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).

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484 - 485

[WZ4020] **Effects of Climate Change on Plant Physiology** | Pflanzenfunktionen im Klimawandel  
486 - 487

[MA9613] **Statistical Computing and Data Analysis (TUM School of Life Sciences)** | Statistical Computing and Data Analysis (TUM School of Life Sciences)  
488 - 489

[WZ4044] **Causes and Impacts of Climate Change** | Ursachen und Auswirkungen von Klimaänderungen  
490 - 492

[WZ4230] **Wildlife Management** | Wildtiermanagement  
493 - 494

[WZ6121] **Vegetation of the Earth** | Vegetation der Erde  
495 - 496

**Specializing in Plant Sciences** | Studienschwerpunkt Pflanzenwissenschaften  
497

Practical-Oriented Modules | Praxisorientierte Module  
497

[LS20031] **Research Internship Plant-Microbe Interaction** | Forschungspraktikum Pflanze-Mikroben Interaktion  
497 - 499

[WZ1333] **Research Project: Plants as Holobionts** | Forschungspraktikum Pflanzen als Holobionten  
500 - 501

[WZ1415] **Research Project: Behavioral Physiology of Plant-insect Interactions** | Forschungspraktikum zu verhaltensphysiologischen Interaktionen zwischen Pflanzen und Insekten  
502 - 504
[WZ1416] Research Project: Chemistry of Plant-Insect Interactions | Forschungspraktikum zu chemischen Interaktionen zwischen Pflanzen und Insekten

505 - 507

[WZ2273] Practical Course in Phytopathology | Forschungspraktikum Phytopathologie

508 - 509

[WZ2380] Research Project Plant Systems Biology | Forschungspraktikum Pflanzensystembiologie

510 - 511

[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 | Forschungspraktikum 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


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
Module Catalog of the study program M.Sc. Biology
Generated on 31.03.2024

[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

Specializing in Animal Sciences | Studienschwerpunkt Tierwissenschaften
582

Practice-Oriented Modules | Praxisorientierte Module
582

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 - 622

[WZ2653] Research Project Neurobiology of Vertebrates | Forschungspraktikum Neurobiologie von Wirbeltieren 623 - 624

[WZ2680] Research Project in Zoological Systematics | Forschungspraktikum Zoologische Systematik 625 - 626

[WZ2687] Research Project Mapping Neural Circuits Underpinning Behavior | Forschungspraktikum Neuronale Netzwerke und Verhalten 627 - 628

[WZ2695] Research Project Wildlife Biology | Forschungspraktikum Wildbiologie 629 - 630

[WZ1993] Laboratory Animal Science | Laboratory Animal Science [VTK] 631 - 632

[LS20005] Models in Computational Neuroscience (M.Sc.) | Models in Computational Neuroscience (M.Sc.) 633 - 634

[LS20033] Zoological Field Trip to Lake Neusiedl | Zoologische Exkursion Neusiedler See 635 - 638

Theory-Oriented Modules | Theorieorientierte Module 639

[WZ2460] Current Topics in Neurobiology | Aktuelle Themen der Neurobiologie 639 - 641

[ME2759] Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen 642 - 644

[WZ0404] Animal Biotechnology 2 | Biotechnologie der Tiere 2 645 - 646
[WZ2664] Animal Biotechnology 1 | Biotechnologie der Tiere 1 647 - 649
[WZ2693] Cognitive Neuroscience | Cognitive Neuroscience 650 - 651
[WZ2938] Course block: Neuroscience of vision | Course block: Neuroscience of vision 652 - 653
Neuroscience of vision
[WZ1331] Research Project Chronobiology | Forschungspraktikum Chronobiologie 654 - 655
[Ls20007] Introduction to Computational Neuroscience | Introduction to Computational Neuroscience 656 - 658
[WZme2670] Innovative Approaches in Viral Gene Technology | Innovative Ansätze in der viralen Gentechnologie 659 - 661
[WZ1085] Science of Laboratory Animals | Labortierwissenschaft 662 - 663
[WZ1993] Laboratory Animal Science | Laboratory Animal Science [VTK] 664 - 665
[WZ2690] Latest Neuroscience - Presenting Papers to Researchers and the General Public | Latest Neuroscience - Presenting Papers to Researchers and the General Public 666 - 668
[WZ2457] Neurobiology | Neurobiologie 671 - 672
[WZ0033] Physiology of Growth, Reproduction and Lactation | Physiologie des Wachstums, der Reproduktion und der Laktation 673 - 675
[WZ2405] Phylogeny and Zoology of Vertebrates | Phylogenie und Zoologie der Vertebraten 676 - 677
[WZ2127] Reproductive Physiology of Vertebrates | Reproduktionsbiologie der Vertebraten 678 - 679
[MA9613] Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences) 680 - 681
[WZ2458] Sensory Neuroscience | Sensory Neuroscience 682 - 683
[ME2090] Viral and Nonviral Gene Transfer: Methods and Applications in Research and Therapy | Viraler und nichtviraler Gentransfer: Methoden und Anwendungen in Forschung und Therapie 684 - 685
[WZ2456] Zoological Field Trip Mediterranean | Zoologische Exkursion Mittelmeer 686 - 689
Scientific Project Planning | Wissenschaftliche Projektplanung 690
[WZ2591] Scientific Project Planning | Wissenschaftliche Projektplanung 690 - 691
Master’s Thesis | Master’s Thesis 692
[WZ2590] Master’s Thesis | Master’s Thesis 692 - 694
Specializing | Studienschwerpunkte

Specializing in Biochemistry 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

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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

**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

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

Description of Examination Method:

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.


Repeat Examination:
Next semester

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

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:
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)
Bauer B, Fischer K, Flisikowska 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

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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 interpretieren 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 Zellbiologie, 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 Forschungsvorhabens.

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

**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](http://campus.tum.de) or [here](http://www.tum.de).
Module Description

LS20001: Research Internship Metabolic Programming | Forschungspraktikum Metabolic Programming

Version of module description: Gültig ab winterterm 2021/22

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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 und Biochemiker
(Forschungspraktikum, 15 SWS)
Uhlenhaut N [L], Friano M, Greulich F, Heddes M, Spanier B, Strickland B
For further information in this module, please click [campus.tum.de](https://campus.tum.de) or [here](#).
Module Description

LS20026: Research Internship Current Topics in Bioinformatics | Forschungspraktikum Aktuelle Themen der Bioinformatik

Version of module description: Gültig ab winterterm 2023/24

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

Description of Examination Method:
For the performance assessment, students complete a project work (a report) with a presentation. The students apply their knowledge to current problems and show that they are able to evaluate, interpret and concisely present the results. The overall grade of the module consists of the presentation and the report (weighting presentation 40% and report 60%).

Repeat Examination:

(Recommended) Prerequisites:
Programming skills are a pre-requisite. The course is offered to the students of the following disciplines: biology, molecular biotechnology, bioinformatics, biochemistry, chemistry, and biophysics (master/bachelor).

Content:
Research internship with changing, current topics in the field of the Chair for Bioinformatics. The interns work under the supervision and in collaboration with one of the institute's staff members and learn f special techniques as well as the analysis of data.

Typical project topics include:
- a) Analysis and prediction of protein interactions
- b) Evolution and host specificity of viruses
- c) Comparative genomics
- d) Protein structure analysis and prediction
- e) RNA informatics
- f) Analysis of heterogeneous OMCIs data
**Intended Learning Outcomes:**
Upon successful completion of the module the students are able to create bioinformatics solutions for specific biological problems in genomics, proteomics, structural biology, and evolution. The students have an in-depth understanding of bioinformatics algorithms and databanks as well as practical experience in applying statistical methods and machine learning. Furthermore, the students have learned to work independently and make independent decisions.

**Teaching and Learning Methods:**
Teaching technique: practical course. Teaching method: practical tasks, supervision during the internship,

Instructional discussions. Learning activities: study of literature, practical work on the computer, development of predictive models and software tools.

**Media:**
Work with a computer, talk (PowerPoint)

**Reading List:**
Project-specific literature

**Responsible for Module:**
Frischmann, Dimitri, Prof. Dr. rer. nat. dimitri.frischmann@tum.de

**Courses (Type of course, Weekly hours per semester), Instructor:**
Aktuelle Themen der Bioinformatik (Forschungspraktikum, 7 SWS)
Frischmann D [L], Frischmann D, Abbas Q
For further information in this module, please click campus.tum.de or here.
Module Description


Version of module description: Gültig ab winterterm 2016/17

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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 eingehen.

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:

**Intended Learning Outcomes:**

**Teaching and Learning Methods:**

**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

WZ0217: Research Practical Course Bioinformatics | Forschungspraktikum Bioinformatik

Version of module description: Gültig ab summerterm 2023

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

Description of Examination Method:
In order to monitor the performance, students prepare a project thesis/report (20 pages) with a presentation (30 min). The students apply their knowledge to current issues and show that they are able to evaluate, interpret and concisely present the results. The overall grade of the module is made up of the presentation and the report (Weighting: presentation 40% and report 60%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Programming skills are of advantage. The course is aimed for students of Biology, Molecular Biotechnology, Bioinformatics, Biochemistry, Chemistry and Biophysics (Master/Bachelor).

Content:
Research internship with current topics from the chair for Experimental Bioinformatics. The interns work under the supervision and cooperation of one of the institute's staff and learn special techniques and data analysis from them.

Typical areas include:
(a) We develop computational methods for Network and Systems Medicine, in particular for de novo endophenotyping, mechanotyping and redefinition of diseases by classifying their mechanistic causes rather than relying on symptoms.
(b) Computational systems medicine on lipids and metabolism.
(c) Big Data in Biomedicine development of prediction models and software tools that integrate large heterogeneous data sets (OMICS). The challenges in the field of data protection as well as the explicable and continuity of modelling will be addressed.
d) Explanation of molecular mechanisms behind phenotypes in general and human diseases in particular. Development of integrative bioinformatics methods based on network analysis, machine learning techniques and statistical approaches.

**Intended Learning Outcomes:**
After successfully completing the module, students are able to create experimental solutions for defined biological and technical problems from the field of bioinformatics. The students have a deep understanding of how results should be evaluated in an experimental context and have the methodological skills to do so. In addition, the students should have learned to act independently and to make decisions on their own.

**Teaching and Learning Methods:**
Teaching technique: practical training. Teaching method: practical tasks, mentoring during the practical training, instructional talks. Learning activities: study of lecture material and literature, practical work on computer, preparation of prediction models and Software tools.

**Media:**
Computer work, lecture (PowerPoint)

**Reading List:**
Practical instructions, for theoretical background Lecture notes, project-specific literature

**Responsible for Module:**
Küster, Bernhard, Prof. Dr. kuster@tum.de  Wilhelm, Mathias, Prof. Dr. rer. nat. mathias.wilhelm@tum.de  Pauling, Josch, Ph.D. josch.pauling@tum.de

**Courses (Type of course, Weekly hours per semester), Instructor:**
Forschungspraktium Bioinformatik (Forschungspraktikum, 12 SWS) Wilhelm M

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

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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 Tumorzelllinien (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:

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

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

Description of Examination Method:

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:**

**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)
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

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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 Gesamtnotenung 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 fragstellungsorientiert 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 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

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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, 1 SWS) Kapurniotu A

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

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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:

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

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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:
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 Problemen eine systematische Fehlersuche einleiten und vorhandene Synergieeffekte im Team nutzen.

**Teaching and Learning Methods:**

**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

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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

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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

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

Repeat Examination:
Next semester

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

Content:
The laboratory assignments are designed to endow the students with chemical biology know-how while answering particular research questions relevant to the larger research topics investigated in the laboratory. They are tailored according to the interest and background of the students but have all in common to investigate novel small molecule tools using quantitative mass spectrometry as a readout. All projects feature affinity enrichment ("pulldowns") and mass-spectrometry data processing and analysis. Either chemical synthesis or cell culture constitute the second skillset of the projects. Possible projects can therefore be e.g.: Preparation and evaluation of novel affinity probes, Target deconvolution of cell active molecules, Proteome-wide screening.
**Intended Learning Outcomes:**
After the completion of the module, the students have acquired the basic experimental skills of chemical proteomics. They understand the scope and limitation of affinity-based proteome profiling. They are able to analyze and be critical of the mass-spectrometry readout that follows their pulldown experiments. Additionally they have either acquired cell culture know-how or they have been able to synthesize new chemical matter. Their report and oral presentations constitute a valuable training for their future masters thesis writing-up and defense.

**Teaching and Learning Methods:**
Learning by doing is the key learning method of this laboratory assignment. Experimental and data analysis methods required for the assignment are explicated and demonstrated to each student individually. Written protocols for hands-on experiments are given to the students, which first perform them under close supervision by a mentor then in autonomy. Proactive suggestions of protocols variations are encouraged, which are discussed one-to-one. Timely discussions of results allow the assignment to move forward.

Presentations of the results are learned through oral presentations, helped by powerpoint slides, and final report writing. Attendance to the weekly group seminars serves both the acquisition of presentation skills (learn by example) and the contextualization of the laboratory assignment within the field of chemical biology (theoretical learning), where members of the Chair present their own work in progress.

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

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

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Forschungspraktikum Chemische Biologie (Praktikum, 10 SWS)
Küster B [L], Wilhelm S
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

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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 competition for students on the field of synthetic biology. It is developed and organized by the iGEM Foundation since year 2003. It is 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

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

Description of Examination Method:

Repeat Examination:

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

Content:


Generell ist der Inhalt nicht fixiert.
Intended Learning Outcomes:

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**

**Module Code:** CIT5130001: 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 2023/24

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

**Description of Examination Method:**

In the 60-minute written exam, students solve applied statistical problems in the life sciences and show proficiency in the R programming language. Solutions require first the identification and classification of the problem and second, application of the appropriate statistical 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:**

The course begins with definitions of univariate and multivariate data types, before proceeding to advanced R programs for multivariate data visualization. Statistical association methods for categorical data, first low- and then high-dimensional, are defined and illustrated, followed by analysis of variance methods for comparing population means across finite groups. Fundamental concepts of experimental design are illustrated, along with methods for computing sample size and power of experiments. The course next covers a spectrum of independent multiple regression methods, including linear, logistic, poisson, and survival. The course ends with linear mixed...
effects models for continuous correlated longitudinal data comprising multiple observations from independent individuals.

**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 regression for continuous, discrete and binary data.

**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:**
Powerpoint slides, R statistical package

**Reading List:**
https://cran.r-project.org/doc/contrib/Verzani-SimpleR.pdf
https://education.rstudio.com/learn/beginner/
Introduction to statistics and data analysis, 2020, Peck, ISBN: 9781337793612
The Elements of Statistical Learning, 2001, Hastie, ISBN: 9780387216065

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

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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 Prüfungsselemente 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 Prüfung (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 industriellen...
Maßstab genutzt werden. Schließlich werden Verfahren des metabolic engineering 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 Makroorganismen, 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; Anleitungsgerätschaften.
Lehrmethoden: Vorlesung, Präsentation, Vortrag, Einzelarbeit, Referate

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

**Reading List:**
Vorlesungsskript, wissenschaftliche Primärliteratur

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

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

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

Version of module description: Gültig ab winterterm 2023/24

<table>
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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 maximum 10 pages (including figures). To do so, the students receive a set of raw data with corresponding metadata. Based on the competences gained during the lecture and exercise the students should process the raw data, apply various forms of data analyses, e.g., clustering, hypothesis testing, enrichment analysis, Principle component analysis, and perform statistical and biological interpretation of the results. The report has to be submitted within ten days 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 (transcriptomics, proteomics, metabolomics) and illustrate different ways of analyzing such data.
Practicals will consist of 1) how to use a programming language 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 the information can be accessed/retrieved.

**Teaching and Learning Methods:**
Lecture: Introduction into statistics, application of Python 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 their 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 blackboard 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  The, Matthew, Ph.D. matthew.the@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

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

Description of Examination Method:

Repeat Examination:
Next semester

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

Content:
In den semesterbegleitenden Vorlesungen inkl. Übungen 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 hergestellt
- 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 Proteinformierung 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:**

**Media:**

**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

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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 acquire 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:**

**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, Williams 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

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<td>105</td>
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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 advised:
“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

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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.

