TUM School of Life Sciences
Technische Universität München

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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[WZ2384] Research Project 2 Molecular Biology of Plant | Forschungspraktikum 2 - Molekularbiologie der Pflanzen 512 - 515
[WZ2400] Practical Course: Computing for Highthroughput Biology | Forschungspraktikum Computeranwendungen für Hochdurchsatz-Biologie 516 - 517
[WZ2401] Research Project 'Molecular Plant Breeding' | Forschungspraktikum Molekulare Pflanzenzüchtung 518 - 519
[WZ2594] Research Project Secondary Plant Metabolites | Forschungspraktikum Sekundäre Pflanzeninhaltsstoffe 520 - 521
[WZ2629] Research Project Chemical Genetics | Research Project Chemical Genetics 522 - 524
[WZ2630] Research Project Plant Growth Regulation | Forschungspraktikum Wachstumsregulation der Pflanzen 525 - 526
[WZ2685] Research Project Redox-Biochemistry in Plant-Environment Interaction | Forschungspraktikum Redox-Biochemie bei der Pflanze-Umwelt Interaktion 527 - 528
[WZ2382] Exercise in Plant Systems Biology | Übung in Pflanzensystembiologie 529 - 530
Theory-Oriented Modules | Theorieorientierte Module 531
[WZ2424] Biotic Plant Stress Physiology | Biotische Stressphysiologie der Pflanzen 531 - 532
[WZ1696] Crop Genomics | Crop Genomics 533 - 534
[WZ1035] Host-Parasite-Interaction | Host-Parasite-Interaction 535 - 536
[WZ1075] Herbicides and Plant Physiology | Herbizide und Pflanzenphysiologie 537 - 539
[WZ1032] Genetic Selection Supported by Markers | Marker-gestützte Selektion 540 - 541
[WZ1589] Marker-assisted Selection | Marker-assisted Selection 542 - 543
[WZ2014] Molecular Plant Breeding | Molekulare Pflanzenzüchtung 544 - 545
[WZ2371] Molecular Plant Physiology 2 | Molekulare Pflanzenphysiologie 2 546 - 548
[WZ2385] Molecular Plant Physiology 1 | Molekulare Pflanzenphysiologie 1 549 - 551

[WZ2617] Molecular Ecology, Molecular Systematics, and Biogeography of Plants | Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen 552 - 553
[WZ2657] Methods and Logic in Molecular Cell Biology and Scientific Writing | Methods and Logic in Molecular Cell Biology and Scientific Writing 554 - 555
[WZ2381] Plant Systems Biology (Lecture and Seminar) | Pflanzensystembiologie (Vorlesung und Seminar) 556 - 558
[WZ2433] Population Biology and Nature Conservation | Populationsbiologie und Naturschutz 559 - 560
[WZ2567] Phytopathology of Woody Plants | Phytopathologie von Gehölzen 561 - 562
[WZ2581] Plant Biotechnology | Pflanzenbiotechnologie 563 - 564
[WZ4020] Effects of Climate Change on Plant Physiology | Pflanzenfunktionen im Klimawandel 565 - 566
[WZ1031] Quantitative Genetics and Selection | Quantitative Genetik und Selektion 567 - 568
[WZ1584] Quantitative Genetics and Selection | Quantitative Genetics and Selection 569 - 570
[LS20016] Rhizosphere Research | Rhizosphere Research 571 - 573
[WZ2689] Plant Redox-Biochemistry | Redox-Biochemie der Pflanzen 574 - 575
[MA9613] Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences) 576 - 577
[WZ1663] Secondary Plant Metabolites and Human Health | Secondary Plant Metabolites and Human Health 578 - 579
[WZ6121] Vegetation of the Earth | Vegetation der Erde 580 - 581
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Practice-Oriented Modules | Praxisorientierte Module 582
[MW2469] Bio-Inspired Design Seminar | Bionik-Seminar [SemBio] 582 - 584
[WZ2750] Course block: Neurobiology of isolated tissue | Blockpraktikum: Neurobiologie am isolierten Gewebe 585 - 586
[WZ2753] Course block: Neurobiology of intact animals | Blockpraktikum: Neurobiologie am intakten Organismus 587 - 588
[WZ2404] Introduction to Mammalian Cell Culture | Einführung in die Kultivierung von Säugetierzellen 589 - 591
[WZ2459] Developmental Biology and Histology of Animals | Entwicklungsbiologie und Histologie der Tiere 592 - 593
[CH0172] Practical Lab Course: Biotechnological Techniques in Mammalian Cells | Forschungspraktikum: Biotechnologische Verfahren in Säugetierzellen 594 - 595

[LS20006] Research Practical Entomology | Forschungspraktikum Entomologie 596 - 597
[WZ0003] Internship Reproductive Biotechnology | Forschungspraktikum Biotechnologie der Reproduktion 598 - 599
[WZ1415] Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten 600 - 602
[WZ2455] Practical Course in Neurobiology of Arthropods | Forschungspraktikum Neurobiologie von Arthropoden 603 - 604
[WZ2463] Research Project Neurobiology of Birds | Forschungspraktikum Neurobiologie an Vögeln 605 - 606
[WZ2464] Research Project Neurobiology of Isolated Networks | Forschungspraktikum Neuronale Netzwerkanalyse 607 - 608
[WZ2465] Research Project Neurobiology of Ultrasound Orientation | Forschungspraktikum Neurobiologie der Echoortung 609 - 610
[WZ2474] Research Project in Molecular Physiology | Forschungspraktikum Molekulare Physiologie 611 - 612
[WZ2478] Research Project Neurophysiology | Forschungspraktikum Neurophysiologie 613 - 614
[WZ2532] Research Project Conservation Genetics | Forschungspraktikum Conservation Genetics 615 - 616
[WZ2533] Research Project Molecular Zoology | Forschungspraktikum Molekulare Zoologie 617 - 618
[WZ2545] Research Project Animal Biotechnology | Forschungspraktikum Biotechnologie der Tiere 619 - 620
[WZ2639] Research Project Neurobiology of behavior | Forschungspraktikum Neurobiologie des Verhaltens 621 - 623
[WZ2653] Research Project Neurobiology of Vertebrates | Forschungspraktikum Neurobiologie von Wirbeltieren 624 - 625
[WZ2680] Research Project in Zoological Systematics | Forschungspraktikum Zoologische Systematik 626 - 627
[WZ2687] Research Project Mapping Neural Circuits Underpinning Behavior | Forschungspraktikum Neuronale Netzwerke und Verhalten 628 - 629
[WZ2695] Research Project Wildlife Biology | Forschungspraktikum Wildbiologie 630 - 631
[LS20005] Models in Computational Neuroscience (M.Sc.) | Models in Computational Neuroscience (M.Sc.) 632 - 633
[WZ1993] Laboratory Animal Science | Versuchstierkunde 634 - 635
[LS20033] Zoological Field Trip to Lake Neusiedl | Zoologische Exkursion Neusiedler See 636 - 639
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[WZ2460] Current Topics in Neurobiology | Aktuelle Themen der Neurobiologie 640 - 642
[WZ2479] Advanced Methods and Findings in Neurophysiology | Advanced Methods and Findings in Neurophysiology 643 - 644
[ME2759] Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen 645 - 647
[WZ0404] Animal Biotechnology 2 | Biotechnologie der Tiere 2 648 - 649
[WZ2664] Animal Biotechnology 1 | Biotechnologie der Tiere 1 650 - 652
[WZ2693] Cognitive Neuroscience | Cognitive Neuroscience 653 - 654
[WZ2938] Course block: Neuroscience of vision | Course block: Neuroscience of vision 655 - 656
[WZ1331] Research Project Chronobiology | Forschungspraktikum Chronobiologie 657 - 658
[LS20007] Introduction to Computational Neuroscience | Introduction to Computational Neuroscience 659 - 661
[WZme2670] Innovative Approaches in Viral Gene Technology | Innovative Ansätze in der viralen Gentechnologie 662 - 664
[WZ1085] Science of Laboratory Animals | Labortierwissenschaft 665 - 666
[WZ2690] Latest Neuroscience - Presenting Papers to Researchers and the General Public | Latest Neuroscience - Presenting Papers to Researchers and the General Public 667 - 669
[LS10014] Managing Poultry Health | Managing Poultry Health 670 - 671
[WZ2457] Neurobiology | Neurobiologie 672 - 673
[WZ0033] Physiology of Growth, Reproduction and Lactation | Physiologie des Wachstums, der Reproduktion und der Laktation 674 - 676
[WZ2405] Phylogeny and Zoology of Vertebrates | Phylogenie und Zoologie der Vertebraten 677 - 678
[MW1029] Lecture Series in Bionics / Biomimetics | Ringvorlesung Bionik 679 - 680
[WZ2127] Reproductive Physiology of Vertebrates | Reproduktionsbiologie der Vertebraten 681 - 682
[MA9613] Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences) 683 - 684
[WZ2458] Sensory Physiology | Sinnesphysiologie 685 - 686
[WZ2682] Sensory and Behavioral Neurogenetics | Sensory and Behavioral Neurogenetics 687 - 688
[ME2090] Viral and Nonviral Gene Transfer: Methods and Applications in Research and Therapy | Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie 689 - 690
[WZ2456] Zoological Field Trip Mediterranean | Zoologische Exkursion Mittelmeer 691 - 694

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[WZ2591] Scientific Project Planning | Wissenschaftliche Projektplanung 695 - 696
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Specializing | Studienschwerpunkte

Specializing in Biochemisty and Cell Biology | Studienschwerpunkt Biochemie und Zellbiologie

Practice-Oriented Modules | Praxisorientierte Module

Module Description

LS20009: Introduction to programming for biologists | Einführung in die Programmierung für Biologen

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:
Examination will be performed in the form of a small project work, including a final presentation. Students (alone or in small groups, depending on the number of the participants) will be suggested to answer the research questions about specific data (for example, if two groups of the genes are different in terms of the specific characteristics). For this students will have to choose and download the dataset from the publicly available recourse, perform the relevant analysis of the data in Python or R and answer the formulated questions about the tendencies in the dataset. At the presentation students will have to explain the source of the data that they have chosen and how they got the data (5-10 minutes/person). Students will also have to show and briefly comment the elements of the code that they wrote to perform the analysis and answer the research questions about the data. Visualizations will also have to be provided. The components of the examination that will be assessed include
- the level of data downloading, processing and visualization automation, which makes it easy to repeat the analysis on another data set (25%),
- the cleanliness, non-redundancy and efficiency of the written code and ability of the student to explain its elements (25 %/,
- the choice of relevant packages in Python and R for data processing (25%),
- the ability of the student to provide the relevant visualizations supporting the scientific conclusions made about the data (25%).

Each of the examination components will be graded from 1.0 (very good) to 5.0 (fail) and the final grade will be calculated as the average grade of individual examination parts. To pass the module at least the score 4.0 is required. Several sessions before the presentation will be booked for the consultation of the students on their projects.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basics of molecular biology
Basics of bioinformatics (we recommend TUM courses Bioinformatics for biosciences I and II)
Basics of Statistics

Content:
The following topics will be covered in module:

- data types in Python and R
- conditional expressions (if, else, etc)
- loops
- functions
- reading data from files and writing the results to the files
- biopython and other special packages in Python and R for the analysis of biological data
- statistical analysis in Python and R
- visualization of the results in Python and R
- basics of Linux command line interface (bash)

Intended Learning Outcomes:
Upon successful completion of the module, students are able to

- define and describe main datatypes in Python and R programming languages
- write the code in Python and R using basic conditional expressions and loops
- read and parse the data from files and save the results of the analysis to the file
- find and download the data from publicly-available biological databases (manually or via scripts)
- choose the available Python or R packages for the analysis of the data
- write scripts in Python and R for the statistical analysis
- visualize the results of the data analysis in Python and R

Teaching and Learning Methods:
The theoretical basics of the module will be delivered to the students with the help of slides, that will include definitions and simple code examples. For each session students will be provided with the list of tasks that help to put the discussing aspect of programming into practice. Students will be given time to write their own code and identify the key challenges. Then the code will be written by the teacher in the real-time mode while sharing the PC screen with the students. After

the session the working code will be also shared with the students. Moodle platform is thought to be used for the delivering learning material to the students.

Media:
PowerPoint slides
Files with code in Python and R

Reading List:
“Python for biologists“ by Dr. Martin Jones, 2013
“Getting Started with R: An Introduction for Biologists“, 2nd edition, by Beckerman, Childs and Petchey, 2017

Responsible for Module:
Frischmann, Dimitri; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to programming for biologists (Praktikum, 4 SWS)
Parr M [L], Parr M
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 2022/23

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:
Das Modul setzt sich aus den Lehrveranstaltungen "Praktikum" und "Seminar" zusammen.
Die Prüfungsleistung der LV „Praktikum“ erfolgt anhand einer Laborleistung, die sich aus einem Testat (30 Minuten), einer Präsentation (10 Minuten) sowie der Bewertung der praktischen Arbeit zusammensetzt. Die Bewertungskriterien der praktischen Arbeit umfassen die Fortschritte bei den praktischen Fähigkeiten, Motivation und Kenntnisse über den Praktikumsablauf. Die Gewichtung der drei Teilnoten erfolgt 1:1:1.

Mit der erfolgreichen Ablage der Prüfungsteile weisen die Studierenden die Befähigung nach, 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. Das Manuskript zum Praktikum dient zur Vorbereitung für das Praktikum.

Zusätzlich zum Praktikum werden mit den Studierenden Seminare durchgeführt, in denen sie mittels Literatur praktische Themen der Kultivierung von Säugetierzellen erarbeiten und präsentieren müssen. Die Prüfungsleistung im Seminar umfasst eine Präsentation (15 Minuten).

Gewichtung Laborleistung:Präsentation = 6:4.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor-Abschluss in Biologie bzw. Molekulare Biotechnologie

Content:
Im Rahmen des Praktikums werden Grundkenntnisse über die Isolierung, Charakterisierung und genetische Manipulierung von Säugetierzellen vermittelt. Inhalte sind u.a.: Steriles Arbeiten, Mikroskopie, Kulturbedingungen, Etablierung und Konservierung von Zelllinien und Primärkulturen, Bestimmung von Zellzahlen, Transfektionsmethoden, Isolierung und Expansion von Zellklonen, Anwendung und Detektierung von Markergenen.

Im Seminar werden insbesondere die Hintergründe und theoretischen Kenntnisse zu den durchgeführten Experimenten vermittelt. Im Rahmen des Praktikums werden grundlegende Methoden zu praktischen Arbeiten mit Säugetierzellen vermittelt. Im zugehörigen Seminar stellen die Studierenden relevante Literatur bezüglich Zellkultur vor.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen für die Kultivierung und genetische Manipulierung von Säugetierzellen. Weiterhin haben sie grundlegende zellbiologische Arbeitstechniken erlernt und geübt. Sie verstehen zellbiologische Fragestellungen und Arbeitstechniken und können das erworbene Wissen auf vertiefte Fragestellungen anwenden.
Die Studierenden haben weiterhin Fähigkeiten zum Lösen von Problemen entwickelt, sowie Einblicke in die Zellbiologie und zellbiologische Problemen erworben.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Praktikum, Seminar
Lehrmethode im Praktikum: Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit, Ergebnisbesprechungen.
Lehrmethode im Seminar: Vortrag
Lernaktivitäten: Studium von Skripten, -mitschrift, Praktikumsskript und Literatur; Üben von labortechnischen Fertigkeiten und zellbiologischen Arbeitstechniken; Zusammenarbeit mit Praktikumspartner; Anfertigung von Protokollen und Präsentationen.

Media:
Präsentationen mittels PowerPoint,
Praktikumsskript (Downloadmöglichkeit für Vorlesungsmaterial) Publikationen zu zellkulturspezifischen Themen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.
Als Grundlage oder zur Ergänzung wird empfohlen:
Sabine Schmitz; Der Experimentator: Zellkultur;
R. Ian Freshney: Culture of Animal Cells: A Manual of Basic Technique

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Kultivierung von Säugetierzellen (Zellkultur - Praktikum) (Praktikum, 3 SWS)
Bak A, Bauer B, Fischer K, Flisikowska T, Preisinger D, Winogrodzki T

Zellbiologische Fragestellungen (Zellkultur - Seminar) (Seminar, 2 SWS)
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:
Forschungspraktikum Zelluläre Biochemie (CH5147) (Praktikum, 10 SWS)
Buchner J, Haslbeck M
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 summerterm 2023

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 Prüfungsleistung entspricht einer Laborleistung.
Die Planung und Durchführung der Laborexperimente bilden die Grundlage zur Erlangung der fachlichen Kompetenz. Die Studierenden zeigen anhand einer Eingangs- und einer Abschlusspräsentation (jeweils etwa 20 min) sowie eines zusammenfassenden Praktikumsberichtes, dass Sie in der Lage sind, die wesentlichen Aspekte des von ihnen bearbeiteten Forschungsprojektes zum Thema Tumorzellbiologie strukturiert und reflektiert darzustellen. Die Gesamtnote errechnet sich aus der Abschlusspräsentation (15%), dem Praktikumsbericht (25%) und der praktischen Laborleistung (60%) mit wesentlichen Kriterien des wissenschaftlichen Arbeitens, wie z.B. Organisation von Arbeitsabläufen, Nachvollziehbarkeit der Aufzeichnungen, Grad des selbständigen Arbeitens etc.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Abgeschlossenes BSc-Studium in den Biowissenschaften.

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 Tumorzellinien (Genome editing, Reporter etc)
- Tumorsphäroid-Modelle im Live cell imaging
- Untersuchung der Zell-Wirkstoff-Interaktion

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

Intended Learning Outcomes:
Nach 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 Molekularbiologie, 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:
Küster, Bernhard, Prof. Dr. kuster@tum.de Kramer, Karl, PD Dr. agr. 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 2023

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 Prüfungsleistung wird anhand der Laborleistung erbracht.
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.
Besuch der VS Proteomics - analytische Grundlagen und biomedizinische Anwendungen wird empfohlen.

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:
Küster, Bernhard, Prof. Dr. kuster@tum.de

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

Module Description

WZ2231: Advanced Laboratory Course "Protein Biochemistry" | Forschungspraktikum Proteinbiochemie

Version of module description: Gültig ab winterterm 2022/23

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:
Die Prüfungsleistung wird als Laborleistung erbracht. Im Verlauf des achtwöchigen praktischen Teils zeigen die Studierenden, dass sie übliche laborpraktische und handwerkliche Fertigkeiten einschließlich theoretischer Vorbereitung, Fehlerbehandlung, analytischem Denken und Selbstorganisation erlangt haben.
Integraler Bestandteil der Laborleistung sind das Führen eines Laborjournals nach guter wissenschaftlicher Praxis und die Erstellung eines zusammenfassenden Protokolls. Dieses Protokoll dient dem Nachweis der wissenschaftlichen Darstellung von Laborergebnissen und gliedert sich in eine Einleitung, die Beschreibung der Methoden sowie der erzielten Ergebnisse, inklusive deren Interpretation und Fehleranalyse, sowie eine Diskussion der erzielten Ergebnisse im wissenschaftlichen Kontext. Vorbereitungs- und Ergebnisbesprechungen und eine abschließende, zusammenfassende Präsentation (Vortrag, ca. 20 min) des Forschungsprojekts zeigen, dass die Studierenden die bearbeitete Thematik und die eingesetzten Methoden verstehen, die erzielten Ergebnisse korrekt darstellen, interpretieren, Arbeitshypothesen erstellen und weiterführende Experimente ableiten können.

In die Gesamtbenotung der Laborleistung geht das Protokoll und der Vortrag zu je 25% und die laborpraktische Arbeit zu 50% ein (die praktische Versuchsdurchführung wird nach qualitativen Kriterien bewertet, z.B. Qualität der Messergebnisse/Daten, Planung, Durchführung und Interpretation der Experimente, Fehleranalyse, Fähigkeiten der Sozialkompetenz, Teamfähigkeit, Motivation, Selbstorganisation, Zuverlässigkeit, Selbstständigkeit).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorausgesetzt werden Grundkenntnisse der Biochemie auf Bachelor-Niveau. Das erforderliche Methodenspektrum richtet sich ansonsten nach dem jeweiligen Forschungsprojekt.

Content:
Das Modul umfasst ein Forschungspraktikum, in dem ein aktuelles Projekt aus den Forschungsthemen des Lehrstuhls im Bereich der Proteinbiochemie (gentechnische Proteinproduktion, Proteinreinigung, spektroskopische Analytik, funktionelle Untersuchungen hinsichtlich Ligandenbindung oder Enzymaktivität) mit modernen molekularbiologischen und proteinchemischen Arbeitstechniken behandelt wird. Die weitgehend eigenständige Bearbeitung eines Forschungsprojektes führt zu vertieften Einblicken in die theoretischen und praktischen Grundlagen sowie die Arbeitsweise in einem proteinbiochemisch orientierten Forschungslabor.

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage, wissenschaftliche Experimente fragestellungsorientiert zu planen, durchzuführen, auszuwerten und zu interpretieren. Sie können ein breites Spektrum von molekularbiologischen und proteinbiochemischen Methoden theoretisch verstehen, beschreiben und praktisch anwenden. Sie sind fähig, sich und ihre Tätigkeiten innerhalb eines biochemisch arbeitenden Forschungsteams zu integrieren sowie ihre Arbeiten in strukturierter Art und Weise zu dokumentieren und diese in schriftlicher und mündlicher Form kritisch zu bewerten und zu diskutieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Forschungspraktikum (10 SWS). Die Studierenden bekommen vom Lehrstuhlinhaber unter Berücksichtigung ihrer spezifischen Interessen ein fachlich passendes Thema aus den aktuellen Forschungsprojekten des Lehrstuhls zugewiesen.
Unter Anleitung eines wissenschaftlichen Mitarbeiters arbeiten die Studierenden selbstständig für 8 Wochen (ganztags, ca. 35 Stunden pro Woche) an einem eigenständigen Forschungsprojekt.
Die Studierenden planen unter Anleitung Experimente mit wissenschaftlicher Fragestellung, führen diese in der Praxis aus, bewerten und interpretieren ihre Ergebnisse als Grundlage für die Planung weiterführender Experimente. Vorbereitungs- und Ergebnisbesprechungen dienen zur Klärung von offenen Fragen und der Diskussion weiterführender Zusammenhänge.
Das zu erlernende Methodenspektrum richtet sich nach dem jeweiligen Forschungsprojekt.

Das Forschungsprojekt wird in einem Laborjournal dokumentiert und in Form einer schriftlichen Ausarbeitung (Protokoll), die spätestens 4 Wochen nach Ende der laborpraktischen Arbeiten abzugeben ist, zusammengefasst dargestellt. Die Forschungsergebnisse werden im Rahmen eines Vortrags (20 min) vor der Arbeitsgruppe des Lehrstuhls präsentiert und diskutiert. Im Rahmen der Ausarbeitung und des Vortrags werden die Studierenden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit der Forschungsthematik angeregt.

Media:
Diskussion, Fachliteratur, Lehrbücher, Internet- und Literaturrecherche, digitale Präsentation.

Reading List:
Geeignete Literatur wird vom Betreuer des Forschungspraktikums bekannt gegeben.

Responsible for Module:
Skerra, Arne, Prof. Dr. rer. nat. habil. skerra@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Proteinbiochemie (Forschungspraktikum, 20 SWS)
Skerra A [L], Schlapschy M, Skerra A
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 summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 30	**Contact Hours:** 270

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

Description of Examination Method:
The examination performance corresponds to the laboratory performance. This consists of the following three partial examinations:
1) Evaluation of the written report of the results (report - 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 and its link to the experiments. Furthermore, the students present and discuss about the results of their work and relevant current literature in the two seminars; this achievement is accordingly 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 "Principles of peptide/protein synthesis and peptides in biomedicine and protein misfolding diseases" 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 with methods 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:
Peptiddesign und Mechanismen der Proteinaggregation und Zelldegeneration (Seminar, 1 SWS)
Kapurniotu A

Protein-Protein Wechselwirkungen (Seminar, 2 SWS)
Kapurniotu A

Peptidchemie und -biochemie (Praktikum, 16 SWS)
Kapurniotu A, Calzi 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

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

Version of module description: Gültig ab winterterm 2022/23

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 mindestens 20-seitigen 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:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, experimentelle Arbeiten selbständig zu planen und durchzuführen. Sie können an den Analysegeräten selbständig arbeiten und dadurch analytische, biochemische oder

molekularbiologische Fragestellungen wie beispielsweise die Bestimmung von pflanzlichen Metaboliten, die Quantifizierung von Allergenen oder die Optimierung von mikrobiellen Wirtsorganismen zur Produktion von Glukosiden lösen. Darüber hinaus können sie beim Auftreten von Probleme eine systematische Fehlersuche einleiten und vorhandene Synergieeffekte im Team nutzen.

