TUM School of Life Sciences
Technische Universität München

Module Catalog

M.Sc. Molecular Biotechnology
TUM School of Life Sciences
Technische Universität München

www.tum.de/
www.ls.tum.de/ls/startseite/

Module Catalog: General Information and Notes to the Reader

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

Notes to the reader:

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

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

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

Index of module handbook descriptions (SPO tree)

Alphabetical index can be found on page 480

Fundamental Modules | Kernbereich

Biomolecules | Biomoleküle

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

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

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

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

Repeat Examination:
Next semester

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

Content:
In this lecture, students will be introduced to the methodology of proteomics research and examples will be given from the fields of basic research, medical research, and drug discovery. The lecture covers the theory and application of protein separation techniques such as 1D/2D gel electrophoresis, different types of protein and peptide chromatography, multidimensional separations, stable isotope labeling, and different forms of mass spectrometry. Furthermore, it will be discussed how these different methods can be combined in a meaningful way, depending on the application or scientific question.

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

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

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

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

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

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

Reading List:
Script for the lecture

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

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

Intensivkurs Proteomics (Übung, 3 SWS)
Küster B [L], Küster B, Ludwig C, Schneider A, The M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2580: Protein Engineering | Protein-Engineering

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

Content:
In diesem Modul werden die wissenschaftlichen Methoden und Arbeitstechniken des Protein-Engineerings auf theoretischer Grundlage diskutiert. Schwerpunkte sind die gentechnische Produktion von Proteinen in Bakterien (cytoplasmatisch und periplasmatisch), Verfahren zur ortsgerichteten Mutagenese, Herstellung von Genbibliotheken, Selektions- und Screening-Methoden sowie Verfahren zur Bestimmung der Affinität zwischen Proteinen (z.B. Antikörpern, Rezeptoren) und ihren Liganden oder Wechselwirkungspartnern sowie ggf. der enzymatischen Aktivität. Des weiteren wird im Modul das Potential gentechnisch hergestellter Proteine als neue

Generation von biologischen Arzneimitteln erläutert. Die pharmakologischen Eigenschaften (Affinität zu medizinisch relevanten Zielstrukturen, Effektorfunktionen, Plasma-Halbwertszeit) können durch Protein-Engineering wie auch mit proteinchemischen Methoden gezielt manipuliert werden. Anhand aktueller Fallbeispiele (Insulin, Wachstumsfaktor, humanisierte Antikörper usw.) wird die Entwicklung und Optimierung innovativer Biopharmazeutika mittels Protein-Engineering dargestellt.

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

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

Media:
Die Vorlesungen erfolgt mit graphischen Präsentationen (Projektor und PowerPoint). Die Folien werden den Studierenden in elektronischer Form zugänglich gemacht.

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

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

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

Methodische Grundlagen des Protein-Engineerings (Vorlesung, 1 SWS)

Skerra A [L], Schlapschy M

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

Cells | Zellen

Module Description

WZ2626: Applied Microbiology | Angewandte Mikrobiologie

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Regular and active student participation is expected. A written exam (60 min, graded) serves as proof of the theoretical knowledge acquired in the lecture courses. In the exam, the students demonstrate their ability to structure the body of acquired knowledge, e.g. about metabolic pathway-based compound conversion and its consequences for biotechnology and environment or about the effects of changes/manipulations in the metabolism on biosynthetic performance (see anticipated learning goals), and to summarize the important aspects of the study matter. The students should be able to describe, interpret, combine in a meaningful way the information learnt, and to transfer this knowledge to similar issues.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good background knowledge in organic chemistry and biochemistry is of advantage for a better understanding of the lecture courses.

Content:
Basic knowledge about metabolic pathways (biosynthetic and degradative capabilities) in microorganisms is repeated and extended in the lecture courses. Furthermore, advanced-level knowledge about the metabolism of microorganisms, in particular prokaryotic microorganisms, and about the application of microorganisms in biotechnological processes is tought. The contents include central metabolism and connected biotechnologically relevant biosynthetic pathways for primary and secondary metabolites, as well as for biopolymer production. Further contents are degradation pathways for sugars, polysaccharides, lignin, proteins, nucleic cids, xenobiotica. Selected examples help to illustrate the applications of organisms and/or their enzymes as well

as the optimization of microorganisms and their metabolism for improved production processes in biotechnology.

Intended Learning Outcomes:
After completion of the courses of this module the students have acquired an advanced level of theoretical understanding about the metabolic capabilities of microorganisms and their application potential in biotechnological processes.
The module should further help develop the ability to solve problems, and boost the students' interest for microbiological issues and for the important role of microorganisms for mankind and the environment.

The students are able to
" understand interconnections between metabolic pathways and conversion of compounds by microorganisms.
" understand, by virtue of selected examples, the effects of changes/manipulations in the metabolism on biosynthetic performance.
" understand, by virtue of selected examples, the effects and consequences of degradation processes in biotechnology and environment.
" apply the acquired knowledge to in-depth problems.

Teaching and Learning Methods:
Form/technique of teaching: lecture courses. Teaching method: oral lecture.
Learning activities: study of lecture handout scripts and own notes.

