conditions (nutrients, water, light and temperature) and the germplasm (constitution of limiting genetic factors and overall genome structure). Plant growth optimization is thus multifactorially conditioned process and strongly dependent on the specific utilization of the crop.

The present research project deals with the molecular characterization of genetic factors which act limiting on the different growth parameters mentioned above. Using modern genetic, chemical genetic and molecular biological approaches known and novel important yield affecting loci are identified and positioned in the established regulatory network.

Intended Learning Outcomes:
Upon completion of this module students are able to understand and assess methods and aims to optimize plant growth of different crop species particularly in characterizing regulatory pathways affecting leaf formation rate, elongation growth and architecture of shoots. They are capable of independently carrying out lab-based experiments with methods of molecular biology, biochemistry, plant physiology and/or genetics and can interpret the results. The module aims to prepare students for a master thesis in the respective research field.

Teaching and Learning Methods:
Personal supervision in experimental work, critical discussion of results, writing of a concice research report in the common publication format, oral presentation and discussion of data with lab peers.

Media:
Oral presentation, lab protocols, relevant scientific publications.

Reading List:
Plant Physiology and Development (2014) L. Taiz and E. Zeiger, Sinauer Associates Inc.,U.S.; Plant Biotechnology and Agriculture: Prospects for the 21st Century (2011) A. Altman and P. M.Hasegawa, Academic Press.

Responsible for Module:
Tobias Sieberer (tobias.sieberer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Wachstumsregulation der Pflanzen (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Sieberer T, Dündar G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2685: Research Project Redox-Biochemistry in Plant-Environment Interaction | Forschungspraktikum Redox-Biochemie bei der Pflanze-Umwelt Interaktion

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 120	**Contact Hours:** 180

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
6-week block internship by arrangement. Regular participation of about 6 hours daily. Preparation, execution, interpretation and discussion of experiments. The students plan and carry out their experiments independently. They conduct independent literature research and make a scientific evaluation of the results. Prerequisites are a sound basic knowledge in protein biochemistry and molecular biology and sufficient confidence in basic techniques of the molecular laboratory. The topics of the work come from current research areas (by arrangement). Grading is based on the quality of the laboratory work (primarily the activity, productivity, creativity and independence of each student is assessed), the protocol written in the form of a scientific paper and a final presentation. Students should show that they are able to present the essential aspects of the experiments in a structured and reflected way.
The examination is a laboratory achievement consisting of the graded protocol and the study achievement "presentation" of 20 minutes duration.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in protein biochemistry, molecular biology and plant physiology.

Content:
Insight into the problem-oriented work with modern methods of life sciences. Acquisition of a profound understanding and ability to apply research methods in plant sciences. Insights into the scientific approach to questions from relevant research projects. Learning how to present research results.

Working on a research project from the subject areas of the research group. (I) NO production (II) NO-signaling: NO-dependent chromatin modulation under environmental stress conditions (III) redox homeostasis and detoxification of ROS and NO and (IV) NO fixation in plants. The lab course provides in-depth skills in redox-signaling, redox metabolism, biochemistry, plant-environment interaction. The following techniques are applied:
(I) Quantitative analysis of reactive oxygen and nitrogen species in plants and the environment (application of staining techniques and specific measurement devices). (II) Determination of the cellular redox status. (III) Expression and purification of recombinant proteins from bacteria, functional test, redox biochemistry. (IV) Analysis of histone modifications, immuno-blotting, gene expression analysis.

Intended Learning Outcomes:
The students practice independent scientific work, practice current molecular biological and biochemical techniques, practice literature research, the integration of relevant literature in a research project and scientific elaboration.

Teaching and Learning Methods:
Laboratory work, literature research, internet research, preparation of an internship report with illustrations in publication quality, presentation of the project.

Media:
Experimental protocols, textbooks in biochemistry, stress biology and plant physiology, Internet.

Reading List:
Biochemistry of plants; Gerhard Richter
Bioanalytics; Lottspeich and Zorbas

Responsible for Module:
Christian Lindermayr christian.lindermayr@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Redox-Biochemie bei der Pflanze-Umwelt Intereaktion (WZ2685)
(Forschungspraktikum, 10 SWS)
Lindermayr C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1035: Host-Parasite-Interaction | Host-Parasite-Interaction

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is rated via written examination, Klausur, (essay exam, no multiple choice, without the use of learning aids, (100 % of the grade; 90 min). The exam tests the ability of the students to transfer the deep knowledge of principles of molecular plant pathogen interaction on new scientific questions. Students have to show their ability to design experiments suitable to test a given hypothesis from molecular host-parasite interactions. Students have to show in how far they are able to extract scientific progress from original data or experiments presented in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of Plant Sciences and Phytopathology at the B.Sc. Level

Content:
In this modul, students reach a deep understanding of plant-pathogen interaction at the molecular level. This comprises pattern-triggered immunity, effector-triggered susceptibility, effector-triggered immunity and translational research. This is not restricted to model plants but extends to crops and fills the gap between basic research and applied plant sciences in breeding and biotechnology for disease resistance. In interactive learning structures with small groups, we train reading and understanding of original literature (Journal Club). In the practical course, we learn real time PCR, plant immune response assays, transient transformation of plants, cell biology of plant defense reactions, etc.

Intended Learning Outcomes:
Education to become a molecular plant pathologist, who is able to judge and design approaches for increasing disease resistance in model and crop plants.
Upon successful completion of the module, students are able

- to understand the molecular basis of plant pathogen interactions in depth.
- to transfer theoretical background and definitions of molecular host parasite interactions.
- to analyze plant immune responses.
- to collect new theoretical knowledge from literature and understand innovative technologies in plant immunity and susceptibility.
- to carry out key molecular methods for quantification of plant immune reactions and disease susceptibility (e.g. real time PCR, reactive oxygen measurement, transient transformation of plants, cell biology of plant defense reactions) in hands-on experience
- to generate experimental design and carry out evaluation of plant disease resistance tests in model and crop plants.

Additionally, students are able to process and present complex information from original literature.

Teaching and Learning Methods:
In the lecture students gain knowledge about theoretical background of plant parasite interactions, which is extracted and focussed by the lecturers from review literature. In the exercise, students practise in small groups key methods for quantification of plant immune reactions and disease susceptibility. They make hands-on experience, practise the use of molecular methods and devices, document their data under guidance and discuss them with group members and supervisors. In the journal club, students are guided in small groups how to critically read original research papers, digest information and present most central findings from a recent original paper.

Media:
PowerPoint

Reading List:
Buchanan 2015: Biochemistry & Molecular Biology of Plants. Review literature provided

Responsible for Module:
Hückelhoven, Ralph; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Host-Parasite-Interaction (Übung, 2 SWS)
Ranf-Zipproth S [L], Engelhardt S, Hückelhoven R, Stam R, Stegmann M

Host-Parasite-Interaction (Vorlesung, 1 SWS)
Ranf-Zipproth S [L], Hückelhoven R

Host-Parasite-Interaction (Seminar, 2 SWS)
Ranf-Zipproth S [L], Hückelhoven R, Engelhardt S, Stam R, Stegmann M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1075: Herbicides and Plant Physiology | Herbizide und Pflanzenphysiologie

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a 90-minute written exam. In the exam, students demonstrate that they understand herbicides in their application and effects in plant protection, that they can consider environmental aspects of herbicide application and that they can present and discuss the main advantages and disadvantages in a structured way. In addition, the students should develop a plan for the use of herbicides using concrete case studies and environmental conditions and assess the associated risks. Answering the questions requires students to formulate their own answers, and if necessary, to tick the appropriate boxes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For a better understanding of the lecture, knowledge of plant physiology is required, basic knowledge of agricultural production is useful.

Content:
* Herbicide classification and use, herbicide action (mode of action) and compounds related to plant metabolism.
* Development of different herbicide classes, sites of action and principles of action
* Methods of approval, testing and legal basis of herbicide use
* Molecular basis of herbicide action in plant metabolism
* Application technique and combinations of active ingredients
* Weed control in conventional, integrated and ecological systems
* Ecotoxicology of herbicides, fate in the environment and herbicide metabolism.

Intended Learning Outcomes:
After successful participation in the module, students will have the basic theoretical knowledge of herbicides, their application and effects in crop protection.
They are able to
- distinguish herbicide classes, selectivity and principles of action
- to assess herbicide damage to individual plants and stands
- describe the molecular basis of the effect and present resistance and tolerance
- to apply the legal basis and the principles of Integrated Pest Management
- take measures to reduce losses and plan site-specific application (climate, soil, damage thresholds)
- to explain how active ingredients enter different environmental compartments after application, how they are detoxified by plants and soil-borne microbes, and how herbicide residues remain in the environment.

Students are able to plan the use of herbicides on concrete application cases and are able to analyze and evaluate it according to performance and sustainability criteria.

Teaching and Learning Methods:
The module consists of a lecture and an accompanying exercise. The contents of the lecture are conveyed in the lecture and through presentations. Students should be encouraged to study literature and the content-related discussion of the topics become. During the field exercises on the experimental farms, concrete questions are answered and selected examples are worked on (e.g. identification of weeds, cultivation methods, soil types, weather data, application methods, alternative measures).

Learning activities: Study of lecture notes, lecture notes and literature; answering key questions provided in Moodle. This helps students to orientate themselves about their learning progress, to control their understanding and to develop the ability to describe, evaluate and interpret the knowledge acquired in self-study.
The exercise allows students to gain insights into practical aspects of crop protection. Trial fields and manufacturers are visited, assessments are carried out, herbicide application and loss-reducing measures are observed. Conditions for application (climate, soil, status of plants, damage thresholds) are critically evaluated. Concrete situations are analyzed in the overall scientific and technical context and evaluated ecologically and economically.

Media:
Presentation, script, field trips

Reading List:
There is no textbook available that covers all contents of this module. Recommended: Hock, Fedtke, Schmidt (1995) Herbicides. Georg Thieme publishing house Stuttgart; Zwerger P; Ammon HU. (2002) Weeds - Ecology and Control. Ulmer. Stuttgart; Martin Hanf (1999) Field weeds of Europe: With their seedlings and seeds. Ulmer, Stuttgart; Andrew Cobb (2010), Herbicides and Plant Physiology, Chapman and Hall

Responsible for Module:
Apl. Prof. Dr. Peter Schröder (peter.schroeder@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Herbizide und Pflanzenphysiologie (Vorlesung, 4 SWS)
Schröder P [L], Schröder P (Gerl G)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1032: Genetic Selection Supported by Markers | Marker-gestützte Selektion

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 120.
Die Prüfungsleistung wird in einer schriftlichen Prüfung (Klausur) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel Probleme der genetischen Kartierung und Marker-gestützten Selektion erkannt werden, und Wege zu einer Lösung gefunden werden können. Die Prüfungsfragen gehen über den gesamten Vorlesungsstoff.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkentnisse in Genetik, Grundkentnisse in Statstik

Content:
" Technische und genetische Prinzipien molekularer Marker
" Erstellung genetischer und physikalischer Karten
Gametenphasenungleichgewicht
" Theoretische Grundlagen und experimentelle Beispiele zur QTL- und Assoziationskartierung
" Theoretische Grundlagen und experimentelle Ergebnisse zur marker-gestützten und genomischen Selektion

Intended Learning Outcomes:
Verständnis für die grundlegenden Konzepte der marker-gestützten und genomischen Selektion und deren Anwendung in Zuchtprogrammen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Übungen

Lernaktivität: Literaturstudium, Rechnen von Übungsaufgaben
Lehrmethode: Vortrag, Übungen, Fragend-entwickelnde Methode

Media:
Präsentationen mittels PowerPoint, Software Übungen

Reading List:
Lynch and Walsh (1998) Genetics and analysis of quantitative traits

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Marker-gestützte Selektion (Vorlesung, 4 SWS)
Schön C, Mayer M, Ouzunova M, Lanzl T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1589: Marker-assisted Selection | Marker-assisted Selection

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written examination (Klasur, 120 min) students show without additional material that they are able to explain the basic concepts of marker-assisted selection. They demonstrate that they understand the required statistical and genetic methods. They are able to apply the methods in case studies and place them in the context of a breeding program. They can explain different methods in the analysis of quantitative trait loci. They show that they understand the basic concepts of genomic prediction and selection. They are able to evaluate the efficiency of marker assisted prediction and selection in breeding programs.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful Bachelor courses in biology, genetics, plant breeding, biotechnology and applied statistics.

Content:
Technical and genetic principles of molecular markers; building genetic and physical maps; theoretical background and experimental data sets for QTL- and association mapping as well as for genome wide prediction; theoretical background and experimental results for marker-assisted selection

Intended Learning Outcomes:
After successful completion of the module students are able to understand the basic concepts of marker-assisted selection, to apply statistical methods to experimental data sets and to use the respective genetic information in breeding programs. Students will be familiar with different regression methods (e.g. single marker regression, multiple marker regression) in the analysis of quantitative trait loci through linkage or genome wide association mapping. Using regularized

regression, they will be able to perform genomic prediction and selection. Based on examples from the literature they will be able to apply the above mentioned statistical methods to data. Using resampling methods, students will know how to evaluate the efficiency of marker-assisted prediction and selection and will be able to judge under which scenarios they are a useful tool for making breeding decisions.

Teaching and Learning Methods:
The module consists of a lecture, in which the theoretical foundations are developed together with the students through lecture and chalkboard work in dialog. PowerPoint presentations are used to visualize the concepts presented. The theoretical knowledge will be extended in computer exercises through the analysis of experimental data sets.

Media:
PowerPoint presentations, chalkboard
Computer exercises, application training

Reading List:
Lynch and Walsh (1998): Genetics and Analysis of Quantitative Traits; Sinauer Verlag, ISBN 978 0878934812
Risk . A Multidisciplinary Introduction (2014), Chapter 7 by Schön and Wimmer: Statistical Models for the Prediction of Genetic Values, Springer Verlag, ISBN 978-3-319-04486-6

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Marker-gestützte Selektion (Vorlesung, 4 SWS)
Schön C, Mayer M, Ouzunova M, Lanzl T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2014: Molecular Plant Breeding | Molekulare Pflanzenzüchtung

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam students have to show that they can recognize and solve a problem without additional help. The questions of the exam cover the full lecture contents.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in genetics and molecular biology

Content:
Principles of plant genetics (classical and molecular), gene mapping and genome analysis (monogenic and polygenic traits) physical mapping, genome sequencing), methods of forward and reverse genetics (map based cloning, characterization of mutants, gene isolation, functional analysis), transgenic crop plants

Intended Learning Outcomes:
General understanding of methods and concepts in genome analysis and molecular genetics of crop plants.

Teaching and Learning Methods:
Lecture.
Learning activity: textbooks, lecture slides, current literature
Teaching method: lecture with powerpoint slides.

Media:
Powerpoint presentations

Reading List:
T.A. Brown: Genome und Gene - Lehrbuch der molekularen Genetik; Spektrum Akademischer Verlag GmbH; ISBN: 978-3-8274-1843-2

Robert H. Tamarin: Principles of Genetics, McGraw Hill Higher Education; ISBN: 0070486670

Heiko Becker: Pflanzenzüchtung, UTB für Wissenschaft, Eugen Ulmer Verlag Stuttgart; ISBN: 3-8252-1744-2

Weiterführende aktuelle Fachliteratur wird jeweils am Ende der Vorlesung angegeben.

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Pflanzenzüchtung [WZ2014] (Vorlesung, 2 SWS)
Frey M, Avramova V, Mayer M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2371: Molecular Plant Physiology 2 | Molekulare Pflanzenphysiologie 2

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen benoteten Klausur und in Form einer mündlichen Präsentation, die im Rahmen des Seminars stattfindet, erbracht. Die Modulnote wird aus der
Klausurnote (50%) und der Note der mündlichen Präsentation (50%) berechnet.

Die Studierenden zeigen in der Klausur (90 min), dass sie in der Lage sind, die vorgestellten experimentellen Ansätze zum Verständnis der molekularen Mechanismen der Wechselwirkungen zwischen Pflanze und abiotischen Faktoren zu beschreiben und die dabei erhaltenen Versuchsdaten kritisch zu interpretieren. Weiterhin zeigen die Studierenden in der Klausur ihre Fähigkeit, experimentelle Ansätze zur Aufklärung der zugehörigen molekularen Mechanismen selbst zu entwerfen. Dafür sind keine Hilfsmittel zulässig.

In der mündlichen Präsentation, die insgesamt 45 Minuten umfasst und aus einem 30 minütigen Vortrag (PowerPoint-Präsentation) und einer 15 minütigen Diskussion besteht, müssen die Studierenden nachweisen, dass sie in der Lage sind, den Inhalt einer typischen internationalen wissenschaftlichen Studie aus dem Gebiet des Seminars zu erfassen und diesen verständlich und didaktisch sinnvoll aufbereitet zu präsentieren. Dabei weisen die Studierende nach, dass sie auch das theoretische Umfeld der Studie sowie die methodischen Ansätze und die Prinzipien der experimentellen Techniken verstanden haben und nachvollzierbar erläutern können. In der Diskussion zeigen die Studierenden, dass sie in der Lage sind, in einen wissenschaftlichen Diskurs einzutreten und Standpunkte begründet zu vertreten oder zu widerlegen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum Verständnis der vermittelten Inhalte sind ein solides Wissen und praktische Erfahrung in der Molekularbiologie, Biochemie und Pflanzenphysiologie zwingend erforderlich. Ein Besuch des Moduls Molekulare Pflanzenphysiologie 1 ist nicht notwendig.

Content:
In diesem Modul stehen die molekularen Mechanismen der Wechselwirkungen zwischen Pflanze und abiotischen Faktoren im Vordergrund. Abiotischer Stress ist der bedeutendste Faktor, der das Pflanzenwachstum und die Nahrungsproduktion limitiert. Als abiotische Faktoren werden Trockenstress, Salzstress, Sauerstoffmangel, Strahlung (UV-Strahlung, Starklicht), Schwermetalle und Xenobiotika behandelt. Vorgestellt werden induzierte Veränderungen im Metabolismus und beteiligte Signaltransduktionswege sowie Vermeidungs- und Anpassungsstrategien. Besonderes Augenmerk wird dabei auf einzelne stresstolerante Arten oder Ökotypen mit einer Toleranz gegen z.B. Salz oder Schwermetalle und ihre besonders effektiven Anpassungsstrategien gerichtet.
Im Seminar setzen sich die Studierenden mit aktuellen Forschungsarbeiten auf dem Gebiet der Stressphysiologie auseinander und arbeiten den Bezug dieser Forschungsergebnisse zum Inhalt der Vorlesung heraus.

Intended Learning Outcomes:
Lernergebnisse:
Nach dem erfolgreichen Abschluss dieses Moduls besitzen die Studierenden vertiefte Kenntnisse über:
" Analytik und experimentelle Ansätze
" die Bedeutung abiotischer Stressfaktoren für das Pflanzenwachstum
" molekulare Mechanismen der Transduktion des Stresssignals
" Anpassungsstrategien
" Darstellung und Interpretation wissenschaftlicher Daten
" Sichtung und Präsentation wissenschaftlicher Literatur
Das vermittelte Wissen kann in verschiedenen Bereichen sowohl der grundlagen- als auch anwendungsorientierten Pflanzenwissenschaften eingesetzt werden. Die Studierenden sind in der Lage, die Ansprüche zu definieren, die Pflanzen für eine erhöhte Toleranz gegenüber abiotischem Streß erfüllen müßten und können daraus erfolgversprechende Strategien zur Generierung bzw. Evaluierung stresstoleranter Pflanzen entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung und Seminar
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Interaktion Lehrender - Studierende, Präsentation durch die Studierenden

Media:
Präsentationen mittels Powerpoint, Tafelanschrieb,
Skript (Downloadmöglichkeit für Vorlesungsmaterial)

Reading List:
Ernst-Detlef Schulze, Erwin Beck, Klaus Müller-Hohenstein: Pflanzenökologie. Spektrum Akademischer Verlag
Peter Schopfer und Axel Brennicke: Pflanzenphysiologie. Spektrum Akademischer Verlag.
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag
Park S. Nobel: Physicochemical and Environmental Plant Physiology. Academic Press
Bob Buchanan, Wilhelm Gruissem and Russell L. Jones: Biochemistry & Molecular Biology of Plants. John Wiley & Sons
Fachartikel aus wissenschaftlichen Zeitschriften. Vertiefende Literatur zu einzelnen Arbeitsthemen werden von den Studierenden referiert.

Responsible for Module:
Erwin Grill (Erwin.Grill@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar: Molekulare Pflanzenphysiologie I (Seminar, 2 SWS)
Grill E, Christmann A

Molekulare Pflanzenphysiologie I [WZ2385] (Vorlesung, 2 SWS)
Grill E, Christmann A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2385: Molecular Plant Physiology 1 | Molekulare Pflanzenphysiologie 1

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen benoteten Klausur und in Form einer mündlichen Präsentation, die im Rahmen des Seminars stattfindet, erbracht. Die Modulnote wird aus der
Klausurnote (50%) und der Note der mündlichen Präsentation (50%) berechnet.

Die Studierenden zeigen in der Klausur (90 min), dass sie in der Lage sind die in dem Modul vorgestellten experimentellen Ansätze zum Verständnis des Wasser- Schwefel- und Stickstoffhaushalts der Pflanzen zu beschreiben und die dabei erhaltenen Versuchsdaten kritisch zu interpretieren. Weiterhin zeigen die Studierenden in der Klausur ihre Fähigkeit, experimentelle Ansätze zur Aufklärung der zugehörigen molekularen Mechanismen selbst zu entwerfen. Dafür sind keine Hilfsmittel zulässig.

In der mündlichen Präsentation, die insgesamt 45 Minuten umfasst und aus einem 30 minütigen Vortrag (PowerPoint-Präsentation) und einer 15 minütigen Diskussion besteht, müssen die Studierenden nachweisen, dass sie in der Lage sind, den Inhalt einer typischen internationalen wissenschaftlichen Studie aus dem Gebiet des Seminars zu erfassen und diesen verständlich und didaktisch sinnvoll aufbereitet zu präsentieren. Dabei weisen die Studierende nach, dass sie auch das theoretische Umfeld der Studie sowie die methodischen Ansätze und die Prinzipien der experimentellen Techniken verstanden haben und nachvollzierbar erläutern können. In der Diskussion zeigen die Studierenden, dass sie in der Lage sind, in einen wissenschaftlichen Diskurs einzutreten und Standpunkte begründet zu vertreten oder zu widerlegen

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum Verständnis der vermittelten Inhalte sind ein solides Wissen und praktische Erfahrung in der Molekularbiologie, Biochemie und Pflanzenphysiologie zwingend erforderlich.

Content:
In diesem Modul werden die zentralen Themenkreise Pflanzlicher Wasserhaushalt, Lipidmetabolismus und Schwefelhaushalt behandelt.
Schwerpunkte der Vorlesung sind dabei: chemische und physikalische Eigenschaften von Wasser; das Wasserpotential-Konzept; Transportwiderstände und Regulationsprozesse auf dem Weg des Wassers aus der Bodenlösung in die Pflanze und von dort aus in die Atmosphäre; Aquaporine; Meßmethoden; Biochemie der Cuticula und der epicuticulären Wachse; biogeochemischer Schwefelzyklus, Schwefelaufnahme und -assimilation; Biosynthese zentraler Schwefelverbindungen; Phytochelatine; Schwefelverbindungen und biotische Interaktionen; Entgiftung von Xenobiotika; Stickstoffaufnahme, -assimilation und -transport in der Pflanze; Symbiosen mit Luftstickstoff-fixierenden Partnern; stickstoffhaltige Verbindungen und biotische Interaktionen.
Im Seminar setzen sich die Studierenden mit aktuellen Forschungsarbeiten auf dem Gebiet des pflanzlichen Wasser-, Schwefel- beziehungsweise Stickstoffhaushalts auseinander und arbeiten den Bezug dieser Forschungsergebnisse zum Inhalt der Vorlesung heraus.

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss des Moduls besitzen die Studierenden vertiefte Kenntnisse über:
" Analytik und experimentelle Ansätze
" den pflanzlichen Wasserhaushalt
" Struktur und Biochemie pflanzlicher Oberflächen
" den pflanzlichen Schwefelhaushalt
" den pflanzlichen Lipidstoffwechsel
" die kritische Sichtung wissenschaftlicher Publikationen
" Präsentationstechniken
Das vermittelte Wissen kann in verschiedenen Bereichen sowohl der grundlagen- als auch anwendungsorientierten Pflanzenwissenschaften eingesetzt werden.
Die Studierenden können die Belastbarkeit experimenteller Ansätze beurteilen und selbst Ansätze der Beforschung entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung und Seminar.
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Interaktion Lehrender - Studierende

Media:
Präsentationen mittels Powerpoint, Tafelanschrieb,
Skript (Downloadmöglichkeit für Vorlesungsmaterial)

Reading List:
Ernst-Detlef Schulze, Erwin Beck, Klaus Müller-Hohenstein: Pflanzenökologie. Spektrum Akademischer Verlag
Peter Schopfer und Axel Brennicke: Pflanzenphysiologie. Spektrum Akademischer Verlag.
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag
Park S. Nobel: Physicochemical and Environmental Plant Physiology. Academic Press
Bob Buchanan, Wilhelm Gruissem and Russell L. Jones: Biochemistry & Molecular Biology of Plants. John Wiley & Sons

Responsible for Module:
Dr. Alexander Christmann (christma@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Pflanzenphysiologie II (Vorlesung, 2 SWS)
Christmann A, Grill E

Seminar: Molekulare Pflanzenphysiologie II (Seminar, 2 SWS)
Grill E, Christmann A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2617: Molecular Ecology, Molecular Systematics, and Biogeography of Plants | Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Seminarvortrag: 30%; schriftliche Pruefung 70%

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
In der Vorlesung werden die Grundlagen der Molekularen Ökologie, Molekularen Systematik und Biogeographie knapp wiederholt, um dann schwerpunktmässig auf neuere Entwicklungen einzugehen: DNA Extraktion und Sequenzierung von sehr altem Material ('ancient DNA' - Mumien, Neandertaler-Knochen, etc.) und komplexen Mischungen (Kot, Mageninhalt, Sedimenten, Bodenproben), Pyrosequenzierung, DNA-Barcoding, Molekulare Uhren, Rekonstruktion von biogeographischen Szenarien mit Hilfe phylogenetischer Datensätze, phylogenetische Analyse von Pflanzengesellschaften. Im Seminar sollen die Studierenden Ergebnisse ausgewählter, aktueller Studien aus dem Bereich Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen in einem Kurzvortrag in eigenen Worten darstellen. Im Anschluss daran erfolgt eine gemeinsame Diskussion, die u.a. der Themenfindung für zukünftige Forschungsprojekte (inkl. Master-und Doktorarbeiten) dienen soll.

Intended Learning Outcomes:
Verständnis der Entstehung von Pflanzenarten und Pflanzengesellschaften

Teaching and Learning Methods:
Vorlesung: Vor- und Nachbearbeitung; Seminar: Literaturrecherche, Zusammenfassung von Forschungsergebnissen aus der Literatur und Präsentation im Rahmen eines Referates mit anschliessender Diskussion.

Media:
Skriptum, PowerPoint (Folien können heruntergeladen werden), Filme

Reading List:
Coyne, J.A. & Orr, H.A. Speciation, Sinauer Associates; Beebee, T. & Rowe, G. 2008. An introduction to molecular ecology, Oxford University Press; Futuyma, D. 2007. Evolution: Das Original mit Übersetzungshilfen. Spektrum Akademischer Verlag.

Responsible for Module:
Hanno Schäfer (hanno.schaefer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen (Seminar, 2 SWS)
Schäfer H

Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen (Vorlesung, 2 SWS)
Schäfer H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2657: Methods and Logic in Molecular Cell Biology and Scientific Writing | Methods and Logic in Molecular Cell Biology and Scientific Writing

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Active discussion and participiation in class discussions, reading, writing, commenting on other student's drafts.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
WS: Part 1. In this seminar we will read five seminal publications and discuss experimental design and logic, controls,
interpretation, significance and presentation. The papers will cover a range of methods and approaches of general
relevance for molecular cell biology. Each student will be required to read all five papers. These will initially be
discussed among the students, who will collectively gather the relevant background knowledge. Thereafter, the
papers will be taken apart in a brainstorm session with the lecturer.
SS: Part 2. In this semester we will apply the principles of scientific writing we discussed in the WS. Students will be
given a set of figures and asked to write the corresponding text. This will be done in groups and will be sequential:
first results, then introduction and discussion, and finally abstract. We will take the text through at least one round of

revision.

Intended Learning Outcomes:
The goal of this course is to develop critical thinking and the skills, essential for any career in science, necessary for
writing and reviewing papers and grants.

Teaching and Learning Methods:
collaborative, critical discourse, argument, debate, reading, writing, reviewing, receiveing individual written feedback

Media:

Reading List:
Recent breakthrough publications, to be announced in the first lectures.

Responsible for Module:
PD Dr. phil. habil. Assaad-Gerbert

Courses (Type of course, Weekly hours per semester), Instructor:
Methods and Logic in Molecular Cell Biology and Scientific Writing Part 1 (Seminar, 2 SWS)
Assaad-Gerbert F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2381: Plant Systems Biology (Lecture and Seminar) | Pflanzensystembiologie (Vorlesung und Seminar)

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular active participation in the lecture and seminar is expected. The module is composed of a lecture (2 SWS) and a seminar (2 SWS). Both take place on the same day, one after the other. At the end of the lecture, the students answer a list of questions as part of a home work (see Prüfungsart) for the preparation of which several weeks are available. The grade of the home work corresponds to 70% of the overall final grade of the module. For the seminar, each student gives a presentation on a current publcation from the area of plant systems biology. Qualtiy of the presentation (style, quality of figures, conception of the presentation and in depth understanding of the content) for the basis of the grade for the seminar (30%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of plant biology, morphology and cell biology is recommended.
The module is designed for students of biology, biochemistry and biotechnology and detailed knowledge of mathematics or informatics are not required.

Content:
In the context of the lecture, in depth-knowledge on the systems biology analysis of genome, proteome and metabolome data (-omics data). Special emphasis will be given to transcription and protein interaction networks as well as to the modelling of cell biological and developmental processes. All lectures are focussing on the biology of the plant hormone auxin, which is currenty the best understood plant biology pathway with regard to systems biology studies and modelling and the understanding of which is of pivotal importance for plant growth and development.
In the concurrent seminar, students summarize a recent publication from the field of plant systems biology in an oral presentation (power point presentation). The modul is thematically

connected to the Modul PlaSysBiol (Übung), which takes place in the same period of time, and it is recommended to particiapte in both modules. Each module can however also been taken individually.

Intended Learning Outcomes:
Following participation in the lecture and the seminar, students will have detailed knowledge to answer systems biology problems in biology, specifically but not exclusively in plant biology. Knowledge on the availability and use of specific data bases to answer systems biology questions will have been gained.

Teaching and Learning Methods:
Form of studies/study techniques: Study of the lecture script, lecture comments and appropriat literature. Possibly transfer of knowledge to the module PlaSysBiol (Übung), which takes place at the same period of time. Preparation of a presentation and giving an oral presentation. Constructive criticism of ones own work and the work of others. Working with time pressure. Meeting deadlines.

Media:
Presentation using Powerpoint. A printout of the presentation is provided at the beginning of the lecture.