Teaching and Learning Methods:
Die Inhalte werden im Praktikum mittels Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit und Ergebnisbesprechungen vermittelt. Zur Vor- und Nachbereitung stehen den Studierenden die Vorlesungsskripte der Professur, die eigene Mitschrift, Praktikumsskripte der Professur sowie Literaturempfehlungen zur Verfügung. Sie üben labortechnische Fertigkeiten und mikrobiologische Arbeitstechniken, in Zusammenarbeit mit Praktikumspartnern. Im Rahmen der Dokumentation fertigen sie Protokolle an und führen Labortätigkeiten unter Anleitung von Post-docs und Doktoranden durch. Sie erhalten zudem ein eigenes Projekt nach Absprache bzw. Mitarbeit in einem laufenden Forschungsprojekt. Am Ende präsentieren sie ihre Ergebnisse im Rahmen des wissenschaftlichen Seminars der Professur.

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

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 2023

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:
A protocol is to be prepared for the performance review. The students should practically apply their knowledge to current problems and show that they are able to evaluate, interpret and concisely present the results as well as to master transfer tasks. The overall grade of the module is composed of the practical laboratory activity (80%) and protocol (20%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Lecture "Simulation and modeling of biological macromolecules".
The course is intended for students of biology, molecular biotechnology, bioinformatics, biochemistry, chemistry and biophysics (Master).

Content:
Practical application of modeling software from the fields of protein ligand docking, molecular simulation, protein engineering to current problems. Depending on the student's inclination, programming issues can also be addressed.

Intended Learning Outcomes:
The students are familiar with the handling and the application range of different programs from the fields of protein ligand docking, molecule simulation and protein engineering and are able to apply them independently for corresponding scientific problems.

Teaching and Learning Methods:
Teaching technique: practical training. Teaching method: practical tasks, supervision during the internship, instructional discussions. Learning activities: study of lecture material and literature, practical work on the computer, preparation of protocols.

Media:
Internship instructions, for theoretical background lecture notes, project-specific literature

Reading List:
General literature recommendations will be given in lectures and project specific literature will be given during the lab.

Responsible for Module:
Dr. Di Pizio, Antonella a.dipizio.leibniz-lsb@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Protein- und Wirkstoffmodellierung (Forschungspraktikum, 10 SWS)
Di Pizio A
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

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:

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

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.

Theory-Oriented Modules | Theorieorientierte Module

Module Description

CIT5130001: Applied Statistics and Data Analysis (TUM School of Computation, Information and Technology [CIT] and TUM School of Life Sciences [SoLS]) | Applied Statistics and Data Analysis (TUM School of Computation, Information and Technology [CIT] and TUM School of Life Sciences [SoLS])

Version of module description: Gültig ab winterterm 2022/23

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 exams will oscillate between campuses Weihenstephan and Garching.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics from the School of Computation, Information and Technology or School of Life Sciences

Content:
Students in this course will learn the R statistical package and state-of-the-art analysis techniques for the design and analysis of experiments and observational data for applied interdisciplinary research.
- 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:
After successful completion of the module students
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

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

Seminar Molekulare Biotechnologie (Seminar, 2 SWS)
Skerra A [L], 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], The M

Analysis of High-Throughput Datasets for Biologists (Vorlesung, 2 SWS)
Küster B [L], The M
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 winterterm 2022/23

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 inkl. Übugnen 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 (3 SWS). 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:
Bioorganische Chemie (CH3039a) (Vorlesung mit integrierten Übungen, 2 SWS)
Bach N, Sieber S

Frontiers in Chemical Biology (CH3039b) (Vorlesung mit integrierten Übungen, 1 SWS)
Bach N, Sieber S
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)
Jacob S, Kreuzer M, Luksch H, Rammes G
For further information in this module, please click campus.tum.de or here.

Module Description

CS0076: Enzyme Engineering | Enzym Engineering

Version of module description: Gültig ab summerterm 2023

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:
To prove that the students are able to show ways to optimize enzymes in their properties and to do this methodically, there is a written exam with a duration of 60 minutes and a written seminar report has to be prepared, the total grade of which is composed of the exam grade (67%) and the grade of the seminar report (33%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisite for successful participation is proof of knowledge of the fundamentals of enzymatics, molecular biology molecular biology, bioprocess engineering, and general basic chemistry knowledge.

Content:
The aim of the module is to teach molecular biology and protein chemistry approaches for the optimization of enzymes, especially by variation of the primary structure. Essential contents are: Limitation analysis at the molecular level, rational methods, computational methods, evolutionary and combined methods, high throughput methods, robotics. The goal of the seminar is to teach basic bioinformatics tools used in rational enzyme design, such as ligand docking, energy minimization, and rational introduction of mutations. These methods will be practiced on real enzymes and used to generate improved enzyme variants for a specific engineering target.

Intended Learning Outcomes:
After attending the lecture, students are able to identify options for improving technically limited enzymes, to estimate the effort required for this and have the theoretical ability to methodically implement these improvements in the subsequent practical course Enzyme Optimization. After

participation in the seminar, the students are able to use different bioinformatic tools for rational enzyme design and to evaluate the results of the generated informatic predictions.

Teaching and Learning Methods:
The lecture is conducted as an ex cathedra teaching in order to provide the students with all necessary basics. In addition, the students work out individual methods and procedures independently, e.g. on the basis of current scientific literature, and present these to each other in a presentation. In the seminar, students are guided through the individual steps of a rational enzyme technology approach with the help of a script. The results of these steps are summarized in a written report to place the individual steps in a larger context. On the one hand, a seminar in which students present current literature on topics covered in the lecture as well as apply and deepen in silico methods for rational enzyme design is designed to internalize and deepen the methods and approaches for optimizing enzymes presented in the lecture. On the other hand, in the seminar students work on concrete problems and questions on topics of rational enzyme design and train and deepen application-oriented work with the help of the presented software packages.

The slides of the lecture and the seminar presentations will be made available online after the respective event.

Media:
PowerPoint, Slide scripts, scientific literature
Lecture: PPT and board
Seminar: PPT, board and software- and online based methods on individual PCs or in a PC classroom

Reading List:
For introduction the following books are adviced:
“Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) und
“Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), beide
Frances H. Arnold, George Georgiou (Hrsg.), Springer, Berlin;
“Protein Engineering Protocols” (Methods in Molecular
Biology), Katja M. Arndt und Kristian M. Muller (Hrsg.), Springer, Berlin.

Responsible for Module:
Prof. Volker Sieber

Courses (Type of course, Weekly hours per semester), Instructor:
Enzym Engineering (Vorlesung, 2 SWS)
Sieber V [L], Kolaitis G, Sieber V

Rationales Enzymdesign (Seminar, 1 SWS)
Sieber V [L], Kolaitis G, Steiger 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:

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

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:
Protein and Drug Design (Praktikum, 3 SWS)
Di Pizio A

Modelling and Simulation of Biological Macromolecules (Vorlesung, 2 SWS)
Di Pizio A
For further information in this module, please click campus.tum.de or here.

Module Description

LS20018: Principles of peptide/protein synthesis and peptides in biomedicine and protein misfolding diseases | Prinzipien der Peptid-/Proteinsynthese und Peptide in Biomedizin und Proteinmissfaltungskrankheiten

Version of module description: Gültig ab summerterm 2023

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:
Die Prüfungsleistung wird für die Vorlesung mit einer schriftlichen benoteten Klausur (60 min) erbracht und mit einer mündlichen Präsentation des Studierenden, die im Rahmen des Seminars stattfindet. Die Modulnote wird aus der Klausurnote (50%) und der Note der mündlichen Präsentation (50%) berechnet.
In der schriftlichen Klausur müssen die Studierenden anhand von Wissens- und Verständnisfragen darlegen, dass sie die Grundlagen der chemischen Peptid-/Proteinsynthese auch im Bezug auf die Anwendung von synthetischen Peptiden in der Biomedizin erlernt und verstanden haben.
In der mündlichen Präsentation, die insgesamt 45 min. umfasst und aus einem 30 minütigen Vortrag (PowerPoint-Folien) und einer 15 minütigen Diskussion besteht, müssen die Studierenden nachweisen, dass sie in der Lage sind, eine einschlägige internationale wissenschaftliche Studie aus dem Gebiet des Seminars zu verstehen und sie sachgerecht und didaktisch sinnvoll aufbereitet vorzutragen. Dabei weisen die Studierende nach, dass sie 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. Zu deren Präsentationen bereiten die Studierenden eine 2-seitige Tischvorlage (handout) vor, deren Benotung der mündlichen Präsentation miteinfließt.
Darüber hinaus wird diese Tischvorlage an alle Seminarteilnehmer verteilt und dient als Vorbereitungsmaterial für die Fragerunde bei der Diskussion der Präsentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organische Chemie; Biochemie

Content:
Die Vorlesung des Moduls vermittelt grundlegende Kenntnisse über die chemischen Prinzipien und die Methoden der chemischen Peptid- und Proteinsynthese. Im Seminar finden dann betreute Präsentationen (auf Englisch) von wissenschaftlichen Artikeln mit den Ergebnissen aus aktuellen Forschungsarbeiten im Gebiet der Peptid- und Proteinmissfaltung und -aggregation im Zusammenhang mit zellgenerativen Krankheiten statt und es wird ein Handout über jede Präsentation vom Studenten angefertigt.

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss dieses Moduls haben die Studierenden ein breites Spektrum von Kenntnissen über die chemische Peptid- und Proteinsynthese und die biomedizinische Anwendung von synthetischen Peptiden erworben. Weiterhin haben sie Kenntnisse zu den Themen Protein-Protein Wechselwirkungen, Proteinfaltung- und -missfaltung sowie über Zusammenhänge mit zelldegenerativen Krankheiten und die Anwendung von synthetischen Peptiden in obigen Gebieten erworben. Darüber hinaus haben sie die Prinzipien von peptidchemischen, biochemischen, und biophysikalischen Methoden, die in den obigen Forschungsbereichen Anwendung finden, erlernt.

Teaching and Learning Methods:
In der Vorlesung werden grundlegende Kenntnisse über die chemischen Prinzipien und die Methoden der
chemischen Peptid- und Proteinsynthese und über die Anwendung von synthetischen Peptiden in der Biomedizin mittels PowerPoint- und (Overhead-)Folien-Präsentationen sowie mittels Tafelanschriebs. Darüber hinaus werden regelmäßig und interaktiv Übungen mittels Tafelanschriebs durchgeführt.
Im Seminar finden betreute studentische Präsentationen von wissenschaftlichen Artikeln über Forschungsarbeiten auf Gebiet der Peptid-/Proteinmissfaltung und -aggregation im Zusammenhang mit zelldegenerativen Krankheiten und der Anwendung von synthetischen Peptiden statt. Die Präsentationen finden mittels PowerPoint-Folien statt und werden von einem vertiefenden wissenschaftlichen Diskurs begleitet. Darüber hinaus werden entsprechende Tischvorlagen (handouts) von den Studierenden angefertigt. Vorlesung und Seminar werden durch intensives Literaturstudium begleitet.

Media:
Folien / Powerpoint / Tafelarbeit

Reading List:
Norbert Sebald und Hans Dieter Jakubke: Peptides: Chemistry and Biology (Wiley-VCH)
Literaturangaben im Rahmen der Vorlesung und des Seminars.

Responsible for Module:
Kapurniotu, Aphrodite, Prof. Dr. rer. nat. akapurniotu@mytum.de

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

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

Module Description

WZ2580: Protein Engineering | Protein-Engineering

Version of module description: Gültig ab summerterm 2023

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:
Eine Klausur (90 min) 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 sowie gentechnische Methoden zur Entwicklung von Proteintherapeutika beschreiben und erläutern können. Darüber hinaus müssen Zusammenhänge zwischen Proteinstrukturen und daraus resultierenden anwendungstechnischen Möglichkeiten beurteilt und Strategien zur Optimierung von rekombinanten Proteinen für biotechnologische oder biomedizinische Anwendungen entwickelt werden.

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 Studierenden in elektronischer Form 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:
Skerra, Arne, Prof. Dr. rer. nat. habil. 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 winterterm 2022/23

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:
The examination for the module will take the form of a written exam (90 min) for the lecture and an oral exam (15 min) for the exercise.

In the written exam it is tested whether the students have mastered the theoretical basics of proteomics and are able to develop answers to biological questions on the basis of the method spectrum of proteomics and to evaluate the results against the experimental background.

The presentation is developed individually on the basis of three tasks. Within the framework of the presentation, students should show that they are able to present essential aspects of their newly acquired skills and strategies in a structured and reflective manner. They must briefly explain the application of the necessary methods and discuss them in the context of the problem. In addition to the content, formal aspects of the presentation are also included in the assessment.

The written exam and the presentation are weighted in a ratio of 3 (written exam) to 2 (presentation). The module is passed if the weighted average is better than 4.09.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is designed for students in the MSc.

Content:
In this lecture, students will be introduced to the methodology of proteomics research and examples will be given from the fields of basic research, medical research, and drug discovery.

The lecture covers the theory and application of protein separation techniques such as 1D/2D gel electrophoresis, different types of protein and peptide chromatography, multidimensional separations, stable isotope labeling, and different forms of mass spectrometry. Furthermore, it will be discussed how these different methods can be combined in a meaningful way, depending on the application or scientific question.

In the exercise, participants will learn mass spectrometry-based methods and evaluation procedures that enable both protein identification and quantification. In each exercise section, participants will work with data from a case study aimed at identifying specific protein interaction partners of clinical kinase inhibitors. Using these case studies, participants will become familiar with the three steps required for each proteomic experiment: i) sample preparation, ii) mass spectrometric measurement, iii) (statistical) data analysis.

The content of the module will be continuously updated according to the latest developments in the field of proteomics.

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.

After participating in the exercise, students will be able to:
- apply proteomic software tools.
- interpret mass spectrometric peptide spectra using the software tools.
- use the information obtained through the application of the software tools to identify and quantify one or more protein.
- Critically evaluate the data obtained through the software tools.
- understand the application of the software tools in different research areas.

Teaching and Learning Methods:
Teaching technique: Lecture and practical training Learning activities: In the lecture, students work out proteomic analytical problems and develop suitable solutions for them using the proteomic tools presented in the lecture.
In the exercise, the participants perform data analyses themselves using the software tools provided. There will be intensive interaction between teachers and course participants.

Media:
Blackboard work, PowerPoint, Script for the lecture, exercise sheets for the exercise

Reading List:
Script for the lecture

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

Courses (Type of course, Weekly hours per semester), Instructor:
Proteomics - Analytische Grundlagen und biomedizinische Anwendungen (Vorlesung, 2 SWS)
Küster B [L], Küster B

Intensivkurs Proteomics (Übung, 3 SWS)
Küster B [L], Küster B, Ludwig C, Schneider A, The 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 winterterm 2022/23

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:
In the written exam (60 min), the students show to what extent they have not only understood the cell biological techniques covered in the lecture, but can also concretize them to solve cell biological problems in the form of an experimental concept. A prediction of probable results derived from the theoretical assumptions as well as a critical reflection of the experimental strategies in detail are expected.

Repeat Examination:
Next semester

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

Content:
In this lecture, methodological approaches for the elucidation of cellular signal transduction will be presented and explained using selected examples. Following an introductory BSc-level review on the topic of signal transduction, experimental strategies/techniques for the elucidation of cellular signaling pathways will not only be presented in the focus (e.g. characterization and detection of molecular interaction in vitro, PTM assays, gene expression analysis, etc), but subsequently their potential and limitations will also be discussed on selected case studies.
Ditto, will be done with the second main topic "cell cultures". In particular, aspects of cell culture will be highlighted that may influence results/conclusions of cell biology experiments (topics: Cell lines, senescence, immortalization, culture systems, single cell analysis, etc).¬ For the seminar, students will have the opportunity to independently select another topic for the entire course, present recent publications from this area that are essentially based on cell biology experiments, and discuss these in the course.

Intended Learning Outcomes:
After participation in the module courses, students will be able to select suitable strategies from the spectrum of methods for the study of cellular signal transduction and apply them specifically to cell biology experiments. In addition, they will be able to assess the impact of technical manipulations/ applications on cellular responses, in particular on signaling pathways, and to take this aspect into account when designing experiments.

Teaching and Learning Methods:
Teaching technique: lecture; seminar: lecture.
Learning activities: Interactive exchange and stimulation of discussion in lecture, study of lecture notes, transcripts and literature. The seminar will be completed in small working groups of 3-4 persons.

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.

Responsible for Module:
Kramer, Karl, PD Dr. agr. karl.kramer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Techniken der Zellbiologie (Vorlesung, 2 SWS)
Küster B [L], Kramer K

Zellbiologisches Seminar (Seminar, 1 SWS)
Küster B [L], Kramer K
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 2022/23

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 Modulstoff.

Repeat Examination:
End of Semester

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

Content:
Im Rahmen des Moduls 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 am Modul besitzen die Studierenden ein detailliertes theoretisches 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.

Specializing in Genetics | Studienschwerpunkt Genetik

Practice-Oriented Modules | Praxisorientierte Module

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, Piecyk R, You Y, Zhang Z, Zhou M
For further information in this module, please click campus.tum.de or here.

Module Description

LS20009: Introduction to programming for biologists | Einführung in die Programmierung für Biologen

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:
Examination will be performed in the form of a small project work, including a final presentation. Students (alone or in small groups, depending on the number of the participants) will be suggested to answer the research questions about specific data (for example, if two groups of the genes are different in terms of the specific characteristics). For this students will have to choose and download the dataset from the publicly available recourse, perform the relevant analysis of the data in Python or R and answer the formulated questions about the tendencies in the dataset. At the presentation students will have to explain the source of the data that they have chosen and how they got the data (5-10 minutes/person). Students will also have to show and briefly comment the elements of the code that they wrote to perform the analysis and answer the research questions about the data. Visualizations will also have to be provided. The components of the examination that will be assessed include
- the level of data downloading, processing and visualization automation, which makes it easy to repeat the analysis on another data set (25%),
- the cleanliness, non-redundancy and efficiency of the written code and ability of the student to explain its elements (25 %/,
- the choice of relevant packages in Python and R for data processing (25%),
- the ability of the student to provide the relevant visualizations supporting the scientific conclusions made about the data (25%).
Each of the examination components will be graded from 1.0 (very good) to 5.0 (fail) and the final grade will be calculated as the average grade of individual examination parts. To pass the module at least the score 4.0 is required. Several sessions before the presentation will be booked for the consultation of the students on their projects.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basics of molecular biology
Basics of bioinformatics (we recommend TUM courses Bioinformatics for biosciences I and II)
Basics of Statistics

Content:
The following topics will be covered in module:

- data types in Python and R
- conditional expressions (if, else, etc)
- loops
- functions
- reading data from files and writing the results to the files
- biopython and other special packages in Python and R for the analysis of biological data
- statistical analysis in Python and R
- visualization of the results in Python and R
- basics of Linux command line interface (bash)

Intended Learning Outcomes:
Upon successful completion of the module, students are able to

- define and describe main datatypes in Python and R programming languages
- write the code in Python and R using basic conditional expressions and loops
- read and parse the data from files and save the results of the analysis to the file
- find and download the data from publicly-available biological databases (manually or via scripts)
- choose the available Python or R packages for the analysis of the data
- write scripts in Python and R for the statistical analysis
- visualize the results of the data analysis in Python and R

Teaching and Learning Methods:
The theoretical basics of the module will be delivered to the students with the help of slides, that will include definitions and simple code examples. For each session students will be provided with the list of tasks that help to put the discussing aspect of programming into practice. Students will be given time to write their own code and identify the key challenges. Then the code will be written by the teacher in the real-time mode while sharing the PC screen with the students. After the session the working code will be also shared with the students. Moodle platform is thought to be used for the delivering learning material to the students.

Media:
PowerPoint slides
Files with code in Python and R

Reading List:
“Python for biologists“ by Dr. Martin Jones, 2013

“Getting Started with R: An Introduction for Biologists“, 2nd edition, by Beckerman, Childs and Petchey, 2017

Responsible for Module:
Frischmann, Dimitri; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to programming for biologists (Praktikum, 4 SWS)
Parr M [L], Parr 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 winterterm 2022/23

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:
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 (30 min) 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:
End of Semester

(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 (6-week laboratory internship, full-time), 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:
After participation in the module courses, the students are able to
- to understand the applied microbiological, genetic and/or biochemical special methods, including safety and material knowledge, and to master them in terms of action,
- plan and carry out experiments independently
- to keep laboratory protocols in a meaningful and comprehensible way.

Teaching and Learning Methods:
The research-related internship enables relatively independent microbiological/molecular biological work under guidance and serves to prepare students for future experimental microbiological theses (master's thesis, doctoral dissertation). By working on a research project, students gain experience under everyday laboratory conditions and acquire broad experimental know-how. The module promotes interest in fungi, their application in research and development, and their importance for humans and the environment.

Translated with www.DeepL.com/Translator (free version)

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:
Benz, Johan Philipp, Prof. Dr. rer. nat. 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 summerterm 2023

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 grade is based on the report by the student who will describe in max. 20 pages the analysis of a genomic dataset or of a mathematical model by means of stochastic simulations. The report consists in 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 scientific question.

Repeat Examination:
End of Semester

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

Content:
Modern evolutionary biology methods and concepts is pervasive in many fields of biology such as medicine, agriculture, plant and animal breeding, or ecology. State of the art scientific project in this field require to integrate sequence data, mathematical theory and computer simulations. This practical course provides an in depth application of these principles. The students will study either genomic datasets or a mathematical model by means of stochastic simulations.
1) Content of the NGS / genomic data analysis: introduction to 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, de novo genome assembly: de novo assembly of a simple genome, annotation of assembly.
2) Content of the mathematical model analysis: formulation of a mathematical model, coding in R, formulation of the stochastic processes involved, simulations in R, statistical analysis of simulations.

3) Exercise and practice writing a report with critical discussion.

Intended Learning Outcomes:
After the course the students are confident in using the classic tools for bioinformatics of NGS data, the Linux operating system, a computer cluster and in performing basic statistics using the software R.
When analyzing genomic data, the students know the different type of data generated by Next Generation Sequencing platforms, they know how to perform all the steps from raw data until obtaining SNP data. They master the analysis of genomic data up to SNP calling, By learning how to use different software, they know how to produce accurate data analysis from NGS sequencing data, are critical of the robustness of the results, and can write a scientific description of the pipeline of analysis.
When performing mathematical modelling and stochastic simulations, the students learn how to develop and to formulate a mathematical model to answer a question in evolutionary biology, and to consider and model the different sources of stochasticity in nature. The students are able to write the model and perform simulations in R and conduct the statistical analysis of the results.

Teaching and Learning Methods:
Learning techniques: exercise on computer, practical research project, autonomous work.
Learning activities: reading and summarizing the relevant literature, formulating a question and a path to answer, applying bioinformatics or mathematical tools, generating results and their statistical analysis, writing a report, critical assessment of the work.

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

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:
Forschungspraktikum: in silico Evolutionsgenetik von Pflanzen und Pathogenen (Forschungspraktikum, 10 SWS)
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 | Research Project Chemical Genetics

Version of module description: Gültig ab winterterm 2022/23

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 done in the form of a laboratory assignment. The students conduct a six-week research project in the lab. The work-schedule can be adjusted to the curriculum of the students. This includes the conductance of 1 to 4 experiments and the subsequent preparation of a protocol (approximately 15 to 20 pages) which has to be handed in usually within 4 weeks after the laboratory work has been concluded. By preparing the lab protocol the students demonstrate the ability to summarize the theoretical background and key aims of the performed experiments and to present the acquired results in a concise and coherent manner and to interpret and discuss the experimental data in the context of available literature. The grade is based on the accuracy of data analysis (50%) and the quality of data presentation (50%), including the description of the theoretical background, presentation of raw data, calculations, application of statistical tests and interpretation and discussion of the results.

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. Successful completion of the lecture 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 within 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.
This module will teach students a subset of the following techniques by participating in a research project in the lab:
- Storage and handling of a chemical library;
- Design of a chemical genetic screen;
- Set up of a chemical genetic screen in conformity with the required quality standards;
- Phenotype-based small molecule screening in Arabidopsis thaliana
- Phenotype-based small molecule screening horticulturally relevant plant species;
- Expression marker-based small molecule screens;

- Hit confirmation assays;
- Dose response assays;
- Structure/function analysis using cheminformatic methods;
- Establishment of an in vitro assay to test ligand-target interaction.

Intended Learning Outcomes:
Upon completion of this module students are able:
- to understand the principles of chemical genetic research approaches;
- to assess for which scientific questions a chemical genetic approach might be helpful;
- to plan and to carry out basic chemical genetic experiments in plants according to the required quality standards;
- to interpret and evaluate the results obtained in chemical genetic screens in a written report.