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 und 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 Überinterpretationen 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  
another, 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](http://campus.tum.de) or [here](http://campus.tum.de).
Module Description

WZ8058: Immunoinformatics | Immunoinformatik

Version of module description: Gültig ab summerterm 2012

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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:
keine

Content:

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:**

**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 winterterm 2023/24

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<td>105</td>
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Number of credits may vary according to degree program. Please see Transcript of Records.

**Description of Examination Method:**
Exam duration (in min.): 90.

The theoretical content of the lecture is tested in a written exam. They form the basis for the practical part, in which the students transfer the acquired knowledge to application-orientated questions on the computer and thus deepen their understanding of the course content. These practical achievements are assessed on the basis of reports. Weighting: written exam 50%, minutes 50%.

**Repeat Examination:**
Next semester / End of Semester

**(Recommended) Prerequisites:**
none

**Content:**

**Intended Learning Outcomes:**
Lecture: Students are familiar with the main features of methods for modelling and simulating biological macromolecules. They know the application-oriented differences between various
molecular models and algorithms and have learnt to select the appropriate models/algorithms for a given application. 

Practical course: Students are familiar with the basic handling and application areas of various programs from the fields of protein-ligand docking, molecular simulation, and protein engineering and can apply these independently to simple scientific problems.

**Teaching and Learning Methods:**
Teaching techniques: Lecture, practical course, learning activities: learning computer-aided and theoretical methods in biology; independent work on the computer; learning research-relevant skills.

**Media:**
Powerpoint presentation, written internship instructions

**Reading List:**
Due to the high level of publication and research activity in this field, the literature list is updated every semester. This is distributed to students at the beginning of the semester.

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Modelling and Simulation of Biological Macromolecules (Vorlesung, 2 SWS)  
Di Pizio A

Protein and Drug Design (Praktikum, 3 SWS) 
Di Pizio A, Nicoli A, Steuer 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 die theoretische Umfeld der Studie sowie die methodischen Ansätze und die Prinzipien der experimentellen Techniken verstanden haben und nachvollzieherbar 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:

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 Tafelanschriebes. Darüber hinaus werden regelmäßig und interaktiv Übungen mittels Tafelanschriebes durchgeführt.

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

Chemische Peptid- und Proteinsynthese (Vorlesung, 1 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

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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 about 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:
Vorlesung Proteintechnologie: Membranen und Membranproteine (2SWS)
For further information in this module, please click campus.tum.de or here.
Module Description


Version of module description: Gültig ab summerterm 2013

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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:
Intended Learning Outcomes:

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung/Präsentation
Lernaktivität: 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:

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

WZ2580: Protein Engineering | Protein-Engineering

Version of module description: Gültig ab summerterm 2023

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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

**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 nachzu vollziehen
• 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:**

**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

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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:
Intensivkurs Proteomics (Übung, 3 SWS)
Küster B [L], Abele M, Küster B, Ludwig C, Schneider A, The M

Proteomics - Analytische Grundlagen und biomedizinische Anwendungen (Vorlesung, 2 SWS)
Küster B [L], Küster B (Kramer K)
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

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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:

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 Unterschieden 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

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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

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

Description of Examination Method:

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...

**Teaching and Learning Methods:**

**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

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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], Bhardwaj R, Chen Y, Johannes F, Schlegel L, Vo T, Zhang Z, Zhou M

Analysis of Epigenomic Data (Forschungspraktikum, 10 SWS)
Johannes F [L], Bhardwaj R, Johannes F, Piecyk R
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

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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

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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 individual 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

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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:**
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

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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
E. Passarge: Taschenatlas der Genetik, Thieme-Verlag, 3. Auflage 2008
C. Schaaf, J. Zschocke: Basiswissen Humangenetik; Springer-Verlag 2008

**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

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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:**
Original 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, Yun N
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

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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

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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

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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.
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, Trimmmomatic, bwa.

**Reading List:**

**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)
Korfmann K [L], Korfmann K, 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

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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:**

**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

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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:

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

Version of module description: Gültig ab summerterm 2017

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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 prepare 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 practical 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:**

**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

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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:**

**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](http://campus.tum.de) or [here](http://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

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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, Korfmann K, 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

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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 Überprüfung 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 / Mutagensesetechniken / 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

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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 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:**
- 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:**
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

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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 fungicide 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 agriculture. 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 platforms i.e. on petri plates and liquid culture and have acquired 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:

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

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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 evaluated 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.
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:

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

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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

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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:

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

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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.
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:**

**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 (Seminar, 2 SWS)
Tellier A [L], Johannes F, Tellier A

Modern topics in Evolutionary Biology (Vorlesung, 2 SWS)
Tellier A [L], Johannes F, Tellier A

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](http://campus.tum.de).
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

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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 Forschungsbeispiele 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 dieses Theorieteils sind gute Kenntnisse in Zellbiologie und Biochemie erforderlich.

Content:
Im Rahmen dieses theoretischen Moduls werden spezielle Kenntnisse 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 Stammzellenische
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 - Stammzellenische (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 Forschungsmanuscript; 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

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<th>Language: German/English</th>
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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:**

**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, Nowak-Imialek M

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

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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)
Fischer K, 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

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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:**

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 summerterm 2024

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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 set of statistics from published datasets or figures from publications. The aim is to demonstrate that the students can analyze and interpret genetic diversity data obtained as sequence of few genes or full genomes using all concepts from the course. The exam questions cover in particular the interpretation of the computed statistics. This includes, for example, understanding how statistics are computed, explaining the underlying principles of evolutionary genetics and population genetics, as well as evaluating and interpreting 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 PopGenom (in R).
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 PopGenome (in R) 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:
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 (Übung, 2 SWS)
Tellier A [L], Tellier A

Evolutionsgenetik der Pflanzen und Mikroorganismen (Vorlesung, 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

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);
Hedrick, Genetics Of Populations 4th Edition (2009);

**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 (Vorlesung, 3,3 SWS)
Tellier A

Applications of Evolutionary Theory in Agriculture: pathogen population genomics and disease
management (Seminar, ,7 SWS)
Tellier A

For further information in this module, please click [campus.tum.de](https://campus.tum.de) or [here](https://campus.tum.de).
Module Description

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

Version of module description: Gültig ab winterterm 2018/19

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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-fluorophore-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)
Michel K
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

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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:**

**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

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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 pursued 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

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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)
Michel K
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

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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, its 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, constructive 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:
- Kavanagh, Kevin, 2011, „Fungi – Biology and Applications”, Wiley-VCH
**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](http://campus.tum.de) or [here](http://example.com).
Module Description

WZ2014: Molecular Plant Breeding | Molekulare Pflanzenzüchtung

Version of module description: Gültig ab summerterm 2021

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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:**


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, Barl L, Liebthal M
For further information in this module, please click campus.tum.de or here.
Module Description

WZ2420: Molecular Genetics | Molekulare Genetik

Version of module description: Gültig ab winterterm 2018/19

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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
- RNA interference
- 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, Caenorhabditis 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:
Ben Lewin et al., GENES XI, 2014 (and higher), Jones & Barlett Learning, Burlington.
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

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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:
Intended Learning Outcomes:

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:
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

Version of module description: Gültig ab winterterm 2019/20

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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 acquired 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 - Computer Practical (Praktikum, 2 SWS)
Bhardwaj R

Plant Epigenetics and Epigenomics (Vorlesung, 3 SWS)
Johannes F

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](http://here).
Module Description

WZ2480: Plant Developmental Genetics 2 | Plant Developmental Genetics 2

Version of module description: Gültig ab winterterm 2023/24

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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 oral exam will be the final grade of the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A basic BSc-level understanding of cell biology, genetics, molecular biology, and plant biology is required.

Content:
The following topics are covered:
- genetics of light-dependent seedling development
- seedling development in the dark
- coordination of light/dark development circadian clock
- 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 have a basic theoretical understanding and specialist knowledge of plant development. They will understand important aspects of the genetic control of central processes, their molecular basis, and the model systems used in the study of plant development. They will be able to link the processes to distinct tissues in the plant and have developed the competence to evaluate their relevance for problems in horticulture and plant breeding.

Teaching and Learning Methods:
The module consists of a lecture (2 SWS) and a seminar (2 SWS).
The lecture provides the theoretical background and concepts. During the seminar, in individual or group work on specific selected original literature with presentations, students show their ability to understand the concepts and to critically analyze 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 video podcasts.

Reading List:
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

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

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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)

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or here.
Module Description

WZ1031: Quantitative Genetics and Selection | Quantitative Genetik und Selektion

Version of module description: Gültig ab summerterm 2023

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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, Kränzlein M, Kugler S

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

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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.

**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:**
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC

Lecture notes, additional material in moodle course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

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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)
For further information in this module, please click [campus.tum.de](http://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

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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:
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)
For further information in this module, please click campus.tum.de or here.
Module Description

ME2414: Research Project Pharmacology and Toxicology | Forschungspraktikum Pharmakologie und Toxikologie

Version of module description: Gültig ab winterterm 2011/12

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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 internship
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 internship, 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](http://campus.tum.de) or here.
Module Description

ME2436: Research Project Molecular Oncology | Forschungspraktikum Molekulare Onkologie

Version of module description: Gültig ab winterterm 2011/12

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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

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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, ELISA, 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

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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:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:

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

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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

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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:
Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 16 SWS)
Haller D [L], Haller D, Aguanno D, Coleman O, Krammel T, Ocvirk S, Omer H, Schmöller I, Schwamberger S, Skurk T, Smith K

External: Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 1 SWS)
Haller D [L], Haller D, Metwaly A, Ocvirk S, Schmöller I

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

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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)
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

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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

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

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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

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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, Pichlmair A, Ebert G, Vincendeau M, Bauer T
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

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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

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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; addressing 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 environment? 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 novel 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...
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 identify 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 successful completion of the module students will acquire 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 strengthen their competences to not only consider the technoscientific but also the social, political and ethical aspects of biomedical innovations.

**Teaching and Learning Methods:**
Supervised independent scientific work in the area of Science and Technology Studies (STS)

**Media:**

**Reading List:**

**Responsible for Module:**
Prof. Dr. Ruth Müller

**Courses (Type of course, Weekly hours per semester), Instructor:**
Forschungsprojekt: Herausforderungen der Biomedizin. Soziale, politische und ethische Dimension der medizinischen Biologie (Projekt, 2 SWS)
Schönwolff M
For further information in this module, please click campus.tum.de or here.
Module Description

WZ2697: Research Project Analysis of High-Throughput Data in Biomedical Research | Forschungspraktikum Analyse von Hochdurchsatz-Daten in der biomedizinischen Forschung

Version of module description: Gültig ab winterterm 2018/19

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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:**

**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](http://campus.tum.de) or [here](#).
Module Description

ME2506: Differentiation of human stem cells into pancreatic organoids for diabetes and cancer research (Research internship) | Humane Stammzelldifferenzierung in Pankreas Organoide für die Diabetes- und Krebsforschung (Forschungspraktikum)

Version of module description: Gültig ab summerterm 2023

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

Description of Examination Method:
The examination performance corresponds to a laboratory assignment. Daily presence and active participation in the laboratory setting is expected. A presentation (30 min, graded) serves to ensure that the student has learned theoretical competences in the studied field. The student needs to demonstrate general knowledge of the field, ability to structure data and results, focus on the relevant aspects of the practical work, and present conclusions drawn from the experiments conducted. Placing the work in context of the current state of the art of the field is expected. The grade of the presentation will be a part of the whole grade (30%).
A laboratory protocol containing all experiments, results, and conclusions will be assessed to determine understanding of the work conducted in the module. This part will constitute the 2nd part of the overall grade of the module (70%). Assessment of the practical aspects with regards to cell culture and analysis of stem cell differentiation will occur during the time in the laboratory.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in cell culture and aseptic techniques is strongly recommended.
Basic knowledge in cell and molecular biology is strongly recommended.
Basic lab techniques are strongly recommended.

Content:
This module consists of a six-week lab course which will teach background knowledge and important techniques for human stem cell culture and differentiation into functional cells using the example of pancreatic islet cells, hormone producing cells essential for the regulation of glucose
homeostasis or pancreatic exocrine cells that form the precursor for pancreatic adenocarcinoma. The lab course will cover general properties of human stem cells, how they can be guided towards a defined differentiation path, and how to test the maturity state of the generated cells. Students will learn how to handle undifferentiated stem cells, initiate 3D differentiation of these cells towards the gastrointestinal organs, and analyze the resulting pancreatic organoids at different stages. For the analysis of differentiated cells, essential molecular and cell biology techniques including fluorescence activated cell sorting (FACS), immunofluorescent labeling, microscopy, and quantitative PCR assays will be applied.

**Intended Learning Outcomes:**

After the successful completion of the module the student will gain general understanding of how human stem cells can be guided towards differentiation into the pancreatic lineages. The student will learn how to culture human stem cells, guide differentiation by addition of signaling factors, analyze molecular and cellular properties of differentiated cells. The overarching goal is for the student to be exposed to general principles of stem cell and pancreas biology as well as develop a deeper interest in organoids technology as a tool to define, understand, and modulate pancreatic diseases. The learning outcomes include:
- Understand and apply the basic principles of human stem cell culture and differentiation for basic research and disease modeling.
- Apply learned knowledge to generate novel hypotheses regarding relevant questions in pancreas biology and disease.
- Recognize the concept of cell lineage specification and ability to identify functional pancreatic cell types phenotypically and molecularly.

The student will obtain the following technical expertise:
- Carry out routine stem cell techniques such as:
  - Media preparation.
  - Sterile handling of undifferentiated stem cells (culturing, passaging).
  - Initiation of guided differentiation of human stem cells towards the pancreatic lineages.
- Utilize molecular and cell biological assays to analyze stem-cell derived organoids by:
  - Fluorescence activated cell sorting (FACS)
  - Immunofluorescent labeling
  - Microscopy
  - Gene expression via quantitative PCR
- Document and evaluate experimental data and present their results.

**Teaching and Learning Methods:**

Way of instruction: Lectures and instruction in laboratory practice; demonstration of experimental settings and instrumentation; discussion of results and guidance in preparation of laboratory book notes and protocols; support in generating of summary lab notes consisting of presentation of data, results, and discussion thereof.

**Media:**

- PowerPoint
Reading List:
There is no science book available that covers all aspects of this module. It is recommended to read the following publications as foundation for the module.

Responsible for Module:
Matthias Hebrok, Matthias.hebrok@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

WZ2411: Immunology 2 | Immunologie 2

Version of module description: Gültig ab summerterm 2018

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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. The 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)

Spezielle Immunologie für Biologen, Biochemiker, Molekulare Biotechnologen und Mediziner (Vorlesung, 2 SWS)

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

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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 erworben 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:
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:

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)
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

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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:**

**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)
Djabali K [L], Djabali K, Krüger P
For further information in this module, please click [campus.tum.de](http://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

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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 Forschungsbeispiele 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

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 Forschungsmanuscript; 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](http://campus.tum.de) or [here](http://campus.tum.de).
Module Description

WZ0219: Chemosensory Perception | Chemosensory Perception

Version of module description: Gültig ab summerterm 2023

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<th>Language: English</th>
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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 biology, biochemistry, cell biology and physiology is required.

Content:
The basics of aroma- and taste recognition, evaluation, and analysis on a molecular level are communicated.
In detail, the following topics are discussed:- basics of human taste recognition (molecules, anatomy, morphology and function of gustatory and olfactory structures, receptors, genetic variability and its influence on sensory sensitivity, establishment of preferences and aversions, the connection between sensory perception and food preferences, extra-sensory functions of taste and odorant receptors, oral somatosensory perception, basic taste modalities, signal transduction).

**Intended Learning Outcomes:**
Upon completion of the module, students understand the molecular bases of taste and smell perception. The students will be able to separate those percepts from other chemosensory cues such as chemesthesis or pheromone detection. Moreover, students are familiar with the putative physiological relevance of extra-sensory chemosensory stimuli. The importance of the chemical senses for food preferences and consumption is known.