Reading List:
Plant Physiology (Taiz/Zeiger) 5th edition. Molecular Biology of the Cell (Alberts). Auxin Signaling: From Synthesis to Systems Biology (Estelle/Weijers/Ljung)

Responsible for Module:
Claus Schwechheimer (claus.schwechheimer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzensystembiologie VL (Vorlesung, 2 SWS)
Schwechheimer C [L], Schwechheimer C, Denninger P, Hammes U

Pflanzensystembiologie SE (Seminar, 2 SWS)
Schwechheimer C [L], Schwechheimer C, Denninger P, Hammes U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2433: Population Biology and Nature Conservation | Populationsbiologie und Naturschutz

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is an oral examination (20 min). Based on the oral examination, students demonstrate that they understand the population biology of plants and their mechanisms of action and are able to evaluate selected current research topics in this field.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of ecosystem connections and processes

Content:
The course introduces the population biological basics and mechanisms of action of plants. The topics covered are: Variation and inheritance in plant populations; evolutionary and ecological genetics; intraspecific interactions; population dynamics; age structure of populations; regional population dynamics and metapopulations; competition and coexistence; evolution of the life history of plants reproductive systems, reproduction, growth, senescence and death. These topics are linked to nature conservation and landscape planning.

Intended Learning Outcomes:
After participating in the module courses, students will have a basic knowledge of the population biology of plants and the mechanisms of action of plants, they will be able to evaluate current research topics in this field and apply the topics in nature conservation and landscape planning.

Teaching and Learning Methods:
Lectures with PPT presentations, which are followed up by self-study of the script, textbook and voluntary homework. In the seminar, the topics of the lecture are scientifically deepened by independently selecting, reading, understanding and reproducing original articles.

Media:
PPT presentations, script, textbook, original articles

Reading List:
Silvertown, J. & Charlesworth, D. (2001): Plant Population Biology. - Blackwell Publishing, Malden.

Further literature:
Crawley, M.J. (Ed.) (1997): Plant Ecology. - Blackwell Science, Oxford.
Rockwood, L.L. (2006): Introduction to Population Ecology. - Blackwell Publishing, Malden.
Townsend, C.R., Begon, M. & Harper, J.L. (2008): Essentials of Ecology. - Blackwell Publishing, Malden.
Urbanska, K.M. (1992): Population biology of plants. - UTB 1631, Stuttgart.

Topic-specific literature for the seminar will be announced at the beginning of the event.

Responsible for Module:
Johannes Kollmann (jkollmann@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Populationsbiologie und Naturschutz (Seminar, 2 SWS)
Kollmann J, Le Stradic S, Teixeira Pinto L

Einführung in die Populationsbiologie der Pflanzen (Vorlesung, 2 SWS)
Kollmann J, Teixeira Pinto L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2567: Phytopathology of Woody Plants | Phytopathologie von Gehölzen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine mündliche Prüfung (30 min, benotet) dient der Überprüfung der in Vorlesung, Seminar und Praktikum erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Prüfung, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Die Prüfungsnote bildet die Gesamtnote des Moduls. Zur Kontrolle des Verständnisses sowie der Fähigkeit zur Beschreibung, Auswertung und Interprätation der im Praktikum durchgeführten Experimente ist ein Protokoll zu führen, welches durch Testat überprüft wird (unbenotet). Im Seminar wird ein ca. 30 minütiger Vortrag erwartet.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine speziellen Voraussetzungen nötig

Content:
Im Rahmen der beiden Vorlesungen werden Grundkenntnisse zu pilzlichen Pathogenen an Gehölzen erarbeitet. Ihr Vorkommen, die Verschleppung sowie die Bekämpfung der Pathogene wird diskutiert. Desweiteren wird ihre Bedeutung für den Menschen exemplarisch dargestellt.
Im Seminar werden aktuelle Probleme im Bereich Pathologie der Gehölze auf der Grundlage wissenschaftlicher Publikationen in Seminarvorträgen zusammengefasst und bewertet.
Im Praktikum werden exempalrisch Methoden zur Diagnose von Pathogenen an Gehölzen eingeübt.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen über pilzliche Pathogene an Gehölzen.
Sie sollen in der Lage sein,
- phytopathoilogische Fragestellungen und Arbeitstechniken zu verstehen und fachliche Fragen selbst zu entwickeln.
- Schadbilder zu erkennen und zu analysieren, um daraus mögliche Bekämpfungsstrategien abzuleiten.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Praktikum Lehrmethode: Vortrag; im Praktikum Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit, Ergebnisbesprechungen.
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Praktikumsskript und Literatur; Üben von labortechnischen Fertigkeiten; Anfertigung von Protokollen.
Seminar: Vorbereitung und Durchführung von Präsentationen

Media:
Präsentationen mittels Powerpoint,
Skript (Downloadmöglichkeit für Vorlesungsmaterial),
Praktikumsskript

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung wird empfohlen:
George N. Agrios. Plant Pathology, 5 Auflage 2005, Academic Press, San Diego
Heinz Butin. Krankheiten der Wald und Parkbäume. 2011, Ulmer
Günter Hartmann, Franz Nienhaus, Heinz Butin. Farbatlas Waldschäden (Diagnose von Baumkrankheiten). 3. Auflage 2007, Ulmer

Responsible for Module:
Wolfgang Oßwald (osswald@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2581: Plant Biotechnology | Pflanzenbiotechnologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written, supervised examination (Klausur, 90min), by answering questions under time pressure and without helping material, students demonstrate that they have obtained knowledge in the areas of plant biotechnology, plant molecular biology and plant biochemistry.
The examination assesses the theoretical background and applied knowledge obtained on up-to-date aspects of current research.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A basic knowledge in genetics, genomics, plant development, biochemistry and/or botany is highly recommended

Content:
The module consists of a lecture and a seminar part.
In the lecture, state-of-the-art methods in plant biotechnology and plant molecular biology are introduced, and advantages and disadvantages are discussed. Current challenges are highlighted.
Topics of the lecture include:
- Genetically modified plants: status, regulations, cultivation, concepts;
- Generation of genetically modified plants: methods, vector systems;
- Concepts for yield improvement;
- Concepts for quality improvement;
- New potentials derived from basic research;
- Model system Arabidopsis: development of new techniques;
- Metabolic engineering.

In the seminar part different speakers from the TUM, which are active in research in plant biotechnology or plant molecular biology, introduce cutting-edge research projects that take place

on campus. The seminar part is conceived to highlight the exciting research that currently takes place and advertise opportunities for master thesis projects.

Intended Learning Outcomes:
The students have a profound knowledge in plant biotechnology, plant biochemistry and plant molecular biology. They are aware of new technological approaches and methodology applied in the fields, including plant transformation, construct and vector design, reporter systems and essential DNA, RNA and protein techniques. They are able to comment critically and reflect on technologies and aims of plant biotechnology. They have insight into latest research developments in the respective areas, in particular also in research projects that currently take place at the TUM

Teaching and Learning Methods:
Lecture: PowerPoint presentations, short movies and use of the black board. Questions to the audience will actively encourage discussion and enable students to ask questions more freely.
Seminar: Power point presentations and use of the black board. The seminar talks are followed by discussions to actively invite students to ask questions. Review papers will be provided as background reading.

Media:
Lecture: PowerPoint, black board, discussion.
Seminars: PowerPoint, black board, discussion.
PDFs of the lectures will be made available to the students. Review publications will be made available for background reading on the seminar contends.

Reading List:
Biochemistry and Molecular Biology of Plants. Buchanan, Gruissem and Jones, John Wiley & Sons, 2015

Responsible for Module:
Poppenberger-Sieberer, Brigitte; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzenbiotechnologie (Seminar, 2 SWS)
Gutjahr C, Benz J, Assaad-Gerbert F, Avramova V, Sieberer T, Schwechheimer C, Tellier A, Hückelhoven R, Johannes F, Schneitz K, Dawid C

Pflanzenbiotechnologie (Vorlesung, 2 SWS)
Poppenberger-Sieberer B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ4020: Effects of Climate Change on Plant Physiology | Pflanzenfunktionen im Klimawandel

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module is normally concluded with an oral examination. In this exam, students should demonstrate that they understand the interrelationship between climate change, plant functions and interactions with biotic and abiotic factors. The participants show that they are able to derive possible risks and potentials of climate change for cultivated as well as natural plant systems (with a focus on woody plants). The duration of the examination is 20 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
not specified

Content:
1. (Woody) Plant systems as components of biogeochemical cycles, global C sink strength and functional biodiversity on different spatio-temporal scales; reaction of plants to increased CO2 concentration, chronic O3 load, elevated temperatures, drought, flooding, high N deposition; consequences of land-use change, cultivation of energy plants, and land degradation.
2. Change of susceptibility or resistance of woody plants due to climate change (increased CO2, O3, N input) to drought and heat.
3. Climate change and the risk for and mitigation by ecosystems. Significance for the C-source/sink ratio on different spatio-temporal scales. International agreements to reduce greenhouse gas emissions.
4. Effects of climate change on the interactions between plants and insects.

Intended Learning Outcomes:
After successful participation students are able to understand mechanistically the effect of global change scenarios on plants and their biotic network. In addition, they are able to assess, analyze and interpret possible uses, development potentials of and risks for plant systems and their interactions with insects.

Teaching and Learning Methods:
The module consists of three lectures and a seminar. In the lectures the present knowledge is presented and discussed. Causes and effects of "global change" scenarios on plants (Lecture 1) will be deepened by evolutionary and ecological aspects of the life form tree (Lecture 2) and the acquired knowledge will be used to estimate future risks for plant-insect interactions (Lecture 3). In the seminar students make enquiries in small groups on current topics and present their results in the form of a scientific poster.

Media:
PowerPoint, showcases, illustrative material, internet enquiries, discussions.

Reading List:
Larcher "Ecophysiology of Plants", UTB Ulmer, 1994.
Lambers, Chapin, Pons "Plant Physiological Ecology", Springer, 1998.
Schlesinger/Bernhardt "Biogeochemistry - An Analysis of Global Change", Academic Press, 2020.
Schoonhoven, van Loon, Dicke „Insect-Plant Biology“, Oxford Univ. Press, 2005.
Smagghe/Diaz (eds.) “Arthropod-Plant Interactions”, Springer, 2012.

Responsible for Module:
Häberle, Karl-Heinz; Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzen in der Umwelt von morgen (Vorlesung, 1 SWS)
Grams T

Seminar "Global Change" (Seminar, 1 SWS)
Grams T, Häberle K, Leonhardt S, Neumann A, Rammig A, Rüdenauer F

Erfolgsmodell Baum (Vorlesung, 1 SWS)
Häberle K

Pflanze-Insekten-Interaktionen im Globalen Wandel (Vorlesung, 1 SWS)
Leonhardt S, Rüdenauer F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1031: Quantitative Genetics and Selection | Quantitative Genetik und Selektion

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 120.
Die Prüfungsleistung wird in einer schriftlichen Prüfung (Klausur) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel Probleme aus dem Bereich der Quantitativen Genetik, Populationsgenetik und Selektionstheorie erkannt werden, und Wege zu einer Lösung gefunden werden können. Die Prüfungsfragen gehen über den gesamten Vorlesungsstoff. Darüberhinaus können kurze Rechenaufgaben gestellt werden.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkenntnisse in Statistik
Grundkenntnisse in Genetik

Content:
" Populationsgenetik: Genetische Zusammensetzung von Populationen, natürliche Selektion und Mutation
" Quantitative Genetik: Inzucht und Heterosis, Epistasie, phänotypische und genotypische Varianzen, Ähnlichkeit zwischen Verwandten, Heritabilität, Genotyp-Umwelt Interaktion
" Selektionstheorie: Berechnung des Selektionserfolgs, Optimierung von Zuchtprogrammen

Intended Learning Outcomes:
" Verständnis für die Prinzipien der Quantitativen Genetik und Populationsgenetik und Ihre Bedeutung für pflanzenzüchterische Fragestellungen
" Verständnis für die Grundlagen der Selektionstheorie zur Optimierung von Zuchtprogrammen

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung, Übungen
Lernaktivität: Literaturstudium, Rechnen von Übungsaufgaben
Lehrmethode: Vortrag, Übungen, Fragend-entwickelnde Methode

Media:
Präsentationen mittels Powerpoint
Software Übungen

Reading List:
Falconer and Mackay (1996) Introduction to quantitative genetics; Lynch and Walsh (1998) Genetics and analysis of quantitative traits

Responsible for Module:
Schön, Chris-Carolin; Prof. Dr.sc.agr. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Quantitative Genetik und Selektion (Vorlesung, 4 SWS)
Schön C, Lanzl T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2689: Plant Redox-Biochemistry | Redox-Biochemie der Pflanzen

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 55	**Contact Hours:** 35

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
1-wöchiges Praktikum mit begleitender Vorlesung. In der Vorlesung zum Praktikum werden insbesondere die Hintergründe und theoretischen Kenntnisse zu den durchgeführten Experimenten vermittelt. Die praktischen Arbeiten werden nach bereitgestellten Protokollen durchgeführt. Die Benotung erfolgt auf Grund der Qualität der Laborarbeit (hier wird primär die Aktivität, Kreativität und Eigenständigkeit jedes Studierenden bewertet) und des Protokolls, das in Form einer wissenschaftlichen Arbeit geschrieben wird. Die Studierenden sollen zeigen, dass Sie in der Lage sind, die wesentlichen Aspekte der Versuche strukturiert und reflektiert darzustellen. Als Vorbereitung zu „Forschungspraktikum Redox-Biochemie bei der Pflanze-Umwelt Interaktion“.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen sind fundiertes Basiswissen in Protein-Biochemie und molekularer Biologie und ausreichende Sicherheit in Basistechniken des molekularen Labors.

Content:
Im Rahmen des Praktikums werden Grundkenntnisse über Pflanzenbiochemie vermittelt, insbesondere Redox-Biochemie bei der Pflanze-Umwelt Interaktion. Die Inhalte im Einzelnen sind Produktion von ROS und NO, ROS- und NO-Signaling Mechanismen, Redox-Homeostase und Entgiftung von ROS und NO. Im praktischen Teil wird die Produktion von ROS und NO quantifiziert, an redox-sensitiven Enzymen gearbeitet und die Entgiftung von ROS und NO untersucht. Folgende Methoden stehen zur Verfügung: DAB- und NBT-Färbung, H2O2-Elektrode zur Quantifizierung von ROS. Fluoreszierende Farbstoffe, NO-Elektrode, NO-Analyzer, Griess-Assay zur Quantifizierung von NO. Biochemische Ansätze zur Identifizierung Charakterisierung redox-sensitiver Proteine/Enzyme (Biotin Switch, Herstellung rekombinanter Proteine, Aktivitätstests, Redox-Biochemie am rekombinanten Protein/Enzym).

Intended Learning Outcomes:
Nach der Teilnahme an dieser Veranstaltung besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen über Redox-Biochemie – wie Redox-Moleküle gebildet werden, wie sie als Signalmoleküle fungieren und wie ihre Konzentrationen kontrolliert werden. Anhand von konkreten Beispielen lernen die Teilnehmer welche physiologischen Prozessen ROS und NO kontrollieren. Außerdem bekommen die Studierenden einen Einblick in die Zusammenhänge von Redox-Prozessen in der Umwelt/Atmosphäre und wie diese Pflanzenwachstum und –entwicklung beeinflussen können.

Teaching and Learning Methods:
Das Modul besteht aus einem Praktikum und einer begleitenden Vorlesung. Die Inhalte der Vorlesung werden durch Präsentationen vermittelt. Studierende sollen zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt werden. Im Praktikum werden spezielle „Redox-Methoden“ vermittelt, konkrete Fragestellungen beantwortet und ausgesuchte Beispiele bearbeitet, um die Zusammenhänge der Redox-Biochemie zu verstehen
Lernaktivitäten: Studium von Vorlesungs- und Praktikumsskript sowie angegebener Literatur; Aktives Mitarbeiten in Vorlesung und Praktikum.

Media:
Vorlesung, Experimentelle Protokolle, Lehrbücher der Biochemie, Stressbiologie und Pflanzenphysiologie, Internet.

Reading List:
Biochemie der Pflanzen; Gerhard Richter
Bioanalytik; Lottspeich und Zorbas

Responsible for Module:
Christian Lindermayr christian.lindermayr@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Redox-Biochemie der Pflanzen (Vorlesung, 1 SWS)
Lindermayr C

Redox-Biochemie der Pflanzen (Praktikum, 2 SWS)
Lindermayr C
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1663: Secondary Plant Metabolites and Human Health | Secondary Plant Metabolites and Human Health

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam duration: 180 min. The students show in the written examination (90 %) that they are able to demonstrate their knowledge on the significance of secondary plant metabolites for the plants life and for human health. In the colloquium they have to present the possibilities to influence the profiles of secondary metabolites in crop plants by agronomic measures, environmental conditions and biotechnology. The examination will cover all topics that have been treated in lectures and lab practical. Students write a lab report (10 % of the examination) about one of the conducted experiments.

Repeat Examination:

(Recommended) Prerequisites:
Basics of chemistry and biochemistry

Content:
Introduction into biochemistry, analysis and biological activity and function of secondary plant metabolites including phenylpropanoids, flavonoids, tannins, carotinoids, terpenoids, glucosinolates etc. Significance of secondary metabolites in plant physiology and resistance against pathogenes as well as possible impact on human health; influence of environmental conditions, of plant cultivation technology and of post-harvest conditions on biosynthesis and accumulation of secondary metabolites in crop plants.

Intended Learning Outcomes:
After participation of the course the students know the chemistry and biochemistry of the most important secondary metabolites in crop plants; the students are able to evaluate their significance in plant physiology, in defence against pathogens and environmental stress. They possess broad

knowledge of tools for management of secondary metabolism in plants by cultivation technology, by environmental conditions and by biotechnology; tehy can assess the relevance of secondary plant metabolites for human health (pharmacy, human nutrition).

Teaching and Learning Methods:
lecture, e-learning

Media:
Power Point, script (download in Moodle)

Reading List:
E. Grotewold, The Science of Flavonoids. Springer, 2006
J. B. Harborne, Introduction to Ecological Biochemistry. Academic Press, 1993
E. Haslam, Practical Polyphenolics. Cambridge University Press, 1998
C. Santos-Buelga, G. Williamson (Eds.), Methods in Polyphenol Analysis. The Royal Society of Chemistry, Athenaeum Press, 2003

Responsible for Module:
Susanne Steger susanne.steger@mytum.de

Courses (Type of course, Weekly hours per semester), Instructor:
VO Secondary Plant Metabolites and Human Health
3 SWS

Laborübung Secondary Plant Metabolites and Human Health
1 SWS
Susanne Steger
susanne.steger@mytum.de

Johanna Graßmann
johanna.graßmann@mytum.de

Harald Schempp
harald.schempp@mytum.de
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2382: Exercise in Plant Systems Biology | Übung in Pflanzensystembiologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 9	**Total Hours:** 270	**Self-study Hours:** 150	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): Der Bericht kann mehrere Wochen nach Beendigung des Praktikums abgegeben werden..
Regelmäßige aktive Teilnahme an der Lehrveranstaltung ist notwendig. Im Anschluss an die dreiwöchige angeleitete Übung in Techniken der Genexpressionsanalyse (Microarrays, quantitative Real-Time PCR und Reporteranalyse im intakten Organismus), der Zellbiologie (Konfokale Mikroskopie, Analyse unterschiedlicher Zellkompartimente mittels GFP-Fusionsproteinen etc.) und der Biochemie (Expression und Aufreinigung rekombinanter Proteine aus Bakterien, Funktionstest) erstellen die Studierenden selbstständig einen Bericht zu den Ergebnissen des praktischen Teils. Die drei Praktikumsteile sind inhaltlich aufeinander abgestimmt. Die übergeordnete Thematik ist die Auxinsignaltransduction und der Auxintransport in der pflanzlichen Entwicklung, so dass der Transfer des in den unterschiedlichen Teilen gewonnenen Wissens notwendig ist. Ähnliches gilt für den Wissenstransfer aus dem im gleichen Zeitraum stattfindenden Modul PlaSysBiol (VL+SE) mit Vorlesung und Seminar und den darin besprochenen Themen. Neben wissenschaftlichen Aspekten wird auch die graphische Aufarbeitung der Abbildungen nach Publikationsmaßstäben mit Adobe Photoshop und Adobe Illustrator bei der Erstellung des Protokolls im Vordergrund stehen. Die Studierenden können selbst einen Termin für die Abgabe des Protokolls bestimmen, so dass ausreichend Zeit für die Erstellung des Berichts verfügbar ist.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Eine grundlegende Kenntnis der Pflanzenbiologie, -morphologie und der -zellbiologie wird empfohlen. Grundlegende Techniken beim Arbeiten im molekularbiologischen Labor sollten bekannt sein, wie z.B. sauberes Pipettieren.

Content:
Die Übung vermittelt eingehende Kenntnisse in Techniken der Genexpressionsanalyse (Auswertung von Microarraydaten, quantitative Real-Time PCR und Reporteranalyse im intakten Organismus), der Zellbiologie (Konfokale Mikroskopie, Analyse unterschiedlicher Zellkompartimente mittels GFP-Fusionsproteinen etc.) und der Biochemie (Expression und Aufreinigung rekombinanter Proteine aus Bakterien, Funktionstest). Die drei Praktikumsteile sind inhaltlich aufeinander abgestimmt und vermitteln zusammengenommen Kenntnisse zur Auxinsignaltransduction und Auxintransport in der pflanzlichen Entwicklung.

Intended Learning Outcomes:
Im Anschluss an die Übung besitzen die Studenten detailliertes praktisches Wissen zur Beantwortung von systembiologischen Fragestellungen in der Biologie, speziell aber nicht ausschließlich in der Pflanzenbiologie.

Teaching and Learning Methods:
Lernaktivitäten: Studium des Praktikumsskripts, -mitschrift und Literatur. Gegebenenfalls Transfer des Erlernten in das in der gleichen Periode stattfindende Modul PlaSysBiol (VL+SE). Erstellung eines Praktikumsberichts mit Abbildungen in Publikationsqualität. Arbeiten unter Zeitdruck. Einhalten von Fristen.

Media:
Arbeiten mit dem Praktikumsskript. Grundlegende Arbeiten mit einer der beiden Softwares, Adobe Photoshop, Adobe Illustrator. Unabhängiges Arbeiten am Fluoreszenzmikroskop.

Reading List:
Plant Physiology (Taiz/Zeiger) 5th edition. Molecular Biology of the Cell (Alberts). Auxin Signaling: From Synthesis to Systems Biology (Estelle/Weijers/Ljung)

Responsible for Module:
Claus Schwechheimer (claus.schwechheimer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzensystembiologie UE I, II und III (Übung, 10 SWS)
Schwechheimer C [L], Schwechheimer C, Hammes U, Denninger P, Bassukas A, Graf A, Sala J, Schröder P
For further information in this module, please click campus.tum.de or here.

Module Description

WZ6121: Vegetation of the Earth | Vegetation der Erde

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung wird in Form einer mündlichen Prüfung (20 min) erbracht. In der Prüfung zeigen die Studierenden, dass sie die wichtigsten Vegetationstypen und Vegetationszonen der Erde analysieren und beispielhafte Arten, Gattungen, Familien und Lebensformen nennen können. Sie demonstrieren zudem, dass sie die globale Differenzierung der Vegetation anhand funktionaler ökologischer Eigenschaften, evolutionärer Prozesse und biogeographischer Rahmenbedingungen analysieren können. Zusätzlich belegen sie, dass sie die Vegetation zur Klassifikation der standörtlichen und nutzungsbedingten Verhältnisse verwenden können. Eine mündliche Prüfung eignet sich zur Erfassung der genannten Studienleistungen, da die Studierenden hier zeigen können, ob sie die komplexen Zusammenhänge der historischen und aktuellen Landnutzung und der Vegetationsgefährdung bewerten und geeignete Maßnahmen für Naturschutz und Renaturierung entwickeln können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Botanik, der Vegetationsökologie, Geographie, Geologie, Bodenökologie und Klimatologie

Content:
Das Modul umfasst folgende Inhalte:
• Entwicklung, Verbreitung, Gliederung und Ökologie der wichtigsten Vegetationstypen der Erde
• Charakteristische Arten, Gattungen, Familien und Lebensformen
• Steuernde Ökosystemprozesse und die entsprechenden ökologischen Eigenschaften der Vegetationstypen
• Klima-, boden- und nutzungsbedingte Anpassungen von Pflanzen
• Auswirkungen von Landnutzung und anderen anthropogenen Einflüssen

• Optionen für Naturschutz und Renaturierung

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss dieses Moduls können die Studierenden die wichtigsten Vegetationstypen und Vegetationszonen der Erde unterscheiden und mit beispielhaften Arten, Gattungen, Familien und Lebensformen von verschiedenen Kontinenten kennzeichnen. Die Studierenden können die globale Differenzierung der Vegetation anhand funktionaler ökologischer Eigenschaften, evolutionärer Prozesse und biogeographischer Rahmenbedingungen analysieren. Umgekehrt können die Studierenden anhand der regionalen Vegetation die standörtlichen und nutzungsbedingten Verhältnisse klassifizieren, und zwar unter Verwendung der vorherrschenden Ökosystemprozesse und spezifischer Anpassungsstrategien der Pflanzen. Darüber hinaus sind sie in der Lage, die historische und aktuelle Landnutzung sowie Gefährdung der regionalen natürlichen Vegetation zu bewerten und entsprechende Maßnahmen des Naturschutzes und der Renaturierung zu entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung mit Powerpoint-Präsentationen, in der den Studierenden die biogeographischen Muster und die sie bedingenden ökologisch-evolutionären Prozesse der Vegetation der Erde vorgetragen werden.

Media:
PowerPoint, Handzettel, Tafelanschrieb, Pflanzenmaterial zur Anschauung

Reading List:
Pfadenhauer, J. S. & Klötzli, F. A. (2015) Vegetation der Erde: Grundlagen, Ökologie, Verbreitung. Springer-Verlag
Schultz, J. (2016) Die Ökozonen der Erde. UTB

Responsible for Module:
Wagner, Thomas; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Vegetation der Erde (Vorlesung, 4 SWS)
Wagner T [L], Wagner T, Albrecht H, Le Stradic S, Teixeira Pinto L
For further information in this module, please click campus.tum.de or here.

Specializing in Zoology/Animal Sciences | Studienschwerpunkt Zoologie/Tierwissenschaften

Module Description

WZ2460: Current Topics in Neurobiology | Aktuelle Themen der Neurobiologie

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Graded presentation (20-30 min.)
Students will have to prepare themselves for the general topic of the respective lesson by means of introductory texts each week; this general part will be discussed together at the beginning of the seminar. Subsequently, one student will present a more detailed text or a current publication from a high-class peer-reviewed journal; this additional information will then be discussed. The entire seminar will be held in English. The overall grade of the module is based on the students' participation and previous knowledge in the general preliminary information and discussions (30 %) as well as on their own presentation performance (categories text comprehension, completeness, structure, presentation style, handout, together 40 %) and participation in the special discussion (20 %).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of neurobiology, at least on the level of the lecture "Human and Animal Physiology", should be available. Ideally, the attendance of this seminar should be combined with the simultaneous attendance of the lecture "Neurobiology".

Content:
Basic and advanced aspects of neurobiology including methods, formal and theoretical foundations, model systems for basic research and for applied research, pharmaceutical research, molecular and molecular biological aspects of complex functions and dysfunctions These contents

are introduced basally by means of basic articles (mostly textbook excerpts, more rarely simpler reviews) and then brought up to the current state of knowledge by means of more recent, top-class published articles. The assessment of further developments in the respective research areas is explicitly made.

Intended Learning Outcomes:
Students acquire scientifically sound, basic knowledge of neurobiology and an overview of current developments in the most important research areas. After completing this seminar, students will be able to extract current research results from publications, put them into context and integrate them into their knowledge system. The topics discussed are not to be understood as a completed historical process. In particular, students will develop ideas about how research lines and processes behave with regard to their further development and will be able to understand the mechanisms of the science establishment.

Teaching and Learning Methods:
Event type/teaching technique: Seminar
teaching method: seminar, question-developing method, presentation, group work
Learning activities: studying the basic information given out, researching material, summarising documents, preparing and giving presentations, gathering information in special lectures, incorporating new information supported by question and answer sessions.

Media:
Literature will be distributed or made available for download on Moodle. Own presentations are to be created using PowerPoint or similar presentation techniques. Additional information will be communicated on Moodle (URLs, further texts)

Reading List:
The basic textbook "Neuroscience. Exploring the brain." by Bear, Connors, Paradiso from the Lippincott, Williams and Wilkins publishing house is recommended as the basic textbook, in the English version. The German edition ("Neuroscience." from Spektrum Verlag) is more expensive and not in the language used in the seminar. Other textbooks of neurobiology are also suitable for the basic contents.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Aktuelle Themen der Neurobiologie: Biologie und Neuroethologie der Fledermäuse (Seminar, 2 SWS)
Firzlaff U

Aktuelle Themen der Neurobiologie: Neurobionik (Seminar, 2 SWS)
Kohl T [L], Luksch H (Kohl T)

Aktuelle Themen der Neurobiologie: Neuroethologie von Räubern und Beute (auf englisch)
(Seminar, 2 SWS)
Ondracek J

Aktuelle Themen der Neurobiologie: Zelluläre und molekulare Neurophysiologie (auf Englisch)
(Seminar, 2 SWS)
Weigel S, Michel K, Bühner S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2479: Advanced Methods and Findings in Neurophysiology | Advanced Methods and Findings in Neurophysiology

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students will prepare and discuss talks on advanced methods and current papers (supplied by us) in the field of neurophysiology. Knowledge gained in the first seminar on methods (winter term) will help the students to evaluate research papers critically that are presented in the second seminar. The final grade for the module is calculated from grades that were achieved for the prepared talks (50%) and the active participation during duscussions in the seminars (50%).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in neurophysiology (e.g. lecture Neurobiology of Prof. Luksch).

Content:
The Seminar consists of two parts: In the first part (winter term) the students will learn about advanced methods in neurophysiology (e.g. live cell imaging with calcium- and membrane potential sensitive dyes, fluorescence microscopy, tracing techniques, electrophysiology with patch clamp and sharp electrodes). Technical and theoretical aspects as well as advantages and limitations of the techniques will be discussed. In the second part (summer term) each student will present a current neurophysiological paper (supplied by the teachers). The paper will be discussed critically in view of the techniques that were learnt in the first part.

Intended Learning Outcomes:
The students will understand advantages and limitations of various neurophysiological methods. This will give them the ability to evaluate research papers critically.

Teaching and Learning Methods:
Seminar, Preparation of a (Powerpoint)-Presentation, independent research for relevant information, discussion.

Media:

Reading List:

Responsible for Module:
Michael Schemann (schemann@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Aktuelle Themen der Neurobiologie: Zelluläre und molekulare Neurophysiologie (auf Englisch) (Seminar, 2 SWS)
Weigel S, Michel K, Bühner S
For further information in this module, please click campus.tum.de or here.

Module Description

ME2759: Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 128	**Contact Hours:** 22

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Der Modul ist aufgebaut aus Vorlesungen (insgesamt 1 SWS: Einleitung somatischer Stammzellen, embryologische Entwicklung des Blutsystems, verschiedene Aspekte der adulten Stammzellen, Stammzellnische, klinische Anwendungen von blutbildenden Stammzellen). Auch werden in Seminare der Kursteilnehmer aktuelle Forschnugsbeispiele aus der Literatur vorgestellt und diskutiert (0,5 SWS).
Die Prüfungsleistung stellt sich zusammen aus: Seminarvortrag (etwa 30 min + Diskussion, 40%) und die Verfassung einer Hausarbeit (60%) zur Kontrolle des Verständnisses sowie der Fähigkeit zur Beschreibung, Interprätation und Bewertung. Das Modul ist bestanden, wenn das gemittelte Ergebnis besser als 4,1 ist.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zum besseren Verständnis dises Theorieteils sind gute Kenntnisse in Zellbiologie und Biochemie erforderlich.

Content:
Im Rahmen dieses theoretischen Moduls werden spezielle Kenntnise über somatische, und insbesondere blutbildender Stamm- und Vorläuferzellen und Stromazellen vermittelt.