Teaching and Learning Methods:
Close theoretical and practical supervision combined with autonomous lab work enables the student to understand and apply basic experiments in Plant Chemical Genetics. By discussing lab protocols, the student analyses the underlying methodological principles of the experiments. By reading original research articles the student learns to assess quality standards for chemical genetic approaches. By writing a research report the student learns to summarize the obtained results and discusses it in the context of relevant literature.

Media:
Oral instructions, 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:
Sieberer, Tobias, Dr. nat. techn. tobias.sieberer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Chemische Genetik (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Sieberer T, Andrade Galan P
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 summerterm 2023

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:
One laboratory performance will be graded: The graded laboratory performance includes the preparation of a protocol and a presentation.

Part of the laboratory performance is the elaboration of the respective theoretical basics incl. literature study. This also includes the description of the experiments, the preparation and practical execution, any necessary calculations, their documentation and evaluation as well as the interpretation of the results with regard to the knowledge to be gained. The laboratory performance is supplemented by a presentation to test communicative competence in presenting scientific topics to an audience.

The concrete components of the laboratory performance and the competences to be tested with it include regular practical work on a small scientific project, a written protocol (introduction, material and methods, results, discussion and literature with a total of 20 pages), and at the end of the practical work a short presentation (30 min) in the context of the institute seminars. Internship duration is 6 weeks full time. Protocol and presentation are evaluated (2:1). The practical performance documented in the protocol will be evaluated primarily on quality (thoroughness, accuracy, documentation, problem-solving strategies) but also on efficiency and quantity. In the written protocol (German or English), the students show whether they are able to structure the experiments carried out, the results and the context of their work and to present the essential aspects. They should be able to describe, interpret and combine the results obtained in a meaningful way and apply them to the current scientific context. In the presentation (preferably in English), the students should again demonstrate how their results fit into the current state of research and be able to present their understanding in this respect by means of a discussion. This also gives the students the opportunity to train for scientific presentations.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
It is recommended to attend the lecture of genomics and/or developmental genetics (compulsory lecture in the bachelor program), or similar. It is advantageous to attend the lectures Neurogenetics I and II concomitant to the internship. Good knowledge of English (laboratory language) is recommended.

Content:
During the internship, students will gain knowledge about practical work in a research laboratory - especially about working in the field of neurogenetics, working with mouse models and their generation, and working with cellular model systems. Contents include: 1. latest molecular biological technologies for the generation of mouse models as well as 2. characterization of these mouse models (especially in the field of neuropsychiatric diseases) and cellular systems derived from them. The work is always integrated into an ongoing current research project of the Department of Developmental Genetics. Applied methods and methods to be learned depend on the research project. However, as examples can be mentioned: Cloning and testing of new vectors to create animal models; gene expression analyses by qPCR - luciferase assays, application of viral vectors for acute elimination of gene expression (knock-down); biochemical methods (Western blots, activity measurements of proteins); histological analyses of mouse models (immunohistochemical, in situ hybridizations; quantitative analyses), metabolic analyses of organs and cell cultures; mitochondrial analyses etc.. The practical work will be guided. However, the goal is to achieve independence and self-responsibility for the experiment(s) performed during the course of the practical.

Intended Learning Outcomes:
The most important competence to be acquired in this internship is the practical experience in carrying out a small scientific project.
After participating in the module, students will have acquired initial experience and competence in scientific work and presentation of scientific results, both in written and oral form. Furthermore, in-depth practical and theoretical content will be taught in at least one neurogenetic method.
Therefore, the following competencies will be acquired in this internship:
1. practical work in the research field of neurogenetics - learning of methods (molecular biological, histological), 2. structured written (protocol) and oral (presentation) processing of the obtained results against the background of a specific scientific question.

After participation in the module, students will be able to perform scientific work in a neurogenetics laboratory, will have learned at least two basic methods from the molecular biological or histological field, and will be able to place results obtained in the laboratory in the context of known knowledge (literature), present them clearly, and interpret them critically. They will be able to discuss and orally defend their results.

Teaching and Learning Methods:
Type of event: practical course
Teaching method: in the practical course, instructional discussions, demonstrations, experiments, discussion of results, feedback on the quality of the practical work.
Learning activities: study of background literature (in English only), internship script and literature; practice of laboratory skills, teamwork; preparation of protocols; preparation of a presentation.

Media:
Presentations by means of PowerPoint,
script (download option for lecture material), practical script.

Reading List:
No textbook is available that covers all the content of this module. Recommended as a foundation or supplement:
L. R. Squire: Fundamental Neuroscience, ed. Larry L. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Wurst, Wolfgang, Prof. Dr. rer. nat. w.wurst@mytum.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

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 winterterm 2022/23

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, a computer cluster and in performing basic statistics using the software R.

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], Bhardwaj R, Ortiz Valencia E, Ramesh A, Schäfer H, Tellier A
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

WZ5240: Laboratory Course Detection of Genetically Modified Organisms | Praktikum Nachweis genetisch modifizierter Organismen

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**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:
Das Lernergebnis des GMO Praktikums wird mit einer 60 minütigen schriftlichen Klausur abgefragt. Zu jedem Praktikumsteil, (1) den Referaten, (2) den Extraktionsmethoden, (3) dem GMO Nachweis via PCR und qPCR sowie (4) dem GMO Nachweis via ELISA, müssen Fragen beantwortet werden:
- Die verschiedenen Extraktionsmethoden von DNA und Proteinen müssen exemplarisch beschrieben werden.
- Der Aufbau, der Ablauf und die Funktionsprinzipien verschiedener Nachweismethoden wie PCR und ELISA müssen z.T. anhand von Skizzen erklärt werden. Zudem müssen Einflussfaktoren benannt und beurteilt werden.
- Der Einsatz von GMOs muss an aktuellen Beispielen vor dem Hintergrund der gesellschaftlichen und politischen Problematik von GMOs auf nationaler und internationaler Ebene diskutiert werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine.

Content:
Im Praktikum "GMO Nachweis in Lebensmitteln" soll den Studenten der molekularbiologische Nachweis von gentechnisch modifizierter Organismen (GMO) in Lebensmitteln nahe gebracht werden.
Die behandelten Themen sind:
- GMO und deren Problematik in Deutschland, Europa und weltweit
- Proteinextraktion aus Pflanzen
- ELISA Immunoassay

- DNA Extraktion aus Pflanzen
- PCR und quantitative PCR (qPCR)

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Modul kennen die Studierenden die rechtlichen Grundlagen zu GMO in Deutschland und Europa und können die gesellschaftlichen und politischen Diskussionen über GMO einschätzen und bewerten. Sie sind in der Lage einen DNA- und Proteinnachweis von GMO in Lebensmitteln selbst im Labor durchzuführen und die Ergebnisse zu interpretieren und zu bewerten.

Teaching and Learning Methods:
Die theoretischen Grundlagen zu den oben genannten Themen werden in einem Seminar vermittelt. Die Studierenden halten Vorträge dazu und diskutieren diese mit dem Dozenten. Dabei werden den Studierenden die nationale und internationale Problematik um GMO verständlich gemacht. Die praktischen Teile der Lehrveranstaltung (verschiedene Extraktion, PCR, qPCR und ELISA) sollen dem Studierenden die Methoden näherbringen sodass er diese in der Praxis anwenden kann. Gängige Labormethoden zum Nachweis von GMO werden anschließend am Beispiel Mais in einem Laborpraktikum eingeübt. Dazu wird von einem transgenen (Bt-176) und einem isogenen (konventionellem) Mais aus Pflanzenmaterial (Maisblätter und Maiskörnern) sowie aus einem verarbeiteten Lebensmittel (selbst hergestelltes Popcorn) DNA und Protein extrahiert und verglichen. Mit folgenden Methoden werden spezifische Marker detektiert und quantifiziert:
- auf DNA Ebene (transgene Cry1Ab DNA) mittels PCR und qPCR
- auf Proteinebene (Cry1Ab Protein) mittels ELISA Immunoassay

Media:
PowerPoint Präsentationen und Tafelskizzen während der Präsentationen und dem Praktikum.

Reading List:
Gesetz zur Regelung der Gentechnik -- https://www.gesetze-im-internet.de/gentg/index.html
GMO @ BFR -- https://www.bfr.bund.de/en/authorisation_of_genetically_modified_food_and_feed-4960.html
GMO Q BVL -- https://www.bvl.bund.de/EN/Tasks/06_Genetic_engineering/genetic_engineering_node.html
GMO @ EFSA -- https://www.efsa.europa.eu/en/topics/topic/gmo

Responsible for Module:
Pfaffl, Michael, Apl. Prof. Dr. michael.pfaffl@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Nachweis gentechnisch modifizierter Organismen (Praktikum, 3 SWS)
Pfaffl M
For further information in this module, please click campus.tum.de or here.

Theory-Oriented Modules | Theorieorientierte Module

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

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 summerterm 2023

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 performance includes a written examination.
In the written exam (60min) the student should prove that in a limited time problems from the field of population genetics and phylogenetics can be recognized and ways to solve them can be found. The exam questions cover the whole lecture material and include practical tasks. The exam requires students to answer six questions that make a connection between population genetics and phylogenetics. The questions are based on illustrations from publications from the practice section, the results and underlying concepts of which must be explained.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in statistics and genetics

Content:
1) Concepts and methods of population genetics with special focus on young species: application of speciation models, concepts of neutral evolution and selection pressure, discussion of the speciation continuum, definition of biological species, analysis of sister species datasets, age estimates using genomic data (molecular clock concept), description of incomplete lineage sorting, allopatric and sympatric speciation processes, and islands of speciation in the genomes of emerging species.
2) Phylogenetics and phylogenomics: assuming extensive reproductive isolation between individuals, how can their relationships and phylogeny be estimated? Using diverse software, maximum parsimony and maximum likelihood algorithms and their theoretical background are introduced, phylogenetic tree analyses and molecular dating are practiced using Bayesian methods, and network analyses are performed for complex speciation scenarios with introgression.

Intended Learning Outcomes:
Upon successful completion of the module, participants will have acquired a comprehensive understanding of the basic principles of population genetics and phylogenetics/phylogenomics. They will be able to state the interrelationships between these topics and practically apply important analysis methods and software packages of population genetics and phylogenetics/ phylogenomics. They will be able to apply the acquired basic knowledge in the field of population genetics, phylogenetics and genomics as well as in the applied disciplines of breeding research and conservation biology. Students will be able to describe how a population splits and multiple species arise over time, and the neutral and selective forces acting on the genomes of individuals in populations. Students will be able to perform structural analysis of single nucleotide polymorphism (SNP) markers to identify patterns in populations/species. Students will be able to describe how SNP data from genomes are used to understand the genetic basis of speciation. Students will be able to describe the different phylogenetic methods and their advantages and disadvantages when analyzing different data sets. They can perform such analyses independently and critically evaluate their results.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture, exercises, seminar
Learning activity: studying literature, calculating exercises, summarizing documents, working on problems and finding solutions to them
Teaching method: Lecture, exercises, questioning-developing method

Media:
Presentations using PowerPoint software exercises: Structure, BEST, RAxML, Geneious, MrBayes, BEAST, splitstree

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:
Tellier, Aurélien, Prof. Dr. aurelien.tellier@tum.de Schäfer, Hanno, Prof. Dr. rer. nat. hanno.schaefer@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, Tellier A
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 2023

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 Klausur (180 min) in the form of a written essay. The essay consists of up to 7 pages (without references). The students have to answer one question at the interface between ecological and evolutionary processes. Several articles, empirical studies and general reviews, are provided before hand for the students to prepare at home. The students will need to 1) develop an introduction with adequate definitions and framing of the topic and the question, 2) develop a well argued answer to the question using as basis the empirical studies provided as well as other studies in the literature, and 3) provide a conclusion answering the topical question. In order to develop a convincing argument and provide a solid and robust answer, the students may have to explain the necessary concepts of evolutionary biology, (epi)genetics, and ecology, as well as evaluate critically the findings of the cited empirical studies.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in Evolution and Genetics

Content:
1) Cooperation: evolution of cooperation, adaptive dynamics, evolutionary stable strategy, cooperation and insect society.
2) Host-parasite coevolution: infectious diseases, epidemiology, evolution of virulence, genetic and epigenetic bases of interactions.
3) Life history traits: evolution and consequences. Dormancy and quiescence, evolution of aging, aging and demography in an ecological context.
4) Epigenetics: Molecular basis of epigenetics, epigenetic inheritance, epigenetics and evolution.
5) Essay writing: structure, plan, developing arguments, building a well argued reasoning.

6) Seminars: cooperation and cancer, cancer and epigenetics, cooperation in human societies and relevance for climate change, epigenetics and cooperation in insect societies, vaccine and virulence evolution of viruses, dormancy in bacteria/fungi/insects, dormancy in human parasites, epigenetics and aging, epigenetics and dormancy/quiescence.

Intended Learning Outcomes:
The students have a profound understanding of four fundamental topics in Ecology and Evolution: cooperation, coevolution between species, evolution of life-history traits and aging, and the role of epigenetics in evolution. For example, the students can explain what cooperation is, how it evolves and what is a stable evolutionary strategy for cooperation.
The students understand the principles of host-parasite interactions and disease epidemiology and the (epi)genetic mechanisms underpinning host-parasite coevolution. They can build basic mathematical models and implement them in R to perform simulations and analyze their behavior.
The students are able to describe the cause and consequences of the evolution of life history traits such as dormancy and aging. To do so, the students are able to build and analyze simple codes in R modelling these ecological and evolutionary mechanisms and processes.
The students can also describe the neutral and selective forces driving the evolution of dormancy and aging.
The students can describe the molecular bases of epigenetics and the role of epigenetic inheritance in evolution.
The students can integrate these ecological and evolutionary aspects and explain their relevance for agriculture and medicine. The seminar part of the course focuses on the analysis of state of the art publications linking these topics. Finally, the students will learn how to write a structured scientific essay to answer a question.

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 present a research paper (an empirical study) linking several topics of the lectures together. The students perform a PowerPoint presentation of this study and afterwards discuss it with the lecturer and the other students. The aim of the presentation is to describe, analyze, interpret and critically evaluate the results of the study. The students will learn how to write an essay.

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

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; Otto and Day, A Biologist's Guide to Mathematical

Modeling in Ecology and Evolution (2007); Charlesworth and Charlesworth, Evolution: a very short introduction, Oxford University Press 2017.

Responsible for Module:
Tellier, Aurélien, Prof. Dr. aurelien.tellier@tum.de

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

Modern topics in Evolutionary Biology (Seminar, 2 SWS)
Tellier A [L], Johannes F, 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, Schreck C
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)
Flisikowska T, Fischer K, Flisikowski K

Biotechnologie der Tiere 2 Seminar (Seminar, 2 SWS)
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)
Flisikowska T, Flisikowski K

Biotechnologie der Tiere 1 Praktikum (Praktikum, 2 SWS)
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:
Crop Genomics (Vorlesung mit integrierten Übungen, 4 SWS)
Ouzunova M, Mayer K, Haberer G, Urzinger S (Guffanti F)
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 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:
The examination consists of a written exam (60 min). The students are given a dataset to analyze. 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 programs DnaSP or Mega (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 various evolutionary forces influence sequence data polymorphism, and how the mathematical models presented in the course predict these outcomes.

Repeat Examination:
End of Semester

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

Content:
1) Molecular evolution: neutral and nearly neutral theory of evolution, mutation-drift equilibrium, natural selection, molecular clock, sexual/asexual reproduction and recombination, inbreeding, Hardy-Weinberg equilibrium.
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 applications: genomics of crop domestication and plant breeding, genomics of human evolution and medicine, evolution of pathogens (bacteria, viruses, fungi), evolution of bacteria populations in laboratory experiments.

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 or Mega. 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, animal breeding, human genetics (medicine) and changes in micro-organisms populations (bacteria, fungi). 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 and Mega are 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. The paper presentation part of the course allows to exemplify the application of evolutionary theory to full genome data.
Learning Activity: Study of scientific articles on evolution of pathogens, plant breeding, human evolution and laboratory evolution experiments 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:
Evolutionsgenetik der Pflanzen und Mikroorganismen (Vorlesung, 2 SWS)
Tellier A [L], Tellier A

Evolutionsgenetik der Pflanzen und Mikroorganismen (Übung, 2 SWS)
Tellier A [L], Tellier A
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 winterterm 2022/23

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 report to be handed to the lecturer at a given date. The report consists of up to 10 pages (without references). The students have to answer one key question related to the evolution of pathogens in response to disease management. One case study (with two articles) is provided. 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 of that particular pathogen, 3) describe the theoretical models used in the course which are adapted to explain the results of the studies, 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 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 analyze and evaluate critically genomic studies of various crop diseases and the link to disease management strategies.

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 evaluate the efficiency of 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
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; Apl. 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

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

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:
The examination takes the form of a written exam (60 minutes) and a presentation (60 minutes; pass/fail credit requirement).
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 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.

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 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)
Schön C [L], Frey M, Avramova V
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
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 summerterm 2023

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:
Die Studierenden zeigen in einer benoteten Klausur (60 min, 2 Klausuren/nach jedem Semester eine), dass sie grundlegenden Konzepte der Entwicklung des zentralen Nervensystems verstehen und zusammenfassen können. Sie sollen komplexe Sachverhalte über die molekularen Grundlagen und Entstehung von neuropsychiatrischen Erkrankungen in begrenzter Zeit aufzeigen können. Darüber hinaus sollen sie zeigen, dass sie ihr erlerntes Wissen dazu nutzen können, Fallbeispiele analysieren und beurteilen zu können.

Der Durchschnitt der beiden Klausuren ergibt dann die Gesamtnote.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretische Kenntnisse in der Genetik (Entwicklungsgenetik der Tiere) sind wünschenswert.

Content:
1. Molekulare und zellbiologische Prinzipien der Entwicklung des zentralen Nervensystems: Neurogenese - Neuronale Migration - Netzwerkbildung - Synaptogenese - elektrische Maturation; 2. Morphologie und Funktion des Großhirns, Kleinhirns, Hippcampus, Basalganglien, Amygdala, Rückenmarks; 3. Erkrankungen des ZNS und deren molekularen Grundlagen: Alzheimer, Parkinson, Schizophrenie, Depression, Infektionen, Rückenmarkserkrankungen, Schlaganfall, Epilepsie, Prionerkrankungen, Erkrankungen des Hypothalamus

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung besitzen die Studierenden das grundlegende theoretische Verständnis über die Entstehung des Nervensystems. Sie sollen die Prinzipien der molekularen Regulation dieser Prozesse verstehen und diese erklären können, Kenntnisse über die Funktion und Morphologie zentraler Strukturen des ZNS besitzen und die Pathogenese (molekulare) von Erkrankungen des ZNS verstehen. Des Weiteren soll das Modul Interesse an der Neurogenetik fördern.

Teaching and Learning Methods:
Lehrmethode: Vorlesung mit fragend-entwicklender Methode
Lernaktivitäten: Studium von Literatur, Lernen von grundlegenden Prozessen, Problemlösung

Media:
Powerpoint, Skriptum auf der neuen Moodle-Plattform, Filme

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:
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)
Piecyk R
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 (Vorlesung, 2 SWS)
Poppenberger-Sieberer B

Pflanzenbiotechnologie (Seminar, 2 SWS)
Poppenberger-Sieberer B [L], Poppenberger-Sieberer B, Benz J, Assaad-Gerbert F, Avramova V, Sieberer T, Schwechheimer C, Tellier A, Hückelhoven R, Johannes F, Schneitz K, Dawid C, Ahmed M, Bienert G
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 2023

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 (120 min) students show without additional material and within a limited time that they are able to explain the basic concepts of quantitative genetics, population genetics and selection theory and their relevance for breeding. The examination questions cover the entire lecture material. Short calculations can be included.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful Bachelor courses in applied statistics (e.g. Statistical Methods module).

Content:
Participants learn the basic principles of quantitative genetics and their relevance in the context of plant breeding. Essential concepts of population genetics, such as the genetic composition of populations and the effects of natural selection and mutations are taught. Quantitative genetics concepts important to plant breeding such as inbreeding and heterosis, epistasis, phenotypic and genotypic variances, resemblance between relatives, heritability, and genotype-environment interactions are introduced. It is shown how these concepts can be used to calculate selection success and optimize breeding programs.

Intended Learning Outcomes:
After successful completion of the module, students are able to understand the basic concepts of quantitative genetics and to evaluate their relevance for problems in plant breeding. They can explain important population genetic concepts such as the Hardy-Weinberg Law, understand the concepts of linkage and linkage disequilibrium and how they can be estimated in experimental populations. Students become familiar with the theoretical concepts underlying breeding values

and combining ability and their application in estimating heritability. They can identify and quantify resemblance between relatives. They are able to apply these concepts to selection theory for the optimization of breeding programs.

Teaching and Learning Methods:
The module consists of a lecture with integrated exercise modules in which the theoretical background and concepts are developed through PowerPoint presentations and chalkboard work. The analysis of experimental data sets in computer exercises extends the theoretical knowledge.

Media:
Presentations using PowerPoint Software exercises

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

Module Description

MA9613: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

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:** 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

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

Practice-Oriented Modules | Praxisorientierte Module

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:

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

ME60855: Research Project viral gene transfer | Forschungspraktikum Viraler Gentransfer

Version of module description: Gültig ab summerterm 2022

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:
Protocol/minutes (ca. 25 pages) / oral presentation (ca. 30 min.)
A protocol/minutes describing the experiments performed in the format of a scientific publication (introduction, materials and methods, results and discussion) must be written. The protocol serves to check the ability to describe, evaluate and interpret the experiments performed in the practical course and will be 75 % graded.
The oral presentation (graded 25 %) allows to test the students' the ability to present and interpret the experiments.

Repeat Examination:

(Recommended) Prerequisites:
Attendance at module “viral and non-viral gene transfer: methods and applications in research and therapy” is required.

Content:
The 6-weeks internship will be carried out in the research group of PD Dr. rer. nat. Martina Anton at the Klinikum rechts der Isar der TUM at the Institute of Molecular Immunology. Students will be participating in current research topics in the field of viral gene transfer, which are the basis for the respective internship topic.
Experiments may include molecular biology and tissue culture techniques, e. g. DNA cloning, plasmid purification, culture of cell lines and/or primary cells, transfection, infection/transduction of mammalian cells, purification of viral vectors (e. g. AAV, AdV, RV/LV), titration methods, reporter gene assays, gene expression analyses, ELISAs, proliferation assays, differentiation assays.

Intended Learning Outcomes:
After successful participation, students possess basic experimental knowledge and are able to independently apply common methods in molecular biology, tissue culture, vector construction and production. Since experiments are connected to current research projects in the area of “viral gene transfer”, students gain insight into current research topics. Independent problem solving is encouraged. Acquired knowledge in molecular and cell biology techniques and skills, like sterile techniques and safe work can be easily transferred to other research projects.
Students know theory and practice of the executed methods, generate and interpret data.
Students are able to produce protocols, present scientific experiments and their results in the field of viral gene transfer and are able to discuss them in the context of up-to-date literature.

Teaching and Learning Methods:
Event type/teaching technique: research lab training

Teaching methods in practical training: oral instructions to topic, oral and written instructions, demonstration, experiments, discussion of results, technical literature, written protocol/minutes, oral presentation.
The oral introduction includes background and research question and is intended to describe the relevant scientific background. The oral and written instructions explain execution and background of the techniques. Demonstration by trained personnel guarantees the transition from abstract description to actual execution in the lab. While conduction experiments themselves, students practice and exercise common methods. Discussion of results exercises presenting, analysis and interpretation of scientific results, under guidance of the supervisor. Additionally, it allows to identify possible problems and thereby optimize experiments in the future. Independent literature study is intended to deepen the understanding of the research question in the context of the literature. This way students exercise literature searches and use them in their oral presentation and protocol.
The protocol is written like a scientific publication in the IMRAD structure (Introduction, M&M, Results, Discussion and References).
With the protocol and talk students demonstrate, that they are able to present and discuss experiments, their results and data in the context of viral gene transfer.

Media:
Presentation: PowerPoint
Protocol/minutes: Text (word) with graphs produced in Excel, PowerPoint, photomicrographs (if applicable)

Reading List:
Current technical literature (PubMed) provided by supervisor.

Responsible for Module:
Martina Anton, martina.anton@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Viraler Gentransfer (Forschungspraktikum, 10 SWS)

Anton M [L], Anton M
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

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

WZ2399: Practical Course: Nutrition and Immunology | Forschungspraktikum Ernährung und Immunologie

Version of module description: Gültig ab summerterm 2023

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 examination performance is based on the laboratory performance.
The experiments, their evaluation and interpretation are documented and discussed by the students in written form (protocol). This protocol is written and graded according to the basic structure of a scientific article. In doing so, the students demonstrate that they are able to apply the theoretical and practical knowledge in this field to the results obtained and to summarize, present and interpret the data in a scientifically sound manner.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
A 6-week blocked laboratory practicum examines current issues in inflammatory bowel disease, tumorigenesis, nutrition, and intestinal microbiota or cellular stress mechanisms as part of ongoing research.