**Teaching and Learning Methods:**
The content of the lecture is presented by means of powerpoint presentations. 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

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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 acquire 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:

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, Williams 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

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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 discuss 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:

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**

**WZ2451: Introduction to Mycopathology | Einführung in die Mykopathologie**

Version of module description: Gültig ab summerterm 2012

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

**Description of Examination Method:**
Prüfungsduer (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:**
" in der Lage sein, wichtige pilzliche Krankheitserreger einschließlich der durch sie verursachten Krankheitsbilder zu benennen.
" beispielhaft molekulare Mechanismen von Pathogenitätsfaktoren, Antibiotikawirkung und -resistenz zu benennen und erläutern können.
" ein Verständnis über die Möglichkeiten zur 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

**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, politische und ethische Dimension der medizinischen Biologie

Version of module description: Gültig ab summerterm 2016

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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:

**Intended Learning Outcomes:**

**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)


**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

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

Description of Examination Method:

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 an 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:**
Molekulare Pathologie (Vorlesung, 2 SWS)

Organspezifische Molekulare Karzinogenese (Vorlesung, 2 SWS)

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

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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 pursued 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

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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 recommend:

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

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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.


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

**Intended Learning Outcomes:**

**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:**
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

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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
- 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:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Biologie humanpathogener Parasiten (Vorlesung, 1 SWS)
Ebner F, Gerner R

Biologie humanpathogener Parasiten (Vorlesung, 1 SWS)
Ebner F, Gerner R

Einführung in die Biologie und Diagnostik humanpathogener Bakterien (Vorlesung, 2 SWS)
Gerner R
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

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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 beschreiben 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:

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

WZ2427: Molecular Cell Biology of Tumorigenesis | Molekulare Zellbiologie der Tumorentstehung

Version of module description: Gültig ab summerterm 2023

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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
Reading List:
There is no textbook available that covers all contents of this module. The following is recommended as a basis or supplement:

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) (Übung, 1 SWS)
Janßen K [L], Janßen K, Laschinger-Bolzer M

Molekulare Zellbiologie der Tumorentstehung (Teil 1) (Vorlesung, 2 SWS)
Janßen K [L], Janßen K, Laschinger-Bolzer M

Molekulare Zellbiologie der Tumorentstehung (Teil 2) (Vorlesung, 2 SWS)
Janßen K [L], Laschinger-Bolzer M

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

WZ2496: Molecular and Medical Virology | Molekulare und Medizinische Virologie

Version of module description: Gültig ab winterterm 2011/12

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Description of Examination Method:

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Kennenisse 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, Immun evasion, 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)
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

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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:
**Intended Learning Outcomes:**

**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:**
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

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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 biologics, 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:
Vertiefungsvolesung Pharmakologie (Vorlesung, 2 SWS)

Seminar für Studierende der Biowissenschaften (Master) (Seminar, 2 SWS)
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

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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.

**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:**
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC

Lecture notes, additional material in moodle course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

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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)
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

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<td>one semester</td>
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Number of credits may vary according to degree program. Please see Transcript of Records.

**Description of Examination Method:**
Throughout the practical part the student’s actions are monitored by the course leader and evaluated on a daily base in form of a debriefing and feedback session. In a written exam (multiple choice tests) two weeks after course end the students will demonstrate their knowledge about the biology and clinical features of high consequence pathogens including ways of infection transmission and pathomechanisms as well as aspects of practical work in a mobile laboratory.

**Repeat Examination:**
Next semester

**(Recommended) Prerequisites:**
A solid background in molecular biology and microbiology. Especially theoretical and practical experience in PCR is desirable.

**Content:**
The module will comprise three parts:
(i) A course-accompanying daily two hour lecture held by Dr. Stoecker. Content will be high consequence pathogens, their diagnostics and outbreak response mechanisms.
(ii) A seminar-part during which the participants will give presentations about selected biological agents.
(iii) A practical part during which the students will be trained in field diagnostics of highly contagious pathogens.
Based on the experience of several laboratory deployments in the course of the West-Africa Ebola outbreak, a training curriculum was developed which covers realistic scientific, medical, technical and operational challenges that could be encountered in a field situation.

**Intended Learning Outcomes:**
After completion of this course the students will:

- Have gained knowledge about biology and clinical features of high consequence pathogens including ways of infection transmission and pathomechanisms
- Have acquired practical knowledge on scientific, medical, technical and operational challenges that could be encountered in a field laboratory situation.
- Be able to safely inactivate potentially contagious samples in a foldable Glovebox
- Be able to select and correctly use appropriate personal protective equipment (PPE)
- Have gained knowledge of how to conduct and interpret diagnostic RT-PCR-Assays
- Understand how to set diagnostic laboratory results in a clinical context
- Gain knowledge of how to process various samples to be expected in a field lab
- Be able to plan for and execute an emergency response for small and medium potentially infectious spills

**Teaching and Learning Methods:**
Lecture; Seminar; Practical course
For the seminar the students will prepare PowerPoint presentations in which they give an overview about selected biological agents. They will read English scientific literature and summarize the most important points in the presentation.

Practical course: After a thorough introduction into the concept and equipment of the deployable laboratory of the Bundeswehr Institute of Microbiology, the students will work in a training field laboratory and will have to handle and process mock samples. They will receipt the samples in a safe way, inactivate them in a foldable Glovebox and perform diagnostic immunochromatographic rapid tests with them. The students will extract RNA from the samples and perform diagnostic reverse transcription real time PCR. Finally they will interpret the results and communicate them. Throughout the whole process the will have to comply with biosafety, biosecurity and diagnostic rules.

Throughout the practical part the student’s actions are monitored by the course leader and evaluated on a daily base in form of a debriefing and feedback session. In a written exam (multiple choice tests) two weeks after course end the students will demonstrate their knowledge about the biology and clinical features of high consequence pathogens including ways of infection transmission and pathomechanisms as well as aspects of practical work in a mobile laboratory

**Media:**
Presentations using Powerpoint,

**Reading List:**
Responsible for Module:
Stöcker, Kilian; Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Diagnostics of High Consequence Pathogens in Deployable Laboratories (Lecture) (Vorlesung, 1 SWS)
Stöcker K

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

Diagnostics of High Consequence Pathogens in Deployable Laboratories (Excercise) (Übung, 2,5 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

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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:**
Mykologische Übungen (Übung, 5 SWS)
Liebl W [L], Köberle M

Einführung in die Mykologie (Vorlesung, 1 SWS)
Liebl W [L], Köberle M

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or here.
Module Description

LS20031: Research Internship Plant-Microbe Interaction | Forschungspraktikum Pflanze-Mikroben Interaktion

Version of module description: Gültig ab summerterm 2023

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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 based on a laboratory assignment. The students conduct a six-week, full-time research project in the lab, during which they carry out a smaller set of experiments (2-5) fairly independently, but under close supervision. After completion of the laboratory work, they write a protocol of approximately 10-15 pages in length, which should be handed in within 8 weeks after completion of the experimental work. With the protocol the students demonstrate their ability to summarize the theoretical background and key aims of the performed experiments, 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 the data analysis (50%) and the quality of the data presentation (50%). For the latter the evaluation is based on whether the theoretical background is properly described, the data is presented in a detailed and visually arresting manner, the calculations and application of statistical tests are accurate, and the results are interpreted and discussed properly.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology, biochemistry, genetics and chemistry. Practical experience with essential wet-lab techniques such as pipetting and working under sterile conditions.

Content:
Plants interact with microbes in many ways. These interactions can be either beneficial, as in the case of symbiosis, or problematic, as in the case of pathogens. Depending on the type of interaction, plants have evolved different molecular modes, which are utilized for symbiont recruitment or establishment or pathogen defenses and while these usually differ, some modes...
are conserved. Studying these events, to gain a deeper understanding of the underlying molecular and biochemical modes, may enable us to develop tools and procedures that benefit plant performance. In addition, research in this field has the potential to uncover molecular mechanisms of organismal interactions that are conserved across the biological kingdoms and can thus benefit our understanding of immunity also in animal systems.

This module is designed to teach students a subset of the following techniques:
+ Storage and cultivation of fungal symbionts or pathogens
+ Culturing of plants for infection assays and infection protocols

+ Phenotyping of plants to evaluate symbiosis or disease development
+ Quantitative histological assays to evaluate pathogen spread
+ Evaluating molecular read-outs of interactions such as marker gene expression (qPCRs) or altered abundance of proteins relevant for the interaction (western blotting)
+ Other relevant methods of molecular biology and biotechnology (for example transformation, genome-editing, line selection, protein-protein interaction assays in vitro and in vivo)
+ Work with model plants (Arabidopsis) and crops (Legumes and others)

**Intended Learning Outcomes:**
Upon completion of this module students are able:
+ to understand the principles of research approaches used to study plant-microbe interactions;
+ to assess for which scientific questions it may be helpful to use them;
+ to plan and to carry out basic experiments using plant-microbe experimental systems;
+ to interpret and evaluate the results obtained 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-Microbe Interaction research. 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 approaches in the field. By writing a research report the students learn to summarize the obtained results and discuss them in the context of relevant literature.

**Media:**
Oral instructions, lab protocols, and relevant scientific publications.

**Reading List:**

**Responsible for Module:**
Poppenberger-Sieberer, Brigitte, Prof. Dr. brigitte.poppenberger@tum.de
Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Pflanze-Mikroben Interaktion (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B [L], Poppenberger-Sieberer B
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

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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 individual 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

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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

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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 research 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 taught 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 planning 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:

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

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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

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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

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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

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</table>

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:
Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 16 SWS)
Haller D [L], Haller D, Aguanno D, Coleman O, Krammel T, Ocvirk S, Omer H, Schmöller I, Schwamberger S, Skurk T, Smith K

External: Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 1 SWS)
Haller D [L], Haller D, Metwaly A, Ocvirk S, Schmöller I

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

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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)
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

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

**Description of Examination Method:**


**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 Fähigkeiten 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, Baudrexl M, 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

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

Description of Examination Method:

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...
and 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 Kompetenzen 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 Selbständigke im Planen und Durchführen von Experimenten
- Fähigkeit zur Führung von Aussagekräftigen, nachvollziehbaren Laborprotokollen
- Kritisches und kreatives Denken verstärkt sowie Fähigkeiten zum Lösen von Problemen erweitert

**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, Baudrexel 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 winterterm 2023/24

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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:

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

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

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

Description of Examination Method:
Prüfungsduer (in min.): Protokoll.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zum besseren Verständnis der Methoden sind ausreichende Kenntnisse in Mikrobiologie, Chemie und Biochemie notwendig.

Content:

**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:**
Lernaktivitäten: Erstellung eines Protokolls.

**Media:**
Tafelarbeit, Arbeitsblätter und Standardarbeitsanweisungen, Versuchsbeschreibungen

**Reading List:**

**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 Enzimatik

Version of module description: Gültig ab summerterm 2012

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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:

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 Enzimatik. 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.


**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, Ehrenreich A, 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

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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, quime2, 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).

---

**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:**
**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](http://campus.tum.de) or [here](http://here).
Module Description

WZ2557: Research Project Soil Microbiology | Forschungspraktikum Bodenmikrobiologie

Version of module description: Gültig ab summerterm 2023

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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:

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.
- 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 campustum.de or here.
## Module Description

**WZ1818: Fungal Genetics Exercise | Pilzgenetische Übung**

Version of module description: Gültig ab summerterm 2015

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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 knowledge 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

Version of module description: Gültig ab summerterm 2024

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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). This module aims to teach you how to design and conduct independent research in a supportive lab 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 by experimental work. 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. This exercise aims 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 the 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 100 points have been granted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor’s in Molecular Biotechnology, Biology or Biochemistry, or other relevant areas.

Content:
Practical work in a microbiome and microbiology research lab, which combines wet and dry lab approaches.

Intended Learning Outcomes:
You will work within a larger research project, which involves understanding how certain commensal microbes, particularly Escherichia (E.) coli spp., shape mucosal immunity and how this affects the subsequent development of autoimmunity and inflammatory diseases. As one of the first gut colonizers after birth, E. coli might significantly impact the training and priming of the mucosal immune system. However, little is known about E. coli’s imprinting properties in the context of gut immunity.

You may focus on studying different aspects of host-commensal or host-pathogen interactions with a particular focus on either commensal, probiotic, or pathogenic E. coli. Other aspects may involve developing and optimizing cutting-edge methods and assays, isolating microbes, and undertaking studies to probe beneficial microbial function, e.g., production of novel anti-microbial and/or immune stimulation.

Teaching and Learning Methods:
Introduction to the lab and training in appropriate methods by a team member of our lab, followed by individual working and teamwork. Problem-solving training, experimental design, and data analysis will also be developed throughout the project.
Media:
Blogs and potential for peer-reviewed scientific publication(s).

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project on Beneficial Properties of the Early Life Microbiota (Forschungspraktikum, 16 SWS)
Gerner R [L], Gerner R
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 summerterm 2024

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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 ask a hypothesis-driven research question based on existing literature/data, which you will then attempt to answer once you start the experimental component of the module. Additionally, we wish to prepare you to apply 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
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, Biology, Biochemistry, or other relevant areas

Content:
Practical work in a microbiome research lab, which may involve a combination of wet and dry lab approaches.

Intended Learning Outcomes:
You will work on a partial aspect within a larger research project – which will involve 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 adherent-invasive Escherichia (E.) coli. 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.

Participants should be able to recognize, understand, and apply laboratory techniques. They can analyze the data produced and evaluate it with appropriate supervision. Participants should think of their 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 lab team member, followed by individual working and teamwork. Problem-solving training, 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:

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

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

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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 taught. 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:**

**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:

**Responsible for Module:**
Liebl, Wolfgang, Prof. Dr. wliebl@tum.de

**Courses (Type of course, Weekly hours per semester), Instructor:**
Angewandte Mikrobiologie - Abbauleistungen (Vorlesung, 1 SWS)
Liebl W, Ehrenreich A

Angewandte Mikrobiologie - Biosyntheseleistungen (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A

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

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

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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:

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Biological Warfare Agents - A Dark Side of Microbiology (Vorlesung, 2 SWS)
Wölfel R

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](http://www.bradford.ac.uk/media-v8/site/news/archive/Preventing-Biological-Threats-What-You-Can-Do-(PDF,-10.6mb).pdf).
Module Description

WZ2559: Soil Microbiology 1 | Bodenmikrobiologie 1

Version of module description: Gültig ab summerterm 2023

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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:
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, Rosenkranz M, 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

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

Description of Examination Method:
A written examination (multiple choice, 60 min, graded) is used to test the theoretical skills learnt. In the exam, students demonstrate whether they are able to structure the knowledge they have acquired about human pathogenic bacteria, including their characteristics, the host's defence mechanisms, immune evasion mechanisms of pathogens and their diagnostics, and present the key aspects. They should be able to describe, interpret and meaningfully combine the acquired information and transfer it to similar situations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Lecture and practical course in general microbiology

Content:
Part I: Biology of pathogenic bacteria.

Intended Learning Outcomes:
After participating in the module courses, students will be able to
- describe the interaction of bacterial pathogens with human hosts
- characterise pathogens on the basis of Koch's postulates
- define typical characteristics of pathogenic bacteria
- distinguish defence mechanisms of the host and defence strategies of pathogenic bacteria
- describe the forms and taxonomy of pathogenic bacteria
- describe diagnostic procedures in medical and food microbiology laboratories
- assess the significance of pathogens in the food biotechnological and medical field.

**Teaching and Learning Methods:**
Teaching techniques: Lecture
Teaching method: lecture, case studies, interactive discourse with students during and after the lecture. Learning activities: Memorising; solving exercises, studying literature

**Media:**
Blackboard work, PowerPoint presentations, films.
Lecture slides and a collection of exercise questions.

**Reading List:**

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Einführung in die Biologie und Diagnostik humanpathogener Bakterien (Vorlesung, 2 SWS)
Gerner R
For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](#).
Module Description

WZ2375: Evolution of Pathogens | Evolution von Krankheitserregern

Version of module description: Gültig ab summerterm 2023

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

Description of Examination Method:

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.
and Pathogenitätsinseln, Ökologie intrazellulärer Pathogene, Reduktive Evolution bei Pathogenen und Symbionten.