Media:
Presentations unsing PowerPoint,
Handout script (download option for lecture material).

Reading List:
There is no textbook available that comprehensively covers all content matter of this module.
Some aspects are covered in the following books:
Fuchs G. (Hrsg.) Allgemeine Mikrobiologie. 8. Auflage, 2007. Georg Thieme-Verlag Stuttgart.
Antranikian G. (Hrsg.) Angewandte Mikrobiologie. 2006. Springer-Verlag Berlin Heidelberg.

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

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

WZ2372: Pathogenic Microorganisms | Mikroorganismen als Krankheitserreger

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Lecture and practical course General Microbiology

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

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

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

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

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

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

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

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

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

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

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

Einführung in Biologie pflanzenpathogener Mikroorganismen (Vorlesung, 1 SWS)

Durner J

Einführung in die Biologie humanpathogener Bakterien (Vorlesung, 2 SWS)
Hall L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2582: In vitro Models in Cell Biology | In vitro-Modelle der Zellbiologie

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Die Studierenden zeigen anhand der benoteten Klausur (60 min), ob sie in der Lage sind verschiedene Methoden zur Untersuchung zellulärer Signalübertragung zu erläutern und bezüglich ihrer Einsatzbereiche gegeneinander abzugrenzen. Darüber hinaus müssen sie zur Lösung zellbiologischer Fragestellungen geeignete Methoden auswählen, die Auswahl begründen und die daraus resultierende wissenschaftliche Aussagekraft bewerten. Die Klausurnote bildet die Gesamtnote des Moduls.
Die Vorlesung wird ergänzt durch Arbeitskreise (4-6 Personen), in denen einzelne Themen bzw. Fragestellung der Vorlesung intensiver bearbeitet werden. Die Studierenden diskutieren die Resultate ihrer Arbeitskreise in Kurzpräsentationen (10 min pro Gruppe). Diese Präsentationen werden nicht benotet (Studienleistung).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zur erfolgreichen Teilnahme am Modul wird das Basiswissen Zellbiologie aus dem BSc-Studium Molekulare Biotechnologie vorausgesetzt. Für das Modul wesentliche Grundlagen werden im einführenden Abschnitt "Signaltransduktion" nochmals aufgegriffen und vertieft.

Content:
In der Vorlesung werden methodische Ansätze zur Aufklärung zellulärer Signaltransduktion vorgestellt und an ausgewählten Beispielen erläutert. Im Anschluss an ein einführendes Repetitorium auf BSc-Niveau zum Thema Signaltransduktion werden im Schwerpunkt experimentelle Strategien/Techniken zur Aufklärung zellulärer Signalwege nicht nur vorgestellt (z.B. Charakterisierung und Nachweis molekularer Interaktion in vitro, PTM-Assays, Genexpressionsanalyse etc.), sondern anschließend auch deren Potential und Limitierungen

an ausgewählten Fallbeispielen diskutiert. Dito, wird mit dem zweiten Schwerpunktthema „Zellkulturen“ verfahren. Insbesondere werden hier Aspekte der Zellkultur hervorgehoben, die Einfluss auf Resultate/Schlussfolgerungen der zellbiologischen Experimente zeitigen können (Themen: Zelllinien, Seneszenz, Immortalisierung, Kultursysteme, Einzelzellanalyse etc.). Darüber hinaus haben die Studierenden die Möglichkeit das Repertoire der Vorlesung durch selbst gewählte Themen zu erweitern. Diese Themen werden in Arbeitskreisen von 4-5 anhand aktueller Literatur aufbereitet und in Form einer 10-minütigen Präsentation mit anschließender Diskussion präsentiert.

Intended Learning Outcomes:
Nach Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, aus dem Methodenspektrum zur Erforschung der zellulären Signaltransduktion geeignete Strategien auszuwählen, zu kombinieren und gezielt einzusetzen.
Sie können die Auswirkung technischer Manipulationen/Applikationen auf zelluläre Reaktionen, insbesondere auf Signalwege einschätzen und diesen Aspekt bei der Konzeption von Experimenten sowie der Interpretation der Resultate entsprechend berücksichtigen.

Teaching and Learning Methods:
Lernaktivitäten: Interaktiver Austausch und Anregung zur Diskussion in der Vorlesung, Studium von Vorlesungsskript, -mitschrift und Literatur; Zu selbst gewählten Themen und Fragestellungen arbeiten die Studierenden in kleinen Gruppen und stellen ihre gemeinsamen Ergebnisse als Kurz-Präsentation vor.

Media:
Präsentationen mittels PowerPoint (Downloadmöglichkeit für Vorlesungsmaterial); Tafelarbeit

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Das Präsentationsmaterial wird durch spezifische Literaturhinweise für die einzelnen Themen ergänzt.

Responsible for Module:
Küster, Bernhard; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
In vitro-Modelle der Zellbiologie (Vorlesung, 3 SWS)
Kramer K
For further information in this module, please click campus.tum.de or here.