Intended Learning Outcomes:
After successful completion of the module, students possess theoretical competences in the field of immunology and inflammatory processes as well as practical competences in molecular biological, cell physiological, animal experimental and/or microbiological techniques. They are able to work on a scientific problem based on their own guided project.

Teaching and Learning Methods:
Working on a scientific question by means of an own project. In doing so, problem-oriented approaches to solutions are to be found. The students plan the experiments in cooperation with their supervisor and carry them out independently. They independently conduct literature research and make a scientific evaluation of the results; practical training, preparation, execution, interpretation and discussion of experiments.

Media:

Reading List:
suitable papers matching the topic of the research internship

Responsible for Module:
Haller, Dirk, Prof. Dr. rer. nat. dirk.haller@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
External: Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 1 SWS)
Haller D [L], Aguanno D, Coleman O, Haller D, Metwaly A, Ocvirk S, Omer H, Rath E, Schmöller I

Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 16 SWS)
Haller D [L], Haller D, Aguanno D, Coleman O, Krammel T, Metwaly A, Ocvirk S, Omer H, Rath E, Schmöller I, Schwamberger S
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)
Buchholz V, Busch D, Gerhard M, Mejias Luque R, Prazeres da Costa C, 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

WZ2477: 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, Ebert G, Pichlmair A, Vincendeau M
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 2023

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:
A laboratory performance is set as the examination performance.
In the course, the laboratory performance is assessed, i.e. the preparation and practical execution of the experiments, any necessary calculations, their documentation and evaluation in the form of a laboratory protocol, as well as the interpretation of the results with regard to the knowledge to be gained. In the protocol, the students show whether they are able to structure the work they have carried out and present the essential aspects. They should be able to describe and interpret the results and place them in a meaningful context to the knowledge gained in the lab.
The laboratory performance is complemented by a final presentation (15 min) to test communicative competence in presenting scientific topics to an audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is suitable for students in BSc (5th/6th semester) or Master. Basic knowledge in molecular biological methods is recommended.

Content:
Within the framework of the research internship in animal biotechnology, students will work on an independent sub-project and become familiar with different scientific methods or possibly establish new methodological approaches themselves. The project will be part of an overall project and the students will learn to understand a specific task area in the larger context. Depending on the project, they will learn practical skills in molecular, cell biological or embryological methods and expand their academic knowledge in the field of stem cell biology, animal models for tumor research or other human diseases and xenotransplantation.

Intended Learning Outcomes:
Students will learn the following:
- Independent scientific work
- Acquisition of new methods, such as genome editing, PCR, cell culture
- Project planning and practical implementation
- Working out solutions to problems independently
- Project description and presentation
- Independently conduct literature search and practical implementation of theoretical knowledge
- Integration and cooperation in a group, social competence

Teaching and Learning Methods:
Independent development of relevant literature, implementation of an independent sub-project under the guidance of a project manager.

Media:
Presentations using PowerPoint
Internship report

Reading List:
Project relevant literature

Responsible for Module:
Flisikowska, Tatiana; Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Tiere (Forschungspraktikum, 10 SWS)
Fischer K, Flisikowska T, Flisikowski K
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 summerterm 2023

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.(10-15 pages)

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:
Charmaz, K. (2008). Constructionism and the grounded theory method. Handbook of constructionist research, 1(1), 397-412.
Charmaz, K. (2008). Grounded theory as an emergent method. Handbook of emergent methods, 155, 172.
Hajer, M. (2002). Discourse analysis and the study of policy making. European Political Science, 2(1), 61-65.
Keller, R. (2001). Wissenssoziologische Diskursanalyse. In Handbuch Sozialwissenschaftliche Diskursanalyse (pp. 113-143). VS Verlag für Sozialwissenschaften, Wiesbaden.

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)
Schönwolff M
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:	Language:	Duration:	Frequency:
Master	German/English	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
10	300	60	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

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)
Andrä I, Bernard B, Bianca S, Buchholz V (Kretschmer L), D'Ippolito E, Kolb S, Kretschmer L, Mejias Luque R, Meyer H (Norman D, Bianca S), Schumann K (Bernard B, Kolb S)

Spezielle Immunologie für Biologen, Biochemiker, Molekulare Biotechnologen und Mediziner (Vorlesung, 2 SWS)
Andrä I, Buchholz V, Busch D, Friedrich V, Gerhard M, Hochrein H, Keppler S, Mejias Luque R, Meyer H, Neuenhahn M, Prodjinotho U, Rosenbaum M, Schumann K
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:	Language:	Duration:	Frequency:
Master	German/English	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
8	240	120	120

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

Description of Examination Method:
Prüfungsdauer (in min.): Präsentation: 25-35 min; Bericht:45-75 Seiten
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet.
Das Erreichen der angestrebten Lernergebnisse wird überprüft durch die täglichen praktischen Arbeiten, durch die Präsentation des*r Studierenden (Englisch) und das Praktikumsprotokoll (Englisch oder Deutsch). Es wird die Durchführung von Versuchen, deren Interpretation und auch deren Auswertung durch Zweiergruppen unter Anleitung nach Skriptvorgabe überprüft.
Die Prüfungsleistung des Moduls wird durch die Präsentation und den Bericht erbracht.
Bericht:
Schriftliche Aufarbeitung (Praktikumsbericht) und Zusammenfassung aller Praktikumsversuche. Die Studierenden zeigen, ob sie in der Lage sind, das erworbene praktische Wissen zu strukturieren (Einleitung, Methoden, Ergebnisse und Diskussion), die Ergebnisse zu analysieren und die wesentlichen Aspekte der einzelnen Versuche im Kontext darzustellen. Der Nachweis der erworbenen praktischen Erkenntnisse erfolgt, indem die Versuchsdurchführung und die Ergebnisse beschreiben und interpretieren sowie anhand von selbst angeeigneten Informationen aus der Literatur diskutiert werden (1-2 Diskussionspunkte je Versuch).
Präsentation:
Die Studierenden zeigen durch eine Präsentation ergänzend zu dem schriftlichen Bericht, ob sie in der Lage sind, selbstständig erarbeitete Inhalte zu strukturieren und zu kommunizieren. Inhalte zu translationalen Themengebieten im Bereich Virologie (z.B. Lentivirale Vektoren in der Forschung, Virus-Wirts-Interaktionen und daraus resultierende Immunevasion-Strategien, therapeutische Entwicklungen und Prävention von mikrobiellen Erkrankungen) sowie deren komplexe Aspekte im Kontext der Biologie von Viren stehen im Fokus. Diese sollen auf die wesentlichen Inhalte reduziert, zusammengefasst und mündlich in verständlicher Form dargestellt werden. Bei der anschließenden Gruppendiskussion soll ein vertieftes Verständnis nachgewiesen werden, indem auf Fragen, Anregungen oder Diskussionspunkte eingegangen werden kann.

Repeat Examination:

(Recommended) Prerequisites:
Grundkenntnisse in Molekular- und Zellbiologie, Immunologie (empfohlen) und Virologie sind erforderlich, Erfolgreiche Teilnahme an Modul WZ2496 (Molekulare und Medizinische Virologie Teil I und II) ist empfohlen.

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 auf Englisch zu praktikumsrelevanten Themen des jeweiligen Kurses. Im Eigenstudium sollen die Studierenden diese Vorträge vorbereiten und zusätzlich ein schriftliches Handout für Ihre Kollegen generieren, welches als Zusammenfassung die wichtigsten Punkte des Vortrags 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 auf Virusinfektionen, Durchfluss-zytometrische Analysen von humanen Zellen, immunohistochemische Analyse von Lebern und lymphatischen Organen und die transkriptionale Analyse von chronisch entzündeten Organen.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage
• allgemeine Begriffe der Virologie zu definieren und zu verstehen
• moderne Techniken der Virologie zu kennen und deren Möglichkeiten und Limitationen einzuschätzen
• Prinzipien der Virologie experimentell zu adressieren und an praktischen Beispielen anzuwenden
• grundlegende Mechanismen der Virus-Wirts-Interaktionen zu erfassen
• Immunevasion durch Viren zu analysieren und zu klassifizieren
• translationale Ansätze in der Virologie zu analysieren und zu diskutieren.

Teaching and Learning Methods:
Das Modul besteht aus dem Praktikumsteil (Laborlehre), dem Seminar mit Einzelpräsentationen und Gruppendiskussionen sowie dem abschließenden Erstellen eines schriftlichen Praktikumsberichts.
Lehrtechniken: Seminar, Übung, Laborlehre
Lehrmethode: Präsentation, Vortrag, Gruppenarbeit (Auswertung der Ergebnisse und Diskussion der vorgestellten Literatur), Laborlehre
Lernaktivitäten: Üben von technischen und labortechnischen Fertigkeiten, Materialrecherche, Studium der relevanten Literatur, Vorbereiten und Halten von Präsentationen sowie deren kritische Diskussion, Rechnen von Übungsaufgaben, Erstellen der Praktikumsberichte
Lernmethode: Gruppenarbeit, Präsentation, Experiment

Media:
Skriptum, Power Point Präsentation

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung wird empfohlen:
Flint et al.; Principles in Virology; Modrow et al., Molekulare Virologie

Responsible for Module:
Prof. Dr. Andreas Pichlmair, Prof. Dr. Ulrike Protzer

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, Vincendeau M
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 2023

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:
Research Project: Novel Therapeutic Strategies to Treat Aging-Related Diseases (Praktikum, 28 SWS)
Krüger P [L], Djabali K
For further information in this module, please click campus.tum.de or here.

Theory-Oriented Modules | Theorieorientierte Module

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, Schreck C
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 summerterm 2023

Module Level: Master	Language: English	Duration: two semesters	Frequency: winter/summer 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 chemesthetic perception as well as extra-sensory processes involving chemoreceptors. To answer the questions, own wordings are necessary and sketches of biomolecules and signaling pathways.

In addition, there is the option of taking a voluntary mid-term assignments as course work in accordance with APSO §6, 5. For this, a report on a scientific publication (1 page plus summary graphic) is to be prepared. This is supplemented by a presentation to test the communicative competence in presenting the contents to an audience.
Passing the course performance will improve the module grade by 0.3 if, based on the overall impression, this better characterizes the student's performance level and the deviation has no influence on passing the examination. No retake date will be offered for the mid-term performance. In case of a repetition of the module examination, a mid-term performance already achieved will be taken into account.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in molecular bilogy, 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. 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. 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:
not specified

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)
Jacob S, Kreuzer M, Luksch H, Rammes G
For further information in this module, please click campus.tum.de or here.

Module Description

ME2656: Development of Vaccines against Infectious Diseases | Entwicklung von Impfstoffen gegen Infektionskrankheiten

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** 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:
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

(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 2023/24

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:
Gerner, Romana, Dr. romana.gerner@tum.de

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

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)
Lammar D, 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 winterterm 2022/23

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.

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, Schüffler P
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

ME2648: Molecular Oncology | Molekulare Onkologie

Version of module description: Gültig ab winterterm 2016/17

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:
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:
Krüger, Achim; apl. Prof. Dr.: 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:	Language:	Duration:	Frequency:
Master	German	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	120	30

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:
a) Benotung der mündlichen Beteiligung (nach 1,0; 1,3; 1,7...) in der Veranstaltung; benotet werden 6 aus 8 Veranstaltungen nach dem Zufallsprinzip.
b) Benotung der Hausaufgabe (nach 1,0; 1,3; 1,7...) (Powerpointdarstellung)-); ; benotet werden 6 von 8 Hausaufgaben nach dem Zufallsprinzip.
c) 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. Die Gewichtung der Leistungen mündliche Beteiligung/Hausaufgabe/Vortrag ist 5:2:3.

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 den 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 befähigen sich, spätere Prüfungsgespräche (WPP; Doktorprüfung) routiniert anzugehen. 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 (Eigenstudium); 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 2023/24

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:
The examination takes the form of a 90-minute written Klausur. In this, it should be demonstrated that the aspects mentioned above can be reproduced and applied to concrete questions. Students should be able to briefly summarise questions of understanding on the topics covered in the lecture in their own words. The examination questions cover the entire module material.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Lecture and practical course General Microbiology

Content:
Contents: Introduction to the biology of human pathogenic bacteria:

Part 1:
- Overview of humans and microbes;
- Relationship between commensals and pathogens;
- Koch's postulates;
- Overview of bacterial pathogenicity and virulence; host defence systems (especially different levels of the innate immune system); pathogen defence systems (immune evasion, adhesion to the host cell, invasion and intracellular growth, bacterial toxins);

Part 2:
- Diagnostics and epidemiology: taxonomy of pathogenic bacteria; species terms; identification (physiological, biochemical, biophysical and genetic methods);
- Diagnostic procedures (enrichments, rapid procedures, automated procedures);

- Clinical case studies;
- Infectious disease epidemiology (significance of infections in Germany, collection of epidemiological data, methods for tracing contamination routes);

Content: Biology of human pathogenic parasites:
- Introduction to human parasitology
- Transmission, diagnostics and host interaction: Malaria, Giardia, Toxoplasma gondii
- Neglected tropical diseases: Chagas disease, Echinococcosis, African trypanosomiasis, Leishmaniasis, Lymphatic filariasis, Onchocerciasis, Schistosomiasis, soil-transmitted helminthiases.
- Control measures and programs, epidemiology, immune escape mechanisms

Intended Learning Outcomes:
After participating in the module courses, students will be able to,
- identify the characteristics of pathogenic bacteria.
- understand and describe the interaction of bacterial pathogens with human hosts.
- to name the importance of pathogens in food biotechnology and the diagnostic procedures in medical and food microbiology laboratories.
- to know the infection epidemiological situation in Germany.
- to name exposure risks for human-relevant parasitic infections, their development cycles and the corresponding clinical pictures.

Teaching and Learning Methods:
Lecture (independent revision based on slides, notes, literature).

Media:
In the lectures, work is done with PowerPoint, slides and blackboard notes.

Reading List:
Madigan TM, Martinko JM, Parker J (2020) Brock Mikrobiologie, Pearson München. Sehr gutes Lehrbuch zur allgemeinen Mikrobiologie mit einzelnen Kapiteln zur medizinischen Mikrobiologie. (auch ältere Auflagen).
Hof H, Dörries R (2019) Medizinische Mikrobiologie. 7. Auflage.
Blech J (2000) Leben auf dem Menschen: Die Geschichte unserer Besiedler.
Lucius, Loos-Frank, Lane: Biologie von Parasiten, 3. Auflage

Responsible for Module:
Prof. Romana Gerner romana.gerner@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in Biologie pflanzenpathogener Mikroorganismen (Vorlesung, 1 SWS)
Durner J

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 2023

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 können toxikologische Probleme mikrobieller Herkunft analysieren und bewerten.
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:

Responsible for Module:
Meyer, Karsten, Dr. agr. karsten.meyer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Mikrobielle Toxine in der Nahrung (Vorlesung, 2 SWS)
Meyer K

Analytik mikrobieller Toxine (Übung, 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 summerterm 2023

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, without aids) at the end of the second semester serves to test the theoretical competences learned during the module. In the written exam, the students show whether they are able to structure the acquired knowledge from tumor biology and to present the essential aspects. They should be able to describe the acquired information, interpret it, combine it in a meaningful way and transfer it to similar situations.

In addition, there is the possibility to take a voluntary course achievement as a mid-term achievement according to APSO §6 para. 5. For this, an oral presentation (20 min) on a current scientific article is to be given, and a handout (2 pages) on the presentation is to be provided.
The module grade will be improved by 0.3 if the student's performance is better characterized by the overall impression and if the deviation has no influence on the passing of the examination. No retake date will be offered for the mid-term performance. In the event of a repeat of the module examination, a mid-term performance already completed will be taken into account.
The mid-term performance (lecture and handout) is intended to demonstrate the acquisition of competence in the independent and critical interpretation of current research papers from the English-language literature.

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
- Telomere structure, immortalization, senescence chromosomal instability.
- Apoptosis, necroptosis, necrosis, autophagy, pyroptosis and 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 and cancer research.
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.

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:
Janßen, Klaus-Peter, Apl. Prof. Dr. rer. nat. klaus-peter.janssen@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Zellbiologie der Tumorentstehung (Teil 1) (Vorlesung, 2 SWS)
Janßen K [L], Janßen K, Laschinger-Bolzer M

Molekulare Zellbiologie der Tumorentstehung (Teil 1) (Übung, 1 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

WZ2496: 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, Ebert G, Kosinska A, Möhl-Meinke B, Pichlmair A, Vincendeau M, Wettengel J
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 summerterm 2023

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

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, 2 Klausuren/nach jedem Semester eine), dass sie grundlegenden Konzepte der Entwicklung des zentralen Nervensystems verstehen und zusammenfassen können. Sie sollen komplexe Sachverhalte über die molekularen Grundlagen und Entstehung von neuropsychiatrischen Erkrankungen in begrenzter Zeit aufzeigen können. Darüber hinaus sollen sie zeigen, dass sie ihr erlerntes Wissen dazu nutzen können, Fallbeispiele analysieren und beurteilen zu können.

Der Durchschnitt der beiden Klausuren ergibt dann die Gesamtnote.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretische Kenntnisse in der Genetik (Entwicklungsgenetik der Tiere) sind wünschenswert.

Content:
1. Molekulare und zellbiologische Prinzipien der Entwicklung des zentralen Nervensystems: Neurogenese - Neuronale Migration - Netzwerkbildung - Synaptogenese - elektrische Maturation; 2. Morphologie und Funktion des Großhirns, Kleinhirns, Hippcampus, Basalganglien, Amygdala, Rückenmarks; 3. Erkrankungen des ZNS und deren molekularen Grundlagen: Alzheimer, Parkinson, Schizophrenie, Depression, Infektionen, Rückenmarkserkrankungen, Schlaganfall, Epilepsie, Prionerkrankungen, Erkrankungen des Hypothalamus

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung besitzen die Studierenden das grundlegende theoretische Verständnis über die Entstehung des Nervensystems. Sie sollen die Prinzipien der molekularen Regulation dieser Prozesse verstehen und diese erklären können, Kenntnisse über die Funktion und Morphologie zentraler Strukturen des ZNS besitzen und die Pathogenese (molekulare) von Erkrankungen des ZNS verstehen. Des Weiteren soll das Modul Interesse an der Neurogenetik fördern.

Teaching and Learning Methods:
Lehrmethode: Vorlesung mit fragend-entwicklender Methode
Lernaktivitäten: Studium von Literatur, Lernen von grundlegenden Prozessen, Problemlösung

Media:
Powerpoint, Skriptum auf der neuen Moodle-Plattform, Filme

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:
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, Laggerbauer B, Lang A, Rammes G, Welling A, Wille T

Seminar für Studierende der Biowissenschaften (Master) (Seminar, 2 SWS)
Welling A [L], Andergassen D, Avramopoulos P, Dueck A, Esfandyari Shahvar D, Laggerbauer B, Lang A, Rammes G, van der Kwast R, Welling A, Wille T

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

Module Description

MA9613: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

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:** 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:
Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M

Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 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

Practice-Oriented Modules | Praxisorientierte Module

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 (Excercise) (Übung, 2,5 SWS)
Stöcker K

Diagnostics of High Consequence Pathogens in Deployable Laboratories (Seminar) (Seminar, ,5 SWS)
Stöcker K

Diagnostics of High Consequence Pathogens in Deployable Laboratories (Lecture) (Vorlesung, 1 SWS)
Stöcker 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 winterterm 2022/23

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:
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 Grundkenntnisse 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 pilzlichen Mikroorganismen 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 Identifizierung 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; 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:
Köberle, Martin, Dr. rer. nat. martin.koeberle@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

WZ1817: Research Project Molecular Fungal Genetics | Forschungspraktikum Molekulare Pilzgenetik

Version of module description: Gültig ab winterterm 2022/23

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:
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 (30 min) 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:
End of Semester

(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 (6-week laboratory internship, full-time), 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:
After participation in the module courses, the students are able to
- to understand the applied microbiological, genetic and/or biochemical special methods, including safety and material knowledge, and to master them in terms of action,
- plan and carry out experiments independently
- to keep laboratory protocols in a meaningful and comprehensible way.

Teaching and Learning Methods:
The research-related internship enables relatively independent microbiological/molecular biological work under guidance and serves to prepare students for future experimental microbiological theses (master's thesis, doctoral dissertation). By working on a research project, students gain experience under everyday laboratory conditions and acquire broad experimental know-how. The module promotes interest in fungi, their application in research and development, and their importance for humans and the environment.

Translated with www.DeepL.com/Translator (free version)

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:
Benz, Johan Philipp, Prof. Dr. rer. nat. 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 2023

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:
Ehrmann, Matthias, Apl. Prof. Dr. matthias.ehrmann@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Lebensmittelbiotechnologie (Forschungspraktikum, 20 SWS)
Ehrmann 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 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** irregularly
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:
The required examination performance corresponds to “Laborleistung” (achievements in the lab). At first, your work will consist of scientific tests and measurements of and with pathogenic bacteria. It is important to show care, speed (without haste), initiative and accuracy. During the internship, a log (“laboratory journal”) must be kept; the extent will depend entirely on the needs during lab work. This practical part is weighted with 50%.
At the end, a written analysis should be submitted. Writings includes the above-mentioned experiments, the respective theoretical basics including literature study, the practical implementation, with any necessary calculations, their documentation and evaluation as well as the interpretation of the results with regard to the knowledge found in scientific literature. Follow the classic arrangement from "Heading - Summary - Introduction - Material & Methods - Results - Discussion - References". The documentation should not exceed 30 pages. This part is weighted with 40%.
A short 10-minute presentation complements the previous parts to test your communicative competence in presenting scientific topics to an audience. Here you put together about 10 slides in e.g. PowerPoint - with about the following division for the slides: Title 1, Introduction 2, Methods 2, Result 3, Discussion 1, Miscellaneous 1. The weighting here is 10%.
In summary, the students prove that they have learned to plan experiments with pathogenic bacteria, carry them out responsibly and document them adequately in accordance with good scientific practice. The students also show that they can discuss their test results and classify the technical context with reference to the scientific literature.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The prerequisite is a completed BSc. in Molecular Biotechnology, Nutrition and Biomedicine, Biology, or Biochemistry. Interest in molecular biology, pleasure in laboratory work, fine motor skills to cope with the experimental requirements in the modern research laboratory.

Content:
Participation in individual aspects of current microbiological research projects on molecular genetics and ecology of pathogens in the Core Facility Microbiome at the ZIEL - Institute for Food & Health. Examples would be: translational and transcriptomics of Pseudomonas aeruginosa with emphasis on overlapping encoded genes, experimental translational arrest of overlapping open reading frames; phenotypic analysis of novel putative protein-coding nucleotide sequences from pathogenic Escherichia coli. Other pathogenic bacteria, especially intestinal pathogens, are also of interest. Species which could be mentioned here can be other pathogens and bacteria, which are, depending on the environment, sometimes pathogenic or even probiotic (example Enterococcus faecalis).

Intended Learning Outcomes:
After participating in this module, the students have a basic understanding in applying safety-relevant microbiological methods when dealing with bacterial pathogens - depending on the specific topic, in the pathogen laboratory of level R1 or R2 and in the genetic engineering laboratory of security level S1, S2 or S3** .
In addition, the students learn how to use advanced molecular genetic methods for the genetic modification of pathogenic bacteria. These include, for example, cloning methods and directed mutagenesis. Depending on the topic, handling of real-time quantitative PCR and / or digital-droplet PCR and sequencing techniques is learned. Further, sequencing like transcriptomics and translatomics might be applied. The associated bioinformatic evaluation methods are also included. Furthermore, how the results are embedded in existing knowledge ("publications") is taught (falsification, verification).

Teaching and Learning Methods:
1) Practical work in the laboratory: Here you will learn how to work in the laboratory, first under supervision and then, if possible, independently.
2) Instruction talks: You will be introduced to the experiments and their possible dangers; you will receive explanations of the processes.
3) Demonstrations: here we show how, for example, certain movements are to be carried out on material and machines.
4) Experiments: These are planned with the supervisor and carried out in the lab.
5) Literature work: here you should gain an overview of your topic and experiments and make use of published protocols.
6) Data analysis / discussion of results: the data obtained must be contextualized - also in the sense of whether the experiment worked in principle, whether improvements need to be made, which follow-up experiments are in order, etc.
7) Presentation of results: first as a laboratory journal, then as a written elaboration and, finally, lecture. Here you learn presenting results to other specialists, such you are your results can be

subjected to scientific criticism (keyword "peer review"). Other scientists must be able to falsify or verify their experiments and hypotheses.

Media:
A laboratory journal is kept during the internship. Participation in weekly, scientific meetings of the other scientific employees is requested. Necessary literature for references and for self-study can usually be obtained online. At the end of the internship, a presentation of 10 min is to be given, which includes use presentation tools.