Intended Learning Outcomes:

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:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Ökologie und Evolution von pathogenen Bakterien (Vorlesung, 2 SWS)
Neuhaus K [L], Neuhaus K

Übungen zur Ökologie und Evolution pathogener Bakterien (Übung, 1 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

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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:

Teaching and Learning Methods:

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

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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, constructive 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:

 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

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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
- 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:
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:
Biologie humanpathogener Parasiten (Vorlesung, 1 SWS)
Ebner F, Gerner R

Biologie humanpathogener Parasiten (Vorlesung, 1 SWS)
Ebner F, Gerner R

Einführung in die Biologie und Diagnostik humanpathogener Bakterien (Vorlesung, 2 SWS)
Gerner R
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

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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 beschreiben 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:

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

WZ2449: Microbial Diversity and Development | Mikrobielle Vielfalt und Entwicklung

Version of module description: Gültig ab winterterm 2022/23

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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 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 microorganisms 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:**
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](http://campus.tum.de) or [here](http://www.tum.de).
Module Description

WZ2452: Modern Methods in Microbiological Diagnostics | Moderne Methoden mikrobiologischer Diagnostik

Version of module description: Gültig ab summerterm 2012

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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:
Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung Lehrmethode: Vortrag, Demonstrationen

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

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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:**

**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 (Praktikum, 5 SWS)
Schloter M, Schulz S

Moderne Methoden der Mikrobiellen Ökologie (Seminar, 2 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

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

Description of Examination Method:

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung und Übungen in Allgemeiner Mikrobiologie

Content:
Vorlesung Lebensmittelmiikrobiologie 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 Konservierungsmethoden (Enzyme, Schutzkulturen); Physikalische Konservierungsmethoden (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:**

**Teaching and Learning Methods:**

**Media:**
PowerPoint, Lehrfilme, Tafelarbeit, Script, Lernhilfe (Übungsfragen), Exkursionen mit Demonstrationen.

**Reading List:**
Krämer J, Prunge A (2017) Lebensmittelmikrobiologie. utb Verlag
Märtlbauer E, Becker H (2016) Milchkunde und Milchhygiene. utb Verlag

**Responsible for Module:**
Siegfried Scherer siegfried.scherer@wzw.tum.de

**Courses (Type of course, Weekly hours per semester), Instructor:**
For further information in this module, please click campus.tum.de or here.
Module Description

WZ2539: Seminar on Microbial Effectors | Proseminar Mikrobielle Wirkstoffe

Version of module description: Gültig ab summerterm 2012

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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

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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.

**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:**
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC

Lecture notes, additional material in moodle course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

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<td>Master</td>
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<td>one semester</td>
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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:
Learning activities: study of lecture handout scripts and own notes.

Media:
Presentations using 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

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<td>60</td>
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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

Makrophyten als Bioindikatoren zu Bewertung der Wasserqualität II (Übung, Limnologie) (Übung, 3 SWS)
Zimmermann S, Hagengruber V, Raeder U
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 winterterm 2023/24

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

Description of Examination Method:
Presentation (30 Minuten)

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Soil science (WZ1825) or comparable courses at other universities

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:
Kögel-Knabner, Ingrid, Prof. Dr. rer. nat. Dr. rer. nat. habil. koegel@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Bodenkundliche Übungen für Fortgeschrittene (Übung, 4 SWS)
Kögel-Knabner I

Bodenkundliche Übungen für Fortgeschrittene (Übung, 4 SWS)
Kögel-Knabner I

Bodenkundliches Seminar für Fortgeschrittene (Seminar, 2 SWS)
Prietzel J [L], Kögel-Knabner I, Höschen C
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

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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:

Media:
PowerPoint, Flipchart, Tafelarbeit, Digitale Mikrophotographie

Reading List:

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

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<td>one semester</td>
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Number of credits may vary according to degree program. Please see Transcript of Records.

**Description of Examination Method:**

**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

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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

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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:

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

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<td>300</td>
<td>240</td>
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Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is a laboratory assignment, i.e. students are required to work on one or more research questions largely independently. In some cases, predefined protocols are available for implementation. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can use the methods mostly completely independently, in some special cases under supervision. As part of the research internship, they collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated behavioral-physiological principles within a limited time and present and conclude it according to scientific conventions. In order to test the necessary ability to communicate the results and to examine related topics that are not a core component of the protocol, a presentation (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before the submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has approximately twice as much weight as the presentation.
The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory, and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

**Repeat Examination:**
Next semester / End of Semester

**Recommended Prerequisites:**
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

**Content:**
Within this research internship, topics from the field of insect ecology can be dealt with. Examples would be the topics "Influence of pesticides on the learning and foraging behavior of bees" or "Nutrient perception in different bee species"; this usually involves a combination of behavioral experiments and field or cage observations. Furthermore, behavioral experiments can also be combined with chemical analyses (e.g. GCMS). Experiments with other insects (butterflies, flies, beetles, ants) are also possible. The focus in this research module is on the study of the physiology of behavior underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

**Intended Learning Outcomes:**
After successfully completing the module, students will be able to carry out experiments on the behavioral-physiological interactions between plants and insects as well as their evaluation largely or completely independently. This includes the design of field experiments, the systematic recording of data in the field, the conditioning of bees using existing laboratory protocols and the statistical analysis of experimental results with the help of the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions posed and hypotheses they have developed and to place them in a broader scientific context.

**Teaching and Learning Methods:**
Teaching method: Discussion, instruction on special equipment, e.g. micromanipulators, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.
Media:
Instructions for field work and laboratory experiments, protocols for conditioning and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

Reading List:
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:

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

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<td>300</td>
<td>240</td>
<td>60</td>
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Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is a laboratory course, i.e. students are expected to work on one or more research questions largely independently. Some of the protocols for carrying out the work are provided. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can usually use the methods completely independently, in some special cases under supervision (e.g. a gas chromatograph coupled to a mass spectrometer, GCMS). As part of the research internship, sis collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated chemical processes within a limited time and that they can present and conclude it according to scientific conventions. In order to also test the necessary ability to communicate the results and to check related topics that are not a core component of the protocol, a lecture (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has about twice as much weight as the presentation.
The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

**Repeat Examination:**
Next semester / End of Semester

**(Recommended) Prerequisites:**
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

**Content:**
Within this research internship, topics from the field of insect ecology can be dealt with in both temperate and tropical ecosystems. Examples would be the topics "Influence of pollen nutrition quality on the foraging behavior of honey bees" or "Importance of plant resins for social bees"; this usually involves a combination of chemical analyses and field or cage observations. Experiments can also be carried out with other insects (butterflies, flies, beetles, ants). The emphasis in this research module is on the study of the chemistry underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

**Intended Learning Outcomes:**
After successfully completing the module, students will be able to carry out experiments on the chemical interactions between plants and insects and evaluate them largely or completely independently. This includes the design of field experiments, systematic data acquisition and sampling in the field, the extraction and chemical analysis of samples using gas chromatography mass spectrometry (GCMS) based on existing laboratory protocols, the chemical analysis of samples using the Chemstation program, and the statistical analysis of experimental results using the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions they have received and the hypotheses they have developed themselves, as well as to place them in a broader scientific context.

**Teaching and Learning Methods:**
Teaching method: discussion, instruction on special equipment, e.g. GCMS, rotary evaporator, Soxhlet apparatus, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.
Media:
Instructions for field work and laboratory experiments, protocols for chemical analyses and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

Reading List:
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:

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

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<td>300</td>
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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:

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

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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:

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

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<th>Language: German/English</th>
<th>Duration: one semester</th>
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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
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

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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

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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
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

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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:

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

Media:

Reading List:
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, Häberle K
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

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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:

Intended Learning Outcomes:
Nach der Teilnahme an dem Praktikum haben die Studierenden die Vorbereitung, Planung und Durchführung einer wissenschaftlichen Arbeit in der Terrestrischen Ökologie gelernt. In Abhängigkeit der konkreten Fragestellung sind die Studierenden nach der Lehrveranstaltung in der Lage, die entsprechenden Methoden selbständig anzuwenden.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Anleitungsgespräche, Demonstrationen, Experimente, Ergebnisbesprechungen.
Lernaktivitäten: Üben von labortechnischen Fertigkeiten und ökologischen Arbeitstechniken; Anfertigung von Protokollen.

Media:

Reading List:
wird in der Veranstaltung vorgestellt und selbst erarbeitet.

Responsible for Module:
Wolfgang Weisser (wolfgang.weisser@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Terrestrische Ökologie (MSc Biologie) (Forschungspraktikum, 16 SWS)
Meyer S [L], Meyer S
For further information in this module, please click campus.tum.de or here.
**Module Description**

**WZ2684: Research 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

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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 prepare 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 practical 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:**

**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

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<th>Language:</th>
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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:
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)
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

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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

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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, Hagengruber V
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

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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

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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 Messergebnisse 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 Messergebnisse in geeigneter und schlüssiger Form auszuwerten und zu präsentieren.

Teaching and Learning Methods:

Media:
PowerPoint, Tafelarbeit, Folien, Messgeräte

Reading List:

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)

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

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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 Beispielen verschiedener Ökosysteme im Nationalpark Berchtesgaden

**Intended Learning Outcomes:**

**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:
Ökosystemdynamik Übungen (Übung, 3 SWS)
Rammer W [L], Mateos Perez Bianco de Araujo B, Rammer W, Seidl R

Grundlagen der Ökosystemdynamik (Vorlesung, 1 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

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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

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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:

Media:
Feldübungen, Powerpoint, Wandtafel

Reading List:

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

LS60018: Planning Exercise Applied River Restoration | Planungsübung Angewandte Fließgewässerrenaturierung [PEARR]

Version of module description: Gültig ab winterterm 2023/24

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

Description of Examination Method:
The exam includes an assessment of the results, which are developed in the planning exercise "Planning Exercise Applied River Restoration" in the winter semester within the framework of a learning portfolio.

The learning portfolio consists of:
A presentation of the written and graphically elaborated planning results at the end of the winter semester (maximum points 80 - weighting 40%).
Logo and restoration objective of the project area (maximum points 10 - weighting 5%)
Plan: "Strengths and weaknesses of the planning area" (maximum points 40 - weighting 20%)
Plan: "Preliminary draft of the restoration planning" (maximum points 40 - weighting 20%)
Plan: "Three sections of detailed planning" (maximum points 20 - weighting 10%)
Explanatory report on the plans, maximum 15 pages (maximum points 10 - weighting 5%)

In this exercise, students will evaluate anthropogenic influences in a complex study area derived from restoration practice and determine the mode of action of their planned restoration. To do this, they will develop possible solutions for river restoration in planning terms and justify and defend the designed plans and their developed solutions in a power point presentation (30 minutes).

There is a certain number of points for each individual part of the learning portfolio. The maximum score that can be reached is 200 points (equivalent to a grade of 1.0) and a minimum of 100 points must be earned to pass the course with a grade of 4.0.

Repeat Examination:
End of Semester
(Recommended) Prerequisites:
Successful completion of the module "Applied River Restoration" which is offered in the summer semester. Knowledge of digital means in terms of graphical data processing (e.g. Auto CAD, Vectorworks, Photoshop, Coreldraw) and graphical area management (e.g. ARCGIS, QGIS) is desirable. Taking other courses in the field of aquatic ecology would be desirable, but is not necessarily a prerequisite as far as basic knowledge in this field exists.

Content:
• How to develop a suitable project logo for a restoration project
• Conducting a "Strengths and Weaknesses Analysis for the project area (SWAT Analysis)
• Recording and evaluating the habitat and species inventory worthy of protection in the project area
• Formulate an objective for the restoration concept based on the SWAT analysis
• Derive targets for the restoration based on the mission statement and the SWAT analysis
• Developing restoration measures on the basis of the objectives for the project area
• Locating the measures in a planning exercise and creating a preliminary restoration design
• Planning of detailed solutions in stream restoration
• Preparation of an explanatory report for a river restoration with practical relevance
• Presentation and defense of planning solutions

Intended Learning Outcomes:
After participating in the exercise "Planning Exercise Applied River Restoration", students are able to record, analyze and evaluate concrete and complex examples from the topic "anthropogenic influences in the planning of river restoration" and predict the effects of their individual restoration planning solutions on the development of the practice-oriented study area. Students are also be able to develop, goal-oriented solutions for river restoration and to justify and defend their individual planned restoration actions. There will be a significant focus on transferring what they have learned from the “Applied River Restoration” module given in the summer semester, where they will learn the fundamentals to successfully pass the “Planning Exercise Applied River Restoration” exercise.

Teaching and Learning Methods:
Portfolio: In the present case, this is a portfolio in which work results, such as plans, planning details, structural analyses, reports and all kinds of presentations up to audio-visual documentations are collected independently by learners and reflected on separately. During the training or learning phase, the portfolio should encourage learners to specifically observe important contents, methods and results (pieces of evidence) and to record and elaborate them in written or other documented form. At the same time, this process is to be reflected upon in a targeted manner in order to protect against schematic adoption and to promote independent judgments on the part of the learners. The portfolio is always both product- and process-oriented (planning process). Products (plans) and processes (planning progress and intermediate stages such as calculations on specific facts) are documented and reflected upon, helping to represent learners’ efforts, results and, if possible, progress. In this way, an analysis of the learning process can begin that takes learning itself as the object of reflection in order to form and continuously improve a
methodical learning competence. This can be achieved by actively involving the learners in the selection of content and modes of presentation, the definition of assessment criteria, and the assessment process. Active participation then presupposes that in-depth discussions (in the present case these are group supervision sessions in face-to-face form) are conducted by learners and teachers about the portfolio in a cooperative manner.

Media:
Case descriptions, cases and solutions, multimedia-based teaching and learning programs, and online procedures. The course is supported by an e-learning course in TUM Moodle.