Es werden 5 Vorlesungen stattfinden, und anschliessend 5, von den Studenten vorbereiteten Seminare in dem aktuelle Forschungsbeispiele präsentiert und besprochen werden sollten.

Vorlesungen
1. Einleitung in der Stammzellbiologie, somatische Stammzellen

2. Embryologische Entwicklung des Blutsystems und blutbildenden Stammzellen
3. normale Physiologie der blutbildenden Stammzellen und die Stammzellnische
4. Abnorme Physiologie der Stammzellen bei Alterung chronische Erkrankungen und Malignitäten
5. klinische Relevanz von blutbildenden Stammzellen

In den Seminaren sollen von den Teilnehmern aktuelle Forschungsergebnisse der Literatur vorbereitet, präsentiert und diskutiert werden. Dabei werden Themen wie:
1 - Stammzellidentität und Isolation
2 - Stammzellverhalten (Regeneration, Apoptose, Überleben, Proliferation, Differenzierung)
3 - Stammzellnische (Identität, Isolation, Relevanz für das Verhalten der Stammzelle)
4 - Maligne Entartungen des Blutsystems und leukämische Stammzellen
ausführlich zur Sprache kommen

Ergänzt werden die Vorlesungen und Seminare durch eine Hausarbeit (in englischer Sprache) in dem die Teilnehmer ihr Verständnisse der erworbenen Kenntnisse beschreiben, Interpretieren und bewerten.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das theoretische Verständnis und spezielle Fachwissen über blutbildenden Stammzellen. Weiterhin haben sie wesentliche Konzepte somatischer Stammzellen integriert, evaluiert und in einer Hausarbeit beschrieben. Sie haben gelernt:

• die Herkunft der somatischen Stammzellen und deren Entwicklung in Embryonen zu verstehen
• grundlegende funktionelle Verhaltensweisen blutbildender Stammzellen zu verstehen
• (Stamm)zellbiologische Fragestellungen und Arbeitstechniken aus aktuelle Forschungsliteratur zu verstehen, kritisch zu evaluieren und fachliche Fragen selbst zu entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesungen, Seminare, Hausarbeit.
Lehrmethode: Vorlesungen, Literaturrecherchen, Diskussionen, Präsentationen, Partnerarbeit (bei höheren Studentenzahlen), Ergebnisbesprechungen.
Lernaktivitäten: Studium von Literatur; Präsentation eines aktuellen Forschungsmunuscript; Anfertigung einer Hausarbeit

Media:
Original Fachliteratur, Präsentationen mittels Powerpoint, Photoshop

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Oostendorp, Robert; Apl. Prof.

Courses (Type of course, Weekly hours per semester), Instructor:
Blutbildende Stammzellen als Modell für somatische Stammzellen (Vorlesung, 1 SWS)
Oostendorp R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0404: Animal Biotechnology 2 | Biotechnologie der Tiere 2

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time: 90min. written + 20 min oral.
The module consists of lecture and seminar. Regular, active participation in the lectures is expected. A written exam (90 min, graded) serves to test the theoretical skills learned in the lectures. The students show in the written exam whether they are able to structure the knowledge they have learned and present the essential aspects. They should be able to describe, interpret, combine meaningfully and transfer the acquired information to similar situations. In the seminar, papers based on specialist literature on current topics from basic and applied research are prepared, presented and discussed (graded). The latter serves to check whether the scientific methods and facts learned in the lecture have been understood and can be transferred to new questions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is suitable for BSc students in 6 semesters or for Master students. Basic knowledge in molecular biological methods would be helpful.

Content:
The lecture will teach different approaches in regenerative medicine, including xeno-transplantation, allo- and autologous transplantation, and stem cell therapy with adult and pluripotent stem cells. Knowledge in the differentiation, de- and transdifferentiation of cells is acquired. The advantages and disadvantages of different therapeutic strategies are discussed and current examples of medical applications are given. Where relevant, ethical and social aspects are addressed. In the seminar the acquired knowledge is deepened and extended.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise about the possible use of transgenic animals in xenotransplantation as well as basic knowledge about human stem cell therapy and possibilities of tissue engineering. for applications in basic research, biomedicine or agriculture.
You should have learned,
"to what extent xenotransplantation is a realistic option for cell, tissue or organ transplantation and which genetic modification is necessary for this in the animal.
"how pluripotent stem cells can be specifically differentiated and which cells can be used for autologous or allogeneic transplantation and what limitations exist.
"They should be able to identify the best possible techniques for certain questions and possibly implement them experimentally.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture, seminar Teaching method: Lecture; at the seminar review of literature, instructions for presentation
Learning activities: study of lecture notes, lecture notes, and independent work on topics from the literature and presentation.

Media:
Presentations via Powerpoint, script (download possibility for lecture material)

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung wird empfohlen: NIH Report Regenerative Medicine (http://stemcells.nih.gov/info/2006report/), Stem Cells: Scientific Progress and Future Research Directions (http://stemcells.nih.gov/info/2001report/2001report.htm)

Responsible for Module:
Angelika Schnieke (schnieke@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biotechnologie der Tiere 2 Vorlesung (Vorlesung, 2 SWS)
Schnieke A, Flisikowska T, Fischer K

Biotechnologie der Tiere 2 Seminar (Seminar, 2 SWS)
Schnieke A, Flisikowski K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2664: Animal Biotechnology 1 | Biotechnologie der Tiere 1

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 60	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Exam time: 90 min written + 20 min oral.
The module consists of a lecture and an internship, whereby the internship includes a term paper. Regular, active participation in the lectures is expected. A written exam (90 min, graded) serves to test the theoretical skills learned in the lectures. The students demonstrate in the exam whether they are able to structure the knowledge they have learned and to present the essential aspects. They should be able to describe, interpret, combine and transfer the acquired information to similar situations. In order to check their understanding as well as their ability to describe, evaluate and interpret the experiments carried out during the practical training, a protocol must be kept and homework must be completed. The oral presentation of the internship and the homework will be graded together. This oral examination serves to check whether the learned working techniques and their areas of application have been understood and can be applied to new questions. The final grade result of the written exam and that of the oral presentation of the minutes and the homework will be counted 3:2.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is suitable for BSc students in 5-6 semesters or for Master students. Basic knowledge in molecular biological methods would be helpful.

Content:
On the one hand, the lecture teaches the different methods of producing genetically modified mammalian cells and mammals. This includes microinjection, the use of viral vectors, transposons, RNAi, Zinc Finger nucleases, nuclear transfer, precise genetic manipulation by homologous recombination and the derivation of pluripotent stem cells in different animal species and in

humans. For each method the advantages and disadvantages are discussed and examples of application are presented (for example: generation of pharmaceutical proteins, generation of animal models for human diseases). Where relevant, ethical and social aspects are addressed. In the two-part practical course important aspects of reproduction and embryo manipulation are taught as well as basic knowledge in the construction of recombinant DNA vectors.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise in genetic engineering methods and techniques for the production of transgenic animals for applications in basic research, biomedicine or agriculture.
They should have learned,
"to understand genetic engineering questions and working techniques and to develop technical questions themselves.
"to apply the acquired knowledge to more in-depth questions.
"They should be able to identify the best possible techniques for specific problems and to implement them experimentally.

Teaching and Learning Methods:
Event type/teaching technique: Lecture, practical course Teaching method: Presentation; in practical course, instructional talks, demonstrations, experiments, partner work, discussion of results.
Learning activities: Study of lecture notes, lecture notes, practical course script and literature; practice of laboratory skills in reproductive biotechnology and embryo manipulation and vector design; cooperation with partners; preparation of protocols, homework and presentation.

Media:
Presentations via Powerpoint, script (download possibility for lecture material)

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Transgenic Animal Technology: A Laboratory Handbook
by Carl A. Pinkert;
Gene Targeting: A Practical Approach by Alexandra L. Joyner;
Animal Biotechnology by Hermann Geldermann

Responsible for Module:
Angelika Schnieke (schnieke@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biotechnologie der Tiere 1 Vorlesung (Vorlesung, 2 SWS)
Schnieke A, Bauer B, Flisikowska T

Biotechnologie der Tiere 1 Praktikum (Praktikum, 2 SWS)
Schnieke A, Flisikowska T, Flisikowski K, Bauer B, Schusser B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2750: Course block: Neurobiology of isolated tissue | Blockpraktikum: Neurobiologie am isolierten Gewebe

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module-related examinations will be a scientific report in which the students should explain the theoretical background and the applied techniques. Furthermore, they shall show that they are able to plan, conduct and evaluate experiments using scientific standards and rules.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in physiology and neurobiology are required. Prior attending of the lectures 'Human and animal physiology', 'Neurobiology' and 'Sensory physiology' is recommended.

Content:
4 weeks intracellular labelling of neurons in chicken brain slices, 1 week whole-cell patch-clamp, 1 week optical imaging

Intended Learning Outcomes:
Upon completion of the module, students are able: a) to discuss the theoretical background for the conducted experiments, b) to evaluate different electrophysiological techniques for their usefulness in experiments with isolated tissue, c) to conduct electrophysiological in vitro experiments. This includes preparing the tissues, different methods for the analysis of neural networks (single cell recordings, optical imaging, tracing) and histological processing. Furthermore, students will know different methods for data analysis, statistics and graphical presentation of results.

Teaching and Learning Methods:
Laboratory

Media:
study of specialist literature, practice laboratory skills

Reading List:
'Neuroscience: Exploring the brain'; specialist literature will be provided during tha course.

Responsible for Module:
Prof. Dr. Harald Luksch

Courses (Type of course, Weekly hours per semester), Instructor:
Blockpraktikum: Neurobiologie am isolierten Gewebe (Praktikum, 16 SWS)
Weigel S [L], Weigel S, Luksch H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2753: Course block: Neurobiology of intact animals | Blockpraktikum: Neurobiologie am intakten Organismus

Version of module description: Gültig ab summerterm 2016

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 30	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module-related examinations will be a scientific report in which the students should explain the theoretical background and the applied techniques. Furthermore, they shall proof that they are able to plan, conduct and evaluate experiments using scientific standards and rules.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in physiology and neurobiology are required. Prior attending of the lectures 'Human and animal physiology', 'Neurobiology' and 'Sensory physiology' is recommended.

Content:
3 weeks extracellular recordings of neurons in the auditory midbrain (IC) of mice, generation of acoustic stimuli and data analysis with Matlab®. At the beginning of the course students will have to present a short talk on a topic relevant for neuronal processing of sound.

Intended Learning Outcomes:
Upon completion of the module, students are able: a) to apply (under supervision) basis techniques for electrophysiological recordings in in-vivo preparation of the mouse and chicken.
b) Furthermore, students will know different methods for data analysis, statistics and methods of stimulus generation for auditory and visual neuroscience experiments with Matlab®.

Teaching and Learning Methods:
Laboratory

Media:
study of specialist literature, practice laboratory skills

Reading List:
Neuroscience: Exploring the brain'; specialist literature will be provided during tha course.

Responsible for Module:
PD Dr Uwe Firzlaff, Prof. Harald Luksch

Courses (Type of course, Weekly hours per semester), Instructor:
Blockpraktikum: Neurobiologie am intakten Organismus (Praktikum, 8 SWS)
Firzlaff U [L], Firzlaff U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3097: Basics in Chronobiology | Basics in Chronobiology

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** English	**Duration:** two semesters	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a written exam at the end of the summer semester (lecture) and a presentation during the winter semester (seminar).In the written exam, students demonstrate their ability to remember the molecular components, the structure and organization of the circadian system including its functions. Important steps, figures and key findings in circadian research should be ranked chronologically and according to relevance. Students show that they understand the functional interrelation of the components of the circadian system and that they are able to transfer their knowledge to exemplary situations / pathologies. The written examination comprises 90 minutes; the questions asked include open questions as well as multiple choice tests.

During the seminar, the knowledge acquired by the lecture is applied on a specific topic of Chronobiology and liked to a pathology / mutation with the use of a scientific study. The examination during the winter semester (seminar) consists of a group presentation (35 min), a subsequent discussion (10 min) and preparation of an abstract. Additionally, a qualified peer-feedback is mandatory as coursework. By the delivery of the presentation students show (I) that they are able to illustrate the interrelation between circadian functions and pathologies with the help of scientific studies and (II) that they are able to analyze and evaluate relevant scientific literature. Additionally, students demonstrate their ability to present a subject to an audience and to stand a discussion about the presented content. By the written abstract, the ability is tested to summarize the major facts and the conclusion of a presentation in clear and concise manner.The final grade is an average grade from the written exam (70%) and the seminar (30%).Further informationPrerequisites (recommended)MediaPower Point Presentation, MoodleReading ListCircadian Physiology; Roberto Refinetti, PhD.; CRC Press: ISBN 9780849322334
Module

Repeat Examination:

(Recommended) Prerequisites:

Content:
The module disseminates the basics in Chronobiology. The circadian system in organisms is presented with a focus on different circadian clocks in various tissues and organs. Students learn how these periferal systems orchestrate the central clock in the brain and how disruption of the system leads to various diseases and pathologies. Based on this knowledge, students develop an understanding of circadian-related pathologies. Using selected examples, the impact of circadian disturbances, e.g. during Jetlag or shift work, on distinct pathologies is exemplified. By applying and transferring the knowledge acquired to a circadian science-associated question, the relevance is illustrated and evaluated.
• History of the science of Chronobiology• Properties of biological oscillators
• Hierarchy of the circadian system: the central circadian clock, peripheral circadian clocks and their synchronization
• Molecular mechanisms of the circadian clock
• Signals of the circadian system
• Disruption of the circadian system and associated diseases
• Analysis of scientific studies with regard to study design
• Presentation of scientific topics related to circadian science.

Intended Learning Outcomes:
Upon completion of the module, students are able to:
• memorize important steps, figures and key findings in circadian research and rank them chronologically and according to relevance.
• describe the molecular components, the structure and organization of the circadian system as well as its functions.
• describe the functional interrelation of the components of the circadian system.
• recognize and characterize the basic principles of circadian response-regulation.
• recognize the circadian aspects of acute diseases.
• analyze and evaluate scientific studies with regard to study design.
• prepare and present the interrelation of circadian functions, given disease and selected pathologies or mouse phenotypes.
• evaluate peer presentations based on given criteria.

Teaching and Learning Methods:
The lecture disseminates basic knowledge on the circadian system and the interrelation of the different components, under normal and diseased conditions or in mutants. The lecture is given with a teacher-centered approach. During the seminar, the knowledge acquired by the lecture is applied on a specific topic and linked to a disease pathology with the use of a scientific study. The seminar consists of a few attendance periods which serve to introduce the task/topic and to organize the seminar and extensive self-studying phases, in which students gather the topic and prepare a presentation and an abstract. Finally, group presentations are held and mutual feedback is given to practice the analysis and evaluation of scientific topics.

Media:
Power Point Presentation, Moodle

Reading List:
Circadian Physiology; Roberto Refinetti, PhD.; CRC Press: ISBN 9780849322334

Responsible for Module:
Dirk Haller dirk.haller@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Basics in Chronobiology (Seminar, 2 SWS)
Haller D [L], Kießling S, Schmöller I

Basics in Chronobiology (Vorlesung, 2 SWS)
Haller D [L], Kießling S, Schmöller I
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2693: Cognitive Neuroscience | Cognitive Neuroscience

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will demonstrate an overview of cognitive processes in the brain during a written exam (60 min.). They can describe the cellular basis and the network architecture in the brain that lead to cognitive processing, and elaborate on the scientific status quo of cortical processing during various cognitive tasks. In addition, they can evaluate and predict the consequences of lesions and pharmacological interventions in the cortex for psychological processes and mental states. Finally, they will demonstrate an overview of the various methodological approaches to study the cognitive functions in the (human) brain.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have a basic knowledge of neurobiological processes in general, at least on the level of a physiology course, better though on the level of the "neurobiology" lecture held at the WZW (or a comparable lecture series).

Content:
computation of sensory information in the mammalian cortex; differences between cortical and non-cortical structures in the forebrain of vertebrates; Structure of the Cortex, canonical circuits, processing principles in the Cortex, Models of cortical function, malfunctions of the cortex in pathological situations, Role of the prefrontal cortex, Role of the hippocampus, Cortical processing of sensory input, Sleep, Food intake, Decision making, Cravings and Addiction, Emotions, Consciousness and Free Will. In addition, we will demonstrate options for technological interactions with the brain, and give an overview of the current approaches for analysing brain functions in the behaving organism.

Intended Learning Outcomes:
After the exam, students can sketch cortical processing, derive these computations from the underlying neurobiological foundations, and explain their functions for the organism. The students will aquire special knowledge on the role of the cortex, can integrate new information into this knowledge framework, and have an overview of pathologies and the possibilities to manipulate cognitive processes.

Teaching and Learning Methods:
Teaching mode: Lecture Teaching method: Presentation. Learning activities: Reading of basic texts, preparation and review of lecture materials, internet searches, summarizing of subjects.

Media:
The powerpoint presentations of this lecture series will be made available on Moodle. Additional information (URLs, additional texts, self-assessments etc.) will be available on Moodle as well.

Reading List:
The basic textbook for this lecture is "Neuroscience. Exploring the brain" from Bears, Connors and Paradiso, published by Lippincott, Williamsn and Wilkins. However, all other modern neurobiology textbooks are also appropriate.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Cognitive Neuroscience (Vorlesung, 2 SWS)
Fenzl T, Kreuzer M, Luksch H, Rammes G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2938: Course block: Neuroscience of vision | Course block: Neuroscience of vision

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:**	**Duration:**	**Frequency:**
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 30	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module-related work will be completion of lab-related assignments (oral and written reports), as well as the completion of a final written project and presentation.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in physiology and neurobiology are required. Prior attending of the lectures 'Human and animal physiology', 'Neurobiology' and 'Sensory physiology' is recommended. Prior experience with programming is recommended (not mandatory). Basic calculus and linear algebra is also recommended.

Content:
3 weeks of intensive lectures and lab practicals: 9:00-12:00 lecture; 13:00-17:00 lab practical. First part covers topics ranging from animal vision, eye anatomy, color, motion, and depth vision. Second part covers computational aspects of vision research including receptive field estimation, retinotopic maps and optics

Intended Learning Outcomes:
Students will be able to explain the anatomy of different animal eyes and their corresponding optics, distinguish between different modes of vision, and explain how visual information is encoded in the brain. They will be exposed to concepts and tools of theoretical neuroscience, and use computational tools such as Matlab to visualize data, write simple scripts to automatize tasks.

Teaching and Learning Methods:
Laboratory skills and protocols, dissection, oral reporting, self-study, programming, modeling of neural data

Media:
Media: study of specialist literature, powerpoint, google VR, Matlab®.

Reading List:
Visual Ecology Thomas W. Cronin, Sönke Johnsen, N. Justin Marshall & Eric J. Warrant; Animal Eyes Dan-Eric Nilsson and Michael F. Land; Theoretical Neuroscience P. Dayan and and L. F. Abbott; Specialist literature will be provided during the course.

Responsible for Module:
Prof. Harald Luksch

Courses (Type of course, Weekly hours per semester), Instructor:

Dr. Janie Ondracek (1st part), Dr. Marina Wosniack (2nd part)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2404: Introduction to Mammalian Cell Culture | Einführung in die Kultivierung von Säugetierzellen

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (in min.): 40 oral and 150 written tests.
The manuscript for the internship serves as preparation for the internship. In addition to the practical course and lectures, seminars are held with the students in which they have to work out and present practical topics of the cultivation of mammalian cells using literature. 5 certificates (graded, 5 x 30 minutes) as well as two 20-minute presentations (graded) serve to test the theoretical skills learned in the lecture, seminar and practical course. Here students show whether they are able to structure the knowledge they have acquired and present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations. The overall grade of the module is determined by the results for the individual certificates and presentations, as well as the practical work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor degree in biology or molecular biotechnology

Content:
The lectures will provide basic knowledge about the isolation, characterization and genetic manipulation of mammalian cells. Contents are among others: Sterile working, microscopy, culture conditions, establishment and conservation of cell lines and primary cultures, determination of cell numbers, transfection methods, isolation and expansion of cell clones, application and detection of marker genes. In the lecture of the practical course, especially the background and theoretical knowledge of the experiments carried out will be taught. In the course of the practical course, basic methods for practical work with mammalian cells are taught. In the corresponding seminar the students present relevant literature concerning cell culture.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise for the cultivation and genetic manipulation of mammalian cells. Furthermore, they have learned and practiced basic cell biological working techniques. They understand cell biological questions and working techniques and can apply the acquired knowledge to more in-depth questions.
Students have also developed problem-solving skills and gained insights into cell biology and cell biological problems.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture, practical course, seminar Teaching method: Lecture; in practical course, instructional talks, demonstrations, experiments, partner work, discussion of results.
Learning activities: study of lecture notes, lecture notes, practical course script and literature; practice of laboratory skills and cell biological work techniques; cooperation with practical course partners; preparation of protocols and presentations.

Media:
Presentations using PowerPoint,
Internship script (downloadable lecture material) Publications on cell culture specific topics

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement: Sabine Schmitz; The Experimentator: Cell Culture; R. Ian Freshney: Culture of Animal Cells: A Manual of Basic Technique

Responsible for Module:
Angelika Schnieke (schnieke@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Kultivierung von Säugetierzellen (Zellkultur - Praktikum) (Praktikum, 3 SWS)
Schnieke A [L], Bauer B, Fischer K, Flisikowska T

Zellbiologische Fragestellungen (Zellkultur - Seminar) (Seminar, 2 SWS)
Schnieke A [L], Fischer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2459: Developmental Biology and Histology of Animals | Entwicklungsbiologie und Histologie der Tiere

Version of module description: Gültig ab winterterm 2011/12

Module Level:	Language:	Duration:	Frequency:
Credits:* 6	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Entwicklungsbiologie und Histologie der Tiere (Fortgeschrittenen-Praktikum) (Übung, 5 SWS)
Weigel S [L], Weigel S, Kettler L
For further information in this module, please click campus.tum.de or here.

Module Description

CH0172: Practical Lab Course: Biotechnological Techniques in Mammalian Cells | Forschungspraktikum: Biotechnologische Verfahren in Säugetierzellen

Version of module description: Gültig ab winterterm 2021/22

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module will take the form of a laboratory performance. During the laboratory performance, a current research topic in the field of biotechnological processes in mammalian cells is worked on. The laboratory performance consists of the following elements: Activity in the laboratory, research protocol with evaluation and discussion and lecture (presentation, approx. 20 min) in the ratio 3:3:1.
In the exam, students demonstrate that they can plan, perform, and statistically evaluate laboratory experiments with all relevant samples and associated controls. The resulting data can be interpreted by the students in the context of the overall biotechnological objective, so that follow-up experiments can be planned that are as informative as possible.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
A bachelor's degree in natural sciences is an advantage. Students should have a solid understanding of molecular biology techniques and mammalian cell physiology.

Content:
Practical and analytical research work embedded in current biotechnological projects on genetic and protein engineering of mammalian cells, involving state-of-the-art gene-editing methods, advanced reporter systems, molecular actuation of cellular processes, and tissue engineering.

Intended Learning Outcomes:
After successfully passing the module, students will:

• have a realistic assessment of the biotechnological possibilities and limitations of current research on genetic and protein engineering of mammalian cells, and its impact, on regenerative medicine approaches,
• be able to assess options for the analysis and manipulation of cellular processes via genetically encoded components,
• master advanced cloning methods,
• master state-of-the-art mammalian cell culture techniques including cutting edge gene-editing methods

Teaching and Learning Methods:
The module consists of a 12-week research internship (10 SWS). During the internship, students work on a research topic under supervision. The experimental work on current (sub-)projects, the analysis and presentation of the research results shall stimulate the students to work independently and to think critically.

Media:
Literature research, lab work, digital data analysis, PowerPoint presentation.

Reading List:
Suitable primary literature will be announced by the instructor. The following is intended to be a stand-alone literature search.

Responsible for Module:
Westmeyer, Gil; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum: Biotechnologische Verfahren in Säugetierzellen (CH0172)
(Forschungspraktikum, 10 SWS)
Westmeyer G
For further information in this module, please click campus.tum.de or here.

Module Description

LS20006: Research Practical Entomology | Forschungspraktikum Entomologie

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
A graded report (maximum 30 pages) summarises the project work including an introduction to the research topic, a „Material and Methods“, a „Results“ and a „Discussion“ section. The “Discussion” provides the opportunity to reflect on on the broader context of the research topic. Examples are e.g. the technological relevane of the topic or its implications for insect biodiversity. The report is rounded off by a complete list of the references used. The deadline for the report is 8 weeks after the finalisation of the practical work.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Contents of the research practical include:
• preparation of insect samples (usually cuticle) for light and scanning electon microscopy,
• study and documentation of these samples by means of light and scanning electon microscopy,
• fabrication of epoxy resin mouldings of surface (micro-)structures,
• physics of insect surfaces and their replicas (mainly contact angle measurements, refection spectroscopy, measurement of adhesive forces),
• quantitative measuremnt of morpological characters (ImageJ, R library „patternize“),
• extraction and preocessing of DNA from insect tissues,
• DNA barcoding, reconstruction of sequence based phylograms (R, Genious, Mega X und andere Software),
• phylogeny of Orthoptera and other taxa,
• statistical data analyses with focus on GLMs and multivariate methods.

Intended Learning Outcomes:
Upon completion of this research practical, students will be able to

• analyse basic issues in entomological research and to develop strategies to tackle these issues,
• create strategies for statistical analyses of data,
• evaluate interactions between proximate and ultimate causes and their influence on the evolution of traits,
• assess the potential influence of the student‘s research onto technical innovation,
• understand the significance of insects as the utmost species-rich taxon and to develop arguments pro insect conservation.

Teaching and Learning Methods:
Learning method: research practical.
Students get an personal primer on the current research topic. Students work on their research topic alone or in a small group. Work includes planning, realisation and analyses of the experiments, all closely tutored by the lecturer.

Media:

Reading List:
Literature of the research practical depens on the topic chosen. The relevant literatur is provided at the start of the research practical or is researched into. Here, articles of the primary literatur are relevant for the practical.

Responsible for Module:
Gebhardt, Michael, Dr. rer. nat. michael.gebhardt@mytum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ0003: Internship Reproductive Biotechnology | Forschungspraktikum Biotechnologie der Reproduktion

Version of module description: Gültig ab winterterm 2018/19

Module Level:	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Internship Report/Presentation

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
B.Sc. Life Sciences; basic knowledge of molecular biology and immunology

Content:
During the internship the student will work on an independent sub-project in the field of reproductive biotechnology/immunology and learn different scientific methods. The subproject is integrated into a larger overall project. Depending on the project, techniques of molecular biology, cell biological, animal breeding and embryological methods will be learned. The student will expand his/her knowledge in the fields of embryology, stem cell biology, immunology and molecular biology.

Intended Learning Outcomes:
After participation in the module course students are able to apply molecular biological, cell biological, embryological and immunological methods and analyse data.

Teaching and Learning Methods:
Practice laboratory skills, prepare and give a presentation

Media:

Reading List:

Responsible for Module:
Benjamin Schusser benjamin.schusser@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Reproduktion (Forschungspraktikum, 10 SWS)
Schusser B [L], Schusser B, Sid H

Forschungsprojekt Biotechnologie der Reproduktion (Projekt, 5 SWS)
Schusser B [L], Schusser B, Sid H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1331: Research Project Chronobiology | Forschungspraktikum Chronobiologie

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 75	**Contact Hours:** 225

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In an 8 week long practical laboratory course, scientific questions related to ongoing projects regarding the role of the circadian clock in the developmente and pathogenesis of gastrointestinal diseases and microbiota composition/function will be investigated.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The practical course buids on the knowledge earned by attending the modul Basics in Chronobiology. On the basis of this knowledge, students should develop an understanding of circadian-related pathologies. By the use of selected examples, the impact of circadian disturbances, e.g. during Jetlag or shift work, on distinct pathologies is analysed. By applying and transferring the knowledge acquired to a circadian science-associated question the relevance is illustrated and evaluated, leading to an intensified understanding.

Intended Learning Outcomes:
At the end of the pracitcal course the students are capable to chose specific methods to answer specific scientific questions and unterstood the limitations of thus methods in the field of chronobiology, especially regarding circadian-related pathologies. The students receive practical experience in the lab.

Teaching and Learning Methods:
Praktisches wissenschaftliches Arbeiten im Labor, mit welcher neben der praktischen Durchführung von Experimenten Recherchearbeit, Nachbeareitung, Selbstorganosation, die Führung eines Laborbuches und die Anfertigung von Protokollen einhergeht. Dadurch erlangen die Studierende ein tieferes Verständnis der Thematik und entwickeln die Fähigkeit sich und ihre Arbeit im Labor zu organisieren.

Media:

Reading List:
Circadian Physiology; Roberto Refinetti, PhD.; CRC Press: ISBN 9780849322334; Biological Timekeeping: Clocks, Rhythms and Behaviour; Vinod Kumar, Springer, ISBN 978-81-322-3688-7

Responsible for Module:
Prof. Hauner

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1415: Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 240	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studien-/Prüfungsleistung ist eine Laborleistung, d.h. die Studierenden sollen eine oder mehrere Forschungsfragen weitgehend selbständig bearbeiten. Zur Durchführung liegen zum Teil vorgegebene Protokolle vor. Die Studierenden führen teilweise Freiland als auch Laborarbeiten durch und werden dabei jeweils in die Arbeitsmethoden und Geräten eingewiesen, so dass Sie die Methoden meist vollkommen selbständig, in einigen speziellen Fällen unter Anleitung, nutzen können. Im Rahmen des Forschungspraktikums erheben sie Daten, die sie auswerten und präsentieren. Hierbei wird erwartet, dass sie die erhaltenen Ergebnisse in Bezug zu den Fragestellungen und selbst entwickelten Hypothesen setzen und in einen breiteren wissenschaftlichen Kontext stellen.
Im Anschluss an das Praktikum wird der Kompetenzgewinn in Form eines benoteten, wissenschaftlichen Standards genügendem Protokolls schriftlich abgeprüft, welches innerhalb von 4-6 Wochen nach Abschluss des Praktikums vorzulegen ist. Dabei handelt es sich um eine 20-50 Seiten umfassende schriftliche Arbeit, die zunächst auf das zu bearbeitende Thema unter Aufführung bereits publizierter wissenschaftlicher Vorarbeiten hinführen, die Forschungsfragen und -hypothesen erläutern, dann die verwendeten Methoden (inklusive Statistik) im Detail aufführen, alle Ergebnisse darstellen und zuletzt in Bezug auf bestehende Literatur diskutieren soll. Mit dem Protokoll weisen die Studierenden nach, dass Sie eine zwar thematisch begrenzte, aber anspruchsvolle Fragestellung der Insekten-Pflanzen Interaktion mit Fokus auf die damit verbundenen Verhaltensphysiologischen Grundlagen innerhalb begrenzter Zeit erfolgreich bearbeiten und entsprechend den wissenschaftlichen Gepflogenheiten darstellen und abschließen können. Um auch die notwendige Fähigkeit zur Vermittlung der Ergebnisse zu prüfen und benachbarte Themen, die nicht Kernbestandteil des Protokolls sind, abzuprüfen, muss im Rahmen der Laborleistung und nach Abschluss von Datenaufnahme und -auswertung ein Vortrag (20 min) innerhalb der Arbeitsgruppe gehalten werden. Es wird empfohlen, den Vortrag 2-3 Woche vor Protokollabgabe zu halten.