Reading List:
The research internship is embedded in current research work at the Core Facility Microbiome of the ZIEL Institute for Food & Health. The prerequisite is knowledge of the last published scientific articles by this working group, according to the chosen topic. Additional current literature is provided.

Responsible for Module:
Neuhaus, Klaus, PD Dr. rer. nat. habil. neuhaus@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum pathogene Bakterien (Forschungspraktikum, 10 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

WZ2399: Practical Course: Nutrition and Immunology | Forschungspraktikum Ernährung und Immunologie

Version of module description: Gültig ab summerterm 2023

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 examination performance is based on the laboratory performance.
The experiments, their evaluation and interpretation are documented and discussed by the students in written form (protocol). This protocol is written and graded according to the basic structure of a scientific article. In doing so, the students demonstrate that they are able to apply the theoretical and practical knowledge in this field to the results obtained and to summarize, present and interpret the data in a scientifically sound manner.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
A 6-week blocked laboratory practicum examines current issues in inflammatory bowel disease, tumorigenesis, nutrition, and intestinal microbiota or cellular stress mechanisms as part of ongoing research.

Intended Learning Outcomes:
After successful completion of the module, students possess theoretical competences in the field of immunology and inflammatory processes as well as practical competences in molecular biological, cell physiological, animal experimental and/or microbiological techniques. They are able to work on a scientific problem based on their own guided project.

Teaching and Learning Methods:
Working on a scientific question by means of an own project. In doing so, problem-oriented approaches to solutions are to be found. The students plan the experiments in cooperation with their supervisor and carry them out independently. They independently conduct literature research and make a scientific evaluation of the results; practical training, preparation, execution, interpretation and discussion of experiments.

Media:

Reading List:
suitable papers matching the topic of the research internship

Responsible for Module:
Haller, Dirk, Prof. Dr. rer. nat. dirk.haller@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
External: Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 1 SWS)
Haller D [L], Aguanno D, Coleman O, Haller D, Metwaly A, Ocvirk S, Omer H, Rath E, Schmöller I

Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 16 SWS)
Haller D [L], Haller D, Aguanno D, Coleman O, Krammel T, Metwaly A, Ocvirk S, Omer H, Rath E, Schmöller I, Schwamberger S
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)
Buchholz V, Busch D, Gerhard M, Mejias Luque R, Prazeres da Costa C, 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:	Language:	Duration:	Frequency:
Master	German	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
10	300	150	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, Ehrenreich A, Edelmann H
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, Baudrexl M, Edelmann H
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:	Language:	Duration:	Frequency:
Master	German/English	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
10	300	100	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, Baudrexl M, Edelmann H
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 2023

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 Prüfung ist eine Laborleistung. Sie setzt sich zusammen aus einem praktischen Laborteil mit etwa 150 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 (Umfang 8-12 Seiten) anzufertigen, der den Standards einer wissenschaftlichen Publikation nahekommt (Titel, Einleitung, Material und Methoden, Ergebnisse, Diskussion, Literatur). Der Bericht wird um eine Präsentation (20 min) ergänzt, um die kommunikative Kompetenz bei der Darstellung von wissenschaftlichen Themen vor einer Zuhörerschaft zu überprüfen.

Die Note ergibt sich aus der Gesamtleistung, die sich aus einer
A) allgemeinen Bewertung (Zusammenarbeit mit Betreuer, selbstständiges Arbeiten, Zuverlässigkeit, Protokollführung),
B) fachlichen Bewertung des Berichts (Literaturstudium, logische Strukturierung, Darstellung des Wesentlichen, wissenschaftliches Verständnis, Bewertung der Ergebnisse),
C) fachliche Bewertung der Präsentation
D) praktischen Fähigkeiten (technisches Verständnis, technische Durchführung, Sorgfalt und Umgang mit Betriebsmitteln)
zu jeweils gleichen Teilen (A:B:C:D=2:1:1:2) zusammensetzt.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Voraussetzung für die Teilnahme am Forschungspraktikum sind die erfolgreiche Teilnahme an Lehrveranstaltungen der mikrobiellen Ökologie z.B. die erfolgreiche Teilnahme am Modul Bodenmikrobiologie 1.

Content:
Verschiedene Methoden der Molekularbiologie (z.B. Proteomik, DNA-/RNA-Analysen, Metabolitanalysen, biochemische Tests, stabile Isotopenanalyse). Datensammlung, Datenauswertung und Dateninterpretation mit Hilfe von fortgeschrittener statistischer Analytik sowie Berichtsanfertigung.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage
- Fragestellungen und Arbeitstechniken der Bodenmikrobiologie zu verstehen, kritisch zu beurteilen und fachliche Fragen und deren Lösung selbst zu entwickeln.
- Boden-Mikroorganismen-Gemeinschaften mit modernen molekularbiologischen Methoden (z. B. Hochdurchsatzsequenzierung, Biostatistik unter Anwendung von R) zu charakterisieren.
- einfache Analysen komplexer Sequenzdatensätze selbständig durchzuführen.
- funktionelle Charakterisierung mikrobieller DNA-sequenzen anhand von Datenbanken (FUNguild, FUNtraits) zu vollziehen.
- ggf. weitere Methoden zur Charakterisierung mikrobieller Gemeinschaften (stabile Isotopen-Techniken anzuwenden).
- Daten eigenständig zu erfassen, auswerten und im Kontext der aktuellen wissenschaftlichen Literatur zu interpretieren.
- vorhandenes Grundlagenwissen mit aktuellen Publikationen zum behandelten Thema eigenständig zu verknüpfen.
- neu generiertes Wissen in der praktischen Forschung anzuwenden.
- eine Forschungsfrage zu bearbeiten, in den wissenschaftlichen Zusammenhang zu stellen und zu diskutieren.

Teaching and Learning Methods:
- Experimente unter 1:1 Anleitung durch wissenschaftliches Personal (Learning by doing) in bestehenden, laufenden Forschungsarbeiten, um Einblicke in Forschungsabläufe zu bekommen
- Präsentationen um Ergebnisse zusammenzustellen und zu diskutieren:
o Kurzpräsentationen (Figure of the day) in regelmäßigen Labortreffen als regelmäßiges Feedback
o Abschlusspräsentation der Ergebnisse als Übung zu Vortragsstil und Feedback
- Abschlussbericht als Übung und Anleitung zum Verfassen einer wissenschaftlichen Arbeit

Media:
Mitarbeit im Labor, Dialog mit Betreuenden

Reading List:
nach Absprache mit den Betreuenden

Responsible for Module:
Pritsch, Karin; Apl. Prof. Dr. rer. nat. habil.: 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

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 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:
Prior participation in the lecture "Molecular Biology of Biotechnologically Relevant Fungi" is recommended.

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, Karl T, Tamayo Martinez E
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 2022/23

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.
Participants should be able to recognize, understand and apply laboratory techniques. They are able to analyze the data produced and to evaluate data with appropriate supervision. Participants should think of own research ideas building up on the research internship (future outlook).

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 2022/23

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.
Participants should be able to recognize, understand and apply laboratory techniques. They are able to analyze the data produced and to evaluate data with appropriate supervision. Participants should think of own research ideas building up on the research internship (future outlook).

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.

Theory-Oriented Modules | Theorieorientierte Module

Module Description

WZ2626: Applied Microbiology | Angewandte Mikrobiologie

Version of module description: Gültig ab winterterm 2022/23

Module Level:	Language:	Duration:	Frequency:
Master	German/English	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	105	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:
Liebl, Wolfgang, Prof. Dr. wliebl@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Mikrobiologie - Biosyntheseleistungen (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A

Angewandte Mikrobiologie - Abbauleistungen (Vorlesung, 1 SWS)
Liebl W, Ehrenreich A
For further information in this module, please click campus.tum.de or here.

Module Description

LS20032: Biological Warfare Agents - A Dark Side of Microbiology | Biological Warfare Agents - A Dark Side of Microbiology

Version of module description: Gültig ab winterterm 2023/24

Module Level: 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:
In the written exam (90 min), students answer questions about the significance of dangerous infectious diseases and historical and current threats posed by biological warfare agents, among other topics. They explain procedures for preventing, detecting, and mitigating potential risks that biotechnological research may pose. They distinguish the hazards of natural, deliberate or accidental releases of pathogens or biological toxins. In addition, they can explain the most important procedures of applied basic research on biosafety and biosecurity. They describe basic principles and methods, e.g., forensic identification of microorganisms. They reflect on the risks posed by Dual-Use Research of Concern and apply the knowledge gained in the context of their own research questions.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
The lectures will provide a basic knowledge of dangerous infectious diseases, their potential for misuse and the dangers of Dual-Use Research of Concern (DURC). This includes knowledge of the biology and clinical features of high consequence pathogens, including modes of transmission and pathomechanisms. Furthermore, the basics of medical biodefence and microbiological investigations of outbreaks of bacterial and viral pathogens and biological toxins will be covered, including examples of their application in biotechnological research projects. Lectures will provide background information and theory directly related to applied medical and biotechnological research projects. Basic and specialised methods of practical laboratory work for the detection of

dangerous pathogens and bioforensic investigation are taught. Students apply their newly acquired knowledge in practical case studies.

Intended Learning Outcomes:
On completion of the module, students will have a basic theoretical understanding and knowledge of the importance of dangerous infectious diseases, the historical and current threats posed by biological warfare agents, and the potential risks posed by the unintended consequences of biotechnology research. In addition, they will have understood and practised the basic procedures for the prevention, detection and containment of such hazards. They should be able to
- recognise the hazards of natural, deliberate or accidental releases of pathogens or biological toxins.
- have an insight into the most important procedures in basic applied biosafety and biosecurity research,
- use fundamental principles and methods, e.g. forensic identification of microorganisms, development of advanced detection and treatment approaches, analytical methods for biotoxins,
- understand risks through Dual-Use Research of Concern (DURC) and adapting them to their own research questions.

The module also aims to develop students' problem-solving skills and interest in applied microbiology and the responsibility of science towards people and the environment.

Teaching and Learning Methods:
Form/technique of teaching: lectures.
Teaching method: oral lecture; teamwork, discussion of results.
Learning activities: study of lecture notes and own notes; study of literature.
Accompanying the lectures, the students have to work on case studies (ungraded) and thus, show their ability to transfer the training contents to challenges in own research projects.

Media:
Presentations using PowerPoint, handout script (download option for lecture material)

Reading List:
There is no textbook that comprehensively covers all the contents of this module. The following documents and books are recommended as basic or supplementary literature:
Medical aspects of biological warfare, eds. Joel Bozue, Christopher K. Cote, Pamela J. Glass, Fort Sam Houston, Texas, Office of the Surgeon General, Borden Institute, 2018, ISBN 9780160941597, https://irp.fas.org/threat/cbw/medical.pdf
National Academy of Sciences Leopoldina and German Research Foundation (2022): Freedom of Science and Responsibility for Science - Empfehlungen zum Umgang mit sicherheitsrelevanter Forschung / Scientific Freedom and Scientific Responsibility - Recommendations for Handling of Security-Relevant Research, 2nd updated edition. Halle (Saale), https://www.leopoldina.org/fileadmin/redaktion/Publikationen/Nationale_Empfehlungen/2022_DFG-Leopoldina_Empfehlungen_Wissenschaftsfreiheit_web.pdf
Whitby S, Novossiolova T, Walther G and Dando M (2015) Preventing Biological Threats: What You Can Do. A Guide to Biological Security Issues and How to Address Them. University of

Bradford, Bradford Disarmament Research Centre. https://www.bradford.ac.uk/media-v8/site/news/archive/Preventing-Biological-Threats-What-You-Can-Do-(PDF,-10.6mb).pdf.

Responsible for Module:
Wölfel, Roman, Apl. Prof. Prof. Dr.med. roman.woelfel@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

WZ2559: Soil Microbiology 1 | Bodenmikrobiologie 1

Version of module description: Gültig ab summerterm 2023

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:
Examination course consisting of written module examination Examination (duration 90 min, 12 questions) on the contents of the VLs Soil Microbiology (2/3) and Mycorrhiza (1/2), as well as assessment of the seminar presentation based on the criteria:
A Content: paper presented in a comprehensible way (title, content, approach), relation to theoretical concept and critical discussion,
B Form: Presentation style and clarity of presentation (A:B=4:1).

The final grade is composed of written exam (75%)+ seminar grade (25%).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of microbial ecology, microbiology, environmental biology, ecology, or related disciplines.

Content:
VL Soil Microbiology:
- Importance of soil as a habitat for microorganisms: chemical, physical, biological characterization.
- Hotspots in the soil: rhizosphere, detritosphere, drillosphere
- Introduction to soil microorganisms
- Methods for studying the diversity and functions of soil microorganisms
- C cycle: Soil as a C sink and source
- N cycle: nitrification, denitrification, N-fixation
- further material cycles (P, S)
- Methods for the investigation of biological processes in soils
- influence of climate change, land use, pollution on soil functions

- Biotic interactions (quorum sensing, volatile signalling)
- Application of soil microorganisms in plant protection
VL Mycorrhiza:
- Deepening knowledge of an ecologically essential group of plant-associated soil microorganisms using mycorrhizae as an example.
- arbuscular myorrhiza: fungal and plant partners, regulation of symbiosis, exchange of substances, ecological importance
- Ectomyorrhiza: fungal and plant partners, regulation of symbiosis, substance exchange, ecological significance
- Ericaceae myorrhiza: ericoid, arbutoid, monotropoid mycorrhizae fungal and plant partners, nature of interactions
- Orchid mycorrhiza: fungal and plant partners, regulation of symbiosis, exchange of substances, ecological significance
- Endophytic (non-mycorrhizal) root-fungal interactions.
- General mechanisms of mutualistic symbioses
- Influence of climate change on mycorrhizae
Seminar:
- Part 1 theoretical-conceptual papers of microbial ecology (e.g. relation between diversity and function of microbial communities (group work)
- Part 2 Examples of experimental research in the context of the theoretical concept (individual presentations)

Intended Learning Outcomes:
Successful participation in the module includes:
- basic knowledge of microbial diversity, functions and influences in soil habitats are understood.
- complex relationships between microbial activities and their importance for global material cycles can be reproduced.
- adaptation strategies of soil microorganisms in natural and managed habitats as well as under changing environmental conditions can be assessed.
- the ability to critically discuss paradigms of soil microbiology.
- theoretical-conceptual contents of microbial ecology are understood exemplarily and can be applied to research work in the mentioned theoretical context.
The ability to critically examine and evaluate research work is acquired.

Teaching and Learning Methods:
Lecture + various interactive elements: transfer of knowledge + short-term repetition and long-term consolidation of learning content
Seminar: independent development of scientific content + presentation

Media:
Script, Blackboard, PowerPoint, ZOOM (or appropriate online format).

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¬
I. Kottke:, Mykorrhiza – Pilz-WurzelSymbioesenhttps://de.wikibooks.org/wiki/Mykorrhiza_%E2%80%93_Pilz-Wurzel-Symbiosen

Responsible for Module:
Pritsch, Karin; Apl. Prof. Dr. rer. nat. habil. karin.pritsch@tum.de Weikl, Fabian; Dr. rer, nat, fabian.weikl@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Mykorrhiza (Vorlesung, 1 SWS)
Pritsch K

Seminar Bodenmikrobiologie (Seminar, 1 SWS)
Pritsch K, Rosenkranz M, Weikl F

Bodenmikrobiologie (Vorlesung, 2 SWS)
Pritsch K, Weikl F
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 2023/24

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:
Gerner, Romana, Dr. romana.gerner@tum.de

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 2023

Module Level:	Language:	Duration:	Frequency:
Master	German	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	105	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 (z.B. 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

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:
Neuhaus, Klaus, PD Dr. rer. nat. habil. neuhaus@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zur Ökologie und Evolution pathogener Bakterien (Übung, 1 SWS)
Neuhaus K [L], Neuhaus K

Ökologie und Evolution von pathogenen Bakterien (Vorlesung, 2 SWS)
Neuhaus K [L], Neuhaus K
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

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

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:
The examination takes the form of a written exam (60 minutes) and a presentation (60 minutes; pass/fail credit requirement).
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 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.

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 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 2023/24

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:
The examination takes the form of a 90-minute written Klausur. In this, it should be demonstrated that the aspects mentioned above can be reproduced and applied to concrete questions. Students should be able to briefly summarise questions of understanding on the topics covered in the lecture in their own words. The examination questions cover the entire module material.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Lecture and practical course General Microbiology

Content:
Contents: Introduction to the biology of human pathogenic bacteria:

Part 1:
- Overview of humans and microbes;
- Relationship between commensals and pathogens;
- Koch's postulates;
- Overview of bacterial pathogenicity and virulence; host defence systems (especially different levels of the innate immune system); pathogen defence systems (immune evasion, adhesion to the host cell, invasion and intracellular growth, bacterial toxins);

Part 2:
- Diagnostics and epidemiology: taxonomy of pathogenic bacteria; species terms; identification (physiological, biochemical, biophysical and genetic methods);
- Diagnostic procedures (enrichments, rapid procedures, automated procedures);

- Clinical case studies;
- Infectious disease epidemiology (significance of infections in Germany, collection of epidemiological data, methods for tracing contamination routes);

Content: Biology of human pathogenic parasites:
- Introduction to human parasitology
- Transmission, diagnostics and host interaction: Malaria, Giardia, Toxoplasma gondii
- Neglected tropical diseases: Chagas disease, Echinococcosis, African trypanosomiasis, Leishmaniasis, Lymphatic filariasis, Onchocerciasis, Schistosomiasis, soil-transmitted helminthiases.
- Control measures and programs, epidemiology, immune escape mechanisms

Intended Learning Outcomes:
After participating in the module courses, students will be able to,
- identify the characteristics of pathogenic bacteria.
- understand and describe the interaction of bacterial pathogens with human hosts.
- to name the importance of pathogens in food biotechnology and the diagnostic procedures in medical and food microbiology laboratories.
- to know the infection epidemiological situation in Germany.
- to name exposure risks for human-relevant parasitic infections, their development cycles and the corresponding clinical pictures.

Teaching and Learning Methods:
Lecture (independent revision based on slides, notes, literature).

Media:
In the lectures, work is done with PowerPoint, slides and blackboard notes.

Reading List:
Madigan TM, Martinko JM, Parker J (2020) Brock Mikrobiologie, Pearson München. Sehr gutes Lehrbuch zur allgemeinen Mikrobiologie mit einzelnen Kapiteln zur medizinischen Mikrobiologie. (auch ältere Auflagen).
Hof H, Dörries R (2019) Medizinische Mikrobiologie. 7. Auflage.
Blech J (2000) Leben auf dem Menschen: Die Geschichte unserer Besiedler.
Lucius, Loos-Frank, Lane: Biologie von Parasiten, 3. Auflage

Responsible for Module:
Prof. Romana Gerner romana.gerner@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in Biologie pflanzenpathogener Mikroorganismen (Vorlesung, 1 SWS)
Durner J

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 2023

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 können toxikologische Probleme mikrobieller Herkunft analysieren und bewerten.
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:

Responsible for Module:
Meyer, Karsten, Dr. agr. karsten.meyer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Analytik mikrobieller Toxine (Übung, 2 SWS)
Meyer K

Mikrobielle Toxine in der Nahrung (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 winterterm 2022/23

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:
In a presentation (20 min) followed by a discussion on special topics of microbial diversity (overview of selected taxa, microbial communities and / or methods for characterization of microorganisms) the participants show that they can independently prepare and present a special microbial topic to an expert audience and also answer more in-depth questions. The material covers the entire microbial diversity and goes in the technical depth significantly beyond the depth achievable in the lecture.
The examination results for the examination of theoretical competences (written examination, 60 min) and the ability to work independently on a very specific topic and to represent this in speech and answer (presentation) are counted (2:1). The module is passed if the weighted average grade is better than 4.1.

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

microbial communities, as well as their properties and importance, are presented and discussed in lectures.

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.
" to work independently on a topic in the field of microbial diversity and to present and discuss the gained knowledge competently and in a well understandable way to an audience.
" 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:
Liebl, Wolfgang, Prof. Dr. wliebl@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 summerterm 2023

Module Level:	Language:	Duration:	Frequency:
Master	German/English	two semesters	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
10	300	165	135

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

Description of Examination Method:
The examination takes place at the end of the two-semester module by means of a written exam (60 min). The questions refer to the theoretical knowledge acquired in the lectures and the knowledge deepened or practically applied in the seminar or practical course. In the written exam, for example, the molecular methods presented in the lectures are to be named and discussed for specific questions. In the written exam, the students show that they are able to structure the knowledge they have acquired and to present the essential aspects. Regular, active participation in the courses is expected.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Introductory lecture "Ecological Microbiology and Microbiomes"; beginner's microbiology practical course; basic knowledge of molecular methods such as PCR.

Content:
Molecular methods play a very important role in microbial ecology to capture the diversity of microorganisms in the environment. However, new approaches to isolate previously unknown prokaryotes are also of great importance in understanding about ecosystem functioning. Accordingly, the module will address a wide range of methods used in modern microbial ecology. These include PCR-based methods as well as high-throughput sequencing techniques or the use of stable isotopes. But 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 directions, especially with regard to proteomics and metabolomics, will also be discussed.

Intended Learning Outcomes:
After completion of the course, students are able to independently make a selection from the "box of methods" that are best suited for specific questions in microbial ecology. Students are familiar with the advantages and disadvantages of individual methods and are thus able to recognize the complementarity and synergies of individual approaches. Furthermore, students are able to use appropriate methods independently, e.g. in the context of a master thesis or PhD. Through the seminar, knowledge from current research is used to develop perspectives of microbial ecology for the future.

Teaching and Learning Methods:
Course type/teaching technique: lecture, seminar; practical course Teaching method: lecture; in practical course instructional discussions, demonstrations, experiments, partner work, discussion of results.

Learning activities: study of lecture notes, transcript, practical script and literature; practice of laboratory skills and microbiological working techniques; collaboration with practical partner; preparation of protocols.

Media:
Lecture: script; PowerPoint presentation; seminar: literature; practical: script; independent work

Reading List:
Handbook of Molecular Microbial Ecology; ed: Frans J. de Bruijn; John Wiley & Sons; ISBN-10: 0470647191

Responsible for Module:
Schloter, Michael; Prof. Dr. rer. nat. habil. schloter@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Moderne Methoden der Mikrobiellen Ökologie (Seminar, 2 SWS)
Schloter M, Schulz S

Moderne Methoden der Mikrobiellen Ökologie (Praktikum, 5 SWS)
Schloter M, Schulz S

Moderne Methoden der Mikrobiellen Ökologie (Vorlesung, 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:
Mikrobiologie und Biotechnologie der Milch- und Milchprodukte (Vorlesung, 1 SWS)
Henkel M [L], Henkel M
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

MA9613: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

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:** 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

Practice-Oriented Modules | Praxisorientierte Module

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 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 (UE) (Übung, 3 SWS)
Loretto M

Bewegungsökologie von Wildtieren (VO) (Vorlesung, 1 SWS)
Loretto M
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

Bodenkundliches Seminar für Fortgeschrittene (Seminar, 3 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

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 summerterm 2023

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:
Upon completion of the module, the students have a profound understanding of key aspects of environmental monitoring and 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.
The examination of the module will be in the form of a written examination (Klausur, 180 min); which consists of two sub parts: first a written part (40%, approx.60 minutes) on monitoring concepts and second a programming part on handling environmental monitoring datasets (60%, approx. 120 minutes).

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 is a combined lecture and exercise sessions where students will work 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:
Menzel, Annette; Prof. Dr. rer. silv.