Reading List:
Publikationen des Lehrstuhls TUM AQUASYS zur Fließgewässerrenaturierung. https://www3.ls.tum.de/aquasys/publikationen/

Responsible for Module:
Pander, Joachim, Dr. rer. nat. joachim.pander@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

WZ2398: Practical Ecotoxicology | Praktische Ökotoxikologie

Version of module description: Gültig ab summerterm 2015

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

Description of Examination Method:

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 quantitative Auswertung
- Auswertung der erhobenen Daten mit gängigen statistischen Auswertungsmethoden (uni- und multivariate Statistik) und Bestimmung der verschiedenen Bewertungspunkte (NOEC).
Intended Learning Outcomes:

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, Kalis E
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

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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 Ökosystemen 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:
Fortgeschrittene Statistik in R (Übung, 2 SWS)
Meyer S

Angewandte Versuchplanung (Übung, 5 SWS)
Meyer S [L], Meyer S

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

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Description of Examination Method:

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

Teaching and Learning Methods:

Media:
PowerPoint-Präsentation, Tafelarbeit, Flipchart, Film, digitale Photographie

Reading List:
Biologische Meereskunde, Sommer; Fauna und Flora des Mittelmeeres, Riedl; Das Mittelmeer, Fauna Flora Ökologie, Hofrichter; Bestimmungsschlüssel für die aquatischen Makrophyten (Gefäßpflanzen, Armeleuchteralgen 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
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

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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:**
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](http://campus.tum.de) or here.
Module Description

WZ2572: Experimental Design (Advanced Course) | Versuchsplanung (Fortgeschrittenenkurs)

Version of module description: Gültig ab winterterm 2018/19

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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 mathematics 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:
Grundlagen der Versuchsplanung (Master) (Vorlesung, 2 SWS)
Meyer S [L], Meyer S

Grundlagen der Statistik in R (Master) (Übung, 4 SWS)
Meyer S [L], Meyer S

For further information in this module, please click campus.tum.de or here.
Theory-Oriented Modules | Theorieorientierte Module

Module Description

LS60019: Applied River Restoration | Angewandte Fließgewässerrenaturierung [ARR]

Version of module description: Gültig ab winterterm 2023/24

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

Description of Examination Method:
The module grade is determined in a 90-minute written exam at the end of the summer semester. In this written exam, the content of the lecture "Applied River Restoration" as well as the content of the seminar "Applied River Restoration Impromptu" will be tested. In the written exam, the students should show that they can remember the problem solutions of river restoration learned in the lecture. They will write the answers in limited time and without aids and show that they can recognize and understand problem definitions and that the learned basic knowledge for problem solving can be applied for important measuring and investigation methods of river restoration. The exam questions cover the entire lecture material. The answers require own formulations. The knowledge gained in the seminar is also tested in the written examination, in which the students must develop drawing and planning solutions. The students show that they can analyze typical questions and problems of stream restoration, differentiate different solutions and derive conclusions. They also show that they can characterize important limiting factors that are of great importance for the restoration of species communities (fish and macrozoobenthos), species or their life stages.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Interest in the topic; taking other courses in the area of aquatic ecology would be desirable, but is not necessarily a requirement as long as basic knowledge in this field exists. Prior knowledge of digital data processing in terms of graphical data processing (e.g. Auto CAD, Vectorworks, Photoshop, Coraldraw) and graphical land use management (e.g. GIS, QGIS) is desirable.
Content:
- Ecosystem services in streams
- Anthropogenic disturbances in streams
- The four dimensions of streams, resolved longitudinally, laterally, vertically, and temporally
- Target species-specific habitat requirements of selected target species
- Legal basis and instruments of planning
- Different scales in stream restoration
- Renaturation of ecosystem-based processes
- Renaturation of life stages of individual species
- Limiting factors (restrictions) of stream restoration
- Different techniques of stream restoration
- Engineering-biological construction methods in stream restoration
- Monitoring of stream restoration
- Communication of success or failure of river restoration projects

Intended Learning Outcomes:
After attending the lecture "Applied River Restoration" the students are able to remember different anthropogenic disturbances in flowing waters as well as techniques of river restoration, to understand the resulting problems and to apply the theoretically learned knowledge of the lecture. Students will be able to apply important measurement and investigation methods of stream restoration. In the seminar "Applied River Restoration Impromptu" the students learn to analyze the lecture material, to differentiate different solutions and to derive conclusions. Furthermore, the students are able to characterize important limiting factors which are of great importance for the restoration of species communities (fish and macroinvertebrates), species or their life stages.

Teaching and Learning Methods:
Lecture Power-Point Presentation: Presentations are very well suited to impart knowledge about the basics of stream restoration. Students are thus able to remember the various facts and understand their interrelationships. Students learn to characterize important potential limiting factors of restoration, which can have a major impact on the restoration success of species communities (fish and macrozoobenthos), species or their life stages.
Blackboard, flip-chart: These media are very well suited for students to develop possible solutions to specific problems in stream restoration under guidance of a lecturer and in joint discussion with the seminar participants. With this method, the basic theoretical knowledge learned in the Power-Point presentation can be applied to specific cases. Possible assistance from the lecturer or even the group flows directly into the application of the learned knowledge without any time delay and can be implemented immediately.
Video: In the videos provided in the e-learning course (Panopto linked to TUM-Moodle), certain facts and processes of stream ecology and restoration are explained in depth and solutions derived from practical experience are shown. They also help to convey certain case descriptions in a catchy way. The videos help students analyze certain scenarios, differentiate various solutions, and draw appropriate conclusions on the video content.
Term papers: In the term papers, students learn to independently analyze and evaluate certain problems in restoration planning and to derive and develop their own conclusions in the form of possible solutions to these problems.

**Media:**
Power-point, white-board, flip-chart, Video, descriptions of case studies, digital plans

**Reading List:**

**Responsible for Module:**
Pander, Joachim, Dr. rer. nat. 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 2024

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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 (120 min). On the basis of the written examination, students demonstrate that they understand legal regulations dealing with contaminated sites, can evaluate the hazard potential of a contaminated site with regard to the type of pollutants and the emission pathway, understand the various investigation methods and can evaluate a suitable sampling strategy and analytical investigation program.

The module "Remediation of contaminated sites - Lecture and exercises" is an alternative module to "Remediation of contaminated sites - Lecture and seminar" (LS10007). Only one of the two modules can be completed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of soil science

Content:
Lecture: Federal Soil Protection Act, procedure for the investigation of contaminated sites; contamination typical of the industry (old deposits - old sites, old armaments and military sites); assessment of contaminants (primary contaminants - priority contaminants, material transport, exposure); Hazard potential, ecotoxicological tests; investigation of contaminated sites (investigation methods, sampling strategy, analytical investigation program); remediation objectives; safety measures; decontamination procedures; recultivation and renaturation (soils on contaminated sites, post-mining landscapes).
Exercises: Visit to contaminated sites in the Munich area: Biological ex-situ remediation of organically contaminated soils; sampling of contaminated soil material in piles; immission control requirements for companies working on contaminated sites; sorting and (interim) storage of contaminated soils prior to disposal in suitable landfills; LAGA landfill classes for the classification of contaminated soils; recycling options for contaminated material; innovative in-situ remediation and securing measures; relationship between investment and operating costs for long-term remediation measures; securing measures in post-mining landscapes; specific problems in lignite mining landscapes; evaluation of recultivation and renaturation measures; legal background: Federal soil protection, recycling management and water protection law.

**Intended Learning Outcomes:**
After successfully completing the module courses, students will be able to understand legal regulations dealing with contaminated sites, apply the correct procedure for the investigation of contaminated sites and suspected contaminated sites as well as for the remediation of contaminated sites, evaluate the hazard potential of a contaminated site with regard to the type of pollutants and the emission pathway, understand the various investigation methods and evaluate a suitable sampling strategy and analytical investigation program, evaluate different remediation techniques and recultivation measures and apply the appropriate one depending on the respective contaminated site. In addition, students will be able to evaluate various contaminated sites and operations and critically analyze the remediation methods used with regard to remediation success and environmental impact.

**Teaching and Learning Methods:**
The module consists of a lecture and an exercise. In the lecture, students are taught the legal regulations dealing with contaminated sites, the correct procedure for the investigation of contaminated sites and suspected contaminated sites and for the remediation of contaminated sites, the hazard potential of a contaminated site with regard to the type of pollutants and the emission pathway, the various investigation methods and a suitable sampling strategy and analytical investigation program, different remediation techniques and recultivation measures.

In the exercises, students will visit selected contaminated sites and remediation facilities, evaluate various contaminated sites and remediation companies, and critically analyze the remediation methods used with regard to remediation success and environmental impact.

**Media:**
Präsentationen

**Reading List:**
Presentations; in-depth book list on request

**Responsible for Module:**
Kögel-Knabner, Ingrid; Prof. Dr. rer. nat. Dr. rer. nat. habil.
Courses (Type of course, Weekly hours per semester), Instructor:
Altlastensanierung - Kontaminierte und rekultivierte Böden (Übung, 2,1 SWS)
Höschen C, Heister K

Remediation of Contaminated Sites - Regeneration of contaminated soils (Vorlesung, 2 SWS)
Zare M
For further information in this module, please click campus.tum.de or here.
Module Description

**WZ0351: Biodiversity in Dynamic Forests and Protected Areas Management | Biodiversität dynamischer Wälder und Schutzgebietsmanagement**

Version of module description: Gültig ab summerterm 2024

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

**Description of Examination Method:**

Die Prüfungsleistung erfolgt in Form einer Projektarbeit im Umfang von 10-15 Seiten ergänzt um eine 5- bis 10-minütige Präsentation. Dabei bearbeiten die Studierenden entweder Themen aus dem Bereich Biodiversität dynamischer Wälder oder Schutzgebietsmanagement. Das Thema wird den Studierenden vom Dozierenden zugeteilt. Die konkreten Bestandteile der Arbeit sind:

- Formulierung der Zielsetzung
- Erhebung von Daten (Anhand von Fachliteratur, Interview mit Nationalparkmitarbeitern, eigene Datenerfassung)
- Auswertung der Daten
- Interpretation der Ergebnisse

Die Projektarbeit erfolgt in Form einer Gruppenarbeit, wobei als Prüfungsleistung die individuellen Beiträge der Studierenden bewertet werden. Diese individuellen Beiträge müssen in der Präsentation und der schriftlichen Auswertung deutlich erkennbar gemacht werden.

**Repeat Examination:**

Next semester

**(Recommended) Prerequisites:**

Für das Verständnis des Moduls sind grundlegende ökologische Kenntnisse erforderlich.
**Content:**
Im Rahmen des Moduls werden Grundkenntnisse zur Artenvielfalt in Wäldern mit einem Fokus auf unterschiedliche Waldentwicklungsphasen bis hin zu natürlichem Offenland und anthropogen bewirtschafteten Almen vermittelt. Die wichtigsten Erfassungsmethoden für Tiere, sowie grundlegende Kenntnisse der Arten sollen im Rahmen angeleiteter Übungen vermittelt werden, bei denen die Studierenden in Gruppen ausgewählte Artengruppen in unterschiedlichen Waldentwicklungsphasen selbst erfassen. Desweiteren werden die grundlegenden Herausforderungen dargestellt, denen sich Schutzgebietsmanager gegenübersehen, ebenso wie mögliche Lösungen. Dieses Themenfeld können die Studierenden in Gruppen im Austausch mit Mitarbeitern des Nationalparks Berchtesgaden erörtern.

**Intended Learning Outcomes:**
Nach dem Besuch des Moduls sind die Studierenden in der Lage,
• die wichtigsten Erhebungsmethoden zu verschiedenen terrestrischer Artengruppen anzuwenden.
• typische Tierarten in Bergwäldern und im montanen Offenland zu bestimmen.
• die Treiber der Artenvielfalt in dynamischen Wäldern zu beschreiben.
• Herausforderungen im Schutzgebietsmanagement zu analysieren.
• Strategien im Schutzgebietsmanagement zu entwerfen.

**Teaching and Learning Methods:**

**Media:**
PowerPoint Präsentationen, Vorlesungsskripten, Fachliteratur

**Reading List:**
Primack & Sher 2016: An Introduction to Conservation Biology, Sinauer; Wohlgemuth et al. 2019: Störungsökologie, utb;

**Responsible for Module:**
König, Sebastian, M.Sc. sebastian.koenig@tum.de
Courses (Type of course, Weekly hours per semester), Instructor:
Schutzgebietsmanagement (Übung, 1,5 SWS)
König S [L], Geres L, König S, Richter T

Walddynamik und Biodiversität (Vorlesung, 1,5 SWS)
König S [L], König S

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

WZ2047: Soil Protection | Bodenschutz

Version of module description: Gültig ab winterterm 2023/24

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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:
Soil science (WZ1825) or comparable courses at other universities

Content:
The module includes the following contents: Soil functions, pathways of action, toxicology, legal basics, determination of soil pollution, soil components (clay minerals, oxides, organic material), ion exchange, adsorption, precipitation and coprecipitation, acidification, salinization, behavior of trace elements in soils (availability, mobility), inorganic pollutants (heavy metals), radionuclides, organic pollutants (e.g. PAK, PCB, dioxins and pesticides), remediation and securing procedures.
**Intended Learning Outcomes:**
After attending the module course, students will be able to understand processes that influence the behaviour of substances in soils (e.g. sorption), to evaluate the influence of acidification and salinization on the behaviour of substances in soils, to analyse the behaviour of heavy metals, radionuclides and organic pollutants in soils and to understand and evaluate different remediation techniques depending on the type of contamination. They are able to independently familiarize themselves with specific questions of soil protection and to present hazards, protection methods and remediation techniques to an audience and to explain them in more detail in the discussion.

**Teaching and Learning Methods:**
The module consists of a lecture and a seminar. In the lecture, students are introduced to the processes that influence the behaviour of substances in soils. The lecture gives a broad overview of the different groups of pollutants and shows their behaviour in soils. For the seminar, students choose a more limited topic from the context of soil protection, in which they independently delve deeper. The students give a lecture on their topic, which is discussed by all students in the plenum under the guidance of the lecturer.

**Media:**
Presentations

**Reading List:**
Lecture: presentations, in-depth book list on request; seminar: special literature lists for the individual topics

**Responsible for Module:**
Kögel-Knabner, Ingrid; Prof. Dr. rer. nat. Dr. rer. nat. habil.

**Courses (Type of course, Weekly hours per semester), Instructor:**
Bodenschutz - Organische und anorganische Schadstoffe in Böden (Vorlesung, 2 SWS)
Bucka F

Bodenschutz - Nutzungsabhängige Funktionsfähigkeit von Böden (Seminar, 2 SWS)
Schweizer S [L], Höschen C, Schweizer S
For further information in this module, please click campus.tum.de or here.
Module Description


Version of module description: Gültig ab summerterm 2024

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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). Based on the examination, students show that they know all soil types on earth with their most important properties and understand their genesis and the reasons for their occurrence in different parts of the world. They also show that they can assess the threat to soils from various forms of land use in relation to natural soil (in)fertility. They demonstrate that they can analyze the consequences of land use for the global carbon balance. They show that they are able to assess the specific requirements for the use of different marginal sites. They also demonstrate that they can develop concepts for sustainable production on marginal sites, soil protection, and increasing soil fertility through the use of trees. Furthermore, they prove that they have understood the formation of the soils presented in the exercise in the field and can evaluate them in terms of their potential use.

In addition, the ability to describe and classify soils in the field and interpret them concerning their ecology is tested by means of a laboratory exercise (in the field) as an ungraded course work.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Soil science (WZ1825) or comparable courses at other universities

Content:
1. Characteristics, distribution, genesis and utilization possibilities of all soil types on earth, presented according to the international soil classification WRB.
2. The world food problem, what is soil degradation, increasing food production on fertile sites, marginal sites (highly erosion-prone, semi-arid, highly weathered), agroforestry (definitions, effects of trees on the soil, erosion control, water balance, nutrient balance, the role of roots).
3. Soil descriptions and classification according to the international WRB system and subsequent ecological interpretation.

**Intended Learning Outcomes:**
Students are familiar with all soil types on earth and their most important properties. They have understood their genesis and the reasons for their occurrence in different parts of the world. Students understand the connections between natural soil (in)fertility and the threat to soils from land use. They know the production possibilities on sites of varying fertility and their historical and cultural implications. They are able to assess the specific requirements for the use of different marginal sites. They have sufficient knowledge of the possibilities of soil protection through the use of trees. Students can apply the field guide of the international soil classification system WRB in the field and describe the most important soil properties using this field guide. They are able to classify soils according to WRB. They are also able to derive the fertility properties of soils and their hazard potential from the description and classification.