Die Leistungen von Protokoll und Vortrag werden mit einer Note bewertet, wobei das Protokoll einen etwa doppelt so hohen Anteil wie der Vortrag hat.
Die Kontaktzeit mit dem Betreuenden sind ungefähr 60 Stunden. Die restlichen 240 Stunden bestehen aus eigenständiger Arbeit in Feld, Labor und Bibliothek. Davon entfallen etwa 40 Stunden auf die Erstellung des Protokolls und des Vortrags.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Ökologie, Botanik und/oder Entomologie sind nötig, beispielsweise auf dem Niveau der Module "Allgemeine Ökologie", "Grundkurs/Allgemeine Botanik" und/oder "Grundkurs/Allgemeine Zoologie". Abhängig vom finalen Projektthema sind grundlegende Kenntnisse der Biodiversität, Ernährungsökologie, Physiologie oder Neurobiologie wünschenswert, beispielsweise auf dem Niveau der Vorlesungen/Seminare "Diversität und Evolution der Farn- und Samenpflanzen", "Vegetation der Erde", "Funktion und Interaktion von Insekten in Waldökosystemen", "Bienenkunde", "Cognitive Neuroscience" oder "Sinnesphysiologie".

Content:
Innerhalb dieses Forschungspraktikums können Themen aus dem Bereich der Ökologie von Insekten behandelt werden. Beispielhaft wären die Themen „Einfluss Pestiziden auf das Lern- und Sammelverhalten von Bienen“ oder "Nährstoffperzeption bei verschiedenen Bienenarten"; dies beinhaltet in der Regel eine Kombination aus Verhaltensversuchen und Freiland- oder Käfigbeobachtungen. Weiterhin können Verhaltensversuche auch mit chemischen Analysen (z.B. GCMS) kombiniert werden. Auch Experimente mit anderen Insekten (Schmetterlinge, Fliegen, Käfer, Ameisen) sind möglich. Der Schwerpunkt in diesem Forschungsmodul liegt auf der Untersuchung der Physiologie des Verhaltens, welche Interaktionen zwischen bestimmten Insektenarten und bestimmten Pflanzenarten zur Grunde liegt. Die Studierenden werden, soweit wie möglich, die Versuche selbstständig durchführen und auswerten. Das genaue Thema ist nach Absprache mit den jeweiligen Dozenten zu vereinbaren.

Intended Learning Outcomes:
Nach erfolgreichem Abschluss des Moduls sind die Studierenden in der Lage, Versuche zu den verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten sowie deren Auswertung weitgehend oder vollständig eigenständig durchzuführen. Dazu gehört das Designen von Feldexperimenten, die systematische Datenaufnahme im Feld, die Konditionierung von Bienen anhand bestehender Laborprotokolle und die statistische Auswertung von Versuchsergebnissen mit Hilfe des "open software" Programms R. Darüber hinaus erlernen sie die Fähigkeit, in wissenschaftlich strukturiertem Format zu schreiben und ihre Ergebnisse in Bezug zu den erhaltenen Fragestellungen und selbst entwickelten Hypothesen zu setzen sowie in einen breiteren wissenschaftlichen Kontext zu stellen.

Teaching and Learning Methods:
Lehrmethode: Gespräch, Anleitung an Spezialgeräten, wie z.B. Mikromanipulatoren, bis eigenständiges Arbeiten möglich ist; Anleitung zu Arbeiten im Freiland, bis eigenständige Feldarbeit durchgeführt werden kann; Diskussionen von Zwischenergebnissen in Lehrstuhlseminar; ggf Anleitung zur Erstellung einer wissenschaftlichen Arbeit.
Lernmethode: Arbeit in Freiland und Labor; systematische Datenerfassung und Auswertung; graphische Darstellung von Ergebnissen, Niederschrift und Vortrag; Studium der Literatur und der grundständigen Lehrbücher.

Media:
Anleitungen zu Freilandarbeiten und Laborversuchen, Protokolle zu Konditionierung und Auswertungen, Arbeitsgruppen-Seminare und Gespräche, mündliche statistische Einführung, R-Skripte, wissenschaftliche Literatur, Bücher, Datenbanken

Reading List:
Wissenschaftliche Literatur wird innerhalb des Praktikums ausgegeben und soll zusätzlich in eigenständiger Literaturrecherche erarbeitet werden.
Beispiel für Standartwerk zum Thema:
Nickolas M. Waser & Jeff Ollerton (2006): Plant-Pollinator Interactions: From Specialization to Generalization
Stephen J. Simpson & David Raubenheimer (2012) The Nature of Nutrition

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten (Praktikum, 10 SWS)
Leonhardt S [L], Leonhardt S, Rüdenauer F
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2455: Practical Course in Neurobiology of Arthropods | Forschungspraktikum Neurobiologie von Arthropoden

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular presence at the laboratory workplace is the basis of the research internship. By writing a protocol of the project, the students show that they are able to structure and convincingly present the data they have acquired themselves. The protocol also shows the students' ability to evaluate the experimental results methodically and correctly, to place them in the context of the research area and to establish a connection between them and hypotheses.

Repeat Examination:

(Recommended) Prerequisites:
Lecture Animal and Human Physiology (Lv-Nr.920807938).
The lectures Neurobiology (Lv-No. 240866469) and Sensory Physiology (Lv-No. 920996974) are advantageous.

Content:
The research internship covers changing topics in the behavioral and neurobiology of arthropods (mainly insects). Examples are:

"Behavioural experiments on wind-evoked flight of crickets.
"Electrophysiology of filiform hairsensils on the cerci of crickets.
"Electrophysiology of insect infrared- and heat-sensils.
"Studies on the function of insect surfaces.

The results of the experiments are evaluated using modern methods, with special emphasis on statistical analysis and graphic presentation of the data.

Intended Learning Outcomes:
The students acquire the competence to carry out a neuro- or behavioral-biological scientific project under guidance and to present and discuss the results adequately. They get a deeper impression of scientific work in these sub-areas of biology. In addition to the understanding of subject-specific safety and material knowledge, this module focuses on the analysis of a specific scientific problem and the synthesis of the methodological and technical knowledge acquired in the previous semesters.

Teaching and Learning Methods:
Event type/teaching technique: Practical course and seminar.
Teaching method: seminar, question-developing method, group work, presentation
Learning activities: studying the literature distributed, preparing and giving presentations, incorporating new information supported by question and answer sessions.

Media:
Literature is distributed or made available for download on Moodle. The seminar presentations should be created using PowerPoint or similar presentation techniques.

Reading List:
Special literature suitable for the project will be distributed at the beginning of the internship.

Responsible for Module:
Michael Gebhardt (Michael.Gebhardt@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2463: Research Project Neurobiology of Birds | Forschungspraktikum Neurobiologie an Vögeln

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation is required. Students will prepare themselves for the aspects of visual and multimodal processing that will be investigated in each case by conducting their own research using suitable literature; students will be enabled to plan, conduct and evaluate experiments in accordance with current scientific standards. At the end of the practical training, the increase in competence will be checked in writing in the form of a protocol.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Furthermore, basic knowledge of physiology and neurobiology is required, for example at the level of the lecture "Human and Animal Physiology", or attendance of the lectures "Neurobiology" and/or "Sensory Physiology

Content:
Within this internship the topic of visual processing and multimodal integration will be covered. This includes common in vivo techniques to study visual and multimodal processing or dressage of chickens in a behavioural experiment. The students will, as far as possible, perform and evaluate the experiments independently. This also includes the care and supervision of the test animals before and after the experiments. The exact topic is to be agreed upon with Dr. J. Verhaal.

Intended Learning Outcomes:
The aim is to learn techniques for the execution of common techniques for the independent execution of experiments as well as analysis and evaluation. Furthermore, the basics of generating visual and multimodal stimuli will be learned. The basics of programming (MATLAB or Python) will

be learned. This practical course also includes evaluation methods, statistical methods and the graphical representation of measurement data.

Teaching and Learning Methods:
Course type/teaching technique: Exercise, laboratory work
Teaching method: question-developing method, individual work, independent preparation, data acquisition and data analysis.
Learning activities: Study of the distributed basic information, integration of new information supported by question-developing leading and independent experiment execution.

Media:
Internship protocol and scientific literature

Reading List:
Scientific literature will be distributed within the course. During the course, students are tested to see if they have understood the literature.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2464: Research Project Neurobiology of Isolated Networks | Forschungspraktikum Neuronale Netzwerkanalyse

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige, aktive Teilnahme ist erforderlich. Die Studierenden werden sich anhand von Eigenrecherche mit geeigneter Literatur auf die jeweils untersuchten Aspekte der visuellen und multimodalen Verarbeitung vorbereiten; die Studierenden werden in die Lage versetzt, in Übereinstimmung mit heute gültigen wissenschaftlichen Standards Versuche zu planen, durchzuführen und auszuwerten. Im Anschluß an das Praktikum wird der Kompetenzzuwachs in Form eines Protokolls schriftlich abgeprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Physiologie und Neurobiologie auf dem Niveau der Vorlesung "Neurobiologie" sind nötig. Der vorherige Besuch dieser Vorlesung wird empfohlen.

Content:
In dem Praktikum werden wissenschaftliche Vorgehensweisen zur Analyse neuronaler Netzwerke am Beispiel von in vitro Präparationen des Hühnerhirns theoretisch und praktisch vorgestellt. Dies beinhaltet elektrophysiologische Versuche an Nervenzellen in Hirnschnitten. Die Studenten werden nach einer Einarbeitungszeit die Versuche selbständig durchführen, auswerten und die Ergebnisse präsentieren.

Intended Learning Outcomes:
Ziel ist das Erlernen von Techniken zur Durchführung elektrophysiologischer Versuche an in vitro Präparaten. Dies beinhaltet die Herstellung von in vitro Präparaten, Techniken zur Analyse neuronaler Netzwerke (z.B. Einzelzellableitung, Optical Imaging, Tracing) sowie histologische

Aufbereitungen. Darüber hinaus werden Auswertmethoden, statistische Methoden und die grafische Darstellung von Ergebnissen erlernt.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborlehre
Lehrmethode: Fragend-entwickelnde Methode,Einzelarbeit, praktische Demonstrationen, eigenständige Labortätigkeit, Experiment. Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Bearbeiten von Problemen und deren Lösungsfindung, Üben von labortechnischen Fertigkeiten, Produktion von wissenschaftlichen Berichten..

Media:
Ein Skript zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte).

Reading List:
Als grundlegendes Lehrbuch wird "Neuroscience: Exploring the brain" von Baer empfohlen. Spezialliteratur steht dem Studenten im Labor zur Verfügung.

Responsible for Module:
Harald Luksch (Harald.Luksch@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Neuronale Netzwerkanalyse (Forschungspraktikum, 10 SWS)
Kohl T, Luksch H, Ondracek J, Weigel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2465: Research Project Neurobiology of Ultrasound Orientation | Forschungspraktikum Neurobiologie der Echoortung

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige, aktive Teilnahme ist erforderlich. Die Studierenden werden sich anhand von Eigenrecherche mit geeigneter Literatur auf die jeweils untersuchten Aspekte der Echoortung vorbereiten; Die Studierenden werden in die Lage versetzt, in Übereinstimmung mit heute gültigen wissenschaftlichen Standards neurophysiologische Versuche zur Echoortung zu planen, durchzuführen und auszuwerten. Im Anschluß an das Praktikum wird der Kompetenzzuwachs in Form eines Protokolls schriftlich abgeprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Weiterhin sind grundlegende Kenntnisse der Physiologie und Neurobiologie nötig, beispielsweise auf dem Niveau der Vorlesung "Human- und Tierphysiologie", oder auch der Besuch der Vorlesungen "Neurobiologie" und/oder "Sinnesphysiologie"

Content:
Die Studierenden werden in einem Forschungsprojekt zur Neurobiologie der Echoortung bei Fledermäusen teilnehmen. Dies beinhalten elektrophysiologische Versuche mit extrazelluären Ableitungen von Neuronen der Hörbahen von narkotisierten Fledermäusen oder die Andressur von Fledermäusen in einem psychophysikalischen Verhaltensversuch. Die Studierenden werden dabei, soweit wie möglich, die Versuche selbstständig durchführen und auswerten. Dies beinhaltet auch die Pflege und Betreuung der Versuchstiere vor und nach den Experimenten.

Intended Learning Outcomes:
Ziel ist das Erlernen von Techniken zur Durchführung von elektrophysiologischen Versuchen. Dies beinhaltet Narkosemethoden, Durchführung der chirurgischen Eingriffe (unter Anleitung des

Betreuers) und Handhabung der Tiere im akuten Versuch. Darüber hinaus werden Grundlagen zur Generierung und Präsentation akustischer Stimuli (digitale Signalverarbeitung) sowie Techniken zur extrazellulären Ableitung von neuronalen Potentialen erlernt. Dies beinhaltet auch Auswertmethoden, statistische Methoden und die graphische Darstllung vom Messdaten. Dabei werden Grundlagen im Umgang mit dem Programm Matlab® erlernt. Je nach Versuchsthema weden auch Grundlagen der Veraltensdressur von Fledermäusen erlernt. Zusätzlich werden grundlegende neuroanatomische Methoden (z.B. Tracerappliktionen) vermittelt.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Übung
Lehrmethode: Fragend-entwickelnde Methode, Einzelarbeit, eigenständige Präparation, Datenaufnahme und Datenauswertung. Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Einbauen von neuen Informationen unterstützt durch fragend-entwickelndes Hinführen und eigenständige Versuchsdurchführung.

Media:
Literatur zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Als grundlegendes Lehrbuch zur Neurobiologie der Echoortung wird 'Biologie der Fledermäuse' von Gerhard Neuweiler empfohlen und vorrausgesetzt. Spezialliteratur zur Pysiologie und Psychologie des Hörens wird vom Betreuer zur Verfügung gestellt.

Responsible for Module:
Harald.Luksch@wzw.tum.de Luksch (Harald.Luksch@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Neurobiologie der Echoortung (Forschungspraktikum, 10 SWS)
Firzlaff U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2474: Research Project in Molecular Physiology | Forschungspraktikum Molekulare Physiologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.
Regelmäßige Teilnahme während des Praktikums ist Pflicht. Eine schriftliche Zusammenfassung der praktischen Arbeit mit theoretischem Hintergrund dient der Überprüfung der im Praktikum erlernten Kompetenzen. Die Studierenden sollen das Erarbeitete in angemessener wissenschaftlicher Weise dokumentieren und das dabei erlernte Wissen zu strukturieren und in wesentlichen Aspekten darzustellen. Innerhalb der Arbeitsgruppe oder im institutsinternen Seminar wird über die Arbeit ein Vortrag gehalten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Zellisolierung, Zellkultur, Gewebekultur, Extraktion von NS und Proteinen, Transcriptomics, Expressionsanalytik (real-time RT-PCR), Proteinanalytik mittels EIA, Blot-Techniken, Nutzung von Datenbanken, Sequenzanalyse, Bioinformatik, Biostatistik, etc.

Intended Learning Outcomes:
Die Studierenden erlangen nach Teilnahme am Modul Fähigkeiten und Fertigkeiten für das molekularbiologische Arbeiten im Labor. Darüber hinaus erhalten Sie die Fähigkeit, die eigenen experimentellen Ergebnisse kritisch nach Varianzursachen zu hinterfragen. Sie erlangen Kenntnisse über die korrekte Dokumentation der Ergebnisse. Im Vortrag sowie im Praktikumsbericht legen sie einen schriftlichen Bericht hierüber ab, der besonders klar

aufzeigt, dass eine Strukturierung nach wissenschaftlichen Themen von der chronologischen Herangehensweise unterschieden werden muss.

Teaching and Learning Methods:
Lehrtechnik: Laborarbeit
Lehrmethode: Einzelarbeit, Experimente
Lernaktivitäten: Literaturrecherche, Durchführung von Experimenten, Kritische Beurteilung der Ergebnisse, Suche nach Varianzursachen, Zusammenfassung im schriftlichen und mündlichen Vortrag

Media:
Eigene Laborarbeit, Datenerfassung, Auswertung, Präsentationen mittels Powerpoint

Reading List:

Responsible for Module:
Zehn, Dietmar; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Physiologie, BiologieM (Forschungspraktikum, 10 SWS)
Zehn D, Pfaffl M

Forschungspraktikum Molekulare Physiologie, BiologieM (Forschungspraktikum, 10 SWS)
Zehn D, Pfaffl M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2478: Research Project Neurophysiology | Forschungspraktikum Neurophysiologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (min.): 20.
The internship is only held after prior consultation with the person responsible for the module!
A regular, active participation of the students in the entire internship is expected. A presentation (20min, graded) at the end of the internship will show whether the students are able to present the acquired practical and theoretical skills and how they relate to each other. They should be able to describe, interpret and combine the acquired information in a meaningful way and apply it to similar situations. A protocol is to be kept to check the understanding as well as the ability to describe, evaluate and interpret the experiments carried out during the practical training (ungraded). The grade of the lecture forms the overall grade of the module.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in the field of neurophysiology.

Content:
During the internship, the students work on a small research project in the field of neurophysiology. Depending on the specific task, the students work with methods established at the chair (e.g: primary culture of enteric neurons, immunohistochemistry, visualization of neuron activity with voltage-sensitive or calcium-sensitive dyes).

Intended Learning Outcomes:
The students have an insight into the current research focus of the chair. They are given the opportunity to apply the lecture material from the field of neurophysiology and are encouraged to critically evaluate the usefulness of different experimental approaches.

Teaching and Learning Methods:
Teaching techniques and teaching methods: laboratory teaching, experiment. Learning activities: Practice technical and laboratory skills, report production.

Media:
Experiments, presentations

Reading List:

Responsible for Module:
Michael Schemann schemann@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2532: Research Project Conservation Genetics | Forschungspraktikum Conservation Genetics

Version of module description: Gültig ab summerterm 2011

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 30	**Contact Hours:** 120

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige, aktive Teilnahme mit 8h je Tag für 3 Wochen ist erforderlich. Die Prüfungsleistung wird in Form eines Abschlussvortrages und eines Abschlussberichtes sowie durch eine laufende Beurteilung erbracht.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Zoologie, Ökologie und Genetik sollten vorhanden sein.

Content:
DNA/RNA Präperation, PCR, Mikrosatelliten und SNP-Genotypisierung populationsgenetische Statistik, Zellkulturen, Zellfärbemethoden,quantitative realtime-PCR.

Intended Learning Outcomes:
Nach Teilnahme der Modulveranstaltung sind die Studierenden in der Lage die interdisziplinären Methoden der Bereiche Genomik und Transkriptomik im Fachgebiet der "Ecological and Evolutionary Functional Genomics" anzuwenden und Projektkonzepte zu verstehen. Zudem haben Sie Einblick in in die Organisation und Konzeption von Laborabläufen. Sie haben ein Verständnis über die Möglichkeiten und Probleme von genetisch-physiologischen und genetisch-funktionellen Forschungsansätzen

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborlehre
Lehrmethode: Fragend-entwickelnde Methode,Einzelarbeit bzw. Gruppenarbeit, praktische Demonstrationen, eigenständige Labortätigkeit, Experiment.

Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Bearbeiten von Problemen und deren Lösungsfindung, Üben von labortechnischen Fertigkeiten, Produktion von wissenschaftlichen Berichten.

Media:
Arbeitsprotokolle zu diesem Praktikum werdenausgeteilt.

Reading List:
The Condensed Protokolls, From Molecular Cloning: A Laboratory Manual (Sambrook)
Der Experimentator Microarray (Müller)
Der Experimentator Genomics (Mülhart)
Functional Genomics (Hunt)

Responsible for Module:
Ralph Kühn (RalphKuehn@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum: "Conservation Genetics" für Master-Studierende (Forschungspraktikum, 8 SWS)
Kühn R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2533: Research Project Molecular Zoology | Forschungspraktikum Molekulare Zoologie

Version of module description: Gültig ab summerterm 2011

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige, aktive Teilnahme mit 8h je Tag für 6 Wochen ist erforderlich. Die Prüfungsleistung wird in Form eines Einführungs- und Abschlussvortrages und eines Abschlussberichtes (paper - style) sowie durch eine laufende Beurteilung erbracht.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Zoologie, Ökologie und Genetik sollten vorhanden sein.

Content:
DNA/RNA Präperation, PCR, Mikrosatelliten und SNP-Genotypisierung populationsgenetische Statistik, Zellkulturen, Zellfärbemethoden,quantitative realtime-PCR , Gen-Expressionsanalytik, Microarrayanalytik, Mikroarrayauswertung.

Intended Learning Outcomes:
Nach Teilnahme der Modulveranstaltung sind die Studierenden in der Lage die interdisziplinären Methoden der Bereiche Genomik und Transkriptomik im Fachgebiet der "Ecological and Evolutionary Functional Genomics" anzuwenden und Projektkonzepte zu evaluieren sowie selbst Projekte zu konzipieren. Zudem sind sie fähig selbständig Laborabläufe zu organisieren und zu konzipieren. Die Studenten können Möglichkeiten und Probleme von genetisch-physiologischen und genetisch-funktionellen Forschungsansätzen bewerten.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborlehre

Lehrmethode: Fragend-entwickelnde Methode,Einzelarbeit bzw. Gruppenarbeit, praktische Demonstrationen, eigenständige Labortätigkeit, Experiment.
Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Bearbeiten von Problemen und deren Lösungsfindung, Üben von labortechnischen Fertigkeiten, Produktion von wissenschaftlichen Berichten.

Media:
Arbeitsprotokolle zu diesem Praktikum werdenausgeteilt.

Reading List:
The Condensed Protokolls, From Molecular Cloning: A Laboratory Manual (Sambrook)
Der Experimentator Microarray (Müller)
Der Experimentator Genomics (Mülhart)
Functional Genomics (Hunt)

Responsible for Module:
Ralph Kühn (RalphKuehn@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum: "Molekulare Zoologie" für Master-Studierende (Forschungspraktikum, 16 SWS)
Kühn R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2545: Research Project Animal Biotechnology | Forschungspraktikum Biotechnologie der Tiere

Version of module description: Gültig ab summerterm 2002

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Tiere (Forschungspraktikum, 10 SWS)
Bauer B, Fischer K, Flisikowska T, Flisikowski K, Schnieke A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2639: Research Project Neurobiology of behavior | Forschungspraktikum Neurobiologie des Verhaltens

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Time allowed (in min.): 40 min (20 min lecture, 20 min scientific discussion).
Regular and active participation during the whole research module is required. Students will prepare themselves for the respective aspects of the course after being instructed by the internship supervisor and by conducting their own research with suitable literature; the basic level of knowledge will be assessed at the beginning of the course. Students will be enabled to assess the neurobiology of animal behaviour on different levels of analysis. Various examination methods can be applied, for example test procedures for characterising animal models in basic biomedical research, behavioural training with animals to determine sensory thresholds or learning behaviour, invasive methods for analysing neuroendocrine and/or molecular biological aspects, or pharmacological influences on specific behaviours. In addition, the research methods used, the validity of the paradigms and the interpretation of the results are critically evaluated. Following the exercise, the increase in competence is tested orally.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Successful participation in the zoological basic course is required. Furthermore, basic knowledge of anatomy and physiology is required, as well as the willingness to work experimentally with the species to be studied and to integrate into a team.

Content:
The practical course deals with the basic characterization of animal models in biological and biomedical research. The focus can be on behavioural, neuroendocrine, pharmacological and/or molecular biological aspects. The topics worked on will be based on or integrated into current projects of the respective research group. The range of topics offered includes pharmacological

modulation of the stress hormone system and its effects on neuroendocrine parameters, emotional behaviour and the investigation of the underlying molecular mechanisms, quantification of sensory processing, for example in the visual or auditory system or in multimodal processing, learning behaviour, analysis of motor responses to sensory stimulation, etc. The experiments will be performed with different animal models, for example with genetic mouse models for psychiatric disorders (generated by specific genetic manipulation or by selective bi-directional breeding), chicken chicks, bats, different insects or different infrared sensitive snakes.

Intended Learning Outcomes:
Students acquire scientifically sound, basic knowledge for the characterisation of behavioural reactions in animal organisms. The relevant theoretical background is taught, for example on stress, affective disorders, multimodal integration, eye movements etc., as well as on the use of corresponding animal models. Furthermore, knowledge will be acquired on the conception, planning, implementation and evaluation of neuroscientific and/or pharmacological studies, which also include the collection and analysis of numerous behavioural and neuroendocrine parameters. Depending on the subject area, students are given an introduction to molecular biological analysis techniques (gene expression, hormone measurement, protein determination) as well as methods for the adequate graphical representation and statistical evaluation of scientific data. The aim of the course is also an introduction to the independent writing of a scientific paper using current specialist literature. In addition, methodological questions (advantages and limitations of the technique) are discussed in all the areas mentioned, so that students can critically question the methods used and evaluate their suitability for a wide range of scientific questions.

Teaching and Learning Methods:
Course type/teaching technique: Practice; teaching methods: Question-and-answer method, lectures on the individual topics/techniques, individual work, practical demonstrations, independent performance of experiments including data acquisition and documentation; learning activities: study of the basic information provided, integration of new information supported by question-and-answer guidance and independent experimental activity.

Media:

Reading List:
Relevant specialist literature; textbooks and journal articles to familiarise students with the topic of the project, some of which are provided by the supervisor or searched for by the students themselves.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum "Neurobiologie des Verhaltens" (Forschungspraktikum, 10 SWS)
Luksch H, Firzlaff U, Gebhardt M, Kettler L, Kohl T, Ondracek J

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2653: Research Project Neurobiology of Vertebrates | Forschungspraktikum Neurobiologie von Wirbeltieren

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation is required. Students will prepare themselves for the aspects of visual and multimodal processing that will be investigated in each case by conducting their own research using suitable literature; students will be enabled to plan, conduct and evaluate experiments in accordance with current scientific standards. At the end of the practical training, the increase in competence will be checked in writing in the form of a protocol.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Furthermore, basic knowledge of physiology and neurobiology is required, for example at the level of the lecture "Human and Animal Physiology", or attendance of the lectures "Neurobiology" and/or "Sensory Physiology.

Content:
Within this practical course, various topics from the field of vertebrate neurobiology can be covered. An example would be the topic of visual processing and multimodal integration; this includes common in vivo techniques to study visual and multimodal processing or dressage of chickens in a behavioural experiment. Furthermore, experiments with other vertebrates (amphibians, reptiles, mammals) can also be performed. The focus in this research module is on the analysis of the intact animal; invasive techniques (electrophysiological derivations, pharmacological influences, transmitter blockers, etc.) can be applied. The students will, as far as possible, carry out and evaluate the experiments independently. This also includes the care and supervision of the experimental animals before and after the experiments. The exact topic is to be agreed upon with the respective lecturers.

Intended Learning Outcomes:
The aim is to learn techniques for the execution of common techniques for the independent execution of experiments as well as analysis and evaluation. In addition, the basics of generating sensory stimuli are learned. The basics of programming (MATLAB or Python) will be learned. This practical course also includes evaluation methods, statistical methods and the graphical representation of measurement data.

Teaching and Learning Methods:
Course type/teaching technique: Exercise, laboratory work
Teaching method: question-developing method, individual work, independent preparation, data acquisition and data analysis.
Learning activities: Study of the distributed basic information, integration of new information supported by question-developing leading and independent experiment execution.

Media:
Internship protocol and scientific literature

Reading List:
Scientific literature will be distributed within the course. During the course, students are regularly asked to check their understanding of the literature. Students will also be asked to search for literature themselves.

Responsible for Module:
Harald.Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2680: Research Project in Zoological Systematics | Forschungspraktikum Zoologische Systematik

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 120	**Contact Hours:** 180

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Presentation and protocol

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in zoological systematics.

Content:
The module contains faunistic-systematic studies on animals, especially insects, but also other invertebrates and in some cases vertebrates. Morphological (incl. genital morphological) and taxonomic studies are in the foreground, but also work with a behavioural-biological background, which goes in the direction of phylogenetic systematics and evolution.

Intended Learning Outcomes:
After the participation in this research practical course the students are able to understand complex approaches with regard to methodology and goals of morphological, taxonomic or behavioural biology work and to evaluate and apply them in a differentiated way regarding other target organisms.

Teaching and Learning Methods:
Familiarization with the morphology of the model organism, practice of preparation skills, collection of various measured values, documentation of scientific drawings and photographic recording by microscopy and scanning electron microscopy Behavioural biological investigation techniques, their analysis and interpretation are taught (if necessary).

Media:
Original scientific articles and books

Reading List:
Is individually adapted to the model organism

Responsible for Module:
Gerstmeier, Roland r.gerstmeier@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2687: Research Project Mapping Neural Circuits Underpinning Behavior | Forschungspraktikum Neuronale Netzwerke und Verhalten

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam consists of a lab report and a digital lab book (labfolder). At the end of the practical period, the student will present their project during lab meeting in form of a ppt or similar presentation. In addition, participation in experimental work is expected.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
general principles and some practical experience in neurobiology, genetics, molecular biotechnology is expected

Content:
Depending on the aim of the research project, different methods and question will be in focus. For instance: • behavioral analysis in adult flies or larvae using videotracking, matlab analysis, optogenetics etc.
• histology of brain and/or gut, immunostainings, genetics with GAL4/UAS
• confocal microscopy
• Image analysis using ImageJ software
• single sensilla recordings and odor stimulation
• statistical analysis with GraphPad or R
• conceptual discussion and literature searches to understand and propose ideas, results, hypotheses

Intended Learning Outcomes:
upon successful participation students can
• use neurogenetics in the model system Drosophila (i.e. Drosophila chemosensation)

• analyze fly behavior with optogenetics, mutants, video analysis, ctraxx program
• interpret and develop the results and suggest further experiments
* carry out some simple electrophysiology and/or imaging experiments

Teaching and Learning Methods:
different methods such as neurogenetics with D. melanogaster, behavioral analysis, molecular biology, optogenetics, mutant analysis, imaging, electrophysiology will be used by the student.

Media:
databases (z.B. Pubmed); ePaper; Labfolder; direkte Interaktion mit Betreuer

Reading List:
papers, protocols etc. will be provided by the supervisor

Responsible for Module:
Ilona Grunwald Kadow grunwald@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Research practical Neural Circuits and Behavior (Forschungspraktikum, 10 SWS)
Grunwald I [L], Grunwald I, De Backer J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2695: Research Project Wildlife Biology | Forschungspraktikum Wildbiologie

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Das anzufertigende wissenschaftliche Protokoll (Einleitung, Material und Methode, Ergebnisse und Diskussion, Umfang 15-25 Seiten) dient der Überprüfung der Fähigkeit zur Beschreibung, Auswertung und Interpretation der im Praktikum durchgeführten Experimente zum Thema Wildbiologie. Die im Praktikum durchgeführten und im Protokoll beschriebenen Experimente oder Datenanalysen sind darüber hinaus in Form eines Vortrags in der Arbeitsgruppe des betreuenden Dozenten vorzustellen, so dass auch die Fähigkeit zur mündlichen Darstellung der wissenschaftlichen Arbeit und die Befähigung zur wissenschaftlich- kritischen Diskussion über das schriftlich formulierte hinaus überprüft werden kann. Für die gesamte Leistung (Qualität der Feld- und / oder Laborarbeit, Protokoll, Vortrag) wird eine Note vergeben.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
BSc Biologie

Content:
Das Modul beschäftigt sich mit der Entwicklung, Konzeption, Methodik und Auswertung von Forschungsarbeiten, Feld- und Labordaten sowie deren wissenschaftlichen Aufbereitung. Arbeitsschwerpunkte sind im Bereich der Populationschätzung über direkte und indirekte Zählmethoden sowie mathematische Verfahren wie Kohortenrechnungen, Raum und Konditions bezogenen Reproduktrionsanalysen bei Gams und Reh, Überlebensraten von Jungtieren, Krankheiten und Parasiten bei Wildterien, Analyse von Organveränderungen im Jahresverlauf, Raum-Zeitanalysen von Wildtieren. Wichtig bei all den Themen ist jedesmal der Raum, Zeit zur Umwelt sowie der hiermit verbunden Konditionsbezug der Einzeltiere sowie Populationsgruppen.