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

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

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 Einflußgrößen 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

WZ1415: Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2022/23

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 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

WZ1416: Research Project: Chemistry of Plant-Insect Interactions | Forschungspraktikum zu chemischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2022/23

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 Prüfungsleistung ist eine Laborleistung, d.h. die Studierenden sollen eine oder mehrere Forschungsfragen weitgehend selbständig bearbeiten. Zur Durchführung liegen zum Teil vorgegebenen Protokolle vor. Die Studierenden führen Teilweise Freiland als auch Laborarbeiten durch und werden dabei jeweils in die Arbeitsmethoden und Geräte eingewiesen, so dass sie die Methoden meist vollkommen selbständig, in einigen speziellen Fällen unter Anleitung nutzen können (z.B. einen Gaschromatographen gekoppelt an ein Massenspektrometer, GCMS). Im Rahmen des Forschungspraktikums erheben sis 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 Insekt-Pflanze Interaktion mit Fokus auf die damit verbundene chemischen Vorgängen innerhalb begrenzter Zeit erfolgreich bearbeiten und entsprechend den wissenschaftliche 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 Laborleistug 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 sowohl in temperaten als auch in tropischen Ökosystemen behandelt werden. Beispielhaft wären die Themen „Einfluss von Pollennährqualität auf das Sammelverhalten von Honigbienen“ oder "Bedeutung von Pflanzenharzen für soziale Bienen"; dies beinhaltet in der Regel eine Kombination aus chemischen Analysen und Freiland- oder Käfigbeobachtungen. Weiterhin können auch Experimente mit anderen Insekten (Schmetterlinge, Fliegen, Käfer, Ameisen) erfolgen. Der Schwerpunkt in diesem Forschungsmodul liegt auf der Untersuchung der Chemie, 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 chemischen Interaktionen zwischen Pflanzen und Insekten sowie deren Auswertung weitgehend oder vollständig eigenständig durchzuführen. Dazu gehört das Designen von Feldexperimenten, die systematische Datenaufnahme und Probenentnahme im Feld, die Extraktion und chemische Analytik von Proben mittels Gaschromatographie Massenspektrometrie (GCMS) anhand bestehender Laborprotokolle, die chemische Auswertung von Proben mittels des Programms Chemstation, 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. GCMS, Rotationsverdampfer, Soxhlet-Apparatur, 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 chemischen Analysen 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

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

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

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

WZ2390: Methods in Fish Biology and Aquatic Ecology | Forschungspraktikum Methoden der Aquatischen Ökologie und Fischbiologie - molekular

Version of module description: Gültig ab winterterm 2022/23

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 overall grade for the practical course results from the practical laboratory performances and the written summary in the form of a report of 10-15 pages (weighting 1:2). The report includes the description of the experimental design, the experimental procedures and the respective theoretical basis incl. literature study, the preparation and practical execution, any necessary calculations, their documentation and (statistical) evaluation as well as the interpretation of the results with regard to the knowledge to be gained. The practical work usually includes a main experiment as well as the preparatory steps necessary for its execution (e.g. DNA/ RNA extraction, purification, primer design). The report tests the competence to communicate scientific results in writing, to present and evaluate the main results in a meaningful way and to place them in the context of the current state of knowledge.

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 and preparation of a scientific research report.

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.

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:
Geist, Jürgen, Prof. Dr. rer. nat. 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

WZ2467: Research Project Plant Ecophysiology | Forschungspraktikum Ökophysiologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** 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:
Die Studierenden erarbeiten ein Protokoll (Hausarbeit), welches die Fragestellung, verwendete Methoden und die Ergebnisse darstellt und diese diskutiert. Diese Protokoll wird bewertet.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
BSc-Praktikum "Experimentelle Pflanzenökologie"
MSc-Praktikum "Plant Ecophysiology - Research at the Plant/Atmosphere-Interface"
Modul "Pflanzenfunktionen im Klimawandel"

Content:
Im Fokus stehen aktuelle ökophysiologische Fragestellungen der Pflanzenökologie. Nach Orientierung in der wissenschaftlichen Literatur zu der gewählten speziellen Fragestellung, wird die Durchführung des Experiments (an Freilandpflanzen oder in Klimakammern) eigenständig geplant und durchgeführt. Hierbei kommen aktuelle ökophysiologischer Methoden wie z.B. stabile Isotope oder Gaswechsel- und Xylemflussmesstechnik zum Einsatz. Die selbstständig gewonnenen Ergebnisse werden im Zusammenhang mit relevanter internationaler Literatur diskutiert.

Intended Learning Outcomes:
Verständis des wissenschaftlichen Prozesses von der Fragestellung, über Hypothesenbildung bis zur Diskussion der Ergebnisse im Zusammenhang mit der internationalen wissenschaftlichen Literatur. Erlernen von Versuchsplanung und -führung. Umgang mit aktuellen Methoden in der Pflanzenökophysiologie. Kritische Beurteilung der angewandten Methoden.

Teaching and Learning Methods:
Vorbereitung des Themas durch ausgewählte internationale Literatur, Gespräche zur Einführung, Üben von technischen und labortechnischen Fertigkeiten, Protokollerstellung, Datenauswertung, kritische Interpretation der Ergebnisse, Methodenkritik

Media:

Reading List:
von Willert D, Matyssek R, Herppich W (1995) Experimentelle Pflanzenökologie, Thieme, Stuttgart;
Tyree M, Zimmermann MH (2002) Xylem structure and the ascent of sap. Springer, Berlin.
Larcher H (2001) Ökophysiologie der Pflanzen, Ulmer-Verlag, Stuttgart
Schulze et al. (2002) Pflanzenökologie, Spektrum
Wissenschaftliche Originalliteratur nach Absprache

Responsible for Module:
Grams, Thorsten; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Ökophysiologie der Pflanzen (Forschungspraktikum, 10 SWS)
Grams T
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)
Weißer W [L], Meyer S
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
hanno.schaefer@tum.de
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], Kollmann J, 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

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

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, Bucka F, Göttlein A, Kolb E, Laniewski R, Leemhuis S, Höschen C
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

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

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 2022/23

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:
End of Semester

(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:
Die Studenten werden in den aktuellen Stand der Forschung zu den wichtigsten Aspekten des besuchten Alpenflusssystems und relevante Methoden der Ökologie eingeführt, und identifizieren unter Anleitung des Dozenten und in Diskussion mit der Gruppe geeignete Fragestellungen inkl. tier- und pflanzenökologischer Feldexperimente. Das besuchte Ökosystem und die relevanten Ökosystemprozesse werden vorgestellt. 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:
Thomas Wagner; Dr. wagner@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Ökologischer Feldkurs: Vegetations- und tierökologische Übungen (Übung, 6 SWS)
Wagner T [L], Wagner T
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

WZ1248: Terrestrial Ecology 2 | Terrestrische Ökologie 2

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:** 60	**Contact Hours:** 90

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

Description of Examination Method:
Die Prüfungsleistung ist eine wissenschaftliche Ausarbeitung von 10-15 Seiten, die von der Form her einer klassischen wissenschaftlichen Publikation entspricht, mit Einleitung (Hintergrund), Methodenteil (inkl. Beschreibung der angewandten statistischen Methoden), Ergebnisteil und Diskussion entspricht.
Anhand der Prüfung zeigen die Studierenden am Beispiel der von ihnen in der Übung entwickelten Fragestellung und Hypothesen, der Anwendung der ökologischen Methoden zur Datenerfassung, der Auswertung der Daten und deren Interpretation, dass sie wissenschaftliche Studien zum Einfluss des Menschen auf oder zur Funktion von ökologischen Lebensgemeinschaften entwerfen, analysieren und bewerten können. In der Diskussion zeigen die Studierenden dabei, wie sie die Ergebnisse für ein verbessertes Ökosystemmanagement nutzen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modul Terrestrische Ökologie I

Content:
Das Modul umfasst folgende Inhalte:
- moderne Methoden der statistischen Analyse ökologischer Daten (z.B. glm, LM, weitere Prozeduren in R)
- Entwicklung einer ökologischen Forschungsfrage basierend auf Freilandbeobachtungen
- Entwicklung einer testbaren Hypothese aus der ökologischen Forschungsfrage
- Auswahl und Anwendung einer Methode der terrestrischen Ökologie, um die Hypothese zu testen
- Analyse der eigenen Daten mit Hilfe der gelernten statistischen Verfahren
- Interpretation der Ergebnisse im Hinblick auf die gestellte Hypothese
- Vergleich der Ergebnisse mit der Fachliteratur

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, die Ergebnisse wissenschaftlicher Untersuchungen zum Einfluss von Umweltfaktoren auf ökologische Lebensgemeinschaften zu analysieren und zu bewerten. Zudem sind die Studierenden in der Lage, eigene Experimente zum Einfluss des Menschen oder zur Funktion von terrestrischen Ökosysteme selbst zu entwickeln, durchzuführen und mithilfe der vermittelten statistischen Verfahren auszuwerten.

Teaching and Learning Methods:
In der Übung Spezielle Methoden in R werden zunächst die statistischen Verfahren vom Dozenten vorgestellt. Mithilfe von Fachliteratur und durch Anwendung der Methoden auf zur Verfügung gestellte Musterdaten werden die Verfahren am Computer eingeübt. In der Übung Terrestrische Ökologie 2 entwickeln die Studierenden in Kleingruppen in Diskussion mit Mitstudierenden und den Dozenten eine eigene Fragestellung zur Funktion von Lebensgemeinschaften und/oder zum Einfluss des Menschen auf die Lebensgemeinschaften. Basierend auf der Fragestellung entwickeln die Studierenden Hypothesen, die sie in einem selbst entwickelten Experiment testen und die eigenen Daten selbst analysieren und mit Hilfe der Fachliteratur bewerten.

Media:
Präsentationen (Powerpoint) vom Dozenten und Studierenden, Protokoll, wissenschaftliches Paper.

Reading List:
Wird den Studierenden zu Beginn der Übungen mitgeteilt.

Responsible for Module:
Wolfgang Weisser Wolfgang.weisser@tum.de

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 [L], Meyer S, Weißer W

Terrestrische Ökologie 2 (Übung, 4 SWS)
Meyer S [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

Artenverbreitung von Makrophyten entlang der vertikalen Gradienten abiotischer Faktoren in Seen/ Forschungstaucherausbildung Block 3 (Limnologie) (Übung, 4 SWS)
Zimmermann S, Leidholdt J

Flora und Fauna des Mittelmeeres (Limnologie) / Forschungstaucherausbildung Block 2 (Übung, 4 SWS)
Zimmermann S, Leidholdt J
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

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:
Versuchsplanung (Fortgeschrittenenkurs) (Vorlesung, 2 SWS)
Meyer S, Weißer W

R für Fortgeschrittene (Übung, 4 SWS)
Meyer S, Weißer W
For further information in this module, please click campus.tum.de or here.

Theory-Oriented Modules | Theorieorientierte Module

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

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)
Höschen C, Schweizer S
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:
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

Böden der Welt (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, 1 SWS)
Rammig A [L], Krause A, Rammer W, Wagner T

Einführung in die ökologische Modellierung (Übung, 3 SWS)
Rammig A [L], Krause A, Rammer W, Wagner T
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], Butschkau S, 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

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)
Leonhardt S, Annighöfer P, Geist J, Grams T, Häberle K, Kögel-Knabner I, Kollmann J, Menzel A, Pauleit S, Seidl R, Tellier A

R für Fortgeschrittene (Focus Ökologie) (Übung, 4 SWS)
Meyer S [L], Meyer S, Weißer W

R für Fortgeschrittene (Übung, 4 SWS)
Meyer S, Weißer W
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 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:
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, create and apply sustainable aquatic conservation tools 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 exercise the students prepare a presentation in form of a brochure, 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 exercise

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 exercise "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 The module combines a lecture "Fisheries Management" with an accompanying practical exercise "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 exercise 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 programs, 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 exercise
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], Pander J, Zingraff-Hamed 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 2 (Übung, 1 SWS)
Donaubauer A

Geoinformationssysteme 1 (Vorlesung, 1 SWS)
Donaubauer A

Übungen zu Geoinformationssysteme 1 (Übung, 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 winterterm 2022/23

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 78	**Contact Hours:** 72

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:
Prietzel, Jörg, Apl. Prof. Dr. prietzel@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Geologie und Gesteinskunde, Teil 1 (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 2 (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:
Aktuelle Themen zu Klimaschutz, Ingenieurökologie und Abwasserbiologie (Seminar, 1 SWS)
Gschlößl T

Ingenieurökologie und Klimawandel in aquatischen Systemen (Vorlesung, 2 SWS)
Gschlößl T

Methoden der technischen und naturnahen Abwasserreinigung (Exkursion, 1 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)
Joschinski J [L], Grams T, Joschinski J, Mimet A, Schäfer H, Weikl F, Weißer W

Konzepte und Forschungsmethoden der Ökologie (Vorlesung, 2 SWS)
Joschinski J [L], Weißer W, Grams T (Layritz L, Meyer B), Joschinski J, Mimet A, Schäfer H, Weikl F
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

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:
Seminar zur Evolution und Biogeographie von Insel-Floren (Seminar, 2 SWS)
Schäfer H [L], Schäfer H

Exkursion zur Evolution und Biogeographie von Insel-Floren (Exkursion, 4 SWS)
Schäfer H [L], Schäfer H
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 2023/24

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 Minuten) fragt ab, ob die Studierenden die grundlegenden Herausforderungen des Biodiversitätsschutzes und die Konzepte zum Schutz der Natur verstehen und komprimiert wiedergeben können (siehe Lernergebnisse). Weiterhin fragt die Klausur ob, ob die Studierenden Lösungen zu konkreten Naturschutzproblemen 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 wie sie in, für den Master Naturschutz- und Landschaftsplanung qualifizierenden Bachelorstudiengängen erworben werden können.

Content:
Das Modul gliedert sich in eine Vorlesung und ein Seminar und hat die Aufgabe, vor allem den Studierenden, die naturschutzfachliche Aspekte aus dem Vorstudium noch nicht im Umfang dieses Moduls kennen, Instrumente und Methoden des Naturschutzes kompakt vorzustellen und die wesentlichen Eigenschaften zu vermitteln. Dadurch wird eine einheitliche Niveaustufe im Bereich des Naturschutzes im Studiengang unter den Studierenden angestrebt und die erreichten Lernergebnisse können in den Studienprojekten des Studiengangs dann angewandt, wissenschaftlich weiterentwickelt und reflektiert werden.
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)

Im Seminar erarbeiten und präsentieren die Studierenden aktuelle Themen aus dem Bereich des Naturschutzes. 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. Praxisbeispiele veranschaulicht und ergänzen dabei die genannten Vorlesungsinhalte. 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 [L], Weißer W

Seminar Naturschutz (Seminar, 2 SWS)
Weißer W [L], Weißer W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1888: Philosophy of Nature and the Landscape - Advanced Level: Environmental Aesthetic, Environmental Ethic, Philosophy of Ecology | Spezielle Themen der Philosophie der Natur und der Landschaft: Ästhetiktheorie, Umweltethik, Wissenschaftstheorie der Ökologie

Version of module description: Gültig ab winterterm 2022/23

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 Prüfung ist eine Projektarbeit Die Prüfung in diesem Modul besteht aus einer Präsentation zu einem selbstgewählten Thema (1/3 der Gesamtnote) und einer Projektarbeit zu diesem oder einem verwandten Thema (2/3 der Gesamtnote). Das Thema können die Studierenden innerhalb des Rahmens wählen, der vorgegeben ist durch das Modulthema (Umweltethik und Wissenschaftstheorie) sowie das in jedem Semester wechselnde Seminar-Oberthema (zum Beispiel Windenergie und Landschaftsästhetik). Anhand der schriftlichen Ausarbeitung wird festgestellt, inwieweit die Studierenden in der Lage sind, Fachliteratur auszuwerten, kritisch zu analysieren und in einen inhaltlichen Zusammenhang mit den im Seminar vermittelten Inhalten zu bringen. Es wird so erkennbar, ob die vermittelten Inhalte verstanden wurden, ob sie auf das gewählte Ausarbeitungsthema angewendet werden können und ob die vermittelten Methoden verinnerlicht wurden. Anhand der Präsentation wird geprüft, ob die Studierenden in der Lage sind, auf der Grundlage der erlernten Inhalte aus Ästhetiktheorie, Umweltethik und Wissenschaftstheorie einen fundierten und für die Mitstudierenden verständlichen Beitrag zur Fachdiskussion zu leisten. Die Ergebnisse der an die Präsentation anschließende Diskussion sollen in die schriftliche Ausarbeitung eingearbeitet werden. Diese Anforderung ermöglicht es zu prüfen, ob die Studierenden in der Lage sind, ihr Thema kritisch zu reflektieren.
Die Studierenden bekommen die Möglichkeit, ihre Note mit freiwilligen Mid-Term-Leistungen um 0,3 Notenpunkte zu
verbessern (Essay zu selbst gewähltem Thema, Redebeitrag zur Abschlussdiskussion).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vertiefte Kenntnisse in Ökologie und Landschaftsplanung; Modul Einführung in die Philosophie der Natur und der Landschaft

Content:
Anhand wechselnder, aktueller Themen (z.B. ecoystem services als Naturschutzbegründungen, Windparks und Landschaftsbild) werden folgende Inhalte vermittelt:
* Vertiefte Kenntnisse zu auswählten Aspekten der Ästhetiktheorie, Umweltethik, Wissenschaftstheorie und Metatheorie der Ökologie
* Welche unterschiedlichen Auffassungen von Natur gibt es?
* Welche Werte liegen diesen Auffassungen zugrunde?
* Was ist "Landschaft"?
* Welche unterschiedlichen Begründungen für den Schutz von Biodiversität gibt es?
* Wie beeinflussen Auffassungen von Natur ökologische Theorien?

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, verschiedene Ansätze in der Ästhetiktheorie und der Umweltethik zu verstehen, kritisch zu reflektieren und auf aktuelle Themen in Landschaftsplanung und Naturschutz anzuwenden. Sie werden grundlegende Konzepte der Wissenschaftstheorie und der Metatheorie der Ökologie (wie die Unterschiede zwischen deskriptiv und normativ sowie zwischen naturwissenschaftlich-kausal und ästhetisch-symbolisch) verstehen und anwenden können. Sie werden sich vertiefte Kenntnisse in Teilbereichen der Umweltästhetik, Umweltethik oder Wissenschaftstheorie unter Anleitung selbst erarbeitet haben. Dies wird sie in die Lage bringen, Fachpublikationen kritisch zu bewerten und wissenschaftstheoretisch fundierte Beiträge zu Fachdiskussionen zu leisten. Sie werden in der Lage sein, verschiedene Methoden zur Textanalyse anzuwenden. Sie werden den Unterschied zwischen wissenschaftlichen Texten verschiedener Formen kennen und methodische Kenntnisse zum Führen wissenschaftlicher Diskussionen erlangt haben.

Teaching and Learning Methods:
Die Dozenten werden mit Hilfe von Kurzvorträgen und Präsentationen grundlegende Inhalte vermitteln und in das für das jeweilige Studienjahr ausgewählte Seminarthema einführen. Die Studenten haben die Aufgabe, zu vorgegebenen oder selbst gewählten Themen Präsentationen vorzubereiten und zu halten. Die Präsentationsvorbereitung wird eigene Materialrecherchen und das Studium vorgegebener Literatur beinhalten. Je nach Anzahl der Teilnehmer können die Präsentationen auch in Gruppen erarbeitet werden. Jede Präsentation wird im Seminar ausführlich diskutiert. Dabei wird das gewählte Ausarbeitungsthema mit dem jewiligen Seminarthema und den übergeordneten Themen des Moduls (Umweltästhetik, Umweltethik und Wissenschaftstheorie) in Verbindung gebracht. Während des Seminars werden in kleineren Lehreinheiten Methoden der Textanalyse, zum Textschreiben und zum Führen von Fachdiskussionen vermittelt, die dann in Gruppenarbeit eingeübt werden.

Zu dem gewählten Präsentationsthemen oder nach Absprache zu einem anderen, selbst gewählten Thema, erstellen die Studenten in Einzel- oder Gruppenarbeit eine schriftliche

Ausarbeitung. Während der Erstellung dieser schriftlichen Ausarbeitungen wird Einzel- und Gruppenbetreuung angeboten; diese Projektarbeit erfordert zudem intensives Eigenstudium.

Die Kombination aus Kurzvorträgen der Dozenten, Präsentationen der Studierenden, umfangreicher schriftlicher Ausarbeitung, Gruppenarbeit und Diskussionen wird es ermöglichen, das kritische Reflektieren der vermittelten Inhalte und der Fachliteratur einzuüben. Die vermittelten Inhalte werden an Fallbeispielen konkretisiert; damit wird ein tiefes Verständnis der Inhalte möglich.

Media:
PowerPoint, Flipcharts, Tafelarbeit

Reading List:
grundlegende Literatur wird im Kurs bzw. über Moodle bereitgestellt

Responsible for Module:
Heger, Tina; Dr. rer. nat. habil.: t.heger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Philosophie und Umweltethik für Naturschutz, Landschafts- und Umweltplanung: Spezielle Themen (Seminar, 2 SWS)
Heger T [L], Heger T

Projekt: Angewandte Philosophie (Projekt, 1 SWS)
Heger T [L], Heger T
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:
Lösung wissenschaftlicher Probleme in Gewässerökologie und Aquakultur (Seminar, 2 SWS)
Beggel S, Kühn R

Aquatic Ecology and Conservation V (Vorlesung, 2 SWS)
Geist J

Einführung in die Methoden der Aquatischen Systembiologie (Übung, 5 SWS)
Geist J [L], Dobler A, 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:	Language:	Duration:	Frequency:
Master	English	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	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

WZ6300: Ecosystem Management and Applied Restoration Ecology | Ökosystemmanagement und angewandte Renaturierungsökologie

Version of module description: Gültig ab winterterm 2023/24

Module Level:	Language:	Duration:	Frequency:
Master	German/English	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	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 (15 min) in form of a scientific talk followed by discussion. (weight: 70%, review, 30% presentation). The presentation is used to test the communicative competence of presenting scientific topics to an audience.

Repeat Examination:
Next semester / End of Semester

(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

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:
Einführung in die Populationsbiologie der Pflanzen (Vorlesung, 2 SWS)
Kollmann J, Teixeira Pinto L

Seminar Populationsbiologie und Naturschutz (Seminar, 2 SWS)
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 2023/24

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 concluded with an oral examination (20 min). 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).

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 CO_2 concentration, chronic O_3 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 CO_2, O_3, 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 in the module, students are able to understand the effect of "global-change" scenarios on plants and organisms interacting with plants on the basis of process-related thinking. Furthermore, they will be able to assess, analyze and interpret potential uses, development potentials of and risks for plant species, communities and interaction partners.

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 „Ökophysiologie der Pflanzen“, UTB Ulmer-Verlag, 5. Aufl. 1994; Lambers, Chapin, Pons „Plant Physiological Ecology“, Springer-Verlag, 1998; Matyssek, Fromm, Rennenberg, Roloff "Biologie der Bäume", UTB Ulmer-Verl., 2010; Schlesinger/Bernhardt „Biogeochemistry – An Analysis of Global Change“, Academic Press, 4. Auflage 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, Krause A, Leonhardt S, 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: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

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:** 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

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:
Vorlesung
Spezielle Fragen des Naturschutzes
2 SWS
Wolfgang Weisser, PD Dr. Jan Habel

Seminar
Spezielle Themen im Naturschutz
2 SWS
Wolfgang Weisser, PD Dr. Jan Habel

Wolfgang
Weisser
TUM, Lehrstuhl für Terrestrische Ökologie
wolfgang.weisser@tum.de

Jan
Habel
TUM, Lehrstuhl für Terrestrische Ökologie
janchristianhabel@gmx.de
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

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

Specializing in Plant Sciences | Studienschwerpunkt Pflanzenwissenschaften

Practical-Oriented Modules | Praxisorientierte Module

Module Description

WZ1333: Research Project: Plants as Holobionts | Forschungspraktikum Pflanzen als Holobionten

Version of module description: Gültig ab summerterm 2023

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 examination is a laboratory performance. It consists of a practical laboratory part with about 240 time hours. In this laboratory, data are obtained according to scientific standards, which then have to be evaluated. In order to prove the desired research competence, a report (8-12 pages) is to be prepared after the practical course, which comes close to the standards of a scientific publication (title, introduction, material and methods, results, discussion, literature). The report is supplemented by a presentation (20 min). The grade results from the overall performance, which is composed of A) general evaluation (cooperation with supervisor, independent work, reliability, keeping of minutes), B) professional evaluation of the report (study of literature, logical structuring, presentation of the essentials, scientific understanding, evaluation of results), C) practical skills (technical understanding, technical implementation, care and handling of operating equipment) in equal parts (A:B:C=1:1:1).

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Courses in microbial ecology in the broad sense or plant physiology, biochemistry, molecular biology, and related disciplines.

Content:
Various methods of molecular biology (e.g. proteomics, DNA/RNA analyses, metabolite analyses, biochemical assays, stable isotope analysis). Data collection, data analysis and data interpretation using advanced statistical analysis and report preparation.

Intended Learning Outcomes:
After participation in the module courses, students will be able to
- characterize plant-microorganism communities with modern molecular biological methods (e.g. high-throughput sequencing, biostatistics using R)
- perform simple analyses of complex sequence data sets independently
- perform functional characterization of fungal DNA sequences using databases (FUNguild, FUNtraits)
- independently collect and analyze data and interpret them in the context of current scientific literature
- independently link existing basic knowledge with current publications on the topic under discussion.
- to apply newly generated knowledge in practical research.
- interpret complex interactions on a biochemical as well as on an ecological level and derive applications for humans.

Teaching and Learning Methods:
- Experiments under 1:1 guidance by scientific staff (learning by doing) in existing, ongoing research to gain insight into research procedures.
- Presentations to compile and discuss results:
o Short presentations (figure of the day) in regular lab meetings as regular feedback.
o Final presentation of results as an exercise in presentation style and feedback.
- Final report as an exercise and guide to writing a scientific paper.