**Teaching and Learning Methods:**
Lecture and presentation (lecture); interactive soil approach, soil classification and soil evaluation (field exercises); literature study, reflection

**Media:**
Lecture: presentations, blackboard notes; field exercise: scripts

**Reading List:**

**Responsible for Module:**
Schad, Peter, Dr. rer. silv. peter.schad@tum.de

**Courses (Type of course, Weekly hours per semester), Instructor:**
Boden degradation und Bodenschutz in den Tropen und Subtropen (Vorlesung, 2 SWS) Schad P

Böden der Welt (Vorlesung, 2 SWS) Schad P

Bodenansprache und Bodenklassifikation nach internationalen Standards (Übung, 2,8 SWS) Schad P, Just C

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

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</table>

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)
Heinen R [L], Heinen R
For further information in this module, please click campus.tum.de or here.
Module Description

LS60005: Introduction in Ecological Modelling | Einführung in die ökologische Modellierung

Version of module description: Gültig ab winterterm 2023/24

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

Description of Examination Method:

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Modell anschließend in einer Programmiersprache (NetLogo, R oder Python). Das Modul beinhaltet eine allgemeine, übergreifende Einführung in Modellierungsprinzipien, die Vorstellung der jeweils behandelten Ökosystemprozesse und Fragestellungen, die Herangehensweisen bei der Erstellung konzeptioneller Modelle sowie die Einführung in den Umgang mit der jeweiligen Modellierungs- und Simulationsumgebung. Behandelte Themen umfassen u.a.:
- Modelle der Populations- und Habitatdynamik
- Ausbreitungsmodelle
- Landschaftsmodelle
- Agentenbasierte Ökosystemmodelle

**Intended Learning Outcomes:**

**Teaching and Learning Methods:**
Das Modul besteht aus einer Übung in deren Rahmen die Grundlagen zur Modellierung von den Studierenden gemeinsam mit den Dozenten erarbeitet und anschließend von den Studierenden an konkreten Beispielen umgesetzt werden:
- Was sind Modelle?
- Erstellen des konzeptionellen Modells
- Implementierung des konzeptionellen Modells in einer entsprechenden Modellierumgebung bzw. Programmiersprache
- Erstellung und Implementierung von Szenarien
- Auswertung und qualitative Beurteilung der Modellergebnisse

**Media:**

**Reading List:**
Weitere Fachliteratur für Fallbeispiele.
Responsible for Module:
Rammig, Anja, Prof. Dr. rer. nat. anja.rammig@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die ökologische Modellierung (Übung, 5 SWS)
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

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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 - Bestimmung, Verhalten und biologische Bedeutung von Insekten (Übung, 3 SWS)
Leonhardt S [L], Leonhardt S, Rüdenauer F

Entomologie - Grundlagen von Interaktionen zwischen Pflanzen und Insekten (Vorlesung, 2 SWS)
Leonhardt S [L], Leonhardt S, Rüdenauer F, Werle S

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or here.
Module Description

WZ2633: Focus Ecology | Fokus Ökologie

Version of module description: Gültig ab winterterm 2020/21

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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:

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 Wissenschaftliche Grundlagen und Anwendungen in der Praxis (Seminar, 2 SWS)
Leonhardt S [L], Kollmann J, Häberle K

Grundlagen der Statistik in R (Master Focus Ökologie) (Übung, 4 SWS)
Meyer S [L], Meyer S
Grundlagen der Statistik in R (Master) (Übung, 4 SWS)
Meyer S [L], Meyer S
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 summerterm 2024

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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 overexploitation, 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
resources

**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], Geist J, Kalis E, Pander J

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or here.
Module Description

BV470020T2: Fundamentals of Geographic Information Systems | Grundlagen Geoinformationssysteme

Version of module description: Gültig ab summerterm 2020

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<th>Language: German</th>
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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:**
Geoinformationssysteme 1 (Vorlesung, 1 SWS)
Donaubauer A

Übungen zu Geoinformationssysteme 2 (Übung, 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

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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:

Teaching and Learning Methods:


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:
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 2 (Vorlesung, 1 SWS)
Prietzel J

Geologie als wichtiger Faktor der Natürräume Bayerns: Großlandschaften und Geotope (Übung, 2,8 SWS)
Prietzel J

Einführung in die Geologie und Gesteinskunde, Teil 1 (Vorlesung, 1 SWS)
Prietzel J

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

WZ1171: Climate change related challenges in sewage treatment biology and engineering ecology | Klimabedingte Herausforderungen für Abwasserbiologie und Ingenieurökologie

Version of module description: Gültig ab winterterm 2018/19

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

Description of Examination Method:

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),
WZ1171: Climate change related challenges in sewage treatment biology and engineering ecology | Klimabedingte Herausforderungen für Abwasserbiologie und Ingenieurökologie

- 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 Gefährdung aquatischer Biodiversität zu verstehen;
- biologische und naturnah Abwasserreinigungssystemen zu bewerten;
- nachhaltige Schutzkonzepte für Gewässer zu entwickeln und zu bewerten;
- wichtige Analysetechniken und Methoden 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 Gefährdung 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 naturnah 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:**
For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](http://here).
Module Description

WZ4225: Concepts and Research Methods in Ecology | Konzepte und Forschungsmethoden der Ökologie

Version of module description: Gültig ab winterterm 2021/22

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<td>Master</td>
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<td>one semester</td>
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<td>150</td>
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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 built 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 targeting 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 (nicht verfügbar WiSe 23/24 - Alternativen finden Sie in der Beschreibung) (Übung, 4 SWS)
Heinen R [L], Heinen R

Konzepte und Forschungsmethoden der Ökologie (nicht verfügbar WiSe 23/24 - Alternativen finden Sie in der Beschreibung) (Vorlesung, 2 SWS)
Heinen R [L], Heinen R, Joschinski J

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

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<td>150</td>
<td>95</td>
<td>55</td>
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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

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<th>Module Level: Master</th>
<th>Language: German/English</th>
<th>Duration: one semester</th>
<th>Frequency: summer semester</th>
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| Credits:* | 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/amended 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 lineages. They have a deeper knowledge of island biogeography and will be able to perform biogeographic analyses for various groups of organisms. They know how to identify plants and animals in the field and how to analyze animal-plant relationships in an ecological context (e.g., pollination, seed dispersal, herbivory relationships). Moreover, they gained the skill to present complex natural science topics in a simplified way for the general public.

Teaching and Learning Methods:
seminars, literature study, team work with other students, preparation of scripts, preparation and presentation of talks, travel guide writing

Media:
script, powerpoint, free speach

Reading List:
for each of the selected island destinations a literature list will be compiled every year

Responsible for Module:
Schäfer, Hanno; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Exkursion
Mehrtägige botanische Exkursion zur Evolution und Biogeographie von Insel-Floren Europas und angrenzender Gebiete
4 SWS

Seminar
Seminar zu Insel-Floren Europas und angrenzender Gebiete
2 SWS

Hanno Schäfer
FG Biodiversität der Pflanzen
hanno.schaefer@tum.de
For further information in this module, please click campus.tum.de or here.
Module Description

WZ2617: Molecular Ecology, Molecular Systematics, and Biogeography of Plants | Molekulare Ökologie, Molekulare Systematik und Biogeographie der Pflanzen

Version of module description: Gültig ab winterterm 2012/13

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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 Prüfung 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:**

**Responsible for Module:**
Hanno Schäfer (hanno.schaefer@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

WZ6324: Molecular Ecology and Restoration Genetics

Version of module description: Gültig ab winterterm 2016/17

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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 exercising 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 ecological 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](http://campus.tum.de) or here.
Module Description

WZ6417: Nature Conservation | Naturschutz

Version of module description: Gültig ab winterterm 2023/24

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<th>Language: German</th>
<th>Duration: one semester</th>
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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.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Ökologie und Landschaftsplanung

Content:
Das Modul gliedert sich in eine Vorlesung und ein Seminar.
In der Vorlesung, die die im Bachelorstudiengang auf verschiedene Lehrveranstaltungen verteilten naturschutzfachlichen Grundlagen zusammenfasst und vertieft, haben aktuelle und internationale Aspekte des Naturschutzes eine besondere Bedeutung.

Folgende Themen werden in der Vorlesung behandelt:
- Kulturwissenschaftliche Grundlagen und Geschichte,
- Naturwissenschaftliche Grundlagen,
- Aufgaben des Naturschutzes,
- Objekte, Methoden und Konzepte des Naturschutzes,
- Planungswissenschaftliche Grundlagen: Rechtliche Instrumente im nationalen und internationalem Rahmen,
- Umsetzung und Management: Nationale und internationale Konflikte und Synergien, Naturschutz und Gesellschaft, Naturschutz im Spiegel aktueller Entwicklungen (z.B. Invasive Arten, Klimawandel)

Zweiter Teil des Moduls ist ein Seminar, in dem die Studierenden aktuelle Themen aus dem Bereich des Naturschutzes erarbeiten und präsentieren. Dieser Teil kann auch zur konkreten Vorbereitung des Masterprojektes genutzt werden.

**Intended Learning Outcomes:**
Nach der Teilnahme an den Modulveranstaltungen (Vorlesung und Seminar) sind die Studierenden in der Lage:

a) die Treiber des aktuellen Biodiversitätsverlustes zu verstehen,
b) die verschiedenen Motivationen für einen Schutz der Natur zu verstehen,
c) aktuelle Methoden der Naturschutzbiologie sowie Schutzstrategien auf konkrete Beispiele anzuwenden,
d) den Forschungsbedarf und das nötige Wissen bei einem Naturschutzproblem zu analysieren,
e) wissenschaftliche Texte zu aktuellen Naturschutzproblemen zu verstehen,
f) verschiedene mögliche Lösungen zu einem Naturschutzproblem zu entwickeln und zu bewerten

**Teaching and Learning Methods:**

**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:**
Seminar Naturschutz (Seminar, 2 SWS)
Achury Morales R, Schäffer N

Vorlesung Naturschutz (Vorlesung, 2 SWS)
Meyer S [L], Achury Morales R

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

**WZ2395: Aquatic Ecology and Conservation | Ökologie und Schutz von Gewässersystemen**

Version of module description: Gültig ab summerterm 2012

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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 (hygiene, distance rules etc.) for examinations with physical presence are not met, the planned examination format can be changed to a digital (remote) examination according to §13a APSO. The decision on this change will be communicated as soon as possible, however latest 14 days before the actual examination date, by the responsible examiner in coordination with the examinations board.

**Repeat Examination:**

Next semester

**(Recommended) Prerequisites:**

Thematic interest; attending other courses in the field of aquatic ecology is not required

**Content:**

Importance of aquatic ecosystems for humans, ecosystem functions, characteristics of the water habitat, gas balance, nutrients and their dynamics, bioindication methods, hazard factors of aquatic biodiversity, ecology and hazard of running waters, ecology and hazard of standing waters, aquatic ecotoxicology; strategies for the protection of aquatic biodiversity; investigation methods and working methods in aquatic systems biology; the exercises serve to deepen, apply and illustrate with concrete case studies

**Intended Learning Outcomes:**

Understanding of central factors and processes in aquatic ecosystems and their interrelationships with the threat to aquatic biodiversity; ability to assess anthropogenic and natural disturbances
of aquatic ecosystems; ability to critically evaluate and develop holistic protection concepts for waters; knowledge of important measurement and investigation methods in aquatic systems biology

Teaching and Learning Methods:
Lecture, tutorial; can be combined with an excursion

Media:
Power-Point presentation, blackboard, flip-chart, leaflet, case studies, practical exercises / demonstrations

Reading List:
Pullin AS Conservation Biology; Cambridge University Press; Primack R.B. A primer of conservation biology; Sinauer Ass.; Gleick PH The world’s water Report on Festwater Resources; weitere Literatur wird bekannt gegeben

Responsible for Module:
Jürgen Geist (geist@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Aquatic Ecology and Conservation V (Vorlesung, 2 SWS)
Geist J

Lösung wissenschaftlicher Probleme in Gewässerökologie und Aquakultur (Seminar, 2 SWS)
Geist J, Beggel S, Kühn R

Einführung in die Methoden der Aquatischen Systembiologie (Übung, 5 SWS)
Geist J [L], Geist J, Knott J, Pander J

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

WZ2415: Ecotourism and Nature Conservation | Ökotourismus und Naturschutz

Version of module description: Gültig ab winterterm 2011/12

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<td>Master</td>
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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 "Ecotourism 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

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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 literature 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](http://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

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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:**

Further literature:

Topic-specific literature for the seminar will be announced at the beginning of the event.

**Responsible for Module:**
Johannes Kollmann (jkollmann@wzw.tum.de)

**Courses (Type of course, Weekly hours per semester), Instructor:**
Seminar Populationsbiologie und Naturschutz (Seminar, 2 SWS)
Bauer M, Kollmann J

Einführung in die Populationsbiologie der Pflanzen (Vorlesung, 2 SWS)
Bauer M, Kollmann J

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

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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 CO2 concentration, chronic O3 load, elevated temperatures, drought, flooding, high N deposition; consequences of land-use change, cultivation of energy plants, and land degradation.
2. Change of susceptibility or resistance of woody plants due to climate change (increased CO2, O3, N input) to drought and heat.
3. Climate change and the risk for and mitigation by ecosystems. Significance for the C-source/sink ratio on different spatio-temporal scales. International agreements to reduce greenhouse gas emissions.
4. Effects of climate change on the interactions between plants and insects.
Intended Learning Outcomes:
After successful participation 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:

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

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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.

**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:**
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC

Lecture notes, additional material in moodle course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

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Description of Examination Method:

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:

Teaching and Learning Methods:

Media:
PowerPoint, Statistiksoftware R

Reading List:
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

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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 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:**

**Media:**
PowerPoint

**Reading List:**

**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 [L], König A, Peters W

Wildtiermanagement (Vorlesung, 2 SWS)
König A, Peters W, Pukall K

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or here.
Module Description

WZ6121: Vegetation of the Earth | Vegetation der Erde

Version of module description: Gültig ab winterterm 2019/20

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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:**

**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:**

**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

LS20031: Research Internship Plant-Microbe Interaction | Forschungspraktikum Pflanze-Mikroben Interaktion

Version of module description: Gültig ab summerterm 2023

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Description of Examination Method:
The examination of the module is based on a laboratory assignment. The students conduct a six-week, full-time research project in the lab, during which they carry out a smaller set of experiments (2-5) fairly independently, but under close supervision. After completion of the laboratory work, they write a protocol of approximately 10-15 pages in length, which should be handed in within 8 weeks after completion of the experimental work. With the protocol the students demonstrate their ability to summarize the theoretical background and key aims of the performed experiments, 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 the data analysis (50%) and the quality of the data presentation (50%). For the latter the evaluation is based on whether the theoretical background is properly described, the data is presented in a detailed and visually arresting manner, the calculations and application of statistical tests are accurate, and the results are interpreted and discussed properly.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology, biochemistry, genetics and chemistry. Practical experience with essential wet-lab techniques such as pipetting and working under sterile conditions.
Content:
Plants interact with microbes in many ways. These interactions can be either beneficial, as in the case of symbiosis, or problematic, as in the case of pathogens. Depending on the type of interaction, plants have evolved different molecular modes, which are utilized for symbiont recruitment or establishment or pathogen defenses and while these usually differ, some modes are conserved. Studying these events, to gain a deeper understanding of the underlying molecular and biochemical modes, may enable us to develop tools and procedures that benefit plant performance. In addition, research in this field has the potential to uncover molecular mechanisms of organismal interactions that are conserved across the biological kingdoms and can thus benefit our understanding of immunity also in animal systems.

This module is designed to teach students a subset of the following techniques:
+ Storage and cultivation of fungal symbionts or pathogens
+ Culturing of plants for infection assays and infection protocols
+ Phenotyping of plants to evaluate symbiosis or disease development
+ Quantitative histological assays to evaluate pathogen spread
+ Evaluating molecular read-outs of interactions such as marker gene expression (qPCRs) or altered abundance of proteins relevant for the interaction (western blotting)
+ Other relevant methods of molecular biology and biotechnology (for example transformation, genome-editing, line selection, protein-protein interaction assays in vitro and in vivo)
+ Work with model plants (Arabidopsis) and crops (Legumes and others)

Intended Learning Outcomes:
Upon completion of this module students are able:
+ to understand the principles of research approaches used to study plant-microbe interactions;
+ to assess for which scientific questions it may be helpful to use them;
+ to plan and to carry out basic experiments using plant-microbe experimental systems;
+ to interpret and evaluate the results obtained 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-Microbe Interaction research. 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 approaches in the field. By writing a research report the students learn to summarize the obtained results and discuss them in the context of relevant literature.

Media:
Oral instructions, lab protocols, and relevant scientific publications.