Intended Learning Outcomes:
Studierenden erwerben Kenntnisse und Fähigkeiten in der Konzeptionierung, Durchführung, Datengewinnung und Analyse von Forschungsarbeiten und -ergebnissen zu verschiedenen Säugetier- und Vogelarten im Freiland und Labor. Sie werden in die Lage gesetzt, Telemetriedaten auszuwerteund zu analysieren, die verschiednen Methoden der Populationschätzung anzuwenden und ihre Grenzen zu bewerten, Einflüsse von Habitat, Klima, Populationsdichte auf die Reproduktion und Krankheitsgeschehen von Wildtierpopulationen zu beurteilen und zu bewerten.

Teaching and Learning Methods:
Mitarbeit in Feld- und Labortechniken in den laufenden verschiedenen Forschungsprojekten der Arbeitsgruppe Wildbiologie und Wildtiermanagement. Zusammenarbeit mit den Praktikumspartner vor Ort und im Labor.

Media:
Aktuelle Fachliteratur und aktuelle Veröffentlichungen. Vorhandene und selbst zu erzeugende Datensätze.

Reading List:
Gossow: Wildökologie, BLV Verlag; Krausmann, P. 2002: Introduction to wildlife management. Pearson Education, Upper Saddle River, New Jersey; Conover, M. 2001: Resolving Human-Wildlife Conflicts. Lewis Publishers, Boca Raton. Bolen, Robinson 1999: Wildlife Ecology and Management

Responsible for Module:
König, Andreas; Apl. Prof. Dr. rer. silv. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Wildbiologie (Praktikum, 10 SWS)
Dahl S, König A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1085: Science of Laboratory Animals | Labortierwissenschaft

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (60 min, benotet) dient der Überprüfung der in Vorlesung und Praktikum erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Die Klausurnote bildet die Gesamtnote des Moduls.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum besseren Verständnis sind Kenntnisse in Zoologie und/oder Tierwissenschaft erforderlich

Content:
Umfang, Art und Zweck von Tierversuchen in Deutschland; Ethische Abwägungen, 3-R-Prinzip; Anatomische, physiologische und ethologische Grundlagen von Labortieren; Fütterung, Haltung, Züchtung und Krankheiten von Labortieren; Hygienemaßnahmen in der Labortierhaltung; Tierschutzrecht und rechtliche Grundlagen zur Betreibung von Versuchstierhaltungen.

Intended Learning Outcomes:
Tierartgerechte Haltung und Umgang mit Labortieren unter den spezifischen Anforderungen größerer und kleinerer Forschungslaboratorien; Vorbereitung auf die Konzeption von Tierversuchen und Tierversuchsanträgen; Reduktion von Tierversuchen nach dem 3-R-Prinzip

Teaching and Learning Methods:
Vorlesung im Seminarstil

Media:
Powerpoint-Präsentationen, die den Teilnehmern zur Verfügung gestellt werden

Reading List:
Weiss, J., Maeß, J., Nebendahl,. K. (Hrsg.): Haus- und Versuchstierpflege, 2. Auflage, 2003, Enke-Verlag, Stuttgart.

Responsible for Module:
Dr. Karsten Meyer (karsten.meyer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Labortierwissenschaften (Vorlesung, 4 SWS)
Meyer K, Paulicks B, Flisikowski K, Kliem H, Kisling S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2690: Latest Neuroscience - Presenting Papers to Researchers and the General Public | Latest Neuroscience - Presenting Papers to Researchers and the General Public

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 58	**Contact Hours:** 32

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
This seminar series will start with an introductory lecture by the course lecturers, followed by an assignment of 2 reviews and 1 research paper to each student. Research paper and reviews will be read and analyzed during self-study hours and discussed with the lecturer during individual meetings. During three and a half days of block seminar, students will in the first two days present the main points of their paper including aims, results and discussion in the context of a comprehensive background that is to be researched and based in part on the distributed reviews. During the second part, students will learn how to present a research finding to the general public and how to write a press release for the layman. Papers and reviews will comprise landmark and latest papers in the field of neuroscience research with a special focus on internal and metabolic state and neuromodulation. Students will discuss the mechanisms of state-dependent neuromodulation and its implications in animal behavior, disease etc. Students will also discuss the latest scientific tools that are used to study neuromodualtion in different animal models based on the assigned papers. In the first part, each student will give a 45 minutes presentation of the selected paper in front of the group. In addition, the students will prepare questions to be discussed with the other participants following the presentations. In the second part, the first half day will be used to look at press releases in the group and to dissect their structure, wording etc. After 1 and a half days of home work, students will present their paper in a presentation format aimed at the general public with general introductions, schemata, conclusions etc. In addition, the students are requested to write a press release on their paper at home, which is again aimed at the general public and should be concise and interesting with some illustrations. The evaluation is based on the presentations, the press release, and the discussion of the selected papers (70%) and the participation in the course (30%).

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of neurobiology is mandatory.

Content:
Group seminar with a 3 hours introductory meeting/discussion and a block of 3 and a half days of presentations by students.

Intended Learning Outcomes:
Students who successfully complete this module will understrand the concept of how internal and metabolic states influence neurons and neuronal processing by neuromodlation and its implications in animal behavior including human behavior in health and disease. In particular, they will know important landmark works, know different modes and forms of neuromodulation including neuropeptides and monoamines, be able to name and describe important techniques used to study neuromodulation. Furthermore, they understand the importance of neuromodulation and neuromodulatory mechanisms in the treatment of common diseases including diabetes, obesity, depression, and get first insights into concepts of drug design and function. Students will learn different ways of presenting scientific works - to a scientific audience as well as to a layman audience. Students will understand the difference between a scientific presentation and manuscript and an article and presentation aimed at the general public to promote Science and important findings. They will have been introduced on how to write a press release and how to explain a scientific problem and finding to a layman.

Teaching and Learning Methods:
A general introduction on the topic and list of proposed papers will be given during the preparatory meeting (3 hrs). Then students will have the option to choose a paper and will have a week to prepare a presentation based on the paper and two accompanying reviews. In addition, students have the opportunity to meet the lecturer in a one-on-one meeting prior to their presentations of the paper to discuss questions. Students will individually present the paper in the group meeting. In the first part, each student will get 45 minutes to present the paper and 20 minutes for discussion. A feedback will be given after each presentation by the group and lecturer and if requested also individually at a later time. In the second part, press releases will be read and analyzed in the group together with the lecturer. Then each student will present a short laymen slide presentation to the group. Finally, each student has to formulate a press release at home.

Media:
Pubmed, powerpoint, black board

Reading List:
Literature for reading will be provided or suggested during the introductory meeting. The internet will be used to find examples of good (and less inspiring) press releases and newspaper articles. Furthermore, TED talks and other science interviews will be studied. In addition, the textbook 'Principles of Neural Science' by Eric Kandel and colleagues is recommended.

Responsible for Module:
Ilona Grunwald Kadow ilona.grunwald@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Latest Neuroscience - Presenting Papers to Researchers and the General Public (Seminar, 2 SWS)
Grunwald I [L], De Backer J, Grunwald I
For further information in this module, please click campus.tum.de or here.

Module Description

LS20005: Models in Computational Neuroscience | Models in Computational Neuroscience

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 150	**Contact Hours:** 150

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination of the module is carried out in the form of a laboratory performance.
which consists of the following elements: activity in the laboratory, lab report (~10 pages) with evaluation and discussion and presentation (30 minutes) in a ratio of 3:3:1.
In it, the students demonstrate the ability to design models in computational neuroscience, code computer programs, analyze data and visualize data. They also demonstrate the ability to present their data to other computational neuroscientists, and synthesize what they learned in a concise written up record of their work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students are expected to have some mathematical knowledge (linear algebra, differential equations) and some programming skills (Matlab, Python or C/C++).

Content:
Minimum of 6-8 weeks research project in laboratory with hands on training in the analysis of neuroscience data and the building of network models.

Depending on the aim of the research project, different methods and questions will be in focus. For instance:
- simulating network models in Julia, Python or Matlab
- designing differential equation descriptions of network interactions
- mathematical analysis based on dynamical systems
- image analysis using ImageJ software
- statistical analysis with Julia, Python or Matlab

- dimensionality reduction techniques of high-dimensional data
- extracting model parameters from experimental data
- conceptual discussion and literature searches to understand and propose ideas, results, hypotheses

Intended Learning Outcomes:
Upon successful participation the students are able to:
- Analyze neuroscience data from electrophysiological or calcium imaging recordings
- Build network models of connected excitatory and inhibitory neurons in numerical simulations
- Include synaptic plasticity rules in the network models for the self-organization of network connectivity
- Analyze the output of the networks in terms of activity and connectivity
- Interpret the numerical results to make predictions for experiments
- Work in the laboratory independently

Teaching and Learning Methods:
Students will work in the lab and learn from PhD students.
They will be given detailed instructions and sample numerical code to perform the simulations.
They will read scientific literature to determine new parameters for their models.
They will learn mathematical methods for writing down differential equations, analyzing them using dynamical systems and visualizing them from PhD students and sample code from related projects.
They will have weekly meetings with their other PhD students and give regular presentations on their progress to get feedback.
They will get regular help with checking their code and analysis.

Media:

Reading List:

Responsible for Module:
Gjorgjieva, Julijana, Prof. Ph.D. gjorgjieva@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Models in Computational Neuroscience (Forschungspraktikum, 10 SWS)
Gjorgjieva J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2457: Neurobiology | Neurobiologie

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Aufgrund des Pandemiegeschehens hat der/die Studierende auch die Möglichkeit, an einer beaufsichtigten elektronischen schriftlichen Fernprüfung (Aufsicht mit Proctorio, 90 min.) teilzunehmen (Onlineprüfung: WZ2457o). Diese schriftliche Prüfung wird zeitgleich parallel in Präsenz angeboten (WZ2457).

Die Studierenden zeigen in einer benoteten Klausur (90 min), das sie in der Lage sind in einer begrenzten Zeit und ohne Hilfsmittel die zugrunde liegenden Mechanismen und Randbedingungen neurobiologischer Prozesse zu verstehen und darzulegen. Sie müssen neurobiologische Befunde auf ihre entwicklungsbiologischen und molekularbiologischen Ursachen zurückführen, komplexe Krankheitsbilder in ihrer Entstehung beurteilen, und physiologische Erklärungen für Gehirnleistungen darstellen. In Transferaufgaben sind sie in der Lage, auf der Basis des erworbenen Orientierungswissens der gesamten Neurobiologie Befunde einzuordnen und einzuschätzen

Repeat Examination:
Next semester

(Recommended) Prerequisites:
erfolgreiche Teilnahme an der Vorlesung "Human - und Tierphysiologie"

Content:
Basic Neuroscience: development of the nervous system, neurophysiology, biophysics, synaptic transmission, learning, emotions, speech, degenerative brain diseases, mental diseases, consciousness.

Intended Learning Outcomes:
Students will aquire a basic knowledge of the entire neuroscience spectrum, will learn to build upon that basis and to integrate new data, will have insight into current research fields.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung
Lehrmethode: Präsentation, Vortrag, Fragend-entwickelnde Methode
Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Nacharbeitung der vermittelten Informationen, Materialrecherche, Zusammenfassen von Dokumenten,

Media:
Ein Skript zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Bear et al., Neurowissenschaften

Responsible for Module:
Luksch, Harald; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Neurobiologie (Vorlesung, 2 SWS)
Luksch H, Weigel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0033: Physiology of Growth, Reproduction and Lactation | Physiologie des Wachstums, der Reproduktion und der Laktation

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung erfolgt anhand einer 30 minütigen mündlichen Prüfung. In dieser soll nachgewiesen werden, dass ohne Hilfsmittel, die physiologischen Vorgänge bei Wachstum, Reproduktion und Laktation sowie die anatomischen und histologischen Grundlagen bei verschiedenen Nutztierarten bewerten können. Die Studierenden weisen nach, dass sie die Einflussfaktoren, z.B. durch die Umwelt, Haltung, Gesundheit oder Fütterung, auf die molekularen Regelkreise einschätzen können. Die Studierenden antworten mit eigenen freien Formulierungen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Erfolgreiche Grundlagen- und Orientierungsprüfung Bachelor Agrarwissenschaften oder äquivalenter Abschluss.

Content:
Vorlesung: Wachstums- und Reproduktionsbiologie der Wirbeltiere
(Regelmechanismen, Anatomie (v.a. Skelett und Muskulatur, Zellaufbau), Morphologie, vergleichende Physiologie;
Systematik der Reproduktionshormone und Hormonrezeptoren, Wirkungsmechanismen der Reproduktionshormone, Hypothalamus-Hypophysen System, Spermatogenese; Oogenese, Sexualzyklusregulation und Manipulation, Gravidität und Geburt; Reproduktionsmanagement);
Exkursion(en): Milchprüfring in Wolnzach und/oder zu einer Besamungsstation.
Praktische Übung: Anatomie der Geschlechtsorgane und des Euters beim Rind. Erkennung funktionaler Veränderungen bei unterschiedlichen Phasen der Reproduktion.

Physiologie und Anatomie der Milchdrüsenentwicklung, Milchbildung und Aufrechterhaltung der Laktation, Kolostrumbildung und Bedeutung, Laktationsverlauf bei verschiedenen Spezies, Probleme in der Laktation und Euterentzündung, aktuelle Forschungsprojekte im Bereich der Milchdrüse, Milchentzug und Melktechnik.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage,
- die wesentlichen Grundprinzipien und Zusammenhänge der physiologischen Regelungen bis zum molekularen Level zu charakterisieren,
- die physiologischen Abläufe des Wachstums, der Reproduktion und der Laktation bei verschiedenen Nutztier-Spezies zu bewerten. Neben dem Schwein wird der Schwerpunkt beim Rind liegen,
- Regel- sowie Wirkungsmechanismen im Kontext Wachstum, Reproduktion und Laktation zu analysieren und zu bewerten.
- positive und negative Einflussfaktoren auf die Tiergesundheit und das Tierwohl zu analysieren.

Teaching and Learning Methods:
Das Modul setzt sich aus primär aus Vorlesungen (80%), einer Exkursion (10%) sowie praktischen Übungsstunden (10%) zusammen. Die Vorlesungen sollen die komplexen Regelkreise der Physiologie bis auf die molekulare Ebene erklären und lehren. Eine Exkursion zum Milchprüfring Bayern und zu einer Besamungssation gibt den Studierenden aktuelle Einblicke in die gesetzlich vorgeschriebene Überwachung der Milch für den menschlichen Verzehr und über die Bedeutung der Fortpflanzungshygiene. Die praktische Übung am Euter sowie den präparierten Geschlechtsorganen vertieft das Verständnis für den anatomischen Aufbau und die physiologische Funktion des Gewebe.

Media:
Präsentationen, Skripten

Reading List:
Friedemann Döcke "Veterinärmedizinische Endokrinologie", Gustav Fischer Verlag Jena, Stuttgart 1994, ISBN 3-334-60432-2

Responsible for Module:
Pfaffl, Michael; Apl. Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Wachstums- und Reproduktionsbiologie (Vorlesung, 2 SWS)
Pfaffl M, Berisha B, Farschtschi S

Laktationsphysiologie (Vorlesung mit integrierten Übungen, 2 SWS)
Pfaffl M, Kliem H, Farschtschi S, Binder A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2405: Phylogeny and Zoology of Vertebrates | Phylogenie und Zoologie der Vertebraten

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Die Prüfungsleistung wird in Form einer Klausur erbracht. Die Prüfungsfragen gehen über den gesamten Vorlesungsstoff. Die Antworten erfordern eigene Formulierungen, Rechenaufgaben werden nicht gestellt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Zoologie, Ökologie und Genetik sollten vorhanden sein.

Content:
Vorlesung: 1. Einführung in die Klassifizierung, Systematik und Taxonomie, 2. Grundlagen der Phylogenetik und phylogenetischen Rekonstruktion, 3. Micro- und Macroevolution, 4. Die Chordaten im Überblick, 5. Merkmale der Chordaten, Merkmale der Vertebraten, 6. Phylogenie und Zoologie der Fische, 7. Bauliche und funktionelle Anpassung der Fische, 8. Phylogenie und Zoologie der Amphibien, 9. Phylogenie und Zoologie der Reptilien 10. Merkmale der Reptilien vs Amphibien, 11. Phylogenie der Vögel, 12. Flug, Flugfähigkeit, Flugunfähigkeit, 13. Grundlagen der Physiologie, des Sozialverhalten und der Fortpflanzung der Vögel, 14. Evolution und Phylogenie der Säugetiere, 15. Bauliche und funktionelle Anpassung der Säugetiere, 16. Unsere frühen Vorfahren. Seminar: Übung mit Vorträgen und Diskussion mit Themenbezug zu aquatischer und terestrischen Ökologie und Conservation Biology Schwerpunkte liegen auf der Lösung wissenschaftlicher Probleme durch Möglichkeiten der Eingrenzung von Fragestellungen / Hypothesenformulierung, Versuchsplanung, Versuchsauswertung und Statistik, Darstellung und Interpretation von Versuchsergebnissen, Präsentation von Ergebnissen in deutscher und

englischer Sprache, kritische Reflexion und Diskussion, Vorgehensweise bei wissenschaftlichen Veröffentlichungen und Recherchemethoden

Intended Learning Outcomes:
Nach Teilnahme des Moduls verstehen die Studenten die Unterschiede der Disziplinen in der Systematik und haben Einblick .in die phylogenetische Rekonstruktion. Sie sind fähig die Artbildung der Vertebraten im micro- und macro evolutiven Kontext darzustellen und haben einen detaillierten Überblick zu deren Evolution und Phylogenie basierend auf ein interdisziplinäres Verständnis von Genetik, Evolution und Physiologie sowie Sozialverhalten und Fortpflanzung. Zudem erhalten die Studenten ein Verständnis von wissenschaftlichen Arbeitsweisen im bereich Conservation Biology und damit Befähigung zur effizienten Planung und Durchführung eigenständiger Forschungsprojekte (z.B. im Rahmen einer Bachelor-, Master- oder Doktorarbeit).

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung
Lehrmethode: Präsentation, Vortrag, Fragend-entwickelnde Methode
Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Nacharbeitung der vermittelten Informationen, Materialrecherche, Zusammenfassen von Dokumenten,

Media:
Ein Skript zu dieser Vorlesung wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Zoologie (CP Hickman)
Spezielle Zoologie (Westheide)
Grundlagen der Phylogenetischen Systematik (Wägele)
Evolutionsbiologie (V Storch)
Systematische Zoologie (Storch)

Responsible for Module:
Ralph Kühn (RalphKuehn@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Wissenschaftliche Konzepte in aquatischer- und terrestrischer Ökologie (Seminar, 2 SWS)
Geist J, Kühn R

Phylogenie und Zoologie der Vertebraten (Vorlesung, 2 SWS)
Kühn R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2127: Reproductive Physiology of Vertebrates | Reproduktionsbiologie der Vertebraten

Version of module description: Gültig ab summerterm 2011

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): mündlich 30 min.
Regelmäßige Teilnahme an den Lehrveranstaltungen wird erwartet. Eine mündliche Prüfung (30 min, benotet) dient der Überprüfung der in der Vorlesung erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Prüfung, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Reproduktionsbiologie und Endokrinologie der Wirbeltiere und des Menschen (Regelmechanismen, Anatomie, Morphologie, vergleichende Physiologie)

Intended Learning Outcomes:
Die Studierenden haben nach Teilnahme am Modul das grundlegende theoretische Verständnis und Fachwissen zur weiblichen und männlichen Reproduktionsendokrinologie und können darüber hinaus pathogene Situationen in den physiologischen Kontext einordnen. Das Modul soll das Interesse an vergleichender Physiologie, insbesondere durch den Vergleich zwischen Mensch, Nutz- und Wildtieren und deren Bedeutung für anwendungsorientiente Fragestellungen fördern.

Teaching and Learning Methods:
Lehrtechnik: Vorlesung
Lehrmethode: Vortrag, interaktiver Diskurs mit Studenten während der Vorlesung.
Lernaktivitäten: Studium von Vorlesungsfolien und Mitschrift, Studium von Literatur

Media:
Präsentationen mittels Powerpoint, ggf. Tafelanschrieb, Downloadmöglichkeit der Folien

Reading List:
Döcke, Veterinärmedizinische Endokrinologie

Responsible for Module:
Heinrich HD Meyer (physio@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Reproduktionsbiologie der Vertebraten (Vorlesung, 4 SWS)
Pfaffl M, Berisha B, Kliem H, Farschtschi S
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613:

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models
Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2458: Sensory Physiology | Sinnesphysiologie

Version of module description: Gültig ab winterterm 2009/10

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 100 min.
Die Studierenden erwerben grundlegende und weiterführende Kompetenzen im Umgang mit sinnesphysiologischen Fragestellungen Auf der Grundlage theoretischer Überlegungen wird ein Überblick verschiedener sinnesphysiologischer Themen behandelt. Darüber hinaus werden methodische Aspekte der verwendeten Untersuchungsmethoden und die Aussagekraft kritisch evaluiert. Im Anschluß an die Übung wird der Kompetenzzuwachs schriftlich abgeprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse des Zentralnervensystems, Sinnessysteme,Projektionssysteme und allgemeine Physiologie

Content:
basic brain anatomy, vertebrate and invertebrate brains.
sensory pathways, basic principles
psychophysics
visual system: Periphery
Visual system: central processing
Mechanosensitive systems
lateral line and related senses
auditory system: periphery
auditory system: central processing
Somatosensory system
Olfaktory und gustatory systems
Infrared perception in insects and snakes

Magnetic field perception
Multisensory processing, , multimodalel integration, etc.
Motor system: motor coding

Intended Learning Outcomes:
After this lecture students will be capable to understand sensory processing from the physical nature of the stimulus up to the object formation in the central nervous system, and to transfer the principles onto other sensory pathways and systems.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung
Lehrmethode: Präsentation, Vortrag, Fragend-entwickelnde Methode
Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Nacharbeitung der vermittelten Informationen, Materialrecherche, Zusammenfassen von Dokumenten,

Media:
Ein Skript zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Als grundlegendes Lehrbuch wird "Neuroscience. Exploring the brain." von Bear, Connors, Paradiso aus dem Lippincott, Williams and Wilkins Verlag empfohlen, und zwar in der englischen Variante. Weitere Lehrbücher der Neurobiologie sind für die grundlegenden Inhalte ebenfalls geeignet.

Responsible for Module:
Harald Luksch (Harald.Luksch@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Sinnesphysiologie (Vorlesung, 2 SWS)
Luksch H, Gebhardt M, Firzlaff U, Kohl T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2682: Sensory and Behavioral Neurogenetics | Sensory and Behavioral Neurogenetics

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a written exam (90 min), where students are expected to remember and reproduce topics that were covered in the lecture (theories of behavioral analysis, methods, examples etc.) without additional aids. The exam will consist of multiple choice, free formulations, tables to be completed and interpretations of schemes etc. In addition, students will write an essay based on literature research on a topic that was discussed in the lecture. Topics will be assigned by the lecturer after discussion with the student. The module is passed, when the essay is successfully completed and the grade of the written exam is at least 4,0.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of neurobiology and genetics are obligatory.

Content:
LECTURE: once a week during the semester for two hours including a break, the lecture will cover the following topics:

• general introduction, deepening of knowledge in form, function, and networks of synaptic connections and nervous systems.
• the role of model animal systems in neuroscience
• illustration and deeper understanding of neuroscience research on the example of sample publications covering model system (including genetic models) such as worm, fly, fish, mouse, monkey, primate.
• Analysis and explanation of model specific methods such as automated behavioral analysis, in vivo imaging, electrophysiology, multiphoton microscopy, live microscopy, modeling

• Examples describing the role of internal state and behavioral context including the role of neuromodulation
• translation and general meaning of results obtained in model organisms
• evolution of neuronal networks and their translational meaning

EXERCISE: The exercise consists of a home assignment, independent literature research and writing of an essay. The topic will be assigned after consultation with the lecturer.

Intended Learning Outcomes:
Upon successful completion of the module, students:
• know important definitions and methods in neurogenetics and behavioral analysis, and why and how they are used in model organisms.
• understand the terms optogenetics, chemogenetics, calcium imaging, connectomics, system neuroscience, neuronal networks, phsychophysics, neuromodulation and can explain them.
• are able to interpret, analyse and develop results obtained in behavioral studies, neurophysiology and neuroanatomy.

Teaching and Learning Methods:
LECTURE: In the lecture material will be presented in a powerpoint presentation, which features many examples, pictures, schemes, videos. In addition, at the beginning of each lecture the content of the previous lecture will be summarized and open questions will be discussed. At the end of each lecture, a list of 'take home messages' will be given. EXERCISE: The exercise consists of a written essay that students will write over the course of several weeks following independent literature research at home. The topic of the essay will follow the topics covered in the lecture and will be assigned by the lecturer after consulting with the student. The aim is too deepen the student's knowledge in a topic of the lecture that is of particular interest to them. To this end, they will use online literature search tools such as Pubmed and Google, but also in person interviews or other sources that they deem informative. The lecturer will be available to discuss content and structure.

Media:
Pubmed, ejournals, video materials, online databases

Reading List:
Standard textbook: Eric Kandel (editor), Principles of Neural Sciences; various journal articles (list will be made available in class)

Responsible for Module:
Grunwald, Ilona; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

ME2090: Viral and Nonviral Gene Transfer: Methods and Applications in Research and Therapy | Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The students are required to attend the lectures on a regular basis. At the end of the semester there is a 120 minutes examination in writing. The examination will assess whether the students are able to replicate the knowledge communicated during the lectures in a structured manner. The students should be able to describe, interpret and combine the informations of the lecture series. Every question of the written exam is attributed a certain number of points. The final grade is calculated from the achieved percentage of points out of total achievable points.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in molecular biology and cell biology

Content:
The lecture series provides in depth insights into the technical/molecular basis of nucleic acid delivery into cells and applications in research and therapy.
Overview of research field / historical development / concepts and goals. Non-viral vectors / barriers for nucleic acid delivery / selected examples and applications.
Adenoviral vectors: Virus biology / vector types and construction / oncolytic adenovirus.
Retro-/lentiviral vectors: Virus biology / vector types, construction, optimization.
Immunological aspects of nucleic acid therapies.
Preclinical models / clinical studies / case discussion.

Intended Learning Outcomes:
Gene technologies are discussed controversially, especially in Germany. Frequently, opinions are adopted in the absence of actual knowledge of the chances and risks of technologies. It is the aim of this lecture to provide the students with sufficient expertise to enable them to participate as competent persons in the debate on the use of gene technologies in medicine.

Teaching and Learning Methods:
lecture course

Media:
PowerPoint, blackboard

Reading List:

Responsible for Module:
Plank, Christian; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie (Vorlesung, 3 SWS)
Anton M [L], Plank C, Anton M, Holm P, Krüger A, Knolle P, Brill T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1993: Laboratory Animal Science | Versuchstierkunde

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer Klausur (90 min), in der die Studierenden unterschiedliche Fragen zu versuchstierkundlichen Themen ohne Hilfsmittel beantworten sollen. Das Beantworten der Fragen erfordert teils eigene Formulierungen und teils das Ankreuzen von vorgegebenen Mehrfachantworten.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundlagen der Anatomie, Physiologie, Versuchstierkunde, BSc Biologie/Life Sciences, BSc Molekulare Biotechnologie, BSc Agrar- und Gartenbauwissenschaften, BSc Ernährungswissenschaften

Content:
In dem Modul werden folgende Themen vermittelt:
- Gesetze rund um den Tierversuch
- Belastungsbeurteilungen und Score Sheets
- Alternativmethoden zum Tierversuch
- Blutentnahme und Applikationstechniken
- Genetik und Zucht im Tierversuch
- Biotechnologische Techniken Schwein und Huhn
- Geflügel als Versuchstier
- Fledermäuse als Versuchstier
- Schlangen als Versuchstier
- Überwachung von Tierversuchseinrichtungen

- Neurologie und Verhalten von kleinen Nagern
- Handling von kleinen Nagern
- Injektionen (s.c., i.p. i.m. i.v.)
- Blutentnahmetechniken
- Orale Applikation von Substanzen

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage verschiedene Verfahren, relevante Gesetze und Methoden der Versuchstierkunde zu nennen. Die Studierenden können diese Vorschriften nach der Teilnahme des Moduls verstehen und anwenden. Die unterschiedliche Auslegung und Anwendung der Gesetze, Methoden und Tiermodelle kann durch die Studierenden eingeschätzt werden und Tierversuchsplanungen können aktiv unterstützt werden. Die Studierenden sind nach der Teilnahme dazu in der Lage ein erstes Handling der Versuchstiere Maus, Ratte und Kaninchen durchzuführen und Injektionen und Blutentnahmen unter Anleitung durchzuführen.

Teaching and Learning Methods:
Im Rahmen der Vorlesung wird Grundwissen zu den beschriebenen Inhalten vermittelt. Durch PowerPoint Präsentation werden den Teilnehmern die wichtigsten Aspekte der jeweiligen Themen veranschaulicht und im Rahmen einer anschließenden Diskussion kritisch hinterfragt.
Im Rahmen der Übung wird anhand von Maus, Ratten und Kaninchenmodellen das Handling dieser Nagerspezies geübt und Blutentnahmen, sowie Injektionenn und Applikationen von Substanzen geübt.

Media:
Präsentation (PowerPoint), Tafelarbeit, praktische Übungen

Reading List:
Vorlesungsunterlagen, Gesetzestexte, LAS-online Kurs

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:
Versuchstierkunde (Seminar, 2 SWS)
Schusser B [L], Firzlaff U, Fischer K, Flisikowski K, Kellermann K, Kisling S, Kohl T, Schusser B, Schwamberger S

Praktische Einführung Versuchstierkunde (Übung, 2 SWS)
Schusser B [L], Schusser B, Schwamberger S, Vikkula H

For further information in this module, please click campus.tum.de or here.

Module Description

WZ1306: Zoological Field Trip to Lake Neusiedl | Zoologische Exkursion Neusiedler See

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 40	**Contact Hours:** 50

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Laborleistung erbracht. Die Laborleistung setzt sich aus der Vorbereitung der Übung in der Form eines Seminars (Studienleistung) und einem Bericht (benotet) zusammen. Der Bericht kombiniert die Ergebnisse der Seminarvorträge und Seminardiskussionen mit den Daten der Übung.

Zur Vorbereitung auf die Übung (Übung in Form einer mehrtägigen Auslandsexkursion an den Übungsort) sind im Rahmen eines Seminares exkursionsrelevante Themen selbständig durch die Studierenden vorzubereiten, vorzutragen und in der Gruppe kritisch zu diskutieren.
In der Diskussion soll auch über das Vorgetragene hinausgegangen werden und vernetzende Themen besprochen werden (30 Minuten Vortrag, 15 Minuten Diskussion). Die Teilnahme am Seminar ist essentiell zur Datenerhebung während der Übung vor Ort und zum Umgang mit wechselnden Umweltbedingungen, die eine neue Datenerfassungsstrategie erfordern.
Durch rege Beteiligung an der Diskussion im Seminar zeigen die Studierenden, dass sie in der Lage sind, Ökosysteme, Einnischung von Tierarten und die zugrundliegenden physikalischen Bedingungen zu verstehen, darzustellen und kritisch zu diskutieren. Auch zeigen die Studierenden im Seminar, dass Sie eigenständig komplexere Themen der zoologischen Ökologie und Physiologie vorbereiten können, dabei die wesentlichen Informationen herausarbeiten und in einem Vortrag vorstellen können, aber gleichzeitig auch auf diesem Gebiet ein großes Hintergrundwissen haben. Sie zeigen, dass sie auch eigenständig eine thematisch eingegrenzte Exkursion fachlich vorbereiten können und auch – z. B. in Vorbereitung auf eine Abschlussarbeit in vergleichbaren Fachgebiet – Datensammlungsstrategien, Hypothesen und Alternativpläne für Versuchsansätze entwickeln, überschauen und vertreten können.
Das Seminar wird als Studienleistung gewertet und erst mit der Abgabe des individuellen Berichts als Laborleistung verbucht.