Media:

Reading List:
after consultation with the supervisors

Responsible for Module:
Pritsch, Karin, Apl. Prof. Dr. rer. nat. habil. karin.pritsch@tum.de Weikl, Fabian, Dr. rer. nat. fabian.weikl@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Pflanzen als Holobionten (Forschungspraktikum, 10 SWS)
Weikl F
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 2022/23

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 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

WZ1416: Research Project: Chemistry of Plant-Insect Interactions | Forschungspraktikum zu chemischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2022/23

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 Prüfungsleistung ist eine Laborleistung, d.h. die Studierenden sollen eine oder mehrere Forschungsfragen weitgehend selbständig bearbeiten. Zur Durchführung liegen zum Teil vorgegebenen Protokolle vor. Die Studierenden führen Teilweise Freiland als auch Laborarbeiten durch und werden dabei jeweils in die Arbeitsmethoden und Geräte eingewiesen, so dass sie die Methoden meist vollkommen selbständig, in einigen speziellen Fällen unter Anleitung nutzen können (z.B. einen Gaschromatographen gekoppelt an ein Massenspektrometer, GCMS). Im Rahmen des Forschungspraktikums erheben sis 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 Insekt-Pflanze Interaktion mit Fokus auf die damit verbundene chemischen Vorgängen innerhalb begrenzter Zeit erfolgreich bearbeiten und entsprechend den wissenschaftliche 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 Laborleistug 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 sowohl in temperaten als auch in tropischen Ökosystemen behandelt werden. Beispielhaft wären die Themen „Einfluss von Pollennährqualität auf das Sammelverhalten von Honigbienen“ oder "Bedeutung von Pflanzenharzen für soziale Bienen"; dies beinhaltet in der Regel eine Kombination aus chemischen Analysen und Freiland- oder Käfigbeobachtungen. Weiterhin können auch Experimente mit anderen Insekten (Schmetterlinge, Fliegen, Käfer, Ameisen) erfolgen. Der Schwerpunkt in diesem Forschungsmodul liegt auf der Untersuchung der Chemie, 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 chemischen Interaktionen zwischen Pflanzen und Insekten sowie deren Auswertung weitgehend oder vollständig eigenständig durchzuführen. Dazu gehört das Designen von Feldexperimenten, die systematische Datenaufnahme und Probenentnahme im Feld, die Extraktion und chemische Analytik von Proben mittels Gaschromatographie Massenspektrometrie (GCMS) anhand bestehender Laborprotokolle, die chemische Auswertung von Proben mittels des Programms Chemstation, 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. GCMS, Rotationsverdampfer, Soxhlet-Apparatur, 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 chemischen Analysen 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

Responsible for Module:
Leonhardt, Sara Diana; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum zu chemischen 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, Schempp H, Stegmann M, Maroschek J, Müller 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, Graf A, Sala J, Schröder P, Zappone D
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:
Grill, Erwin; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum II: [WZ2384] (Forschungspraktikum, 10 SWS)

Assaad-Gerbert F, Wiese C
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)
Polzer C
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 summerterm 2023

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 www1.ls.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)
Eggels S, Lin Y, Würstl L
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 | Research Project Chemical Genetics

Version of module description: Gültig ab winterterm 2022/23

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 done in the form of a laboratory assignment. The students conduct a six-week research project in the lab. The work-schedule can be adjusted to the curriculum of the students. This includes the conductance of 1 to 4 experiments and the subsequent preparation of a protocol (approximately 15 to 20 pages) which has to be handed in usually within 4 weeks after the laboratory work has been concluded. By preparing the lab protocol the students demonstrate the ability to summarize the theoretical background and key aims of the performed experiments and to present the acquired results in a concise and coherent manner and to interpret and discuss the experimental data in the context of available literature. The grade is based on the accuracy of data analysis (50%) and the quality of data presentation (50%), including the description of the theoretical background, presentation of raw data, calculations, application of statistical tests and interpretation and discussion of the results.

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. Successful completion of the lecture 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 within 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.
This module will teach students a subset of the following techniques by participating in a research project in the lab:
- Storage and handling of a chemical library;
- Design of a chemical genetic screen;
- Set up of a chemical genetic screen in conformity with the required quality standards;
- Phenotype-based small molecule screening in Arabidopsis thaliana
- Phenotype-based small molecule screening horticulturally relevant plant species;
- Expression marker-based small molecule screens;

- Hit confirmation assays;
- Dose response assays;
- Structure/function analysis using cheminformatic methods;
- Establishment of an in vitro assay to test ligand-target interaction.

Intended Learning Outcomes:
Upon completion of this module students are able:
- to understand the principles of chemical genetic research approaches;
- to assess for which scientific questions a chemical genetic approach might be helpful;
- to plan and to carry out basic chemical genetic experiments in plants according to the required quality standards;
- to interpret and evaluate the results obtained in chemical genetic screens in a written report.

Teaching and Learning Methods:
Close theoretical and practical supervision combined with autonomous lab work enables the student to understand and apply basic experiments in Plant Chemical Genetics. By discussing lab protocols, the student analyses the underlying methodological principles of the experiments. By reading original research articles the student learns to assess quality standards for chemical genetic approaches. By writing a research report the student learns to summarize the obtained results and discusses it in the context of relevant literature.

Media:
Oral instructions, 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:
Sieberer, Tobias, Dr. nat. techn. tobias.sieberer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Chemische Genetik (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Sieberer T, Andrade Galan P
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, Andrade Galan P, Ramirez V, Yang S
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:

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

Theory-Oriented Modules | Theorieorientierte Module

Module Description

WZ2424: Biotic Plant Stress Physiology | Biotische Stressphysiologie der Pflanzen

Version of module description: Gültig ab winterterm 2022/23

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:
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.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet.

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: Chlorphyllfluoreszenz, 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:
Hückelhoven, Ralph, Prof. Dr. rer. nat. hueckelhoven@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Biotische Stressphysiologie der Pflanzen (Seminar, 1 SWS)
Schempp H [L], Hückelhoven R, Lindermayr C, Müller M, Schempp H, Stegmann M, Steidele C

Biotische Stressphysiologie der Pflanzen (Vorlesung, 2 SWS)
Schempp H [L], Hückelhoven R, Schempp H, Lindermayr C, Müller M, Stegmann M, Steidele C

Biotische Stressphysiologie der Pflanzen (Übung, 2 SWS)
Schempp H [L], Schempp H, Stegmann M, Lindermayr C, Müller 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:
Crop Genomics (Vorlesung mit integrierten Übungen, 4 SWS)
Ouzunova M, Mayer K, Haberer G, Urzinger S (Guffanti F)
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)
Hückelhoven R, Müller M, Stegmann M, Steidele C

Host-Parasite-Interaction (Seminar, 2 SWS)
Hückelhoven R, Stegmann M

Host-Parasite-Interaction (Vorlesung, 1 SWS)
Hückelhoven R, Steidele C
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:	Language:	Duration:	Frequency:
Master	German/English	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	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, Ouzunova M, Auinger H
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, Ouzunova M, Auinger H
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)
Schön C [L], Frey M, Avramova V
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:

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 I [WZ2385] (Vorlesung, 2 SWS)
Grill E, Christmann A

Seminar: Molekulare Pflanzenphysiologie I (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 (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

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:
Scientific Writing Part 2 (Methods and Logic in Molecular Cell Biology) (Seminar, 2 SWS)
Assaad-Gerbert F, Wiese C

Methods and Logic in Molecular Cell Biology and Scientific Writing Part 1 (Seminar, 2 SWS)
Assaad-Gerbert F, Wiese C
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 2023

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:
At the end of the module, students independently answer a list of questions within the framework of a scientific paper, for which they have four weeks to prepare.
The scientific paper tests the acquired knowledge on the basis of a real or fictitious biological problem or finding, and tries to illuminate this problem or the same finding from different perspectives in its entirety. In doing so, it actively seeks to answer biological and systems biology questions about the biological topic of auxin biology being addressed, using publicly available online resources and databases. Thus, the biochemical and genetic interaction data on auxin biology and systems biology work, especially the multiple effects of these plant hormones on growth and differentiation processes, e.g. with different -omics resources will be reviewed. The grade of this scientific paper will be included with 70% in the final grade.
In the seminar, each student presents a recent publication in the field of plant systems biology in the form of a talk (approx. 30 min). By doing so, students demonstrate that they are able to summarize scientific data, present it to an expert audience in the form of a presentation, and discuss the data presented. The quality of the presentation (quality of the illustrations, the conception of the presentation as well as the understanding, communication and discussion of the biological content) will be graded (30%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of plant biology, morphology and cell biology is recommended.
The module is aimed at students with a background in biology, biochemistry or biotechnology. Prior knowledge of mathematics or computer science is not assumed.

The module is thematically and temporally coordinated with the exercise PlaSysBiol offered in the same period and a simultaneous participation in the exercise module is recommended; however, the modules can also be taken separately.

Content:
This module provides in-depth knowledge of the systems biology analysis of genomic, proteomic and metabolomic data (umbrella term -omics). The techniques underlying the individual approaches or resources are explained and critically evaluated in biological contexts. The focus is on transcriptional and protein interaction networks, cell biological and biochemical methods, and modeling of cell biological and developmental processes.
Thematically, the module is largely oriented towards the biology of the plant hormone auxin (auxin receptor action, auxin signal transduction, auxin transport, auxin transport regulation), which is currently best understood in terms of systems biology studies and modeling and has a non-negligible importance for plant growth. In the accompanying seminar, students will present (PowerPoint presentation) a recent paper in the field of plant systems biology. The topics build on the contents of the lecture, but go thematically further in depth or allow the transfer of the biology or methodology learned in the lecture to other topics.

Intended Learning Outcomes:
Following participation in the module, students will have detailed knowledge to answer systems biology questions, specifically, but not exclusively, in plant biology. This includes the independent identification of selected genes and gene mutants in databases, the search and evaluation of proteomic and phosphoproteomic as well as protein-protein interaction data in databases, knowledge of the most important biochemical and cell biological methods, their advantages and disadvantages and thus knowledge for the critical evaluation of available data sets.

Students will be able to summarize scientific data in a meaningful way and present it in a visually appealing way, to present it compactly to an expert audience and to discuss controversial data.

Teaching and Learning Methods:
Learning activities: Study of the lecture notes, transcript and literature. If necessary, transfer of what has been learned to the PlaSysBiol module (exercise) taking place in the same period. Development of a new topic (seminar topic). Preparation and execution of presentations. Constructive criticism of own work and the work of others. Working under time pressure. Meeting deadlines.
The module consists of a lecture (2 SWS) and a seminar (2 SWS). The seminar takes place as a block seminar following the lecture cycle. In the seminar, students present recent publications in plant systems biology in lectures. The seminar topic is chosen by the students from the environment of the material covered in the lecture.

A recent publication will be discussed and prepared together with the chair. The seminar presentation of about 30 minutes can be discussed with the chair in advance. Possible topics are systems biology work on gene expression analysis, protein-protein interaction networks, or cell biology approaches.

Media:
Lecture supported by a PowerPoint presentation or similar. The lecture notes will be made available online.

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:
Schwechheimer, Claus, Prof. Dr. claus.schwechheimer@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:
Einführung in die Populationsbiologie der Pflanzen (Vorlesung, 2 SWS)
Kollmann J, Teixeira Pinto L

Seminar Populationsbiologie und Naturschutz (Seminar, 2 SWS)
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 (Vorlesung, 2 SWS)
Poppenberger-Sieberer B

Pflanzenbiotechnologie (Seminar, 2 SWS)
Poppenberger-Sieberer B [L], Poppenberger-Sieberer B, Benz J, Assaad-Gerbert F, Avramova V, Sieberer T, Schwechheimer C, Tellier A, Hückelhoven R, Johannes F, Schneitz K, Dawid C, Ahmed M, Bienert G
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 2023/24

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 concluded with an oral examination (20 min). 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).

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 CO_2 concentration, chronic O_3 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 CO_2, O_3, 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 in the module, students are able to understand the effect of "global-change" scenarios on plants and organisms interacting with plants on the basis of process-related thinking. Furthermore, they will be able to assess, analyze and interpret potential uses, development potentials of and risks for plant species, communities and interaction partners.

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 „Ökophysiologie der Pflanzen", UTB Ulmer-Verlag, 5. Aufl. 1994; Lambers, Chapin, Pons „Plant Physiological Ecology", Springer-Verlag, 1998; Matyssek, Fromm, Rennenberg, Roloff "Biologie der Bäume", UTB Ulmer-Verl., 2010; Schlesinger/Bernhardt „Biogeochemistry – An Analysis of Global Change", Academic Press, 4. Auflage 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, Krause A, Leonhardt S, 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 2023

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 (120 min) students show without additional material and within a limited time that they are able to explain the basic concepts of quantitative genetics, population genetics and selection theory and their relevance for breeding. The examination questions cover the entire lecture material. Short calculations can be included.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful Bachelor courses in applied statistics (e.g. Statistical Methods module).

Content:
Participants learn the basic principles of quantitative genetics and their relevance in the context of plant breeding. Essential concepts of population genetics, such as the genetic composition of populations and the effects of natural selection and mutations are taught. Quantitative genetics concepts important to plant breeding such as inbreeding and heterosis, epistasis, phenotypic and genotypic variances, resemblance between relatives, heritability, and genotype-environment interactions are introduced. It is shown how these concepts can be used to calculate selection success and optimize breeding programs.

Intended Learning Outcomes:
After successful completion of the module, students are able to understand the basic concepts of quantitative genetics and to evaluate their relevance for problems in plant breeding. They can explain important population genetic concepts such as the Hardy-Weinberg Law, understand the concepts of linkage and linkage disequilibrium and how they can be estimated in experimental populations. Students become familiar with the theoretical concepts underlying breeding values

and combining ability and their application in estimating heritability. They can identify and quantify resemblance between relatives. They are able to apply these concepts to selection theory for the optimization of breeding programs.

Teaching and Learning Methods:
The module consists of a lecture with integrated exercise modules in which the theoretical background and concepts are developed through PowerPoint presentations and chalkboard work. The analysis of experimental data sets in computer exercises extends the theoretical knowledge.

Media:
Presentations using PowerPoint Software exercises

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

Module Description

WZ1584: Quantitative Genetics and Selection | Quantitative Genetics and Selection

Version of module description: Gültig ab summerterm 2021

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 (Klausur, 120 min) students show without additional material that they are able to explain the basic concepts of quantitative genetics and population genetics and their relevance for breeding. They demonstrate their ability to use the acquired knowledge for the design of optimized breeding strategies. The grade of the exam will be the final grade of the module.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful Bachelor courses in applied statistics (e.g. module Statistische Methoden)

Content:
Population genetics: genetic constitution of populations, selection and mutation
Quantitative genetics: Inbreeding and heterosis, epistasis, phenotypic and genetic variance, resemblance between relatives, heritability, genotype-environment interaction
Selection theory: response to selection

Intended Learning Outcomes:
After successful completion of the module, students are able to understand the basic concepts of quantitative genetics and to evaluate their relevance for problems in plant breeding. They can explain important population genetic concepts such as the Hardy-Weinberg Law, understand the concepts of linkage and linkage disequilibrium and how they can be estimated in experimental populations. The students become familiar with the theoretical concepts underlying breeding values and combining ability and their application in estimating heritability. They can identify and quantify resemblance between relatives. They are able to apply these concepts to selection theory for the optimization of breeding programs.

Teaching and Learning Methods:
The module consists of a lecture, in which the theoretical background and concepts are developed through PowerPoint presentations and chalkboard work. The analysis of experimental data sets in computer exercises extends the theoretical knowledge.

Media:
PowerPoint presentations, chalkboard
Computer exercises, application training

Reading List:
Falconer and Mackay (1995) Introduction to quantitative genetics; Pearson Education Limited, ISBN: 978-0582243026, 4th edition

Lynch and Walsh (1998): Genetics and Analysis of Quantitative Traits; Sinauer Verlag, ISBN 978 0878934812

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

Module Description

LS20016: Rhizosphere Research | Rhizosphere Research

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:
This module is graded, and students are asked to give a seminar presentation complemented by the submission of an extended summary on a selected topic to demonstrate a solid understanding of topics discussed in the lectures. The oral presentation is expected to be 15 min presentation followed by a subsequent 30 min discussion to demonstrate that he or she is able to respond competently to any questions, suggestions, or discussions brought by the audience and relating to his or her subject area. The extended summary is expected to be a minimum of 5 pages and will be graded. Students will be informed about the grading criteria of their extended summary during the lecture via a template. The presentation will be scheduled within the last three weeks of the semester. The extended summary should be submitted by the end of the semester.

In addition, there is the option of taking a voluntary mid-term assignment as coursework in accordance with APSO §6, 5. For this, an oral examination (30 min) has to be given. The oral exam targets the learning outcomes of the lecture of Soil Biophysics. The module grade can be improved by 0.3 by passing the course work if this better characterizes the student's performance level based on the overall impression and the deviation has no influence on passing the examination. No repeat date is offered for the mid-term performance. Successfully passed mid-term assignments will be considered when retaking a failed module examination at the next possible examination date.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
The scope of this module is to learn fundamental biophysical processes taking place at the root zone and particularly at the root-soil interface and their emerging impacts on water and nutrient exchange between the soil-plant-atmosphere continuum. In this module, we will discuss the basic principles of soil physics in the context of water and nutrient transport within soils and plant roots. The particular attention is to learn why, when, and where soil physics plays an important role in water and nutrient transport across the soil-plant-atmosphere continuum.

Intended Learning Outcomes:
This module aims to enable students:
1) To mechanistically describe the theories of water and nutrients retention and transport across the soil-plant-atmosphere continuum
2) To mechanistically discuss why and when plant access to soil resources is limited in different soils and how plants may deal with these limitations
3) To evaluate the potential roles of different belowground traits (soil and plants) in improving plant access to limited soil resources under different conditions
4) To explore the state-of-the-art search in the field of soil-plant interactions and rhizosphere

Teaching and Learning Methods:
This module consists of two parts:
1) Lecture on Soil Biophysics: In weekly lectures, students will be introduced to the principle of water and nutrient transport within porose media, such as the soils-plants-atmosphere continuum. We will first begin by introducing students to the fundamental principle of the following key physical processes in soils: water retention in soil, water potential (freedom) in soils, the flow of water within soils, infiltration, evaporation, transpiration, root water uptake, and solute transport within soils. Then we will continue by focusing on the feedback between soil and plants and soil and microorganisms. Students will learn how biota's life (plants and microorganisms) may impact soil's physical properties and how the physical properties of soil may impact the emergence of life in soils.

2) Seminar on New emerging topics in Soil Biophysics: This seminar aims to discuss the fundamental biophysical and biochemical processes taking place across the soil-root interface and their emerging impacts on water, nutrient, and carbon flux across the soil-plant-atmosphere continuum. Students will be briefly introduced to some selected state-of-the-art topics and will be asked to perform a deep literature review and present their findings in the form of an oral presentation and an extended summary at the end of the semester.

Media:

Reading List:

Responsible for Module:
Zare, Mohsen, Prof. Dr. mohsen.zare@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
New emerging topics in Soil Biophysics (Seminar, 2 SWS)
Zare M

Soil Biophysics (Vorlesung, 2 SWS)
Zare M
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:
Vorlesung
Redox-Biochemie der Pflanzen (Vo/Le)
1 SWS

Praktikum
Redox-Biochemie der Pflanzen (Pr/Pr)
2 SWS

Christian
Lindermayr
Helmholtz Zentrum München, Institut für Biochemische Pflanzenpathologie
lindermayr@helmholtz-muenchen.de
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

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:** 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

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

Specializing in Animal Sciences | Studienschwerpunkt Tierwissenschaften

Practice-Oriented Modules | Praxisorientierte Module

Module Description

MW2469: Bio-Inspired Design Seminar | Bionik-Seminar [SemBio]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor/Master	**Language:** German/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:
The achievement is assessed in the format of project work (required achievement). This comprises:
- a final oral presentation (15 min + questions) of the independently developed concepts to assess the quality of the concepts as well as the methodological competence and communication skills of the participants.
- a short written report (approx. 5 pages) to assess the ability of technical transfer of biological phenomena as well as interdisciplinary cooperation
- and the design and manufacturing of a prototype and demonstration at the end of the work to assess the ability to conceptualize, evaluate and independently create technical concepts based on biological functions for a technical problem in self-study or with guidance in the context of a student research project.
The grade is given in equal proportions.
The quality of the concept, implementation of the specifications, transfer of biological system into technology and the presentation style are evaluated.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Lecture Bionics (optional)

Content:
The bio-inspired design seminar is about conceptualizing engineering problems through biologically inspired approaches. Desirably teams of biologists and engineers are formed to work on and create bionic concepts. Current technical problems will be addressed in interdisciplinary teams. Solution ideas will be demonstrated by generating prototypes. The following content will be conveyed:
- Methods of problem solving/product development as applied to bio-inspired design: defining requirements, functional analysis, abstraction, identification of biological models, analogy transfer and evaluation.
- Top-down/bottom-up design in bio-inspired design
- Application areas of bio-inspired design
- Current technical problems
- Self-independent development of a bio-inspired design project

The event will take place all as a concentrated two-week event usually in January.
We recommend blocking the entire period, as project-related work may also occur outside the event days.

Intended Learning Outcomes:
After participating in the module course "Bio-inspired design Seminar", students are able to apply practice-oriented knowledge of methods of conceptualization on technical problems by bio-inspired design.
Students will be able to apply creativity techniques and analogy transfer of natural phenomena to technical problems.
At the end of the module course, students shall be able to conceptualize and evaluate a technical problem on their own or with guidance as part of a student research project and independently create technical concepts based on biological functions.

Teaching and Learning Methods:
The seminar takes place as a block event in the form of a workshop (10 days). First, the students participate in two pre-events (after the pre-events, students can still withdraw from participation). Afterwards, the project work is carried out in interdisciplinary teams.
Highlights:
- Tools and methods for the development of a prototype demonstrator will be provided on site.
- Participants will be supported by experts and coaches who will provide methods and expertise in the areas of product development as well as bio-inspired design. The design approach refers to other approaches such as Design Thinking, TRIZ, Systems Engineering, Lean and Agile Development
- On the last day, the DemoDay, all teams present their projects to an audience and demonstrate the concepts using prototypes.

The project is carried out by
- Group work
- Workshops: To communicate essential methodological basics for interdisciplinary collaboration and innovative product development.

- Hands-on Learning: All participants are encouraged to become active themselves and learn through practical experience.
The practical elaboration of the project topic within the groups with possible teaching supervision helps the students to evaluate the problems and independently create technical concepts based on biological functions as well as train interdisciplinary collaboration.
Proactivity, self-efficacy and personal responsibility within the team are basic requirements. In this way, you will learn to independently find, conceptualize and develop bionic solutions based on current problems and biological phenomena.

Media:
Lecture, presentation, independent research on the computer, team work on flip boards, etc.

Reading List:
Nachtigall, W.; Wisser, A. (2013): Bionik in Beispielen: 250 illustrierte Ansätze: Springer Berlin Heidelberg. Online verfügbar unter https://books.google.de/books?id=iv4Y9XoI26IC.
Nachtigall, Werner; Wisser, Alfred (2015): Bionics by examples. 250 scenarios from classical to modern times. Online verfügbar unter http://www.springer.com/.
Nachtigall, Werner (2002): Bionik. Grundlagen und Beispiele für Ingenieure und Naturwissenschaftler. 2. Auflage. Berlin, Heidelberg, s.l.: Springer Berlin Heidelberg.
Hashemi Farzaneh, Helena; Lindemann, Udo (2019): A Practical Guide to Bio-inspired Design. Berlin, Heidelberg: Springer Berlin Heidelberg.
Corazza, Giovanni Emanuele; Agnoli, Sergio (Hg.) (2016): Multidisciplinary contributions to the science of creative thinking. Singapore: Springer (Creativity in the twenty first century).

Responsible for Module:
Zimmermann, Markus; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar: Bionik (Seminar, 2 SWS)
Zimmermann M [L], Frank J, Zimmermann M
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
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

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

Version of module description: Gültig ab winterterm 2022/23

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:
Das Modul setzt sich aus den Lehrveranstaltungen "Praktikum" und "Seminar" zusammen.
Die Prüfungsleistung der LV „Praktikum“ erfolgt anhand einer Laborleistung, die sich aus einem Testat (30 Minuten), einer Präsentation (10 Minuten) sowie der Bewertung der praktischen Arbeit zusammensetzt. Die Bewertungskriterien der praktischen Arbeit umfassen die Fortschritte bei den praktischen Fähigkeiten, Motivation und Kenntnisse über den Praktikumsablauf. Die Gewichtung der drei Teilnoten erfolgt 1:1:1.

Mit der erfolgreichen Ablage der Prüfungsteile weisen die Studierenden die Befähigung nach, 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. Das Manuskript zum Praktikum dient zur Vorbereitung für das Praktikum.