Reading List:
Responsible for Module:
Poppenberger-Sieberer, Brigitte, Prof. Dr. brigitte.poppenberger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Pflanze-Mikroben Interaktion (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B [L], Poppenberger-Sieberer B
For further information in this module, please click campus.tum.de or here.
Module Description

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

Version of module description: Gültig ab summerterm 2023

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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:
  - Short presentations (figure of the day) in regular lab meetings as regular feedback.
  - 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)
Pritsch K, 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

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

Description of Examination Method:

The examination is a laboratory assignment, i.e. students are required to work on one or more research questions largely independently. In some cases, predefined protocols are available for implementation. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can use the methods mostly completely independently, in some special cases under supervision. As part of the research internship, they collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated behavioral-physiological principles within a limited time and present and conclude it according to scientific conventions. In order to test the necessary ability to communicate the results and to examine related topics that are not a core component of the protocol, a presentation (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before the submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has approximately twice as much weight as the presentation.
The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory, and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

Content:
Within this research internship, topics from the field of insect ecology can be dealt with. Examples would be the topics "Influence of pesticides on the learning and foraging behavior of bees" or "Nutrient perception in different bee species"; this usually involves a combination of behavioral experiments and field or cage observations. Furthermore, behavioral experiments can also be combined with chemical analyses (e.g. GCMS). Experiments with other insects (butterflies, flies, beetles, ants) are also possible. The focus in this research module is on the study of the physiology of behavior underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

Intended Learning Outcomes:
After successfully completing the module, students will be able to carry out experiments on the behavioral-physiological interactions between plants and insects as well as their evaluation largely or completely independently. This includes the design of field experiments, the systematic recording of data in the field, the conditioning of bees using existing laboratory protocols and the statistical analysis of experimental results with the help of the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions posed and hypotheses they have developed and to place them in a broader scientific context.

Teaching and Learning Methods:
Teaching method: Discussion, instruction on special equipment, e.g. micromanipulators, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.
**Media:**
Instructions for field work and laboratory experiments, protocols for conditioning and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

**Reading List:**
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:

**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](http://campus.tum.de) or [here](http://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

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<th>Module Level: Master</th>
<th>Language: German/English</th>
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Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination is a laboratory course, i.e. students are expected to work on one or more research questions largely independently. Some of the protocols for carrying out the work are provided. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can usually use the methods completely independently, in some special cases under supervision (e.g. a gas chromatograph coupled to a mass spectrometer, GCMS). As part of the research internship, sis collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated chemical processes within a limited time and that they can present and conclude it according to scientific conventions. In order to also test the necessary ability to communicate the results and to check related topics that are not a core component of the protocol, a lecture (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has about twice as much weight as the presentation.
The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

Content:
Within this research internship, topics from the field of insect ecology can be dealt with in both temperate and tropical ecosystems. Examples would be the topics "Influence of pollen nutrition quality on the foraging behavior of honey bees" or "Importance of plant resins for social bees"; this usually involves a combination of chemical analyses and field or cage observations. Experiments can also be carried out with other insects (butterflies, flies, beetles, ants). The emphasis in this research module is on the study of the chemistry underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

Intended Learning Outcomes:
After successfully completing the module, students will be able to carry out experiments on the chemical interactions between plants and insects and evaluate them largely or completely independently. This includes the design of field experiments, systematic data acquisition and sampling in the field, the extraction and chemical analysis of samples using gas chromatography mass spectrometry (GCMS) based on existing laboratory protocols, the chemical analysis of samples using the Chemstation program, and the statistical analysis of experimental results using the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions they have received and the hypotheses they have developed themselves, as well as to place them in a broader scientific context.

Teaching and Learning Methods:
Teaching method: discussion, instruction on special equipment, e.g. GCMS, rotary evaporator, Soxhlet apparatus, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.
Media:
Instructions for field work and laboratory experiments, protocols for chemical analyses and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

Reading List:
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:

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

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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)
For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](#).
Module Description

WZ2380: Research Project Plant Systems Biology | Forschungspraktikum Pflanzensystembiologie

Version of module description: Gültig ab summerterm 2024

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

Description of Examination Method:
The students conduct a six-week research project in the lab. The work-schedule can be adjusted to the curriculum of the students. The examination will be in the form of an oral presentation (20-30 min) within the progress report meeting of the department in German or English language. This presentation will be graded. Besides scientific criteria also the graphic representation of the results, figures following publication quality guidelines (Adobe Photoshop, Adobe Illustrator), will be paid attention to.

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 or more 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. Statistical methods are applied for data evaluation. Many of these techniques are applicable to other (non-plant) organisms.
Intended Learning Outcomes:
Upon successful completion of this module, students are able to perform advanced experimental techniques in – but not limited to - plant biology, specifically Plant Systems Biology in an efficient and productive manner. The students can evaluate data and are able to design experiments with all necessary controls, apply statistical tests, and interpret the results. The students further have increased their competence in display of scientific data in publication quality and presentation of these data to a scientific community.

Teaching and Learning Methods:
Close theoretical and practical supervision combined with autonomous lab work.
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:

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, Giordano G, Hsu B, 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

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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:

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 nekrotothen Pilzen; Beurteilung des Befallsstadiums; Untersuchung von Reporterlinien bzw. ko-Mutanten; Mikroskopie, Konfokalmikroskopie; Proteinuntersuchungen (Hochregulierung der KDEL-Cystein Endopeptidasen, Immunpräzipitation, Aktivitätsmessung.


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
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

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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)
Auinger H, Kränzlein M, Lin Y, Urzinger S, Guffanti F, Polzer C, Barl L
For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](#).
Module Description

WZ2401: Research Project 'Molecular Plant Breeding' | Forschungspraktikum Molekulare Pflanzenzüchtung

Version of module description: Gültig ab summerterm 2023

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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:

**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)
Barl L, Kränzlein M, Lin Y, Polzer C, Urzinger S, Würstl L, Guffanti F
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

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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, interpret, 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 biosynthesis 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 characterization of the molecule structure and the metabolite quantification.
The participants have advanced knowledge on biosynthesis of secondary 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

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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:**

**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

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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 concise 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 concise 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:**

**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, Dünder G, Ramirez V
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

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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

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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.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Content:

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:

Media:

Reading List:

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, Pappas D, Hsu B, Zappone D
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

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

Description of Examination Method:
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlagen in den Pflanzenwissenschaften

Content:
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, Steidele C

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

Biotische Stressphysiologie der Pflanzen (Übung, 2 SWS)
Schempp H [L], Schempp H, Lindermayr C, Müller M, Steidele C

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

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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:

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

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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, Müller M, Stegmann M, Steidele C

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

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<td>German/English</td>
<td>one semester</td>
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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:
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

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

Description of Examination Method:
Prüfungsdauer (in min.): 120.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkentnisse in Genetik, Grundkentnisse in Statistik

Content:
" Technische und genetische Prinzipien molekularer Marker
" Erstellung genetischer und physikalischer Karten
Gametenphasedungleichgewicht
" 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, Kränzlein M
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

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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 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:

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, Kränzlein M
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

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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:


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, Barl L, Liebthal M
For further information in this module, please click campus.tum.de or here.
Module Description

WZ2371: Molecular Plant Physiology 2 | Molekulare Pflanzenphysiologie 2

Version of module description: Gültig ab summerterm 2019

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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 nachvollzieharbar 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:  

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 stressstoleranter 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
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

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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 zugehöri gen 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 nachvollziehbar 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
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag

Responsible for Module:
Dr. Alexander Christmann (christma@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

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

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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 Prüfung 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:

Responsible for Module:
Hanno Schäfer (hanno.schaefer@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

WZ2657: Methods and Logic in Molecular Cell Biology and Scientific Writing

Version of module description: Gültig ab summerterm 2013

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

Description of Examination Method:
Active discussion and participation 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...
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, receiving individual
written feedback

Media:

Reading List:
Recent breakthrough publications, to be announced in the first lectures.

Responsible for Module:
PD Dr. phil. habil. Assaad-Gerbert

Courses (Type of course, Weekly hours per semester), Instructor:
Methods and Logic in Molecular Cell Biology and Scientific Writing Part 1 (Seminar, 2 SWS)
Assaad-Gerbert F

Scientific Writing Part 2 (Methods and Logic in Molecular Cell Biology) (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

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<th>Module Level:</th>
<th>Language:</th>
<th>Duration:</th>
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<tbody>
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<td>Master</td>
<td>German/English</td>
<td>one semester</td>
<td>winter/summer semester</td>
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### 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:

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

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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:

Further literature:

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)
Bauer M, Kollmann J

Seminar Populationsbiologie und Naturschutz (Seminar, 2 SWS)
Bauer M, Kollmann J

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

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

Description of Examination Method:
Prüfungsdauer (in min.): 30.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine speziellen Voraussetzungen nötig

Content:
Im Rahmen der beiden Vorlesungen werden Grundkenntnisse zu pflanzlichen 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 exemplarisch 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:

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:
Heinz Butin. Krankheiten der Wald und Parkbäume. 2011, 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

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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)

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](http://here).
Module Description

WZ4020: Effects of Climate Change on Plant Physiology | Pflanzenfunktionen im Klimawandel

Version of module description: Gültig ab winterterm 2023/24

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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 CO2 concentration, chronic O3 load, elevated temperatures, drought, flooding, high N deposition; consequences of land-use change, cultivation of energy plants, and land degradation.
2. Change of susceptibility or resistance of woody plants due to climate change (increased CO2, O3, N input) to drought and heat.
3. Climate change and the risk for and mitigation by ecosystems. Significance for the C-source/sink ratio on different spatio-temporal scales. International agreements to reduce greenhouse gas emissions.
4. Effects of climate change on the interactions between plants and insects.
Intended Learning Outcomes:
After successful participation 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:

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

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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, Kränzlein M, Kugler S
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

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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:


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, Kränzlein M, Kugler S
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

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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)
Hafner B, 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

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

Description of Examination Method:

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-Analyser, Griess-Assay zur Quantifizierung von NO. Biochemische Ansätze zur Identifizierung Charakterisierung redox-sensitiver Proteine/Enzyme (Biotin Switch, Herstellung rekombinanter Proteine, Aktivitätstests, Redox-Biochemie am rekombinannten Protein/Enzym).
Intended Learning Outcomes:

Teaching and Learning Methods:
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

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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.

**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:**
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC

Lecture notes, additional material in moodle course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

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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 pathogens 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; they 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:**

**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](http://campus.tum.de) or [here](http://campus.tum.de).
Module Description

WZ6121: Vegetation of the Earth | Vegetation der Erde

Version of module description: Gültig ab winterterm 2019/20

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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
Intended Learning Outcomes:

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:

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

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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:**
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:**

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

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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 the course.

Responsible for Module:
Prof. Dr. Harald Luksch

Courses (Type of course, Weekly hours per semester), Instructor:
Blockpraktikum: Neurobiologie am isolierten Gewebe (Praktikum, 16 SWS)
Weigel S [L], Weigel S, Luksch H, Ondracek J
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 the 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

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

Description of Examination Method:

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.


Repeat Examination:
Next semester

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

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:

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)
Bauer B, Fischer K, Flisikowska 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 | Entwicklungsbio logie und Histologie der Tiere

Version of module description: Gültig ab winterterm 2011/12

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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

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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

LS2006: Research Practical Entomology | Forschungspraktikum Entomologie

Version of module description: Gültig ab summerterm 2022

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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 the broader context of the research topic. Examples are e.g. the technological relevance 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 electron microscopy,
• study and documentation of these samples by means of light and scanning electron 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 measurement of morphological characters (ImageJ, R library „patternize“),
• extraction and preprocessing 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.

Module Catalog of the study program M.Sc. Biology
Generated on 31.03.2024
**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

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<th>Module Level:</th>
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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

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**Description of Examination Method:**

The examination is a laboratory assignment, i.e. students are required to work on one or more research questions largely independently. In some cases, predefined protocols are available for implementation. The students carry out some field work as well as laboratory work and are instructed in the working methods and equipment so that they can use the methods mostly completely independently, in some special cases under supervision. As part of the research internship, they collect data, which they analyze and present. They are expected to relate the results obtained to the questions and hypotheses they have developed and place them in a broader scientific context.

Following the internship, the skills gained are assessed in writing in the form of a graded report that meets scientific standards and must be submitted within 4-6 weeks of completing the internship. This is a written paper of 20-50 pages, which should first introduce the topic to be worked on by listing previously published scientific papers, explain the research questions and hypotheses, then list the methods used (including statistics) in detail, present all results and finally discuss them in relation to existing literature. With the protocol, the students prove that they can successfully work on a thematically limited but challenging question of insect-plant interaction with a focus on the associated behavioral-physiological principles within a limited time and present and conclude it according to scientific conventions. In order to test the necessary ability to communicate the results and to examine related topics that are not a core component of the protocol, a presentation (20 min) must be given within the working group as part of the laboratory work and after completion of data acquisition and evaluation. It is recommended that the presentation be given 2-3 weeks before the submission of the protocol.

The performance of the protocol and presentation will be assessed with one grade, whereby the protocol has approximately twice as much weight as the presentation.
The contact time with the supervisor is approximately 60 hours. The remaining 240 hours consist of independent work in the field, laboratory, and library. Of these, around 40 hours are spent on the preparation of the protocol and the presentation.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of ecology, botany and/or entomology is required, for example at the level of the modules "General Ecology", "Basic Course/General Botany" and/or "Basic Course/General Zoology". Depending on the final project topic, basic knowledge of biodiversity, nutritional ecology, physiology or neurobiology is desirable, for example at the level of the lectures/seminars "Diversity and Evolution of Ferns and Seed Plants", "Vegetation of the Earth", "Function and Interaction of Insects in Forest Ecosystems", "Bee Science", "Cognitive Neuroscience" or "Sensory Physiology".

Content:
Within this research internship, topics from the field of insect ecology can be dealt with. Examples would be the topics "Influence of pesticides on the learning and foraging behavior of bees" or "Nutrient perception in different bee species"; this usually involves a combination of behavioral experiments and field or cage observations. Furthermore, behavioral experiments can also be combined with chemical analyses (e.g. GCMS). Experiments with other insects (butterflies, flies, beetles, ants) are also possible. The focus in this research module is on the study of the physiology of behavior underlying interactions between certain insect species and certain plant species. As far as possible, students will carry out and evaluate the experiments independently. The exact topic is to be agreed with the respective lecturer.

Intended Learning Outcomes:
After successfully completing the module, students will be able to carry out experiments on the behavioral-physiological interactions between plants and insects as well as their evaluation largely or completely independently. This includes the design of field experiments, the systematic recording of data in the field, the conditioning of bees using existing laboratory protocols and the statistical analysis of experimental results with the help of the open software program R. In addition, they learn the ability to write in a scientifically structured format and to relate their results to the questions posed and hypotheses they have developed and to place them in a broader scientific context.

Teaching and Learning Methods:
Teaching method: Discussion, instruction on special equipment, e.g. micromanipulators, until independent work is possible; instruction on work in the field until independent field work can be carried out; discussion of interim results in the chair seminar; if necessary, instruction on the preparation of a scientific paper.
Learning method: work in the field and laboratory; systematic data collection and evaluation; graphical presentation of results, writing and presentation; study of literature and basic textbooks.
Media:
Instructions for field work and laboratory experiments, protocols for conditioning and evaluations, working group seminars and discussions, oral statistical introduction, R scripts, scientific literature, books, databases

Reading List:
Scientific literature is handed out during the practical course and should also be compiled in independent literature research.
Example of a standard work on the topic:

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

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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

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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

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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:

Content:

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

**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:**

**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

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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:

Intended Learning Outcomes:
Ziel ist das Erlernen von Techniken zur Durchführung von elektrophysiologischen Versuchen. Dies beinhaltet Narkosemethoden, Durchführung der chirurgischen Eingriffe (unter Anleitung des

**Teaching and Learning Methods:**
Veranstaltungsform/Lehrtechnik: Übung

**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:**

**Responsible for Module:**
Harald.Luksch@wzw.tum.de Luksch (Harald.Luksch@wzw.tum.de)

**Courses (Type of course, Weekly hours per semester), Instructor:**
Forschungspraktikum Neurobiologie der Echoortung (Forschungspraktikum, 10 SWS)
Firzlaff U
For further information in this module, please click campus.tum.de or here.
Module Description

WZ2474: Research Project in Molecular Physiology | Forschungspraktikum Molekulare Physiologie

Version of module description: Gültig ab winterterm 2023/24

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Description of Examination Method:
The examination takes place as part of a laboratory assignment, which consists of a report (15-20 pages) and a presentation (20-30 minutes) about the performed practical work in the scientific context. One-half of each of these examination performances is included in the final examination mark.