Durch die aktive Teilnahme an der Übung in Form einer Exkursion setzen die Studierenden die im Seminar vorbereiteten Aufgaben und Themen handelnd um und übertragen das Erlernte ggf. auf neue Situationen.

Nach der Übung muss jeder Studierende einen benotetenschriftlichen Bericht erstellen, der kombiniert zu einem Gemeinschaftsbericht allen Exkursionsteilnehmer am Ende zur Verfügung gestellt wird. Darin werden die jeweils behandelten Themen strukturiert und dokumentiert, wobei auch Ergebnisse des Seminars mit zu verarbeiten sind, z. B. im Rahmen einer jeweiligen Diskussion. Die Studierenden zeigen mit dem individuellen Beitrag zum Sammelbericht, dass sie die im Seminar erworbenen theoretischen Kenntnisse und die Ergebnisse der praktischen Arbeit vor Ort miteinander kombinieren können und mit den jeweiligen Einzelbeiträgen in Teamarbeit einen gemeinsamen, umfassenden Übungsbericht erstellen können. Der Bericht fasst die in der Gruppe erworbenen Kompetenzen (theoretische Vorbereitung eines Themas, Datensammlung, Datendokumentation und Bewertung der gewonnenen Ergebnisse) zusammen und macht die Ergebnisse für alle Teilnehmenden zugänglich.
Die individuellen Beiträge im Sammelbericht zur Übung werden jeweils benotet.

Die individuellen Berichte sind spätestens 4 Wochen nach Übungsende vorzulegen. Ansonsten wird die Leistung mit 5,0 bewertet. Eine Wiederholung (Abgabe individueller Bericht) ist dann im Folgesemester möglich.

Das Modul wird erst mit positiver Studienleistung und einem Bericht besser als 4,0 als Bestanden verbucht.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnisse in grundständiger Zoologie und Ökologie / Biodiverität, idealerweise auch der Human- und Tierphysiologie und , Sinnesphysiologie
Teilnehmer sollten Interesse an Artenerfassung im Freiland haben

Content:
Der Naturraum des Neusiedler Sees ist von Elementen verschiedener Landschaftsräume geprägt: alpine, pannonische, asiatische, mediterrane und nordische Einflüsse führen zu einer hohen Artenvielfalt. In diesem Modul wird die Fauna dieses Lebensraums behandelt und ein Fokus auf die Vogelwelt, die Insektenvielfalt und die Fledermauspopulationen gelegt. Dabei werden Echoortungslaute mit Lautaufnahmesystemen aufgenommen und analysiert, um die Arten zu ermitteln. Im vorgelagerten Seminar werden grundlegende Themen des Lebensraumes und der behandelten Tiergruppen besprochen. Diese Exkursion findet in der Woche statt, in der Christi Himmelfahrt liegt (variabler Termin), von Mittwochmittag (Abfahrt) bis Sonntagabend (Rückkehr). Die Themen umfassen unter anderen:

• Geologie und Biogeografie des Neusiedler Sees
• Ökologische Aspekte eines Steppensees und der umgebenden Salzlacken: Wasserbilanz, Durchmischung, Plankton und Nahrungsketten.
• Systematik, Biologie und Ökologie ausgesuchter terrestrischer Taxa
(z.B. Spinnentiere, Insekten, Amphibien und Reptilien, Fledermäuse).
• Systematische Erfassung von Tierpopulationen durch bioakustische Untersuchungen am Beispiel von Fledermauspopulationen in verschiedenen Habitaten

Die Seminarvorträge werden an einem vorbereitenden Termin gehalten, der nach der Vorbesprechung und Platzvergabe vereinbart wird. Dabei wird auch die Arbeit mit Bestimmungsschlüsseln und die Anwendung der Geräte zur bioakustischen Untersuchung eingeübt.

Während der Übung in der Organisationsform Exkursion werden die oben genannte Inhalte durch Feldarbeit an geeigneten Exkursionszielen praktisch umgesetzt. Die Erfassung, Protokollierung und Auswertung von Ergebnissen wird beispielhaft eingeübt.

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul werden die Studierenden die folgenden Fähigkeiten erworben haben:

• Ein breites Wissen zum Ursprung, zur Diversität und zur Gefährdung der Fauna des Neusiedler See-Raumes als Beispiel eines durch geophysikalische Gegebenheiten geprägten Lebensraums
• Methoden zur systematischen Erfassung von Tiergruppen kennen und sicher anwenden können
• die Arbeit mit anspruchsvollen Bestimmungsschlüsseln beherrschen,
• die Kenntnisse zur Biologie einer Art im Freiland praktisch umzusetzen (auffinden, fangen, 'handling'),
• die Ergebnisse der Exkursion in Form eines wissenschaftlichen Exkursionsberichts festzuhalten und zu wissenschaftlich-fachlich zu kommentieren

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Seminar und Übung (in der Organisationsform der Auslandsexkursion).
Lehrmethode: Seminar, Fragend-entwickelnde Methode, Gruppenarbeit, Präsentation
Lernaktivitäten: Studium der ausgeteilten Literatur, Eigenrecherche zu einzelnen Themen des Seminars, Vorbereiten und Durchführen von Präsentationen, Einbauen von neuen Informationen unterstützt durch fragend- entwickelndes Hinführen.

Media:
Literatur wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Die Seminar-Vorträge sollen mittels Powerpoint oder ähnlichen Vortragstechniken erstellt werden. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Material wird über Moodle zugänglich gemacht. Für einige Themen ist Eigenrecherche notwendig.

Responsible for Module:
Harald Luksch harald.luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2456: Zoological Field Trip Mediterranean | Zoologische Exkursion Mittelmeer

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 46	**Contact Hours:** 104

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): immanenter Prüfungscharakter.
Durch einen mündliche Präsentation und durch rege Beteiligung an der Diskussion im Seminar zeigen die Studierenden, dass sie in der Lage sind, neue Inhalte zu verstehen, darzustellen und kritisch zu diskutieren. Die Note des Seminars setzt sich aus der Beurteilung des Seminarvortrags (60%), des ausgeteilten Arbeitsblattes (10%) und der Diskussionsbeteiligung (40%) zusammen.
Durch die aktive Teilnahme an den Exkursionen setzen die Studierenden neue Inhalte handelnd um und übertragen das Erlernte auf neue Situationen. Ein schriftlicher Bericht zur Exkursion strukturiert und dokumentiert die Ergebnisse der Istrien-Exkursion.

Repeat Examination:

(Recommended) Prerequisites:
Vorlesung Allgemeine Biologie 1: Biologie der Organismen (Lv-Nr. 240830092)
Zoologischer Grundkurs (Lv-Nrn. 0000000032 bzw. 920077566 und 240089013)

Content:
Im Seminar (Wintersemester) werden grundlegende Themen der marinen und terrestrischen Fauna des Mittelmeer-Raumes am Beispiel Istrien behandelt. Die Themen umfassen unter anderen:

" Geologie, Biogeografie und Biodiversität des Mittelmeers,
" Systematik, Biologie und Ökologie ausgesuchter mariner Taxa (z.B. Schwämme, Cephalopoden, Knorpel- und Knochenfische),
" Systematik, Biologie und Ökologie ausgesuchter terrestrischer Taxa (z.B. Spinnentiere, Insekten, Amphibien und Reptilien).

Die faunistischen Inhalte werden in einer eintägigen vorbereitenden Exkursion (Winter- oder Sommersemester) vertieft, vor allem hinsichtlich der Artenkenntnis der Fischfauna des Mittelmeers.

Während der Exkursion nach Istrien (Sommersemester) werden die oben genannte Inhalte durch Feldarbeit an geeigneten Exkursionszielen praktisch umgesetzt. Der Auswertung des Fangs einer Dredgefahrt kommt besondere Bedeutung bei der Bestimmung mariner Organismen zu.

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul werden die Studierenden die folgenden Fähigkeiten erworben haben:

" Ein breites Wissen zum Ursprung, zur Diversität und zur Gefährdung der Fauna des Mittelmeer-Raumes,
" diese Inhalte interessant und verständlich darzustellen und kontrovers zu diskutieren,
" neue, den Studierenden bis dato unbekannte Taxa einzuordnen und zu bestimmen,
" die Kenntnisse zur Biologie einer Art im Freiland praktisch umzusetzen (auffinden, fangen, 'handling'),
" die Ergebnisse der Exkursion in Form eines wissenschaftlichen Exkursionsberichts fest zu halten und zu kommentieren,
"aus den Erfahrung der Exkursion Rückschlüsse über die eigene Karriereplanung ziehen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Seminar und Exkursion.
Lehrmethode: Seminar, Fragend-entwickelnde Methode, Gruppenarbeit, Präsentation
Lernaktivitäten: Studium der ausgeteilten Literatur, Eigenrecherche zu einzelnen Themen des Seminars, Vorbereiten und Durchführen von Präsentationen, Einbauen von neuen Informationen unterstützt durch fragend- entwickelndes Hinführen.

Media:
Literatur wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Die Seminar-Vorträge sollen mittels Powerpoint oder ähnlichen Vortragstechniken erstellt werden. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Grundlegende Literatur:
"Robert Hofrichter (Hrsg.), Das Mittelmeer, Fauna, Flora, Ökologie. Spektrum Akademischer Verlag Heidelberg Berlin, Bände I - III.
"Rupert Riedl, Fauna und Flora des Mittelmeeres, Verlag Paul Parey Hamburg und Berlin.
Weiteres, spezielleres Material wird über moodle zugänglich gemacht. Für einige Themen ist Eigenrecherche notwendig.

Responsible for Module:
Michael Gebhardt (Michael.Gebhardt@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Zoologische Exkursion nach Kroatien (mehrtägig) (Exkursion, 4 SWS)
Luksch H [L], Kohl T, Luksch H, Schwarz Y
For further information in this module, please click campus.tum.de or here.

General Education Subject | Allgemeinbildendes Fach

Module Description

CLA10800: Economic Thinking: Business Management | Betriebswirtschaftlich Denken

Version of module description: Gültig ab winterterm 2013/14

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden bereiten eine Präsentation vor, in welcher sie die Inhalte der Vorlesung wiedergeben und reflektieren. Dadurch wird nachgewiesen, dass die Studierenden grundlegende ökonomische Zusammenhänge anwenden können (Prüfungsleistung).

Repeat Examination:

(Recommended) Prerequisites:

Content:
Die berufliche und private Lebenswelt ist zu einem erheblichen Teil durch ökonomische Determinanten und Kalküle bestimmt. Ein Ziel der Veranstaltung ist das Erkennen grundlegender ökonomischer Zusammenhänge. Ökonomische Begriffe und Prinzipien als fachliche Grundlage betriebswirtschaftlichen Denkens und Handelns werden im Workshop anhand der nachfolgenden Themen erworben:

1. Markt und Unternehmen
2. Betriebswirtschaftliche Ziele und Planung
3. Führung und Entscheidung im Unternehmen
4. Planung und Organisation
5. Gründungskonzept
6. Marketing und Produktion
7. Investition und Finanzierung

8. Rechnungswesen und Kontrolle
9. Fallstudie

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme sind die Studierenden in der Lage grundlegende ökonomische Zusammenhänge zu erkennen und zu beurteilen. Darüberhinaus können sie ökonomische Begriffe und Prinzipien als fachliche Grundlage für Diskussionen anwenden und darlegen.

Teaching and Learning Methods:
Präsentation, Gruppenübung, Diskussion, Fallstudie

Media:

Reading List:

Responsible for Module:
Karin Aschenbrücker

Courses (Type of course, Weekly hours per semester), Instructor:

Karin Aschenbrücker
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0207: Intensive Course Chinese - China at a glance | Blockkurs Chinesisch - China auf einen Blick

Module Description

WZ5297: Accounting | Buchführung, Kosten- und Investitionsrechnung

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Prüfung (Klausur, 120 min)
In der Prüfung, die Prüfungselemente aus der Buchführung und der Kosten- und Investitionsrechnung enthält, müssen die Studierenden darlegen, dass sie einfache Buchungssätze aus der Finanzbuchhaltung durchführen können und Grundbegrifflichkeiten aus der Kosten- und Investitionsrechnung verstehen. Sie sollen bestehende Rechnungssysteme und -vorgänge anhand von Beispielen beschreiben.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Folgende Themen werden behandelt:
-- Eröffnungsbilanz (Verzeichnis und Bewertung der Vermögensgegenstände und Schulden, Bewertungsprinzipien, Erstellung der Bilanz)
-- Laufende Buchführung (Geschäftsvorfälle, Auflösung der Bilanz in Konten, Buchungssatz)
-- Schlussbilanz (Abschluss der verschiedenen Buchungskonten)
-- Besondere Buchungsfälle (Mehrwertsteuer, Warenverkehr, Privatentnahmen, Privateinlagen, Löhne und Gehälter, Abschreibungen, Rücklagen)
-- Abschlussauswertung (Bilanzanalyse, Erfolgsanalyse
-- Grundlagen und Grundbegriffe der Kostenrechnung (Definition und Abgrenzung ausgewählter Begriffe, Gliederungsmögllichkeiten von Kosten, Kostenrechnunge
-- Rechnungssysteme auf der Basis von Vollkosten (Merkmale der Vollkostenrechnung, Ausgewählte Rechnungssysteme)

- Rechnungssysteme auf der Basis von Teilkosten (Merkmale der Teilkostenrechnung, Entscheidungsunterstützung durch Teilkosten- bzw. Deckungsbeitragsrechnungen
-- Weiterentwicklungen in der Kostenrechnung (Prozesskostenrechnung, Target Costing, Lifecycle Costing)
-- Investitionsrechnung (Grundlagen, Methoden, Anwendung)

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Modul Buchführung, Kosten- und Investitionsrechnung sind die Studierenden in der Lage, eine einfache Unternehmensbilanz zu diskutieren und mit Hilfe der Bewertungsprinzipien zu beschreiben. Desweiteren verstehen sie die Grundlagen und Grundbegriffe der Kostenrechnung. Sie sind in der Lage, Rechnungssysteme auf der Basis von Teil- oder Vollkosten und Weiterentwicklungen in der Kostenrechnung zu veranschaulichen. Desweiteren können sie mit Hilfe der erlernten Grundlagen, Methoden und Anwendungbeispiele einfache Investitionsrechnungen durchführen.

Teaching and Learning Methods:
Vorlesung: Vortrag, unterstützt durch Folien und ppt-Präsentationen
Übung: Gruppenarbeit/Fallstudien
Lernaktivitäten: Bearbeiten von Problemen und deren Lösungsfindung, Fallstudien

Media:
Ein Skriptum für Buchführung und Kosten- und Investitionsrechnung ist digital verfügbar.

Reading List:
- DÖRING, U. und R. BUCHHOLZ: Buchhaltung und Jahresabschluss. 10. Auflage. Erich Schmidt Verlag, Berlin 2007
-- FALTERBAUM, H. U. H. BECKMANN: Buchführung und Bilanz. Fleischer Verlag, 20. Aufl.,Achim 2007

Responsible for Module:
Pahl, Hubert; Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Kosten- und Investitionsrechnung (WZ5297) (Vorlesung, 3 SWS)
Pahl H [L], Pahl H

Buchführung (Finanzbuchhaltung) (WZ5297) (Vorlesung, 2 SWS)
Pahl H [L], Pahl H
For further information in this module, please click campus.tum.de or here.

Module Description

CLA10555: Communication and Facilitation in Project Teams | Communication and Facilitation in Project Teams

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 22	**Contact Hours:** 8

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will write a short exam which proves that they understand various aspects of project management and are able to handle team conflicts successfully. Furthermore they are able to apply communication and facilitation skills (exam achievement).

Repeat Examination:

(Recommended) Prerequisites:
Students require adequate English skills to achieve the expected level of participation.

Content:
Team roles and team development stages (team development clock, team triangle)
How to create a good and well-structured work environment and enhance collaboration
Motivating a team with constructive feedback
How to handle conflicts successfully
Creative problem solving tools

Intended Learning Outcomes:
Here you will gain new insights into your own role within your team and gain appreciation of other roles that may appear during conflicts. By learning better ways of looking at team dynamics you will improve your ability to create a good and well-structured work environment and enhance team collaboration. After completing this workshop you will have an expanded set of useful communication and facilitation skills that will enable you to build good work relationships and deal with conflicts in a constructive manner.

Teaching and Learning Methods:
Trainer input, demonstrations, exercises, role-playing games, group discussions, feedback, etc. Each participant is encouraged to explore his/her style and thus expand their individual set of communication, dialogue facilitation and project team collaboration skills.

Media:

Reading List:
Belbin RM (1993) Team Roles At Work. Butterworth-Heinemann, Oxford

Hanlan M (2004) High-Performance Teams – How to Make Them Work. Praeger, Westport CT.

Pentland A (2012) The New Science of Building Great Teams. In: Harvard Business Review 04:2012.

Waters K (2012) All About Agile: Agile Management Made Easy! CreateSpace Independent Publishing Platform.

West MA (1990) The Social Psychology of Innovation in Groups. In: MA West, JL Farr (Eds) Innovation and Creativity at Work. Wiley, Chichester.

Yukl GA (2013) Leadership in Organizations. 8th ed. Pearson Eucation, Harlow.
"

Responsible for Module:
Monika Thiel

Courses (Type of course, Weekly hours per semester), Instructor:
Communication and Facilitation in Project Teams (Workshop, ,5 SWS)
Thiel M
For further information in this module, please click campus.tum.de or here.

Module Description

CLA20705: Diversity and Conflict Management | Diversität und Konfliktmanagement

Version of module description: Gültig ab summerterm 2013

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 38	**Contact Hours:** 22

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden verfassen einen Essay im Umfang von 1000 - 1500 Worten. Im Rahmen des Essays zeigen sie, dass sie Konflikte theoretisch einordnen und Methoden zur Konfliktlösung anwenden können (Prüfungsleistung).

Repeat Examination:

(Recommended) Prerequisites:

Content:
Das Seminar erläutert theoretisch die Rolle von Diversität in Konflikten und die Chancen und Risiken, die sich daraus ergeben. Es wird sich dabei mit den Hintergründen von Konflikten und deren systematischen Kategorisierung als auch mit Lösungsansätzen und Konfliktstrategien beschäftigen. Theoretische Modelle werden anhand eigener Beispiele praktisch greifbar gemacht.

Intended Learning Outcomes:
Nach der Teilnahme am Workshop sind die Studierenden in der Lage, die Chancen von Diversität in einer Gruppe zu erkennen und sie konstruktiv in ihre Arbeit zu integrieren. Sie können Konflikte theoretisch einordnen und kennen praktische Methoden welche zur gelungenen Konfliktlösung führen. Zudem sind sie in der Lage diese Methoden im späteren Arbeitsleben einzusetzen.
Die Studierenden können ihr eigenes Konfliktverhalten reflektieren und gegebenenfalls verschiedene Schemata als Analysebehelfe einsetzen.

Teaching and Learning Methods:
Die Teilnehmer/innen werden an praktischen, teils auch eigenen Beispielen und mit partizipativen Methoden ihren eigenen sozio-kulturellen Hintergrund reflektieren, Konfliktmanagement erfahren und die praktische Erfahrung in theoretische Hintergründe einbetten.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Diversität und Konfliktmanagement (Streiten über Unterschiede, Unterschiede im Streiten) (Workshop, 1,5 SWS)
Haberl M
For further information in this module, please click campus.tum.de or here.

Module Description

CLA30230: Ethics and Responsibility | Ethik und Verantwortung

Version of module description: Gültig ab winterterm 2010/11

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:** 45	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Das Modul wird mit einer Modulprüfung in Form eines Essays (4000-5000 Zeichen) abgeschlossen. In diesem dokumentieren die Studierenden, dass sie ethische Argumente differenziert zuordnen und i.S. von Handlungspositionen konzeptionell umsetzen, sowie sprachlich verständlich darstellen können.
In einem Referat oder einer Präsentation (25-35 min) stellen die Studierenden eine Methode ethischer Urteilsbildung für mögliche Konfliktszenarien in den Problemfeldern Wissenschaft und Technik vor (Prüfungsleistung).

Repeat Examination:

(Recommended) Prerequisites:

Content:
Wir treffen täglich Entscheidungen. Dabei spielen Fakten eine große Rolle, oft aber auch das sogenannte Bauchgefühl. In gesellschaftlichen Debatten um brisante Anwendungen von Wissenschaft und Technik kommt viel darauf an, beides voneinander zu unterscheiden und vor allem gute Gründe pro oder contra zu finden. Ethik leitet dazu an, mit Konflikten verantwortlich umzugehen. Aber welche Art von „Wissen“ wird dabei eingesetzt? Wie verhalten sich Recht und Ethik zueinander? Und wie lässt sich über angewandte Ethik sprechen, ohne Moral zu predigen?

Intended Learning Outcomes:
Die Studierenden sind in der Lage mithilfe einer Methode ethischer Urteilsbildung exemplarische Konfliktszenarien auf den Problemfeldern von Wissenschaft und Technik zu beschreiben und abzuschätzen. Nach der Teilnahme am Seminar sind sie in der Lage, ethische Argumente im Hinblick auf ihre Geltungsansprüche zu unterscheiden und verantwortliche Handlungsoptionen

in verständlicher und zugleich anwendungsnaher Sprache für ein ethisches Gutachten reflektiert aufzubereiten.

Teaching and Learning Methods:
Präsentation, Referat, Diskussion, Textanalyse

Media:

Reading List:
Wird im Rahmen der Veranstaltung zur Verfügung gestellt.

Responsible for Module:
PD Dr. Jörg Wernecke

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Angewandte Ethik: aktuelle Problemfelder (Seminar, 2 SWS)
Wernecke J
For further information in this module, please click campus.tum.de or here.

Module Description

CLA31314: Introduction to Philosophical Thinking | Einführung ins philosophische Denken

Version of module description: Gültig ab winterterm 2016/17

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 68	**Contact Hours:** 22

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Das Modul wird in Form eines Referats (Textvorbereitung) oder eines Protokolls sowie zur vertiefenden Reflexion mit einem Essay als Nachweis für eine eigenständige kreative philosophische Auseinandersetzung mit einem Text abgeschlossen (Gewichtung 1:1). Voraussetzung für den Leistungsnachweis ist die aktive Teilnahme in Form von vorbereitender Lektüre und Mitarbeit in Gruppenübungen und Diskussionen.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Was ist Philosophie? Wie denken Philosophen? Wie argumentieren sie in ihren Texten? Wie kann man diese besser verstehen? Mittels der gemeinsamen Lektüre eines klassischen oder mehrerer Primärtexte zu einem Thema erhalten die TeilnehmerInnen einen Einblick in Probleme und Methoden der Philosophie, ihrer Bedeutung und Grenzen.
Insbesondere in den Blick genommen werden dabei Probleme der modernen Natur- und Ingenieurwissenschaften wie:
• Wie ist sicheres Wissen möglich?
• Was ist Natur?
• Wo beginnt Leben?
• Wie können wir gerecht handeln?
• Wann sind wir frei?

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage
• eine erste Antwort auf die Frage nach der Philosophie zu geben.
• verschiedene Herangehensweisen zur Erschließung eines philosophischen Textes zu gebrauchen und
• insbesondere ein Exzerpt des Textes anzufertigen und entsprechende Thesen aufzustellen (Problematisieren und nicht Nacherzählen).
• einen Bezug zu aktuellen Problemen der technisierten Wissensgesellschaften herzustellen.
• in schriftlicher Form bezugnehmend auf einen oder mehrere Textabschnitte eigenständig philosophische Gedanken zu formulieren

Teaching and Learning Methods:
Seminar, Referate (Textvorbereitung) oder Protokolle, gemeinsame Lektüre und Textarbeit, Diskussionen, Selbststudium und insbesondere eigenständige Erarbeitung eines Themas, Gruppenarbeit, JiTT, Blended Learning

Media:
Tafelbilder, Präsentationen, Handouts, Moodlekurs

Reading List:

Responsible for Module:
Slanitz, Alfred; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Probleme der Philosophie: Eine Einführung in das philosophische Denken (Seminar, 1,5 SWS)
Ott M

Gedankenexperimente. Eine Einführung in das philosophische Denken (Seminar, 1,5 SWS)
Ott M

Gedankenexperimente. Eine Einführung in das philosophische Denken (Seminar, 1,5 SWS)
Ott M
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0403: English - Academic Presentation Skills C1 - C2 | Englisch - Academic Presentation Skills C1 - C2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Grades for video-taped oral presentations (including handouts and visual aids) in which students demonstrate ability to communicate in formal public speaking contexts serving a variety of rhetorical purposes such as describing, explaining, persuading or analyzing contribute equally to the final course grade.

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the C2 level as evidenced by a placement test score of at least 75 percent.

Content:
This course allows students to practice and improve ability to carry out formal speaking tasks in English such as a class presentation, dissertation defense or conference talk.

Intended Learning Outcomes:
After completion of this module students can understand with increased ease virtually everything heard or read; they can summarize information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation, and they can express themselves spontaneously very fluently and precisely, differentiating finer shades of meaning even in more complex situations.

Teaching and Learning Methods:
This course makes use of video-taping and classroom evaluation to help students develop their public speaking skill and uses a variety of training techniques such as extemporaneous speaking and PechaKucha to hone specific skills.

Media:
Text material, online platform, video taping

Reading List:
Silyn-Roberts, Heather. (2000) Writing for Science and Engineering: Papers, Presentations and Reports. Butterworth Heinemann Publishers. ISBN 0-7506-4636-5.

Reinhart, Susan (2002) Giving Academic Presentations. Ann Arbor: University of Michigan Press. ISBN 0-472-08884.

Responsible for Module:
Heidi Minning

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Academic Presentation Skills C1 - C2 (Seminar, 2 SWS)
Field B, Jansen van Rensburg P

Blockkurs Englisch - Academic Presentation Skills C1 - C2 (Seminar, 2 SWS)
Ritter J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0406: English - Writing Academic Research Papers C2 | Englisch - Writing Academic Research Papers C2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will write a 350-word abstract for an academic research paper (15% of final grade); make a 15-minute oral “academic-conference-style” presentation of research and findings (35% of final grade); and complete an academic research paper of up to 5,000 words including references (APA/MLA style) (50% of final grade), in which they demonstrate an ability to critically engage in academic discourse, making use of rhetorical devices and conventions appropriate for their audience.

Repeat Examination:

(Recommended) Prerequisites:
Students should have a minimum course entry level equivalent to upper CER C1 or C2.

Content:
This is a process writing course during which students will study effective organization of written academic English incorporating discourse markers, topic sentences, and good paragraphing; study effective use of rhetorical structures appropriate to academic English: e.g. theme and rheme, nominalisation, use of passive, as well as register and style appropriate to target audience; and choose a topic commensurate with their interests/area of study and produce an abstract, a presentation and an academic research paper with the support of peers and tutor.

Intended Learning Outcomes:
Upon completion of this module, students will be able to identify and eradicate bad writing habits in areas of particular difficulty (e.g. refined use of verb tenses, more complex sentence structures, appropriate style and register); develop more effective writing and presentation skills for academic

essays for publication (style & register, sentence structure/complexity, presentation of research); and have developed general competence in the appropriate format for academic publications.

Teaching and Learning Methods:
Students will:
a) Research a topic and gather information pertinent to a self-chosen thesis/research question
b) Prepare a presentation outlining their chosen research question or thesis which they will have to defend orally
c) Work on their chosen topic with tutor support and regular tutorials
The tutor will:
a) Give short input presentations with accompanying language based activities (pair work, group work) at the beginning of each sessions in the first half of the course
b) Give regular tutorial support

Media:
Powerpoint presentations (student and lecturer generated); Audio and visual recordings from a variety of sources; printed handouts.

Reading List:
Academic Writing: A Practical Guide for Students (2003) Bailey, S.
What Every Student Should Know About Preparing Effective Oral Presentations (2007) Cox, M. R.
How to Write and Publish A Science Paper (Sixth edition) (2006) Day, R. A. and Gastel, B.
Writing for Academic Journals (2005) Murray, R.

Responsible for Module:
Heidi Minning

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Writing Academic Research Papers C2 (Seminar, 2 SWS)
Hughes K, Sanchez D
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0414: English - Intercultural Communication C1 | Englisch - Intercultural Communication C1

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
A classroom presentation (including a handout and visual aids) (50%) and a final exam (50%) form the basis for final assessment. Duration of the final examination: 60 minutes. In the presentations and final exam students demonstrate a critical awareness of various dimensions and theories of cultural difference and show that they can apply them in situations where intercultural communication occurs.

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the C1 level of the GER as evidenced by a score in the range of 60 – 80 percent on the placement test at www.moodle.tum.de. (Please check current announcements as the exact percentages may vary each semester.)

Content:
This course, taught in English, should familiarize you with some dimensions of cultural variation and theories of culture and communication. While learning to understand and appreciate cultural difference, you will improve your ability to communicate effectively in a global context.

Intended Learning Outcomes:
After completion of this module, students can communicate more effectively with partners from other cultures. Specifically, they can recognize cultural differences when they occur, understand some specific ways in which cultures can differ, and have developed self-awareness of their own cultural behaviors and values, which helps them be more effective in cross-cultural communication situations.

After completion of this module, non-native speakers of English can better understand a wide range of demanding, longer texts, and recognize implicit meaning; they can express themselves fluently and spontaneously without much obvious searching for expressions; they can use language flexibly and effectively for social, academic and professional purposes and they can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organizational patterns, connectors and cohesive devices; They are better prepared for studying or working abroad. Corresponds to C1 of the CER.

Teaching and Learning Methods:
Communicative and skills oriented treatment of topics with use of group discussion, case studies, presentations, writing workshops, listening exercises, and pair work to encourage active use of language, and provide opportunities for ongoing feedback.

Media:
Textbook, use of online learning platform, presentations, film viewings, podcasts and audio practice.

Reading List:
Tuleja, Elizabeth (2007) Intercultural Communication for Business (2nd Edition). Mason: Southwestern.

Spencer-Oatey, Helen and Franklin, Peter (2009) Intercultural Interaction: A Multidiscioplinary Approach to Intercultural Communication. Palgrave Macmillan.

Responsible for Module:
Heidi Minning

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Intercultural Communication C1 (Seminar, 2 SWS)
Hughes K
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0427: English - Academic Writing C2 | Englisch - Academic Writing C2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will write at least 4 texts of 300 to 500 words in various genres. They will receive feedback on each draft and have multiple opportunities to revise in which they are expected to demonstrate a command of the conventions of each genre (e.g. in an evaluative essay they will be able to respond to readers' needs for information, state a clear judgment, provide evidence for it, use appropriate strategies such as comparing and contrasting, citing sources responsibly, anticipating and acknowledging counterarguments, and adopting a credible voice).

In each essay, students will show that they are familiar with and can apply conventions of Anglo-American academic writing such as beginning a text with an introduction, supplying a transparent, coherent set of supporting paragraphs, and ending with a succinct conclusion. They will be able to apply conventions of grammar and mechanics consistently, and will demonstrate a sensitivity to readers' needs by responding to feedback given by fellow students in workshops and by the instructor in consultations and in writing.

Students will also demonstrate the ability to produce texts spontaneously in a final in-class writing assignment. Duration of the final examination: 60 minutes. They will also participate in writing workshops in which they demonstrate an ability to analyze texts of fellow students and provide appropriate feedback.

The drafts of each text, as well as the final in-class assignment will count equally toward the final grade. Students may use dictionaries.

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the C2 level as evidenced by a placement test score in the range of 75 – 100 percent. (Please check current announcements as the exact percentages may vary each semester.)

Content:
In this course students write and revise essays of various genres including description, evaluation, explanation, argument and analysis, while learning how to evaluate and interpret written texts of others in regular workshop sessions.