Zusätzlich zum Praktikum werden mit den Studierenden Seminare durchgeführt, in denen sie mittels Literatur praktische Themen der Kultivierung von Säugetierzellen erarbeiten und präsentieren müssen. Die Prüfungsleistung im Seminar umfasst eine Präsentation (15 Minuten).

Gewichtung Laborleistung:Präsentation = 6:4.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor-Abschluss in Biologie bzw. Molekulare Biotechnologie

Content:
Im Rahmen des Praktikums werden Grundkenntnisse über die Isolierung, Charakterisierung und genetische Manipulierung von Säugetierzellen vermittelt. Inhalte sind u.a.: Steriles Arbeiten, Mikroskopie, Kulturbedingungen, Etablierung und Konservierung von Zelllinien und Primärkulturen, Bestimmung von Zellzahlen, Transfektionsmethoden, Isolierung und Expansion von Zellklonen, Anwendung und Detektierung von Markergenen.

Im Seminar werden insbesondere die Hintergründe und theoretischen Kenntnisse zu den durchgeführten Experimenten vermittelt. Im Rahmen des Praktikums werden grundlegende Methoden zu praktischen Arbeiten mit Säugetierzellen vermittelt. Im zugehörigen Seminar stellen die Studierenden relevante Literatur bezüglich Zellkultur vor.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen für die Kultivierung und genetische Manipulierung von Säugetierzellen. Weiterhin haben sie grundlegende zellbiologische Arbeitstechniken erlernt und geübt. Sie verstehen zellbiologische Fragestellungen und Arbeitstechniken und können das erworbene Wissen auf vertiefte Fragestellungen anwenden.
Die Studierenden haben weiterhin Fähigkeiten zum Lösen von Problemen entwickelt, sowie Einblicke in die Zellbiologie und zellbiologische Problemen erworben.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Praktikum, Seminar
Lehrmethode im Praktikum: Anleitungsgespräche, Demonstrationen, Experimente, Partnerarbeit, Ergebnisbesprechungen.
Lehrmethode im Seminar: Vortrag
Lernaktivitäten: Studium von Skripten, -mitschrift, Praktikumsskript und Literatur; Üben von labortechnischen Fertigkeiten und zellbiologischen Arbeitstechniken; Zusammenarbeit mit Praktikumspartner; Anfertigung von Protokollen und Präsentationen.

Media:
Präsentationen mittels PowerPoint,
Praktikumsskript (Downloadmöglichkeit für Vorlesungsmaterial) Publikationen zu zellkulturspezifischen Themen

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.
Als Grundlage oder zur Ergänzung wird empfohlen:
Sabine Schmitz; Der Experimentator: Zellkultur;
R. Ian Freshney: Culture of Animal Cells: A Manual of Basic Technique

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Kultivierung von Säugetierzellen (Zellkultur - Praktikum) (Praktikum, 3 SWS)
Bak A, Bauer B, Fischer K, Flisikowska T, Preisinger D, Winogrodzki T

Zellbiologische Fragestellungen (Zellkultur - Seminar) (Seminar, 2 SWS)
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:

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:
Forschungspraktikum Entomologie (Forschungspraktikum, 10 SWS)
Gebhardt M [L], Gebhardt M
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], Bauer B, 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

WZ1415: Research Project: Behavioral Physiology of Plant-insect Interactions | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten

Version of module description: Gültig ab winterterm 2022/23

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 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:	Language:	Duration:	Frequency:
Master	German	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
10	300	60	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)
Luksch H, 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 summerterm 2023

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:
Die Prüfungsleistung erfolgt im Rahmen einer Laborleistung, die sich aus der Mitarbeit im Praktikum, einem Bericht (15-20 Seiten) und einer Präsentation (20-30 Minuten) zusammensetzt. Die Prüfungsleistungen gehen zu je einem Drittel in die Prüfungsleistung ein.

Regelmäßige Teilnahme während des Praktikums ist erforderlich. 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:
Keine Angabe

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 2023

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:
A laboratory performance is set as the examination performance.
In the course, the laboratory performance is assessed, i.e. the preparation and practical execution of the experiments, any necessary calculations, their documentation and evaluation in the form of a laboratory protocol, as well as the interpretation of the results with regard to the knowledge to be gained. In the protocol, the students show whether they are able to structure the work they have carried out and present the essential aspects. They should be able to describe and interpret the results and place them in a meaningful context to the knowledge gained in the lab.
The laboratory performance is complemented by a final presentation (15 min) to test communicative competence in presenting scientific topics to an audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module is suitable for students in BSc (5th/6th semester) or Master. Basic knowledge in molecular biological methods is recommended.

Content:
Within the framework of the research internship in animal biotechnology, students will work on an independent sub-project and become familiar with different scientific methods or possibly establish new methodological approaches themselves. The project will be part of an overall project and the students will learn to understand a specific task area in the larger context. Depending on the project, they will learn practical skills in molecular, cell biological or embryological methods and expand their academic knowledge in the field of stem cell biology, animal models for tumor research or other human diseases and xenotransplantation.

Intended Learning Outcomes:
Students will learn the following:
- Independent scientific work
- Acquisition of new methods, such as genome editing, PCR, cell culture
- Project planning and practical implementation
- Working out solutions to problems independently
- Project description and presentation
- Independently conduct literature search and practical implementation of theoretical knowledge
- Integration and cooperation in a group, social competence

Teaching and Learning Methods:
Independent development of relevant literature, implementation of an independent sub-project under the guidance of a project manager.

Media:
Presentations using PowerPoint
Internship report

Reading List:
Project relevant literature

Responsible for Module:
Flisikowska, Tatiana; Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Tiere (Forschungspraktikum, 10 SWS)
Fischer K, Flisikowska T, Flisikowski K
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

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:

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

LS20005: Models in Computational Neuroscience (M.Sc.) | Models in Computational Neuroscience (M.Sc.)

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 (M.Sc.) (Forschungspraktikum, 10 SWS)
Gjorgjieva J, Dauphin A, Dwulet J, Onasch S, Parkinson-Schwarz J
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], Fischer K, Flisikowski K, Kellermann K, Kisling S, Schusser B, Schwamberger S

Praktische Einführung Versuchstierkunde (Übung, 2 SWS)
Schusser B [L], Schusser B, Schwamberger S
For further information in this module, please click campus.tum.de or here.

Module Description

LS20033: Zoological Field Trip to Lake Neusiedl | Zoologische Exkursion Neusiedler See

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 33	**Contact Hours:** 57

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 (Studienleistung) erbracht.
Sie setzt sich zusammen aus
a) einer Präsentation, die im Rahmen des vorbereitenden Seminars gehalten wird sowie
b) einer Zusammenfassung (Bericht), die im Nachgang der Geländeübung angefertigt wird.

Zur Vorbereitung auf die Geländeübung sind im Rahmen eines Seminares exkursionsrelevante Themen in Einzelarbeit durch die Studierenden vorzubereiten, vorzutragen und in der Gruppe kritisch zu diskutieren, um die kommunikative Kompetenz bei der Darstellung von wissenschaftlichen Themen vor einer Zuhörerschaft zu überprüfen.

In der Diskussion soll über das Vorgetragene hinausgegangen und vernetzende Themen besprochen werden (30 Minuten Vortrag, 15 Minuten Diskussion). Die Teilnahme am Seminar ist essentielle Voraussetzung zur Datenerhebung während der Übung vor Ort 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 ein Teil der 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.

Im Nachgang zur Geländeübung ist eine schriftliche Zusammenfassung einzureichen, die die Inhalte und Ergebnisse der jeweiligen Seminarpräsentation und -diskussion mit den in der Geländeübung erhobenen Daten kombiniert. Die Auswertung fließt in den abschließenden Gemeinschaftsbericht ein, der
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 Berichte sind spätestens 4 Wochen nach Übungsende vorzulegen. Ansonsten wird die Leistung mit “nicht bestanden“ bewertet.

Repeat Examination:

(Recommended) Prerequisites:
Kenntnisse in grundständiger Zoologie und Ökologie / Biodiversität, 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 zwei vorbereitenden Terminen gehalten, die nach der Vorbesprechung und Platzvergabe vereinbart werden. 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:
Luksch, Harald, Prof. Dr. rer. nat. harald.luksch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Botanisch-zoologische Geländeübung zum Neusiedler See (mehrtägig) (Übung, 2,8 SWS)
Luksch H [L], Luksch H (Firzlaff U), Firzlaff U
For further information in this module, please click campus.tum.de or here.

Theory-Oriented Modules | Theorieorientierte Module

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)
Luksch H (Luksch H, Mosedale G)

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, Schreck C

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)
Flisikowska T, Fischer K, Flisikowski K

Biotechnologie der Tiere 2 Seminar (Seminar, 2 SWS)
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)
Flisikowska T, Flisikowski K

Biotechnologie der Tiere 1 Praktikum (Praktikum, 2 SWS)
Flisikowska T, Flisikowski K, Bauer B, Schusser B
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)
Jacob S, 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

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:
Haller, Dirk, Prof. Dr. rer. nat. dirk.haller@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

LS20007: Introduction to Computational Neuroscience | Introduction to Computational Neuroscience

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/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:
In a graded final 20 minute presentation (slides, e.g. with Power Point) the students present their project work, where they aim for reproducing results from a scientific paper with methods of computational neuroscience, that are taught in the lecture and practiced in the tutorials. In addition, the students should synthesize the relevant findings of the paper and critically discuss the modeling choices of the authors, following examples that are given throughout the lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Previous exposure to python is helpful, but not required.
Basic knowledge of neuroscience/neurophysiology is recommended.

Content:
Introduction to programming with python

The concepts and implementation in python of:
Neuroelectronics - Cable Properties, different neuron models and synaptic conductances
Network models - Feed-forward and recurrent models with spiking and rate-based neurons
Plasticity and Learning - spike time dependent and rate based plasticity rules and synaptic normalization
Neural Codes - Mutual information, Spike trains and receptive fields
Machine Learning - Dimensionality reduction, Model fitting, Generalized Linear Models, Reinforcement learning

Intended Learning Outcomes:
Upon completion of the module students will be able to
• describe the field of computational neuroscience and its sub-disciplines, like dynamical systems, machine learning, stochastic processes and information processing.
• understand the different levels of, and approaches to modeling of biological processes
• understand general concepts of model fitting, like mean squared error, maximum likelihood estimate and the variance/bias trade-off
• implement classical but still relevant models of computational neuroscience (e.g. Leaky Integrate and Fire, Hodgkin-Huxley, Wilson-Cowan, Hopfield), compare their level of description and analyze their strength and weaknesses.

Finally, they will be able to deconstruct computational neuroscience papers into the components taught in the lecture.

Teaching and Learning Methods:
The students learn the basic concepts of computational neuroscience in the lecture and can solidify the learned material in hands-on tutorials with peer-programming tasks and interactive notebooks. Furthermore, they will apply the learned concepts from the lecture and the tutorials in a group-project, that consists of a mix of self-study and guided sessions and leads to a final presentation; where the students present their findings and how they relate to the learned concepts.

Media:
The lecture consists of a PowerPoint presentation.
The tutorials consist peer-programming sessions with the use of interactive notebooks. The project work consist of self-study sessions and guided sessions and a Power Point presentations prepared by the students.

Reading List:
Dayan, P., & Abbott, L. F. (2005). Theoretical neuroscience: computational and mathematical modeling of neural systems. MIT press.
Bear, M., Connors, B., & Paradiso, M. A. (2020). Neuroscience: Exploring the Brain, Enhanced Edition: Exploring the Brain. Jones & Bartlett Learning.
MacKay, D. J., & Mac Kay, D. J. (2003). Information theory, inference and learning algorithms. Cambridge university press.

Responsible for Module:
Gjorgjieva, Julijana, Prof. Ph.D. gjorgjieva@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Computational Neuroscience – Lecture (M.Sc.) (Vorlesung, 2 SWS)
Gjorgjieva J

Introduction to Computational Neuroscience – Exercise (M.Sc.) (Übung, 2 SWS)

Onasch S

Introduction to Computational Neuroscience – Project Work (M.Sc.) (Projekt, 2 SWS)
Onasch S
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

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, Schwamberger 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:
Übung/seminar
Current topics in neuromodualtion
1 SWS
Jean-Francois De Backer

Übung/seminar
Latest Neuroscience - presenting papers to researchers and the general public
1 SWS
Ilona Grunwald Kadow

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

Module Description

LS10014: Managing Poultry Health | Managing Poultry Health

Version of module description: Gültig ab summerterm 2023

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 examination performance of the module will be a 20 minutes oral presentation of a research paper about a published case report. The presented case report will demonstrate the ability of the student to summarize the subject and present it to an audience. Students have to add and elaborate on the gained theoretical knowledge by choosing specific case reports, which will reflect their personal opinion and how they would manage similar problems in the future. The discussion with the tutor and the recommendations at the end of their presentations will show the importance of the problem in the field and what will they suggest to improve the health status of the animals.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of animal sciences and pathology
B.Sc. in various areas of Life Sciences including Agricultural and Horticultural Sciences

Content:
In this module, students are introduced to theoretical background regarding various aspects in poultry production that start with the hatch and breeding to the environment and technical measures. In addition, different case reports from the field will be analyzed and discussed. The students will be able to make a judgement regarding the health status of the birds and suggest alternative solutions based on the theoretical background.
The following elements will be approached during the lecture and the seminars:
- Particular features of poultry and what to consider in poultry production
- Causes of major health disorders
- Intoxications
- Disease prevention
- Important regulations for poultry production

Intended Learning Outcomes:
After successful participation in this module, students will be able to understand the important aspects required for the success of poultry production. They will differentiate between different production systems and what makes the poultry flock achieve best agricultural performances. They will be able to determine the risk associated with suboptimal management or health problems and to provide suggestions to improve the situation.

Students will understand various practical problems related to poultry production. They will evaluate the risk factors that may decrease poultry productivity. They will be able to analyze field problems and to evaluate clinical cases in a critical manner by determining their importance depending on the clinical outcome and economic impact.

Teaching and Learning Methods:
The module consists of lectures in the topic of poultry health, which will be followed by the seminars. After gaining a basic knowledge about possible problems that may face poultry health and welfare, the students will independently choose and present relevant topics related to the management of poultry health and the problems that may affect the productivity and the welfare of poultry flocks. The presented cases will be carefully discussed in groups and conclusions will be drawn.

Media:
PowerPoint presentations, round table discussions

Reading List:
Avian Immunology 2nd edition, Elsevier 2013
Veterinary Immunology 10th edition, Elsevier 2017
PowerPoint slides:
Avian Pathology: https://www.tandfonline.com/toc/cavp20/current
Avian Diseases: https://www.aaap.info/aviandiseases

Review and original literature is additionally provided.

Responsible for Module:
Sid, Hicham, Ph.D. hicham.sid@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Journal club – practical problems facing poultry production and breeding (Seminar, 2 SWS)
Sid H [L], Bauer B, Schusser B, Sid H

Managing Poultry Health (Vorlesung, 2 SWS)
Sid H [L], Bauer B, Schusser B, Sid H
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 summerterm 2023

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 primär aus Vorlesungen (80%), sowie einer Vorlesung mit integrierter Übung zusammen. Letztere umfasst neben der Vorlesung eine Exkursion (10%) sowie praktischen Übungsstunden (10%).
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

Laktationsphysiologie (Vorlesung mit integrierten Übungen, 2 SWS)
Pfaffl M, Kliem H

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 2022/23

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 Klausur (90 min) 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 terrestrischen Ökologie und Naturschutzbiologie. 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, 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 in den Bereichen Zoologie und Naturschutzbiologie und damit die 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. Zusätzliche 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:
Kühn, Ralph, Apl. Prof. Dr. agr. habil. ralph.kuehn@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Phylogenie und Zoologie der Vertebraten (Vorlesung, 2 SWS)
Kühn R

Wissenschaftliche Konzepte in aquatischer und terrestrischer Ökologie (Seminar, 2 SWS)
Kühn R
For further information in this module, please click campus.tum.de or here.

Module Description

MW1029: Lecture Series in Bionics / Biomimetics | Ringvorlesung Bionik

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/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 Lernergebnisse werden in einer schriftlichen bzw. mündlichen Klausur überprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Es müssen keine Voraussetzungen erfüllt werden.

Content:
Natürliche Lösungen zu analysieren und auf ihre Übertragbarkeit in die Technik hin zu überprüfen, ist der Ansatz der Bionik. Dabei geht es aber nicht nur darum, Ideen aus der Natur zu kopieren und in technische Versionen zu überführen. Bionische Forschung muss die biologischen Objekte zuerst verstehen   das heißt, durch Grundlagenforschung die relevanten Aspekte in ihren natürlichen Randbedingungen analysieren und in die Sprache der Physik und der Mathematik zu übersetzen. Erst mittels dieser formalen Beschreibungsebene ist es möglich, das Prinzip des biologischen Systems in die Technik zu übertragen. Im Rahmen der Ringvorlesung Bionik, bei welcher es sich um eine fakultätsübergreifende Veranstaltungsreihe handelt, werden Studierenden disziplinspezifische und -übergreifende Perspektiven zum Thema Bionik vermittelt. Neben zahlreichen innovativen Praxisbeispielen bionischer Produkte stehen die Vermittlung aktueller Erkenntnisse aus der ingenieur- und naturwissenschaftlichen Forschung sowie das systematische Vorgehen in bionischen Entwicklungsprojekten im Mittelpunkt.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung ist der Studierende in der Lage, wesentliche Aspekte der interdisziplinären Arbeitsumfeld der Bionik zu durchdringen.

Nach der Teilnahme an den Modulveranstaltungen ist der Studierende in der Lage, Herangehensweisen bionischer Entwicklungsprozesse zu analysieren.

Teaching and Learning Methods:
Die Inhalte werden als Vorlesung mit darbietenden Lehrverfahren, wie Vorträgen mit Powerpoint-Präsentationen, vermittelt.

Media:
Präsentationen

Reading List:
Veröffentlichungen der Dozenten zum jeweiligen Thema

Responsible for Module:
Zimmermann, Markus; 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

WZ2127: Reproductive Physiology of Vertebrates | Reproduktionsbiologie der Vertebraten

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor/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.): 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 anwendungsorientierte 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:
Pfaffl, Michael, Apl. Prof. Dr. michael.pfaffl@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Reproduktionsbiologie der Vertebraten (Vorlesung, 4 SWS)
Pfaffl M, Berisha B, Kliem H, Thaqi G
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

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:** 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, Firzlaff U
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

WZ2456: Zoological Field Trip Mediterranean | Zoologische Exkursion Mittelmeer

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 120	**Self-study Hours:** 37.5	**Contact Hours:** 82.5

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 (Studienleistung) erbracht .
Sie setzt sich zusammen aus
a) einer Präsentation, die im Rahmen des vorbereitenden Seminars gehalten wird sowie
b) einer Zusammenfassung (Bericht), die im Nachgang der Geländeübung angefertigt wird.

Zur Vorbereitung auf die Geländeübung sind im Rahmen eines Seminares exkursionsrelevante Themen in Einzelarbeit durch die Studierenden vorzubereiten, vorzutragen und in der Gruppe kritisch zu diskutieren, um die kommunikative Kompetenz bei der Darstellung von wissenschaftlichen Themen vor einer Zuhörerschaft zu überprüfen.

In der Diskussion soll über das Vorgetragene hinausgegangen und vernetzende Themen besprochen werden (20 Minuten Vortrag, 10 Minuten Diskussion). Die Teilnahme am Seminar ist essentielle Voraussetzung zur Datenerhebung während der Übung vor Ort 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 ein Teil der Studienleistung gewertet und erst mit der Abgabe des individuellen Berichts als Laborleistung verbucht.

Durch die aktive Teilnahme an der Geländeübung in Form einer Exkursion setzen die Studierenden die im Seminar vorbereiteten Aufgaben und Themen handelnd um und übertragen das Erlernte ggf. auf neue Situationen.

Im Nachgang zur Geländeübung ist eine schriftliche Zusammenfassung einzureichen, die die Inhalte und Ergebnisse der jeweiligen Seminarpräsentation und -diskussion mit den in der Geländeübung erhobenen Daten kombiniert. Die Auswertung fließt in den abschließenden Gemeinschaftsbericht ein, der
allen Exkursionsteilnehmer am Ende zur Verfügung gestellt wird. Darin werden die während der Geländeübung erhobenen Daten (vor allem Tierarten) strukturiert und dokumentiert, wobei auch weitere Aspekte (klimatische Bedingungen, Standortfaktoren etc.) zu berücksichtigen sind. 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 Berichte sind spätestens 6 Wochen nach Übungsende vorzulegen. Ansonsten wird die Leistung mit “nicht bestanden“ bewertet.

Repeat Examination:

(Recommended) Prerequisites:
Kenntnisse in grundständiger Zoologie und Ökologie / Biodiversität, idealerweise auch der Human- und Tierphysiologie und Sinnesphysiologie

Content:
Der Naturraum Istrische Halbinsel in Kroatien ist von Elementen verschiedener Landschaftsräume geprägt, vor allem Trockenstandorte sowie die direkte Küstenregion mit dem Mittelmeer. In diesem Modul wird die Fauna dieses Lebensraums behandelt und ein Fokus auf die marinen Organismen, die Herpetofauna sowie die Insektenvielfalt gelegt. Dabei werden im marinen Bereich Unterwasseraufnahmen mit Kameras durchgeführt, um die Arten zu ermitteln.
Im vorgelagerten Seminar werden grundlegende Themen des Lebensraumes und der behandelten Tiergruppen besprochen. Diese Exkursion findet in der Woche nach Pfingsten statt (variabler Termin), von Sonntagmorgen (Abfahrt) bis Samstagabend (Rückkehr). 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 Seminarvorträge werden an zwei vorbereitenden Terminen gehalten, die nach der Vorbesprechung und Platzvergabe vereinbart werden. 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 Mittelmeer-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,
• 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 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:
Luksch, Harald, Prof. Dr. rer. nat. harald.luksch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Zoologische Geländeübung nach Kroatien (mehrtägig) (Übung, 3,5 SWS)
Luksch H [L], Luksch H, Schwarz Y
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.

Master´s Thesis | Master´s Thesis

Module Description

WZ2590: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 300	**Contact Hours:** 600

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

Description of Examination Method:
Der Abschluss des Moduls Master’s Thesis besteht aus einer Präsentation (60 min) im Rahmen der wissenschaftlichen Projektplanung der Thesis (Studienleistung), einer wissenschaftlichen Ausarbeitung (ca. 100 Seiten; abhängig von der Themenstellung) sowie einer Präsentation (20 min) über deren Inhalt. Die Präsentationen gehen nicht in die Benotung ein.

Für das Modul Master’s Thesis werden 30 Credits vergeben.

Vor Beginn der Master`s Thesis muss die Wissenschaftliche Projektplanung (Präsentation) in Form einer Studienleistung erfolgreich abgelegt sein. Die wissenschaftliche Projektplanung wird vom voraussichtlichen Themensteller oder der voraussichtlichen Themenstellerin der Master’s Thesis und einem weiteren Hochschullehrer oder einer weiteren Hochschullehrerin der Technischen Universität München abgenommen.

Um die für die Masterarbeit erforderlichen Kompetenzen zu fördern und das Verständnis für die Themenstellung zu vertiefen, soll die wissenschaftliche Projektplanung vor der Anmeldung der Arbeit in einem Zeitrahmen von 60 Minuten präsentiert werden. Die Studierenden haben 20 Minuten Zeit, das voraussichtliche Thema und den Projektplan der Thesis vorzustellen. Daran schließt sich eine Disputation (40 min) an.

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 praktische 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. Aus diesem Grund sollen ausreichend Module belegt worden sein, um den Studiengang mit dem Abschluss der Thesis beenden zu können. Details hierzu regelt die Fachprüfungsordnung. Die Anmeldung der Master´s Thesis ist frühzeitig beim Schriftführer des Prüfungsausschusses Biologie persönlich einzureichen.

Content:
Im Rahmen der Master‘s Thesis bearbeiten die Studierenden ein eigenes Forschungsthema an der TUM oder einem fachnahen Forschungsinstitut. Details regelt die Fachprüfungsordnung.
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.

Intended Learning Outcomes:
Nach Abschluss der Master`s Thesis sind die Studierenden in der Lage:
- ein neuartiges Forschungsprojekt zu identifizieren.
- wissenschaftliche Fragestellungen präzise zu formulieren.
- einen realistischen Zeitplan für die Bearbeitung des Projekts 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 bzw. der jeweiligen Fachbetreuerin eigenständig durch und dokumentieren ihre erzielten Ergebnisse gemäß den wissenschaftlichen Standards. Die schriftliche Ausarbeitung der Master’s Thesis erfolgt eigenständig durch die Studierenden in enger Abstimmung und unter Rücksprache mit dem jeweiligen Fachbetreuer bzw. der jeweiligen Fachbetreuerin.

Media:
Abhängig von der Themenstellung.

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.

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