Regular attendance during the practical course is required. A written summary of the practical work with a theoretical background serves to review the skills acquired during the practical course. Students should document their work in an appropriate scientific manner and structure and present the essential aspects of the knowledge they have acquired. A presentation on the work is given within the working group or in the institute's internal seminar.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
BSc lecture in basic animal or human physiology.

Content:
Cell isolation, cell culture, tissue culture, extraction of cells, nucleic acids and proteins, transcriptomics, transcript expression analysis (real-time RT-PCR), protein analysis using ELISA or flow cytometry, blotting techniques, use of databases, sequence analysis, bioinformatics, biostatistics, etc.

Intended Learning Outcomes:
After successfully participating in the module, students acquire basic skills and abilities for molecular biology work in the laboratory. In addition, they will acquire the ability to critically
scrutinize their own experimental results for causes of variance. Students will acquire knowledge about the correct scientific documentation of results. In the presentation as well as in the report, students clearly demonstrate that structuring according to scientific topics must be distinguished from the chronological approach.

**Teaching and Learning Methods:**
Teaching technique: Laboratory work  
Teaching method: individual work, experiments  
Learning activities: literature research, conducting experiments, critical evaluation of results, searching for causes of variance, summarizing in written and oral presentations

**Media:**
Own laboratory work, data acquisition, evaluation, and presentations using 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

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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

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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 Präparation, PCR, Mikrosatelliten und SNP-Genotypisierung populationsgenetische Statistik, Zellkulturen, Zellfärbemethoden, quantitative realtime-PCR.

**Intended Learning Outcomes:**

**Teaching and Learning Methods:**
Veranstaltungsform/Lehrtechnik: Laborlehre

Media:
Arbeitsprotokolle zu diesem Praktikum werden ausgeteilt.

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

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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 Präparation, PCR, Mikrosatelliten und SNP-Genotypisierung populationsgenetische Statistik, Zellkulturen, Zelfärbermethoden, quantitative realtime-PCR, Gen-Expressionsanalytik, Microarrayanalytik, Mikroarrayauswertung.

Intended Learning Outcomes:

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborlehre

**Media:**
Arbeitsprotokolle zu diesem Praktikum werden ausgeteilt.

**Reading List:**
The Condensed Protokolls, From Molecular Cloning: A Laboratory Manual (Sambrook)
Der Experimentator Microarray (Müller)
Der Experimentator Genomics (Mühlart)
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

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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](http://campus.tum.de) or [here](http://here).
Module Description

WZ2639: Research Project Neurobiology of behavior | Forschungspraktikum Neurobiologie des Verhaltens

Version of module description: Gültig ab winterterm 2013/14

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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:**

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

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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

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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

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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

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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:
**Intended Learning Outcomes:**

**Teaching and Learning Methods:**

**Media:**
Aktuelle Fachliteratur und aktuelle Veröffentlichungen. Vorhandene und selbst zu erzeugende Datensätze.

**Reading List:**

**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](http://campus.tum.de) or here.
Module Description

WZ1993: Laboratory Animal Science | Laboratory Animal Science [VTK]

Version of module description: Gültig ab summerterm 2024

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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 (Klausur, 90 min) in which students have to answer various questions on laboratory animal science topics without any aids. Answering the questions partly requires students to formulate their own answers and partly requires them to mark multiple answers.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Anatomy, Physiology, Laboratory Animal Science, BSc Biology/Life Sciences, BSc Molecular Biotechnology, BSc Agricultural and Horticultural Sciences, BSc Nutritional Sciences

Content:
The following topics are covered in the module:
- Laws relating to animal testing
- Exposure assessments and score sheets
- Alternative methods to animal testing
- Blood collection and application techniques
- Genetics and breeding in animal experiments
- Biotechnological techniques in pigs and chickens
- Poultry as laboratory animals
- Bats as laboratory animals
- Snakes as laboratory animals
- Monitoring of animal testing facilities
- Neurology and behavior of small rodents
- Handling of small rodents
- Injections (s.c., i.p. i.m. i.v.)
- Blood sampling techniques
- Oral application of substances

**Intended Learning Outcomes:**
After successfully attending the module courses, students will be able to name various procedures, relevant laws and methods of laboratory animal science. Students will be able to understand and apply these regulations after completing the module. Students will be able to assess the different interpretations and applications of laws, methods and animal models and actively support the planning of animal experiments. After completing the module, students will be able to carry out initial handling of laboratory animals such as mice, rats and rabbits and perform injections and blood sampling under supervision.

**Teaching and Learning Methods:**
The module consists of a seminar (2 SWS) and an exercise (2 SWS). The seminar provides basic knowledge on the topics described. PowerPoint presentations are used to illustrate the most important aspects of the respective topics to the participants and are critically scrutinized in a subsequent discussion. As part of the exercise, the handling of these rodent species is practiced using mouse, rat and rabbit models and blood sampling, as well as injections and applications of substances are practiced.

**Media:**
Presentation (PowerPoint), blackboard work, practical exercises

**Reading List:**
Lecture notes, legal texts, LAS-online course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Versuchstierkunde (Seminar, 2 SWS)

Praktische Einführung Versuchstierkunde (Übung, 2 SWS)
Schusser B [L], Schusser B, Schwamberger S

For further information in this module, please click [campus.tum.de](http://campus.tum.de) or [here](http://campus.tum.de).
Module Description

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

Version of module description: Gültig ab summerterm 2022

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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, Dwulet J, Ferreira Castro A, Festa D, Getz M, Maoutsa D, Onasch 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

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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 Seminars 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.


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.


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 Artenfassung 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.


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

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, Dawo 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 2023/24

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

Description of Examination Method:
Students take two seminars offered as part of this module. A presentation (20-30 min) must be given in each seminar. The module examination thus consists of two presentations, the grades of which are counted 1:1.

Students will have to prepare for the general topic of each lesson by means of introductory texts each week; this general part will be talked through together at the beginning of the seminar. Afterwards, one student at a time will present an in-depth text or a recent publication from a high-class peer-reviewed journal; this additional information will then be discussed. The entire course is held in English. The grade of a presentation is determined from the assessment of participation and prior knowledge in the general preliminary information and discussion (30 %) as well as from the student’s own presentation performance (categories text comprehension, completeness, structuring, 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. Further neurobiological knowledge, for example from other lectures of the chair, is also advantageous (but not a prerequisite).
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:
Luksch, Harald, Prof. Dr. rer. nat. harald.luksch@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: Neuroethologie von Räubern und Beute (auf englisch)
(Seminar, 2 SWS)
Ondracek J

Aktuelle Themen der Neurobiologie: Zelluläre und molekulare Neurophysiologie (auf Englisch)
(Seminar, 2 SWS)
Weigel S, Michel K, Bühner S
For further information in this module, please click campus.tum.de or here.
Module Description

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

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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, Stammzelllinische, klinische Anwendungen von blutbildenden Stammzellen). Auch werden in Seminare der Kursteilnehmer aktuelle Forschungsbeispiele 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 des Theorieteils sind gute Kenntnisse in Zellbiologie und Biochemie erforderlich.

Content:
Im Rahmen dieses theoretischen Moduls werden spezielle Kenntnisse 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 - Stammzelidentität 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

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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 xenotransplantation, 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:**

**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, Nowak-Imialek M

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

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<td>one semester</td>
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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)
Fischer K, 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

<table>
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<th>Module Level:</th>
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<tr>
<td>Bachelor/Master</td>
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<td>one semester</td>
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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 acquire 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:

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, Williams 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

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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

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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 development and pathogenesis of gastrointestinal diseases and microbiota composition/function will be investigated.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The practical course builds on the knowledge earned by attending the module 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 practical course the students are capable to choose specific methods to answer specific scientific questions and understand the limitations of these 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 Rechercharbeit, Nachbeareitung, Selbstorganisation, 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:**

**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

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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:

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)
Gjorgjieva J [L], Ferreira Castro A, Maoutsa D

Introduction to Computational Neuroscience – Project Work (M.Sc.) (Projekt, 2 SWS)
Gjorgjieva J [L], Ferreira Castro A, Maoutsa D
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

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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 pursued 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

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<td>one semester</td>
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Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
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:

Responsible for Module:
Dr. Karsten Meyer (karsten.meyer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Labortierwissenschaften (Vorlesung, 4 SWS)
For further information in this module, please click campus.tum.de or here.
Module Description

WZ1993: Laboratory Animal Science | Laboratory Animal Science [VTK]

Version of module description: Gültig ab summerterm 2024

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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 (Klausur, 90 min) in which students have to answer various questions on laboratory animal science topics without any aids. Answering the questions partly requires students to formulate their own answers and partly requires them to mark multiple answers.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamentals of Anatomy, Physiology, Laboratory Animal Science, BSc Biology/Life Sciences, BSc Molecular Biotechnology, BSc Agricultural and Horticultural Sciences, BSc Nutritional Sciences

Content:
The following topics are covered in the module:
- Laws relating to animal testing
- Exposure assessments and score sheets
- Alternative methods to animal testing
- Blood collection and application techniques
- Genetics and breeding in animal experiments
- Biotechnological techniques in pigs and chickens
- Poultry as laboratory animals
- Bats as laboratory animals
- Snakes as laboratory animals
- Monitoring of animal testing facilities
- Neurology and behavior of small rodents
- Handling of small rodents
- Injections (s.c., i.p., i.m., i.v.)
- Blood sampling techniques
- Oral application of substances

**Intended Learning Outcomes:**
After successfully attending the module courses, students will be able to name various procedures, relevant laws and methods of laboratory animal science. Students will be able to understand and apply these regulations after completing the module. Students will be able to assess the different interpretations and applications of laws, methods and animal models and actively support the planning of animal experiments. After completing the module, students will be able to carry out initial handling of laboratory animals such as mice, rats and rabbits and perform injections and blood sampling under supervision.

**Teaching and Learning Methods:**
The module consists of a seminar (2 SWS) and an exercise (2 SWS).
The seminar provides basic knowledge on the topics described. PowerPoint presentations are used to illustrate the most important aspects of the respective topics to the participants and are critically scrutinized in a subsequent discussion.
As part of the exercise, the handling of these rodent species is practiced using mouse, rat and rabbit models and blood sampling, as well as injections and applications of substances are practiced.

**Media:**
Presentation (PowerPoint), blackboard work, practical exercises

**Reading List:**
Lecture notes, legal texts, LAS-online course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Versuchstierkunde (Seminar, 2 SWS)

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

WZ2690: Latest Neuroscience - Presenting Papers to Researchers and the General Public

Version of module description: Gültig ab summerterm 2017

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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 neuromodulation 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 understand the concept of how internal and metabolic states influence neurons and neuronal processing by neuromodulation 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 neuromodulation
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

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

Journal club – practical problems facing poultry production and breeding (Seminar, 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 2023/24

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

Description of Examination Method:

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful participation in the lecture "Human and Animal Physiology"

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 acquire 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:
Teaching method: Lecture
Teaching method: Presentation, lecture, question-developing method
Learning activities: studying the basic information provided, reviewing the information provided, researching material, summarising documents

Media:
A script for this practical course will be handed out or made available for download on Moodle. Additional information will be communicated on Moodle (URLs, further texts)

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

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Description of Examination Method:

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);


**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 Gewebes.

**Media:**
Präsentationen, Skripten

**Reading List:**

**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

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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:

Interpretation von Versuchsergebnissen, Präsentation von Ergebnissen, kritische Reflexion und Diskussion, Vorgehensweise bei wissenschaftlichen Veröffentlichungen und Recherchemethoden

**Intended Learning Outcomes:**

**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

WZ2127: Reproductive Physiology of Vertebrates | Reproduktionsbiologie der Vertebraten

Version of module description: Gültig ab summerterm 2023

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

Description of Examination Method:
Prüfungsdauer (in min.): mündlich 30 min.

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

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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.

**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:**
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC

Lecture notes, additional material in moodle course

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

**Courses (Type of course, Weekly hours per semester), Instructor:**
Applied Statistics and Data Analysis [CIT5130001] (Vorlesung, 2 SWS)
Ankerst D, Chernova O

Applied Statistics and Data Analysis [CIT5130001] (Vorlesung mit integrierten Übungen, 3 SWS)
Chernova O

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

WZ2458: Sensory Neuroscience | Sensory Neuroscience

Version of module description: Gültig ab winterterm 2023/24

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

Description of Examination Method:
The module is completed in the form of a written exam (100 minutes). Students acquire basic and advanced skills in dealing with sensory physiology. On the basis of theoretical considerations, an overview of various sensory physiology topics is covered. In addition, methodological aspects of the scientific methods used and their significance are critically evaluated. At the end of the lecture, students are tested in writing on the skills they have acquired. Basic knowledge of the sensory systems covered is expected, as well as transfer knowledge of sensory physiology issues.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of neuroscience, at least at the level of the lecture „Human- und Tierphysiologie“, better still on the level of the lecture "Neurobiologie", are expected as these basics are not part of the lecture. As always, students who lack the background but are REALLY eager to participate in this lecture may also fill their gaps in the basics through self-study.

Content:
In this lecture, we will cover all major sensory systems that vertebrates possess. The processing of sensory information is essential to understand nervous processing, and eventually also higher cognitive functions in the vertebrate (and human) brain. As the visual system is the most relevant sense for humans, we will broadly cover vision and auditory processing. We will also cover multimodal processing in the brain, as well as the motor system, as (in the end) sensory processing needs to yield adequate motor responses for survival.
General brain anatomy, structure of vertebrate brain
General principles of sensory processing (parallel distributive, feedback etc.)
Psychophysics, (Weber-Fechner etc.)
Touch and chemoperception
Visual system: periphery up to V1 and structure of V1
Visual system: subcortical processing, eye movements
Visual system: V2 and upwards, visual attention etc.
Mechanosensitive systems in vertebrates lateral line and descendants
Auditory system: physics, propagation, cochlea, structure and function, etc.
Auditory system: Physiology from auditory nerve onwards, auditory recognition, etc.
Unusual senses - infrared and magnetic perception
Multisensory systems, multimodal integration, etc.
Motor systems: from motor coding to robotics applications

**Intended Learning Outcomes:**
After attending this lecture, students will be able to derive sensory physiological processes from their physical and chemical boundary conditions. Students acquire orientation knowledge in the entire field of sensory physiology and can classify findings in this basic framework, gain an overview of various topics and various sensory systems in different organisms.

**Teaching and Learning Methods:**
Teaching method: PowerPoint presentation, lecture with interactive elements, student response system, self-assessment sheets, additional material for self study
Learning activities: studying the basic information lectured and contained in the script, reviewing the information provided, reading additional material provided via Moodle

**Media:**
A script for this practical course will be made available for download on Moodle. Additional information will be communicated on Moodle (URLs, further texts, self-assessment sheets)

**Reading List:**
The basic textbook is "Neuroscience. Exploring the brain." by Bear, Connors, Paradiso, published by Lippincott, Williams and Wilkins, is recommended. Other neurobiology textbooks are also suitable for the basic content.

**Responsible for Module:**
Luksch, Harald, Prof. Dr. rer. nat. harald.luksch@tum.de

**Courses (Type of course, Weekly hours per semester), Instructor:**
Sensory Neuroscience (Vorlesung, 2 SWS)
Luksch H, Firzlaff U
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

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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:
**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)
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

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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.


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.


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 Untersuchungen mit Kameras durchgeführt, um die Arten zu ermitteln.

Im vorherigen Seminar werden grundlegende Themen des Lebensraumes und der behandelten Tiergruppen besprochen. Diese Exkursion findet in der Woche nach Pfingsten statt (variable Termin), von Sonntagmorgen (Abfahrt) bis Samstagabend (Rückkehr). Die Themen umfassen unter anderem:

- 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.


**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

**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

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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.
Module Description

WZ2590: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2023

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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:

Content:

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 Fachgebiets 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:

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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