Intended Learning Outcomes:
After completion of this module, students have improved their ability to communicate clearly and powerfully in formal written English, become familiar with some common forms of expository writing, increased academic, professional and everyday vocabulary, developed regular habits to continue this learning process, and generally have increased their self-confidence with regard to written text production.

In addition, students can understand formal texts with increased ease, summarize information from different written sources, reconstructing arguments and accounts in a coherent presentation; they can express themselves spontaneously very fluently and precisely, differentiating finer shades of meaning even in more complex situations.

Teaching and Learning Methods:
In this workshop-style course we explore a range of topics through short readings and essay-length composition writing. Techniques for evaluating one's own writing will be practiced, with opportunities to revise drafts. Oral and written peer evaluations will form a regular component of the class sessions including use of an online peer forum and online instructor feedback.

Media:
Text material, online platform with forum and text archive allow students to develop writing ability in a process-oriented manner.

Reading List:
Recommended resources:
Silyn-Roberts, Heather (2000) Writing for Science and Engineering: Papers, Presentations and Reports. Butterworth Heinemann Publishers. ISBN 0-7506-4636-5.

Oshima, Alice, Ann Hogue (2006) Writing Academic English 4th Ed. Pearson Longman. ISBN 0-13-152359-7.

Wiliams, Joseph (2000) Style: Ten Lessons in Clarity and Grace Addison, Wesley Longman Co. ISBN 0-321-28831-9.

Responsible for Module:
Heidi Minning

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Academic Writing C2 (Seminar, 2 SWS)
Schrier T
For further information in this module, please click campus.tum.de or here.

Module Description

CLA11108: Leadership | Führung übernehmen

Version of module description: Gültig ab summerterm 2012

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In einer Präsentation analysieren die Studierenden die grundlegenden Konzepte/Methoden und Aufgaben der Personalführung (Prüfungsleistung).

Repeat Examination:

(Recommended) Prerequisites:

Content:
Führung kann gelernt werden - sofern die Bereitschaft für diese Aufgabe besteht. Hierzu gehört Selbstreflektion, die Übernahme von Verantwortung und ein Verständnis über die grundlegenden Konzepte und Methoden der Personalführung.

Inhalte
- Management und Führung
- Wirksamkeit nachhaltiger Führung
- Führungs-Kompetenzen
- Leistungs-Pyramide
- Aufgaben einer Führungskraft
- Diversity, Interkulturelle Führung
- Kommunikation und Feedback
- Recruiting und Bewerbungsgespräche
- Situative Führung
- Persönlicher Entwicklungsplan

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an diesem Workshop sind die Studierenden in der Lage die Wirksamkeit nachhaltiger Führung in Bezug auf die Leistungs-Pyramide zu veranschaulichen. Weiterhin identifizieren sie sich mit den erlernten Führungs-Kompetenzen und können je nach Situation den angemessenen Führungsstil demonstrieren und auch im Bereich der interkulturellen Führung angemessen reagieren.

Teaching and Learning Methods:
Praxisnahe Übungen zur Führungsübernahme, Diskussion

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Führung übernehmen (Workshop mit praxisnahen Übungen (Fallstudie) (Workshop, 1 SWS)
Turbanski J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0502: French A1.2 | Französisch A1.2

Version of module description: Gültig ab winterterm 2015/16

Module Level:	Language:	Duration:	Frequency:
Bachelor/Master	Language taught	one semester	
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
3	90	60	30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussprüfung (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Text- bzw. Leseverstehen, sowie Aufgaben zur freien Textproduktion. Das Hörverstehen wird anhand von Hörbeispielen mit Hörverstehens-Fragen überprüft, die schriftlich beantwortet werden müssen. Die Aufgabestellung einiger Prüfungsfragen fordert von den Studierenden in schriftlicher Form eine adäquate Reaktionsfähigkeit ähnlich wie in mündlichen Situationen.

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A1/1
Einstufungstest mit Ergebnis A1/2

Content:
In diesem Modul werden die Grundkenntnisse in französischer Lexik und Grammatik für einfache, mündliche und schriftliche Kommunikationssituationen im Alltag erweitert. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt. Der/Die Studierende lernt z.B., einfache Fragen zu Person und Familie zu stellen und zu beantworten, Verabredungen zu treffen, Reservierungen von Hotel zu tätigen, über Freizeit und Ferien zu berichten, vergangene Erlebnisse zu erzählen. Es werden u.a. folgende grammatische Themen behandelt: Passé Composé, Futur proche, Mengenangaben, Possessivbegleiter, direkte und indirekte Objektpronomen.
Es werden Strategien vermittelt, die eine Verständigung trotz noch geringer Sprachkenntnisse in alltäglichen Grundsituationen ermöglichen. Außerdem werden Möglichkeiten aufgezeigt,

den Lernprozess in der Fremdsprache effektiver zu gestalten und die eigene Lernfähigkeit zu verbessern.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau „A1 – Elementare Sprachverwendung“ des GER. Der/Die Studierende ist nach Abschluss dieses Moduls in der Lage, alltägliche Ausdrücke und sehr einfache Sätze zu verstehen und zu verwenden. Er/sie kann sich auf einfache Art verständigen, wenn die Gesprächspartnerinnen oder Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen. Er/sie kann einfache schriftliche Mitteilungen zur Person machen.
Sowohl im mündlichen als auch im schriftlichen Sprachgebrauch ist der/die Studierende in der Lage, situationsadäquat, bzw. der A 1-Stufe entsprechend, Wortschatz und Grammatik korrekt anzuwenden.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezieltem Hör-, Lese-, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Die Studierenden erwerben Teamkompetenz durch kooperatives Handeln in gemischten Gruppen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache Französisch eigenverantwortlich und effektiver zu gestalten und damit die eigenen Lernfähigkeiten zu verbessern.
Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor-und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial (Tafel, Folie, Übungsblätter, Bild, Film, etc.), auch online.

Reading List:
Lehrbuch (wird im Kurs bekanntgegeben)

Responsible for Module:
Jeanine Bartanus

Courses (Type of course, Weekly hours per semester), Instructor:
Französisch A1.2 (Seminar, 2 SWS)
Bartanus J, Suek C, Worlitzer M

Blockkurs Französisch A1.2 (Seminar, 2 SWS)
Paul E, Suek C
For further information in this module, please click campus.tum.de or here.

Module Description

CH0136: Principles of Patent Law | Grundlagen des Patentrechts

Version of module description: Gültig ab summerterm 2018

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 45	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer 90-minütigen schriftlichen Klausur erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit eine Fragestellung des Patentrechts richtig erkannt wird und Wege zu einer Lösung gefunden werden können. Beispielsweise können dies Fragen zum Ablauf einer korrekten Patentanmeldung oder die Bewertung von Erfindungen in patentrechtlichen Prüfungsverfahren sein. Die Antworten erfordern gegebenenfalls eigene Formulierungen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Gute Deutschkenntnisse erforderlich. Englischkenntnisse sind nicht erforderlich, aber hilfreich.

Content:
Einführung in den gewerblichen Rechtsschutz und insbesondere das EPÜ-Patentsystem (Europäisches Patent). Das Modul vermittelt Grundkenntnisse im Hinblick auf Anmeldeerfordernisse, Patentierungsvoraussetzungen, Priorität, Prüfungsverfahren, Einspruch und Nichtigkeit, Beschwerde, Durchsetzung und Wirkungen von Patenten.

Intended Learning Outcomes:
Nach der Teilnahme am Modul "Grundlagen des Patentrechts" kennen die Studierenden die Abläufe im Patentsystem des EPÜ. Sie sind in der Lage, die patentrechtlichen Aspekte von Erfindungen zu bewerten und wissen, wie die patentrechtlich richtige Vorgehensweise bei der Anmeldung von Patenten ist.

Teaching and Learning Methods:
Die Inhalte des Moduls werden in einer Vorlesung (1 SWS) durch Vortrag und Präsentation vermittelt. Ferner werden gemeinsam konkrete Fragestellungen beantwortet und ausgesuchte Beispiele bearbeitet, wodurch die Studierenden zur inhaltlichen Auseinandersetzung mit den Themen angeregt werden.

Media:
Präsentationen, Skript, Übungsaufgaben

Reading List:
-EPÜ in Auszügen
-Skript
-Broschüre "Der Weg zum Europäischen Patent" des Europäischen Patentamts

Responsible for Module:
Faktultät für Chemie

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen des Patentrechts (CH0136) (Vorlesung, 2 SWS)
Parchmann S (Steinberger I)
For further information in this module, please click campus.tum.de or here.

Module Description

WI000404_2: Introduction to Social and Communication Psychology | Grundlagen der Sozial- und Kommunikationspsychologie

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor	**Language:** German	**Duration:** two semesters	**Frequency:**
Credits:* 5	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer 120minütigen schriftlichen Klausur und 5-7 Übungsaufgaben à 30 Min. (Studienleistung) erbracht. In der schriftlichen Klausur weisen die Studierenden nach, dass sie in der Lage sind, sozial- und kommunikationspsychologische Theorien und Befunde wiederzugeben, zu interpretieren und auf verschiedene soziale und kommunikative Situationen anzuwenden. Zu diesem Zweck enthält die Prüfung Single-Choice-Items und offene Fragen in verschiedenen Formaten:
- Mit Wissensfragen wird überprüft, ob die Studierenden die den angestrebten Lernergebnissen entsprechenden Konzepte wiedergeben und erklären können.
- Mit Verständnisfragen wird überprüft, ob die Studierenden die den angestrebten Lernergebnissen entsprechenden Konzepte interpretieren, analysieren und diskutieren können
- Mit Szenario-Fragen wird überprüft, ob die Studierenden die den angestrebten Lernergebnissen entsprechenden Konzepte anwenden und auf verschiedene soziale und kommunikative Situationen übertragen können. Das dazugehörende Seminar kann momentan aufgrund der Situation bezüglich Covid-19 nicht in Präsenzform stattfinden. Daher werden Übungsaufgaben innerhalb der Klausur abgefragt. Um die Seminarleistung angerechnet zu bekommen, muss die Klausur „Kommunikation, Interaktion & Konflikte in der Schule mit mindestens 4.0 bestanden werden.
Der Creditumfang umfasst für Studienanfänger ab WS 18/19 5 Credits.
Es können Mid-Term-Leistungen in Form von Teilnahmen an sozial- und kommunikationspsychologischen Studien/Experimenten im Umfang von 120-240min erbracht werden. Die Erbringung der Mid-Term-Leistungen ist freiwillig. Sie dient der Praxiserfahrung sowie der Veranschaulichung von methodischen Zugängen zur sozial- und kommunikationspsychologischen Forschung.

Repeat Examination:

(Recommended) Prerequisites:
Sozialpsychologie: Keine.
Kommunikation, Interaktion und Konflikte in der Schule: Besuch der Veranstaltung Sozialpsychologie empfohlen.

Content:
In Vorlesung und Übung werden folgende Schwerpunktthemen mit Bezug zur schulischen und alltäglichen Praxis behandelt: Sozialer Einfluss, Autorität und Gehorsam, Gruppenprozesse und Gruppenleistung, Selbstkonzept und Kognitive Dissonanz, Soziale Attraktion, Soziale Wahrnehmung, aggressives Sozialverhalten, verbale und nonverbale Kommunikation, Einstellung und Überzeugung, Konflikte und Konfliktbewältigung. Um das grundlegende Verständnis der Themen zu erleichtern, werden psychologische Forschungsmethoden vermittelt.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, soziale Interaktionen, Gruppenprozesse, Kommunikation und Konflikte systematisch zu analysieren und mit Hilfe sozial- und kommunikationspsychologischer Kenntnisse im Schulkontext zu gestalten. Sie können klassische Studien der Sozialpsychologie und grundlegende methodische Zugänge der Psychologie zu sozialen und kommunikativen Prozessen wiedergeben. Weiterhin sind die Studierenden in der Lage, soziale Einstellung und soziale Kognition, Kommunikationsmodelle und Konfliktlösungsmöglichkeiten sowie deren Bedeutung für den Kontext Schule zu nutzen.

Teaching and Learning Methods:
Zum Erreichen der angestrebten Lernergebnisse werden die wichtigsten Konzepte und Theorien der Sozial- und Kommunikationspsychologie zunächst in der Vorlesung in einem Lehrgespräch und im Vortrag mit begleitenden Folien und Skript vorgestellt und diskutiert. Eingebettete aktivierende Elemente in Form von praktischen Individual- und Gruppenübungen ermöglichen den Transfer der Lernergebnisse in alltägliche und berufliche Situationen. In der ganztägigen Übung findet mit Hilfe von verschiedenen interaktiven und fallbasierten Lehr- und Lernmethoden (etwa Arbeit in Kleingruppen, Fallbesprechungen, Simulationen) ein Training der gelernten Theorien, Konzepte und Vorgehensweisen statt. So gelingt ein Überführen der theoretischen Konzepte in handlungspraktisches Wissen. In allen Veranstaltungen werden die Studierenden zum Eigenstudium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt.

Media:
Präsentation mit Powerpoint
Begleitendes Handout und Literaturhinweise auf moodle
Online-Ted
Seminar-Tools

Reading List:
(1) Aronson, E., Wilson, T.D. & Akert, R.M. (2014). Sozialpsychologie. München: Pearson.
(2) Jonas, K., Stroebe, W. & Hewstone, M. (2007). Sozialpsychologie Eine Einführung (5. Auflage). Berlin: Springer.

(3) Schulz v. Thun, F. (2010). Miteinander Reden 1: Störungen und Klärungen. Allgemeine Psychologie der Kommunikation. Hamburg: Rowohlt.

Pflichtliteratur und weiterführende Literatur wird in der Vorlesung und im Handout bekanntgegeben.

Responsible for Module:
Kehr, Hugo; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Sozialpsychologie (WI000399, WI000404_2) (Vorlesung, 2 SWS)
Brunner D

Kommunikation, Interaktion und Konflikte in der Schule (WI000404_2, WI000405) - Vorlesung (Vorlesung, 1 SWS)
Holzemer L, Jais M, Voigt J

Kommunikation, Interaktion und Konflikte in der Schule (WI000404_2, WI000405) - Übung (Übung, 1 SWS)
Jais M, Holzemer L
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0608: Italian A2.2 | Italienisch A2.2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Prüfung (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Text- bzw. Lese- und Hörverstehen sowie Aufgaben zur freien Textproduktion. Das Hörverstehen wird anhand von Hörbeispielen bzw. Hervorstehens-Fragen, die schriftlich beantwortet werden müssen, überprüft. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen getestet.

Repeat Examination:

(Recommended) Prerequisites:
Fundierte Kenntnisse des Moduls A2.1 (bestandene Klausur) oder Einstufungstest mit Ergebnis A2.2.

Content:
Inhalt:
Abschlussmodul des A-Niveaus des Gemeinsamen Europäischen Referenzrahmens für Sprachen (Grundstufe)
In diesem Modul werden Grundkenntnisse in der Fremdsprache Italienisch aufgebaut, die den Studierenden ermöglichen, sich in Alltagssituationen wie z.B. beim Arzt oder bei der Wohnungssuche zurechtzufinden. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt.
Der/die Studierende lernt und übt u.a. eine höfliche Aufforderung, einen Wunsch, eine Vermutung auszudrücken; Ratschläge bzw. Anweisungen zu geben; jemanden um Rat zu bitten; eine Entscheidung zu begründen und die eigene Meinung zu äußern.

Es werden Strategien vermittelt, die mündlich wie schriftlich eine Verständigung trotz geringer Sprachkenntnisse erlauben. Außerdem werden Möglichkeiten aufgezeigt, wie man den Lernprozess in der Fremdsprache Italienisch eigenverantwortlich und effektiv gestalten kann.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A2–Elementare Sprachverwendung des GER.
Nach Abschluss des Moduls kann der/die Studierende im Gespräch elementare Sätze und Ausdrücke zu einem erweiterten Spektrum an vertrauten Themen wie z.B. Essgewohnheiten und Traditionen, Wohnen oder Gesundheitsproblematiken verstehen und gebrauchen. Er/sie kann längere Texte zu bekannten und allgemeinen Themen verstehen, in denen gängige bzw. einfache, alltagsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind. Er/sie ist zudem in der Lage, kurze, informative Texte schriftlich zu verfassen. Er/sie ist außerdem in der Lage, höfliche Aufforderungen, Wünsche, Vermutungen auszudrücken; Ratschläge bzw. Anweisungen zu geben; jemanden um Rat zu bitten; Entscheidungen kurz zu begründen; die eigene Meinung in einfacher Form zu äußern.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; Förderung kooperativen Lernens; Kontrolliertes Revidieren einzelner Aspekte der Grammatik mit vorgegebenen (online-) Materialien; Referieren und Präsentieren; moderierte Diskussionen.
Freiwillige Hausaufgaben zur Vor- und Nachbereitung festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online.

Reading List:
Lehrbuch (wird im Unterricht bekannt gegeben)

Responsible for Module:
Debora Mainardi

Courses (Type of course, Weekly hours per semester), Instructor:
Italienisch A2.2 (Seminar, 2 SWS)
Alfieri L, Aquaro M, Bonvicin A
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0707: Japanese A1.3 | Japanisch A1.3

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussklausur (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Schriftzeichen (Kanji), Wortschatz und Grammatik, zu Text- bzw. Lese- und Hörverstehen (als Diktat/anhand von Hörbeispielen, kombiniert mit schriftlich zu beantwortenden Fragen) sowie Aufgaben zur freien Textproduktion. Mündliche Reaktionsfähigkeit wird anhand von Dialogbeispielen bzw. durch die Wiedergabe von entsprechenden Redemitteln schriftlich überprüft.

Repeat Examination:

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an der Stufe A 1.2 oder vergleichbare Kenntnisse

Content:
In dieser LV werden die Grundkenntnisse des Japanischen erweitert, die es den Studierenden ermöglichen, sich in alltäglichen Situationen mit Basissprachkenntnissen zurechtzufinden. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt. Das Erlernen der Schriftzeichen (Kanji) ist ebenfalls grundlegend. Um dieses Ziel zu erreichen, wird Kommunikation im Kontext folgender Situationen eingeübt: im Restaurant; mit dem Taxi fahren; über Ferien und Freizeit berichten etc. Dazu werden u.a. folgende Themen der Grammatik behandelt: Ausdrücke für Zahlen und Mengen, Wunschformen, te-Form der Verben. Die Studierenden lernen, mit dem grundlegenden Vokabular zu Themen wie Familie, Beruf, Freizeit und Wohnen einfach strukturierte Hauptsätze zu formulieren und Alltägliches zu berichten/erfragen.

Intended Learning Outcomes:
Nach Abschluss dieses Moduls sind die Studierenden in der Lage, vertraute, alltägliche Ausdrücke und ganz einfache Sätze zu verstehen und zu verwenden, die auf die Befriedigung konkreter, in der Bewältigung des Alltags wesentlicher Bedürfnisse zielen. Der/die Studierende kann sich und andere vorstellen und anderen Leuten Fragen zu ihrer Person stellen, bzw. Fragen dieser Art beantworten. Er/Sie kann in einfacher Weise Tagesabläufe beschreiben und Wünsche kommunizieren. Außerdem kann er/sie neben den japanischen Silbenschriften Hiragana und Katakana ca. 60 für den Alltag relevante Kanji (chinesische Schriftzeichen) verstehen und verwenden.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; Gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; Förderung kooperativen Lernens. Freiwillige Hausaufgaben (zur Vor- und Nachbearbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch (wird in der Lehrveranstaltung bekanntgegeben)
Vom Kursleiter selbst angefertigte/zusammengestellte Arbeitsblätter und (online-)Materialien.

Responsible for Module:
Marie Miyayama

Courses (Type of course, Weekly hours per semester), Instructor:
Japanisch A1.3 (Seminar, 2 SWS)
Bauer K, Taguchi-Roth Y

Blockkurs Japanisch A1.3 (Seminar, 2 SWS)
Taguchi-Roth Y
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0812: Cultural Competence: Choir and Orchestra | Kulturelle Kompetenz: Chor- und Orchesterarbeit

Version of module description: Gültig ab summerterm 2010

Module Level:	Language:	Duration:	Frequency:
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Chor- und Orchesterarbeit (Workshop, 2 SWS)
Mayer F
For further information in this module, please click campus.tum.de or here.

Module Description

CLA31900: Lecture Series Environment - TUM | Vortragsreihe Umwelt - TUM

Version of module description: Gültig ab winterterm 2019/20

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 67	**Contact Hours:** 23

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a poster created in a group of 2-3 people connecting topics from at least two lectures. In order to collect material for the poster, participants have to organize themselves in discussion groups with 5-6 people.
Each discussion group will split into two groupes for the poster. At the end of the semester the poster has to be presented. Every member of the poster group has to speak one minute,
The grade will consist of the poster and its presentation.
Mandatory requirements for the examination
For the 3-ECTS course a successful accomplishment of 16 academic performances is mandatory for the examination!

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The systematic integration of education for sustainable development at the university is an extremely complex challenge that can only be addressed through a plural and multi-perspective approach. Within the framework of the UNESCO World Programme of Action "Bildung für Nachhaltige Entwicklung“ (BNE; =Education for Sustainable Development), the interdisciplinary lecture series Umwelt - TUM takes place at the TUM Campus Garching, which deals with changing topics in the field of environmental sustainability.

It is organized by the newly founded branch of the environmental department AStA TUM at the Garching campus to promote sustainability awareness at TUM and to offer interested students the opportunity to deal with the topic in more detail.

Intended Learning Outcomes:
After successful participation in this module, students are able to understand lectures at a high scientific level and reproduce central statements. Students are able to comprehend analyses of sustainable development and are familiar with formulating their own positions and justifying them in discussions. Furthermore, they know where they can explore the topic of sustainability in more detail on campus, whether in the form of course offerings, internships, projects or thesis.

Teaching and Learning Methods:
It consists of six lectures and an organizational meeting at the beginning. Each lecture includes two 40-minute presentations, a 15-minute break and a subsequent 45-minute discussion with the speakers, which is realized in cooperation with the Zentrum for Schlüsselkompetenzen (Center for Key Competencies) of the Faculty of Mechanical Engineering.
The lectures and presentation slides will be uploaded to the online learning platform Moodle.
As homework, students will prepare a short report of the lectures and the discussion session. In addition, introductory and further literature will be addressed to enhance more detailed discussions of the lectures.

Media:

Reading List:

Responsible for Module:
Dr. phil. Alfred Slanitz (WTG@MCTS)

Courses (Type of course, Weekly hours per semester), Instructor:
Will Technology Save Us All? A Glimpse into a Sustainable Future (Ringvorlesung Umwelt) (Vorlesung mit integrierten Übungen, 1,5 SWS)
Biller B, Dörringer L, Kopp-Gebauer B, Recknagel F, Slanitz A

Responsibility in Times of (Climate) Change (Ringvorlesung Umwelt) (Vorlesung mit integrierten Übungen, 1,5 SWS)
Dörringer L, Kopp-Gebauer B, Recknagel F, Slanitz A, Trentmann L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3234: Life Sciences & Society. An Introduction | Lebenswissenschaften & Gesellschaft. Eine Einführung

Version of module description: Gültig ab summerterm 2015

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regelmäßige Anwesenheit und aktive Teilnahme am Seminar, Lektüre und Vorbereitung der Basisliteratur, Gestaltung von kleineren Inputelementen für das Seminar (Kurzreferat/ Sitzungsmoderation)

Schriftliche Abschlussarbeit (Hausarbeit)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Welche Rolle spielen die Lebenswissenschaften in der heutigen Gesellschaft? Wie sind sie Teil unserer modernen, hochtechnisierten "Wissensgesellschaften"? Lebenswissenschaftliches Wissen und neue Biotechnologien verändern Gesellschaft auf vielfaltige Weise, in der Medizin und der Landwirtschaft, aber auch in Bereichen wie Energie und Umwelt. Neue molekulare Perspektiven verändern, wie wir über Körper, Krankheit, Gesundheit, Umwelt und Ökosysteme nachdenken. Diese neuen Blickwinkel und technologischen Möglichkeiten sind oft von großen gesellschaftlichen und ökonomischen Hoffnungen begleitet, aber auch von kontroversen Debatten in der Gesellschaft, die nach den Risiken und Konsequenzen neuen lebenswissenschaftlichen Wissens fragen, wie etwa im Bereich der Stammzellforschung, der synthetischen Biologie oder der agrarischen Biotechnologie. Politische Debatten spielen wiederum eine große Rolle für die Ebene der Forschungsförderung und bei der Regulation neuer Technologien. Lebenswissenschaftliche Forschung ist somit auf vielen Ebenen in gesellschaftliche und politische Diskurse und Strukturen eingebettet. Das interdisziplinäre Forschungsfeld der Wissenschaft- und Technikforschung

beschäftigt sich mit diesem vielfältigen Verhältnis zwischen Wissenschaft, Technik und Gesellschaft. Anhand von Fallstudien aus dem Bereich der Lebenswissenschaften werden wir in diesem Kurs lernen, wie dieses Verhältnis kritisch beleuchtet und analysiert werden kann. Ziel ist, ein Verständnis dafür zu entwickeln, wie Wissenschaft und Technik in die Gesellschaft eingebettet ist und welche Rolle im Spezifischen die Lebenswissenschaften in unserer heutigen Gesellschaft spielen.

Intended Learning Outcomes:
Nach erfolgreichem Absolvieren des Moduls erwerben Studierende die Fähigkeit sich zu Themen an der Schnittstelle von Lebenswissenschaften und Gesellschaft kompetent zu positionieren, indem sie verschiedene gesellschaftliche und wissenschaftliche Positionen zu diesen Themen kritisch reflektieren, sowie eigene Einschätzungen artikulieren können. Studierende erwerben in diesem Sinne im Laufe der Lehrveranstaltung die Kompetenzen 1) Themen an der Schnittstelle von Lebenswissenschaften und Gesellschaft zu identifizieren; 2) Wissenschaftliche Text, die entlang von Fallstudien in die Beziehung von (Lebens)Wissenschaften und Gesellschaft beschreiben, zu lesen, zu diskutieren und die Kernargumente zu verstehen; 3) Eigenständig aktuelle Debatten in Gesellschaft, Medien und Politik zu Lebenswissenschaften und Gesellschaft zu recherchieren; 4) Die erworbenen Analysefähigkeiten auf diese aktuellen gesellschaftlichen Debatten anzuwenden und die Beziehung zwischen Lebenswissenschaften und Gesellschaft im Seminar zu reflektieren und zu diskutieren.

Teaching and Learning Methods:
Lektürearbeit; angeleitete Gruppenarbeiten zur Diskussion und Vertiefung des Textverständnisses und zur Entwicklung eigener Fragen; Diskussion im Plenum; Inputelemente von Seiten der Studierenden wie Kurzreferate oder Sitzungsmoderation; eigenständige Recherchen zu Themen im Kontext der Lehrveranstaltung; schriftliche Hausarbeit als Abschluss der Lehrveranstaltung.

Media:
PowerPoint, Moodle, Flipchart, Film(ausschnitte), Reader

Reading List:
Beispiele (im Kurs werden Auszüge/Kapitel gelesen) Beck, Stefan; Niewöhner, Jörg; Sörensen, Estrid (2012): Science and Technology Studies. Eine sozialanthropologische Einführung. Bielefeld: transcript.

Collins, Harry & Pinch, Trevor (2000): Der Golem der Technologie: Wie unsere Wissenschaft die Wirklichkeit konstruiert. Berlin: Berlin Verlag.

Edwards, Paul (2010): A Vast Machine Computer Models, Climate Data, and the Politics of Global Warming. Cambridge, MA: MIT Press.

Reardon, Jenny (2005): Race to the Finish: Identity and Governance in an Age of Genomics. Princeton: Princeton University Press.

Thompson, Charis (2013): Good Science: The Ethical Choreography of Stem Cell Research. Cambridge, MA: MIT Press.

Responsible for Module:
Prof. Dr. Ruth Müller

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ5440: Make your thing: A project in the Makerspace | Mach ein Ding! Ein Projekt im Makerspace

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 100	**Contact Hours:** 50

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam will be held in form of a presentation about the project progress. During this final presentation the students will not only describe the steps of their project, but will also present a functioning prototype. The final grading will be a combination of the oral presentation (25%), the functionality of the prototype (50 %) and the combined assessments from the CAD and electronics workshops. Criteria for the assessment of the prototype are: independence of the design, functionality, complexity andworkmanship.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in practical hand work and craftsmanship, persistency in the project and the will to solve any upcoming problem.

Content:
What is a makerspace? A makerspace is a workshop in which students can realize technological projects. In the makerspace students will find 3D printers, CNC routers and laser cutters.
The module encompasses a semester-long project during which the students will create a functional prototype. The project work will be accompanied by block wise lessons in CAD, electronics and programming of microcontrollers. Furthermore the students will be advised in the use of all machines in the makerspace.
In the beginning, students will set-up a detailed project plan as a Gantt diagram and present their project to their class mates. They will define their own milestones which they have to fulfil during the project process. Finally the students must present a functional prototype.

Intended Learning Outcomes:
After participating in that course, the students will be able to plan a technical project in detail and deliver a functioning prototype in time. They will have learned how to split a complex project in parts, which are easier to be calculated in terms of time and resources. They will have learned to structure their project so that they can demonstrate specific intermediary results at pre defined time points. They will be able to respond to upcoming difficulties and find their own way to circumvent them. This will be help them to manage even larger future projects.

Teaching and Learning Methods:
The module is designed as an exercise with an intensive practical course part. In the practical part, students will work in groups of two to produce a functional prototype of a technological device.
In parallel to the theoretical lessons, the students will work in groups of two to deign their technical prototype. They will have to use further input from online tutorials and videos to finalize their design. They may also develop simple demo objects in order to address problems that may arise during the development of the final prototype.

Media:
During blocked lessons in CAD and project management: Powerpoint presentations. During electronics and programming lessons: computer work. During self studies: use of online tutorials and videos.

Reading List:

Responsible for Module:
Gütlich, Markus

Courses (Type of course, Weekly hours per semester), Instructor:
Praktischer Apparatebau in Life Sciences: Ein Projekt im Makerspace (Vorlesung mit integrierten Übungen, 5 SWS)
Gütlich M [L], Gütlich M, Ortner M
For further information in this module, please click campus.tum.de or here.

Module Description

MW1535: Introduction to Patent, Trademark and Design Law for Engineers | Patent-, Marken- und Musterrecht für Ingenieure: Eine Einführung

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In a written exam (60 min.) the taught content have to be applied to different questions.

Repeat Examination:

(Recommended) Prerequisites:

Content:
This lecture is aimed in particular at engineering students and is intended to provide a basic understanding of industrial property rights. The aim of the course is to provide an overview of the most important industrial property rights, i.e. patent, trademark and design, and to deal in depth with the topics of obtaining, defending and enforcing a technical property right using the example of the patent. The lecture also covers the topics of copyright law, customs regulations, due diligence in Mergers & Acquisitions.

Intended Learning Outcomes:
The aim of the course is to provide an overview of the most important industrial property rights, i.e. patent, trademark and design, and to deal in depth with the topics of obtaining, defending and enforcing a technical property right using the example of the patent.

Teaching and Learning Methods:
In the lecture, the course contents are taught by means of lecture and presentation. Problems and topics from practice are presented as examples. The slides and further information are made available to the students online via the e-learning portal.

Media:
Lecture, presentation, handouts, online teaching materials, videos

Reading List:
Ilzhöfer/Engels, Patent-, Marken- und Urheberrecht, 8. Auflage, Verlag Vahlen, 2010;
Beck-Texte, 11. Auflage, Patent- und MusterR, dtv, 2011;
Beck-Texte, 31. Auflage, Wettbewerbsrecht, Markenrecht und Kartellrecht, dtv, 2010;
Benkard, Kommentar zum Patentgesetz, 10. Auflage, Verlag C. H. Beck, 2006;
Schulte, Kommentar zum Patentgesetz, 8. Auflage, Heymanns Verlag, 2008;
Ingerl/Rohnke, Kommentar zum MarkenG, 3. Auflage, Verlag C. H. Beck, 2010;
Ströbele/Hacker, Kommentar zum MarkenG, 10. Auflage, Heymanns Verlag, 2009
Patentgesetz (PatG), Gebrauchsmustergesetz (GebrMG), Designgesetz (DesignG)

Responsible for Module:
Mela, Petra; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Patent-, Marken- und Musterrecht für Ingenieure: Eine Einführung (Vorlesung, 2 SWS)
Mela P [L], Wende C, Müller K, Mela P, Mansi S, Ahrens M
For further information in this module, please click campus.tum.de or here.

Module Description

CLA11317: Interdisciplinary Lecture Series Environment: Politics and Society | Ringvorlesung Umwelt: Politik und Gesellschaft

Version of module description: Gültig ab summerterm 2015

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
A successful accomplishment of 9 academic performances is mandatory for the examination! The examination consists of a short PowerPoint presentation at the end of the semester. The presentation can be created alone or in groups of two. Everyone has to speak one minute. The examination is ungraded.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The lecture series Umwelt (environment) is an interdisciplinary, public lecture organised by the Environmental Department of the Studentische Vertretung (Student Representatives) of the TU Munich. Experts speak e.g. on technical environmental protection, health, consumer and climate protection. In the summer semester, it offers students the opportunity to learn about the political and social dimensions of current ecological topics and research results at a scientific level.

The lecture series Umwelt (environment) is offered in the winter semester in the module CLA11200 Ringvorlesung Umwelt: Ökologie und Technik (Lecture series on the environment: ecology and technology). It is only possible to gain given credits twice for the lecture series within each study program.

Intended Learning Outcomes:
Students are able to follow expert presentations on political and social dimensions of environmental problems and identify core theses and central facts.

Teaching and Learning Methods:
Lectures, presentations, discussions

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Will Technology Save Us All? A Glimpse into a Sustainable Future (Ringvorlesung Umwelt) (Vorlesung mit integrierten Übungen, 1,5 SWS)
Biller B, Dörringer L, Kopp-Gebauer B, Recknagel F, Slanitz A

Responsibility in Times of (Climate) Change (Ringvorlesung Umwelt) (Vorlesung mit integrierten Übungen, 1,5 SWS)
Dörringer L, Kopp-Gebauer B, Recknagel F, Slanitz A, Trentmann L
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0902: Russian A1.2 | Russisch A1.2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussklausur (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Text- bzw. Leseverstehen sowie Aufgaben zur freien Textproduktion. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft.

Repeat Examination:

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an der Stufe A 1.1 oder vergleichbare Sprachkenntnisse.

Content:
In diesem Modul werden elementare Kenntnisse der Fremdsprache Russisch vermittelt. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt. Die Studierenden lernen grundlegendes Vokabular zu verschiedenen Themen in einfachen sprachlichen Strukturen zu formulieren und über sie im Präsens zu berichten. Die Studierenden üben zum Beispiel einfache Fragen zum Beruf zu stellen und zu beantworten, sich über Freizeitbeschäftigungen und Hobbys auszutauschen, Einkaufsgespräche zu führen, eine Speisekarte zu verstehen und etwas zu bestellen, zu fragen, was man gern zu den Mahlzeiten isst und trinkt. Es werden kommunikative Situationen geübt, die auf einen Aufenthalt im Zielland vorbereiten. Dazu werden die notwendigen grammatikalischen Themen behandelt und Lernstrategien vermittelt, die eine erfolgreiche Gestaltung des weiteren Lernprozesses in der Fremdsprache Russisch ermöglichen.

Intended Learning Outcomes:
Dieses Modul orientiert sich an den Zielen der Elementarstufe des GER. Nach Bestehen des Moduls sind die Studierenden in der Lage vertraute, alltägliche Ausdrücke und einfache Sätze

zu verstehen und zu verwenden, die auf die Befriedigung konkreter Bedürfnisse zielen. Die Studierenden können sich auf einfache Art verständigen, wenn die Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; kontrolliertes Selbstlernen mit vorgegebenen Materialien; Vorbereitung einer Präsentation in der Zielsprache; selbständige Recherchen zu den vorgegebenen Themen. Freiwillige Hausaufgaben festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial (wird in der LV bekannt gegeben)

Responsible for Module:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Russisch A1.2 (Seminar, 2 SWS)
Legkikh V, Tagieva T
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0904: Russian A2.2 | Russisch A2.2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussklausur (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Text- bzw. Leseverstehen sowie Aufgaben zur freien Textproduktion. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft.

Repeat Examination:

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an der Stufe A 2.1 oder vergleichbare Kenntnisse.

Content:
In diesem Modul werden Grundkenntnisse der Fremdsprache Russisch vermittelt. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt. Die Studierenden üben, einfache Gespräche in alltäglichen Kommunikationssituationen zu beginnen und in Gang zu halten sowie sich über vertraute Themengebiete zu äußern. Die Studierenden lernen zum Beispiel sich über Studium/Arbeitsalltag auszutauschen, die Wohnsituation zu beschreiben und Wegbeschreibungen zu geben. Es werden kommunikative Situationen geübt, die auf einen Aufenthalt im Zielland vorbereiten. Dazu werden die notwendigen grammatikalischen Themen behandelt und Lernstrategien vermittelt, die eine erfolgreiche Gestaltung des weiteren Lernprozesses in der Fremdsprache Russisch ermöglichen.

Intended Learning Outcomes:
Dieses Modul orientiert sich an den Zielen der Basisstufe (Niveau A2) des GER. Nach Bestehen des Moduls sind die Studierenden in der Lage, sich in einfachen, routinemäßigen Gesprächssituationen zu verständigen, in denen es um einen direkten Austausch von

Informationen über vertraute und geläufige Dinge geht. Die Studierenden können die Bedeutung von kurzen, klaren und deutlich artikulierten Mitteilungen und Durchsagen erfassen. Sie sind in der Lage, häufig gebrauchte Ausdrücke anzuwenden und Sätze zu formulieren, die mit Bereichen von ganz unmittelbarer Bedeutung zusammenhängen

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; kontrolliertes Selbstlernen mit vorgegebenen Materialien; Vorbereitung einer Präsentation in der Zielsprache; selbständige Recherchen zu den vorgegebenen Themen. Freiwillige Hausaufgaben festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online.

Reading List:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial (wird in der LV bekannt gegeben)

Responsible for Module:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Russisch A2.2 (Seminar, 2 SWS)
Tagieva T
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1002: Swedish A2 | Schwedisch A2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussklausur (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Text- bzw. Lese- und Hörverstehen sowie Aufgaben zur freien Textproduktion. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen und das Hörverstehen mittels Hörbeispielen, bzw. Hörverstehens-Fragen, die schriftlich beantwortet werden, überprüft.

Repeat Examination:

(Recommended) Prerequisites:
Bestandene Abschlussklausur A1

Content:
In diesem Modul werden Grundkenntnisse in der Fremdsprache Schwedisch vermittelt, die es den Studierenden - trotz noch geringer Sprachkenntnisse – ermöglichen sollen, sich in alltäglichen Grundsituationen zurechtzufinden.
Wir lernen/üben grundlegendes Vokabular und Konversation und produzieren auch kürzere Texte (z. B. Brief; Textzusammenfassung und Kurzpräsentationen); vertiefen und erweitern die Grammatik aus der A1-Stufe und lesen Texte in leicht leserlicher Form.
Grammatische Inhalte: Wiederholung der Pronomen; Komplettierung der Possessivpronomen; komplexer strukturierte Haupt- und Nebensätze mit Modalverben; Imperativ; Präteritum; Perfekt und Plusquamperfekt; Zeitausdrücke /-angaben; Zeit-, Ort- und Richtungsadverbien, Steigerung des Adjektivs.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A2 des GER. Der/Die Studierende erlangt Grundkenntnisse in Schwedisch mit allgemein sprachlicher Orientierung unter Berücksichtigung kultureller und landeskundlicher Aspekte. Nach Abschluss dieser LV kann der / die Studierende im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen verstehen und gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen Themen unter Einbeziehung landeskundlicher Aspekte. Der/die Studierende ist in der Lage kurze informative Texte oder Mitteilungen zu grundlegenden Situationen zu verfassen und kann längere Texte zu vertrauten Themen verstehen, in denen gängige bzw. einfache alltagsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind.
Sowohl im mündlichen als auch im schriftlichen Sprachgebrauch ist der/die Studierende in der Lage, situationsadäquat, bzw. der A2-Stufe entsprechend, Wortschatz und Grammatik korrekt anzuwenden.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-Partner- und Gruppenarbeit; Kontrolliertes Revidieren einzelner Aspekte der Grammatik mit vorgegebenen (online-) Materialien; Referieren und Präsentieren nach vorgegebenen Kriterien; moderierte (Rollen-) Diskussionen.
Freiwillige Hausaufgaben zur Vor- und Nachbearbeitung festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch (wird in der LV bekannt gegeben); multimedial gestütztes Lehr- und Lernmaterial

Responsible for Module:
Christina Thunstedt

Courses (Type of course, Weekly hours per semester), Instructor:
Blockkurs Schwedisch A2 (Seminar, 2 SWS)
Matyas E

Schwedisch A2 (Seminar, 2 SWS)
Matyas E, Noreen-Thönebe J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1201: Spanish A1 | Spanisch A1

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussprüfung (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Lese- und Hörverstehen, sowie Aufgaben zur freien Textproduktion. Das Hörverstehen wird anhand von Hörbeispielen mit Hörverstehens-Fragen/-Fragebogen überprüft. Die Aufgabestellung einiger Prüfungsfragen fordert von den Studierenden in schriftlicher Form eine adäquate Reaktionsfähigkeit ähnlich wie in mündlichen Situationen.

Repeat Examination:

(Recommended) Prerequisites:
Keine

Content:
In diesem Modul werden Grundkenntnisse in der Fremdsprache Spanisch vermittelt, die es den Studierenden ermöglichen, sich in vertrauten und alltäglichen Grundsituationen trotz noch geringer Sprachkenntnisse zurechtzufinden. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt.
Die Studierenden lernen einfache Fragen zur Person/Familie zu stellen und zu beantworten, Anmeldeformulare mit persönlichen Daten auszufüllen, über Studium, Beruf und Freizeitaktivitäten zu sprechen, Gefallen, Interessen und Vorlieben auszudrücken, Orte zu beschreiben etc. Sie lernen/üben grundlegendes Vokabular zu diesen Themen und berichten in einfach strukturierten Hauptsätzen über Alltägliches im Präsens. Es werden u.a. folgende Themen der Grammatik behandelt: Präsens regelmäßiger und (einige) unregelmäßigen Verben, bestimmte und unbestimmte Artikel, Demonstrativpronomen, Verneinung einfache Sätze etc.

Es werden Strategien vermittelt, die eine Verständigung in alltäglichen Grundsituationen ermöglichen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau „A1 – Elementare Sprachverwendung“ des GER.
Der/die Studierende kann nach der Teilnahme an der Modulveranstaltung einfache Fragen über vertraute Themen zu stellen und zu beantworten. Er/sie kann sich auf einfache Art verständigen, wenn die Gesprächspartnerinnen oder Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen. Er/sie kann einfache schriftliche Mitteilungen zur Person machen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezieltem Hör-, Lese-, Schreib- und Sprechübungen in Einzel-, Partner und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Durch die Kombination dieser Übungen wird die Interaktion mit den Partnern unterstützt und gefordert. Die Studierenden erwerben Teamkompetenz durch kooperatives Handeln in gemischten Gruppen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache Spanisch eigenverantwortlich und effektiver zu gestalten und damit die eigenen Lernfähigkeiten zu verbessern.
Durch kontrolliertes Selbstlernen

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial (Tafel, Folie, Übungsblätter, Bild, Film, etc.), auch online.

Reading List:
Lehrbuch (wird im Kurs bekanntgegeben)

Responsible for Module:
Maria Jesús García

Courses (Type of course, Weekly hours per semester), Instructor:
Spanisch A1 (Seminar, 2 SWS)
Barreda C, Galan Rodriguez F, Garcia Garcia M, Gomez Cabornero S, Gonzalez Sainz C, Guerrero Madrid V, Hernandez Zarate M, Lopez Agudo E, Martinez Wahnon A, Nevado Cortes C, Rey Pereira C, Rodriguez Garcia M, Sosa Hernando E, Tapia Perez T

Blockkurs Spanisch A1 (Seminar, 2 SWS)
Barreda C, Garcia Garcia M, Gonzalez Sainz C, Henche I, Mayea von Rimscha A, Zuniga Chinchilla L
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1207: Spanish A1 + A2.1 | Spanisch A1 + A2.1

Version of module description: Gültig ab summerterm 2013

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:**
Credits:* 6	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Written examination (90 minutes, no learning aids allowed); active class participation; required homework.

Repeat Examination:

(Recommended) Prerequisites:
None

Content:
In this module, students gain basic knowledge of Spanish as a foreign language and learn strategies enabling them to successfully manage basic everyday situations. They learn/practice fundamental vocabulary concerning family, work, leisure time, food and eating habits; to pose questions to others about themselves and their families and to answer similar questions; numbers, gain an understanding of prices, using money and telling time; and talk about their day-to-day activities in the present tense using simple sentences (main clauses). Students will learn strategies for communicating in day-to-day situations successfully with minimal language skills. They acquire knowledge of the necessary, basic grammar. Additionally, opportunities will be made available to more effectively structure the learning process of Spanish as a foreign language and thus improving the ability to learn.

Intended Learning Outcomes:
The module is aimed at level "A1 - Basic Language Use" of the CEFR (Common European Framework of Reference). Students gain basic knowledge of Spanish as a foreign language with a general language orientation while taking into consideration intercultural and cultural aspects. After completion of this module, students will be able to use and understand everyday expressions and very simple sentences aimed at satisfying the concrete needs of everyday life. Students can

introduce themselves and others, ask others about themselves and answer similar questions. They can interact in a simple way, if their counterparts speak slowly and clearly and are prepared to help.

Teaching and Learning Methods:
The module consists of a seminar in which course objectives will be achieved in an activity-oriented, communicative atmosphere through listening, reading, writing and speaking exercises in individual, partner and group work, promoting cooperative learning. Language skills conveyed in the classroom are reinforced through the use of guided self-learning in the form of prepared (online) materials covering fundamental grammar and communication patterns in the foreign language.

Media:
Textbook; multimedia teaching and learning materials and online resources.

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Spanisch A1 + A2.1 (intensiv) (Seminar, 4 SWS)
Garcia Garcia M, Henche I, Nevado Cortes C, Zuniga Chinchilla L
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1218: Spanish B1.1 | Spanisch B1.1

Version of module description: Gültig ab winterterm 2015/16

Module Level:	Language:	Duration:	Frequency:
Bachelor/Master	Language taught	one semester	
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
3	90	60	30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Schriftliche Abschlussprüfung (keine Hilfsmittel erlaubt). Prüfungsdauer: 90 Minuten. In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Fragen zur Anwendung von Wortschatz und Grammatik, zu Lese- und Hörverstehen, sowie Aufgaben zur freien Textproduktion. Das Hörverstehen wird anhand von Hörbeispielen mit Hörverstehens-Fragen/-Fragebogen überprüft. Die Aufgabestellung einiger Prüfungsfragen fordert von den Studierenden in schriftlicher Form eine adäquate Reaktionsfähigkeit ähnlich wie in mündlichen Situationen.

Repeat Examination:

(Recommended) Prerequisites:
Gesicherte Kenntnisse der Stufe A2.2; Einstufungstest mit Ergebnis B1.1

Content:
In diesem Modul werden Kenntnisse in der Fremdsprache Spanisch erarbeitet, die es den Studierenden ermöglichen, (sich) in vertrauten Situationen, z.B. in Studium, Arbeit, Freizeit und Familie, und zu Themen von allgemeinem Interesse selbständig und sicher zu operieren/bewegen/verständigen, wenn Standardsprache verwendet wird. Sie erweitern Ihren Wortschatz sowie festigen und vertiefen die bisher erlernten grammatikalischen Schwerpunkte der spanischen Sprache. Die Studierenden lernen/üben u.a.: wie man über biografische und historische Ereignisse spricht; wie man Meinungen und Bewertungen ausdrückt. Dazu werden entsprechende, hierfür notwendige grammatische Themen behandelt.

Intended Learning Outcomes:
Dieses Modul orientiert sich am Niveau „B1- Selbständige Sprachverwendung“ des GER. Der/Die Studierende erlangt in diesem Modul vertiefte Kenntnisse in der Fremdsprache

Spanisch mit allgemeinsprachlicher Orientierung unter Berücksichtigung interkultureller und landeskundlicher Aspekte. Nach erfolgreicher Teilnahme am Modul kann der/die Studierende sich in den ihm/ihr vertrauten Situationen, denen man im Studium oder Beruf, Freizeit und auf Reisen im Sprachgebiet begegnen kann, sicher verständigen. Der/Die Studierende ist in der Lage wesentliche Inhalte in einfachen authentischen Texten aus alltäglichen Bereichen zu verstehen und sich spontan an Gesprächen zu vertrauten Themen zu beteiligen. Die Studierenden können mündlich wie schriftlich über Erfahrungen, Gefühle und Ereignisse einfach und zusammenhängend berichten und zu vertrauten Themen eine persönliche Meinung äußern und argumentieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezieltem Hör-, Lese-, Schreib- und Sprechübungen in Einzel-, Partner und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Durch die Kombination dieser Übungen wird die Interaktion mit den Partnern unterstützt und gefordert. Die Studierenden erwerben Teamkompetenz durch kooperatives Handeln in gemischten Gruppen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache Spanisch eigenverantwortlich und effektiver zu gestalten und damit die eigenen Lernfähigkeiten zu verbessern.
Kontrolliertes Selbstlernen grundlegender grammatischer Phänomene der Fremdsprache mit vorgegebenen (online-) Materialien. Diskutieren in Gruppen zu vorbereiteten Themen und nach vorgegebenen Kommunikationsmustern.
Freiwillige Hausaufgaben (zur Vor-und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online.

Reading List:
Lehrbuch (wird im Kurs bekanntgegeben)

Responsible for Module:
Maria Jesús García

Courses (Type of course, Weekly hours per semester), Instructor:
Spanisch B1.1 (Seminar, 2 SWS)
Barreda C, Galan Rodriguez F, Guerrero Madrid V, Hernandez Zarate M, Nevado Cortes C, Sosa Hernando E
For further information in this module, please click campus.tum.de or here.

Module Description

WI000399: Social Psychology | Sozialpsychologie [SozPsy]

Introduction to Social Psychology

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer 60minütigen schriftlichen Klausur erbracht.
In dieser weisen die Studierenden nach, dass sie in der Lage sind, sozial- und kommunikationspsychologische Theorien und Befunde wiederzugeben, zu interpretieren und auf verschiedene soziale und kommunikative Situationen anzuwenden. Zu diesem Zweck enthält die Prüfung Single-Choice-Items und offene Fragen in verschiedenen Formaten:
- Mit Wissensfragen wird überprüft, ob die Studierenden die relevanten Kozepte und damit verbundenen Lernergebnisse erinnern und erklären können.
- Mit Verständnisfragen wird überprüft, ob die Studierenden die die relevanten Kozepte und damit verbundenen Lernergebnisse verstehen, interpretieren, analysieren und diskutieren können
- Mit Szenario-Fragen wird überprüft, ob die Studierenden die relevanten Kozepte und damit verbundenen Lernergebnisse anwenden und auf verschiedene soziale Situationen übertragen können.
Es kann eine Mid-Term-Leistung in Form von Teilnahmen an sozialpsychologischen Studien/ Experimenten im Umfang von 60-120min erbracht werden. Die Erbringung der Mid-Term-Leistunge ist freiwillig. Sie dient der Praxiserfahrung sowie der Veranschaulichung von methodischen Zugängen zur sozialpsychologischen Forschung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage, soziale Interaktionen, Gruppenprozesse, Kommunikation und Konflikte systematisch zu analysieren und mit Hilfe sozial- und kommunikationspsychologischer Kenntnisse im Schulkontext zu gestalten. Sie können klassische Studien der Sozialpsychologie und grundlegende methodische Zugänge der Psychologie zu sozialen Prozessen wiedergeben. Weiterhin sind die Studierenden in der Lage, soziale Einstellung und soziale Kognition sowie deren Bedeutung für den Kontext Schule zu nutzen.

Teaching and Learning Methods:

Media:
- Präsentation
- begleitendes Handout
- Literaturhinweise auf moodle
- Online-Ted
- interaktive Übungen
- Fragen zur Wiederholung und zum Transfer des Lernstoffes

Reading List:
(1) Aronson, E., Wilson, T.D. & Akert, R.M. (2004). Sozialpsychologie. München: Pearson.
(2) Jonas, K., Stroebe, W. & Hewstone, M. (2007). Sozialpsychologie Eine Einführung (5. Auflage). Berlin: Springer.
Pflichtliteratur und weiterführende Literatur wird in der Vorlesung und im Handout bekanntgegeben.

Responsible for Module:
Kehr, Hugo; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Sozialpsychologie (WI000399, WI000404_2) (Vorlesung, 2 SWS)
Brunner D
For further information in this module, please click campus.tum.de or here.

Module Description

CLA10813: Economic Thinking: Economics | Volkswirtschaftlich Denken

Version of module description: Gültig ab winterterm 2010/11

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In einer Präsentation (10-15 Min.) zeigen die Studierenden ihr Verständnis von grundlegenden ökonomischen Zusammenhängen.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Die berufliche und private Lebenswelt ist zu einem erheblichen Teil durch ökonomische Determinanten und Kalküle bestimmt. Besonders deutlich wird die Wahrnehmung und die Kommunikation ökonomischer Fragen in Krisen.
Ein Ziel der Veranstaltung ist das Erkennen grundlegender ökonomischer Zusammenhänge. Ökonomische Begriffe und Zusammenhänge als fachliche Grundlage volkswirtschaftlichen Denkens und Handelns werden im Workshop anhand folgender Themen erworben:

1. Wirtschaftliches Denken und Handeln
2. Marktwirtschaftliche Ordnungen
3. Markt und Preisbildung
4. Wirtschaftssubjekte
5. Übung
6. Wirtschaftskreislauf
7. Konjunktur und Stabilität
8. Finanzsystem
9. Fallstudie

Intended Learning Outcomes:
Nach der Veranstaltung sind die Studierenden in der Lage grundlegende ökonomische Begriffe und Zusammenhänge zu verstehen.

Teaching and Learning Methods:
Vortrag, Gruppenübung, Präsentation, Diskussion, Fallstudie

Media:

Reading List:

Responsible for Module:
Karin Aschenbrücker

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

CLA30622: From Invention to Patent | Von der Erfindung zum Patent

Version of module description: Gültig ab winterterm 2009/10

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In einer schriftlichen Prüfung demonstrieren die Studierenden ihre Kenntnisse über die verschiedenen Aspekte des Patentierens von technischen Ideen und wissenschaftlichen Forschungsergebnissen (Prüfungsleistung). Damit weisen die Studierenden nach, dass sie eine Erfindungsmeldung zu einer eigenen Erfindung verfassen und umsetzen können.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Forschungsergebnisse sind in der Zeit von Open Innovation für Wirtschaft und Industrie wichtige Quellen für neue Produkte und Dienstleistungen. Wie lassen sich jedoch Forschungsergebnisse schützen und verwerten?
Praxisorientierte Einführung in den gewerblichen Rechtsschutz unter besonderer Berücksichtigung von Hochschulerfindungen:
Es werden neben Patenten weitere relevante Gebiete des geistigen Eigentums (Intellectual Property Rights), nämlich Designschutz, Schutz von Domains und Marken sowie Gebrauchsmuster, durch Experten auf dem jeweiligen Gebiet eingehend behandelt. Dabei wird der Weg von der Erfindung zur Erlangung des jeweiligen Schutzrechtes, dessen rechtliche Durchsetzung vor Gericht und die wirtschaftliche Verwertung des Schutzrechtes, insbesondere im Rahmen von Firmenausgründungen, betrachtet. Für unterschiedliche technische Fachgebiete erfolgt dann in getrennten Studierendengruppen eine Vertiefung des Wissens über die Patentierungsmöglichkeiten von Erfindungen im jeweiligen Fachgebiet anhand von praktischen Fallbeispielen.

Intended Learning Outcomes:
Nach der Teilnahme an der Veranstaltung sind die Studierenden in der Lage einzuschätzen, ob eine technische Entwicklung oder ein Forschungsergebnis patentrechtlich schützbar ist, und außerdem fähig, eine entsprechende Erfindungsmeldung zur eigenen Erfindung zu verfassen. Der Teilnehmer versteht, wie man Patente national und international erlangen, rechtlich durchsetzen und wirtschaftlich verwerten kann.

Teaching and Learning Methods:
Vorlesung

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Von der Erfindung zum Patent (Schutz und Verwertung von Forschungsergebnissen) (Vorlesung, 2 SWS)
Diller K, Merkl P, Papaderos A, Recknagel F
For further information in this module, please click campus.tum.de or here.

Module Description

CLA10029: Writer's Lab | Writer's Lab

Version of module description: Gültig ab winterterm 2012/13

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 22	**Contact Hours:** 8

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden zeigen in einer Textprobe (3-5 Seiten) für das online Lektorat, dass sie korrekte Zitiersysteme, Literaturnachweise und Argumentationsstrukturen umsetzen können (Prüfungsleistung).

Repeat Examination:

(Recommended) Prerequisites:

Content:
Ob wissenschaftliche Ausarbeitung, Exposé, oder Artikel in einer Fachzeitschrift: Schreibkompetenz ist ein Erfolgsfaktor. Die erste Sitzung des Workshops führt an das Schreiben und Strukturieren wissenschaftlicher Texte heran. In der Zeit bis zur zweiten Sitzung steht Ihnen die Referentin für ein Feedback zu individuellen Texten per E-Mail zur Verfügung. Die abschließende Sitzung dient dazu, allgemein wiederkehrende Problematiken zu besprechen sowie Tipps zum Sprachstil und Layout zu vermitteln.

Intended Learning Outcomes:
Nach der Teilnahme sind die Studierenden in der Lage
- Zitiersysteme zu unterscheiden und Literaturnachweise im eigenen Text formal richtig aufzuschreiben
- unterschiedliche wissenschaftliche Argumentationsstrukturen anzuwenden
- wissenschaftliche Sprache hinsichtlich Stil und Lesbarkeit zu optimieren
- sich in kleinen Gruppen Feedback auf die eigenen Texte zu geben

Teaching and Learning Methods:
Dozentenvortrag, praktische Textübungen, individuelles Online-Lektorat

Media:

Reading List:
Schneider, W. (2010). Deutsch für junge Profis – wie man gut und lebendig schreibt, Berlin: Rowohlt.
Kruse, O. (2007). Keine Angst vorm leeren Blatt. Ohne Schreibblockaden durchs Studium, Frankfurt/New York: Campus.
Esselborn-Krumbiegel, H. (2002). Von der Idee zum Text. Eine Anleitung zum wissenschaftlichen Schreiben, Paderborn u. a.: Schöningh.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Writer's Lab - Scriptorium (Workshop, ,5 SWS)
Uecker K (Recknagel F)
For further information in this module, please click campus.tum.de or here.

Module Description

CLA10450: When Engineers Become Managers | Wenn aus Ingenieuren Manager werden

Version of module description: Gültig ab summerterm 2014

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 18	**Contact Hours:** 12

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Im Rahmen einer Fallstudie (3-5 Seiten)oder durch das Vorbereiten einer Präsentation (10-15 Min.) beschreiben die Studierenden, welche komplexen Problemstellungen im Management zu erwarten sind, und stellen hierzu Lösungsvorschläge vor (Prüfungsleistung).

Repeat Examination:

(Recommended) Prerequisites:

Content:
In den Ingenieur-Disziplinen gibt es für die meisten Aufgabenstellungen erprobte Theorien, Näherungsverfahren und Simulationsansätze. Im Management ist dies anders. Es gibt keine geschlossene, umfassende Theorie; allenfalls Ansätze für isolierte, begrenzte Themenbereiche.In dem Workshop werden bewährte Methoden und Instrumente für Standardsituationen vorgestellt, zusammen mit neuen, bisher nicht veröffentlichten Ansätzen zur Geschäftsoptimierung (Winning Business Models). Besonderen Raum nehmen die Themen Soft Skills und Veränderung ein. In diesem Zusammenhang wird ein neues Charakterstruktur-Ebenen Modell vorgestellt. Ausgewählte Themen werden in Arbeitsgruppen vertieft, die Ergebnisse werden von den Teilnehmern vorgetragen.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Seminar sind die Studierenden in der Lage Antworten auf zwei relevante Fragen zu geben:
-was erwartet mich in der Managementpraxis?
-welche Instrumente kann ich für die Lösung typischer Managementprobleme einsetzen?

Teaching and Learning Methods:
Vortrag; offener Dialog; Gruppenarbeit; Präsentation; Erfahrungsberichte von Dozenten und Teilnehmern

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Wenn aus Ingenieuren Manager werden (Workshop, ,5 SWS)
Rüll H, Schrems A
For further information in this module, please click campus.tum.de or here.

Module Description

CLA10626: Communicating Science | Wissenschaft in der Öffentlichkeit

Version of module description: Gültig ab summerterm 2002

Module Level:	Language:	Duration:	Frequency:
Credits:* 1	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Wissenschaft kommunizieren (Verständliche Texte, kontroverse Dialoge und mehr) (Workshop, 1 SWS)
Weitze M
For further information in this module, please click campus.tum.de or here.

Scientific Project Planning | Wissenschaftliche Projektplanung

Module Description

WZ2591: Scientific Project Planning | Wissenschaftliche Projektplanung

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is oral. The duration of the examination is always 60 minutes. The examination is conducted by two university teachers, one of whom is the planned topic presenter and examiner for the thesis. The examination begins with the presentation of the planned thesis by the examinee, e.g. by submitting written documents or a presentation by the examinee.
This is followed by a disputation, which questions the presentation. It is also possible that, based on the expected topic of the Master's thesis, further questions on associated and fundamental topics are asked.

Repeat Examination:

(Recommended) Prerequisites:
According to the statutes, sufficient professional Credits must be proven.

Content:
Presentation of the planned thesis, e.g. the points
current state of research
the question that can be derived from it
the scientific relevance of the research question
the relation to these points in the work
Null Hypothesis
Material and method
Choice of samples
statistical tests
Evaluation

Possible difficulties
Demolition or plan change criteria
Alternatives: Plan B, Plan C
Weighing up the opportunities and risks of alternative plans
Possible opportunities and questions that could arise from the work for further research
Schedule
Related topics and techniques

Intended Learning Outcomes:
The student is able to independently plan and present a time-limited, own scientific project, from the concretization of the question to the technical implementation and the generation of results. They can help to concretize the core question and assess and present problems and risks of the technical implementation up to the generation of results. The student has learned to critically question a scientific question to a large extent independently and to record and structure it in its complexity, starting with a hypothesis and ending with a written report and to show a plan for the solution. He or she can present the project to scientists and engage in a scientific discussion. Students know which theoretical and planning requirements are necessary for the practical implementation of such a project.

Teaching and Learning Methods:
Teaching method: Preliminary talk with the topic presenter about the question, task, relevant technical literature. Exchange with experts on site. Learning method: Consolidation of the knowledge required for the final thesis through self-study. Creation of a robust project plan through a deep examination of the subject matter in dialogue with the topic presenter.

Media:
Scientific publications, scientific communication

Reading List:
Specific scientific publications in the field of interest. Basic literature on e.g. statistical methods.

Responsible for Module:
Studienfakultät Biowissenschaften

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

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