Organisms | Organismen

Module Description

WZ2581: Plant Biotechnology | Pflanzenbiotechnologie

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
In the written, supervised examination (Klausur, 90min), by answering questions under time pressure and without helping material, students demonstrate that they have obtained knowledge in the areas of plant biotechnology, plant molecular biology and plant biochemistry.
The examination assesses the theoretical background and applied knowledge obtained on up-to-date aspects of current research.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A basic knowledge in genetics, genomics, plant development, biochemistry and/or botany is highly recommended

Content:
The module consists of a lecture and a seminar part.
In the lecture, state-of-the-art methods in plant biotechnology and plant molecular biology are introduced, and advantages and disadvantages are discussed. Current challenges are highlighted.
Topics of the lecture include:
- Genetically modified plants: status, regulations, cultivation, concepts;
- Generation of genetically modified plants: methods, vector systems;
- Concepts for yield improvement;
- Concepts for quality improvement;
- New potentials derived from basic research;
- Model system Arabidopsis: development of new techniques;
- Metabolic engineering.

In the seminar part different speakers from the TUM, which are active in research in plant biotechnology or plant molecular biology, introduce cutting-edge research projects that take place on campus. The seminar part is conceived to highlight the exciting research that currently takes place and advertise opportunities for master thesis projects.

Intended Learning Outcomes:
The students have a profound knowledge in plant biotechnology, plant biochemistry and plant molecular biology. They are aware of new technological approaches and methodology applied in the fields, including plant transformation, construct and vector design, reporter systems and essential DNA, RNA and protein techniques. They are able to comment critically and reflect on technologies and aims of plant biotechnology. They have insight into latest research developments in the respective areas, in particular also in research projects that currently take place at the TUM

Teaching and Learning Methods:
Lecture: PowerPoint presentations, short movies and use of the black board. Questions to the audience will actively encourage discussion and enable students to ask questions more freely.
Seminar: Power point presentations and use of the black board. The seminar talks are followed by discussions to actively invite students to ask questions. Review papers will be provided as background reading.

Media:
Lecture: PowerPoint, black board, discussion.
Seminars: PowerPoint, black board, discussion.
PDFs of the lectures will be made available to the students. Review publications will be made available for background reading on the seminar contends.

Reading List:
Biochemistry and Molecular Biology of Plants. Buchanan, Gruissem and Jones, John Wiley & Sons, 2015

Responsible for Module:
Poppenberger-Sieberer, Brigitte; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzenbiotechnologie (Vorlesung, 2 SWS)
Poppenberger-Sieberer B

Pflanzenbiotechnologie (Seminar, 2 SWS)
Poppenberger-Sieberer B [L], Poppenberger-Sieberer B, Benz J, Assaad-Gerbert F, Avramova V, Sieberer T, Schwechheimer C, Tellier A, Hückelhoven R, Johannes F, Schneitz K, Dawid C, Ahmed M, Bienert G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2589: Animal Biotechnology | Biotechnologie der Tiere 1+2

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In a graded written exam (90 min), the students show whether they are able to describe and compare methods for the generation of genetically modified cells and animals in a differentiated manner. They demonstrate that they can use this knowledge in a targeted manner to address scientific questions and to apply the knowledge they have acquired in an exemplary manner.
The written exam tests whether the students know what types of stem cells are isolated for, know their possible applications in research and biomedicine, and know what the challenges are in cell, tissue and organ transplantation. Students demonstrate that they can independently develop approaches to address theoretical problems in regenerative medicine.

Repeat Examination:
Next semester

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

Content:
The lecture will first teach different methods for generating genetically modified mammalian cells and mammals. These include microinjection, the use of viral vectors, transposons, RNAi, nucleases, nuclear transfer, genome editing (Crispr/Cas9), precise genetic manipulation by homologous recombination, and derivation of pluripotent stem cells in the different animal species and in humans. For each method, the advantages and disadvantages will be discussed and examples of applications will be presented (for example: generation of pharmaceutical proteins, generation of animal models for human diseases).
In the second part of the lecture, different approaches in regenerative medicine are taught, including xenotransplantation, allo- and autologous transplantation, and stem cell therapy with adult and pluripotent stem cells. Knowledge is acquired in the differentiation, de-differentiation and

trans-differentiation of cells. The advantages and disadvantages of different therapeutic strategies are discussed and current examples of medical applications are given. Where relevant, ethical and social aspects will be addressed.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise in genetic engineering methods to generate transgenic animals for biomedical applications and have basic knowledge in regenerative medicine. They are able to:
" understand genetic engineering issues and working techniques and develop technical questions on their own. " to what extent xeno-transplantation is a realistic option for cell, tissue or organ transplantation and what genetic modification is required in animals for this purpose.
" how pluripotent stem cells can be specifically differentiated and which cells can be used for autologous or allogeneic transplantation and what the limitations are.
" they are able to apply the acquired knowledge to in-depth questions.
"They are able to identify the best possible techniques for specific questions and possibly implement them experimentally.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture
Learning activities: Study of lecture notes, lecture transcript

Media:
Script (download option for lecture material)

Reading List:
Transgenic Animal Technology: A Laboratory Handbook by Carl A. Pinkert
Principles of Cloning by Jose Cibelli et al.
Molekulare Biotechnologie by Bernard Glick & Jack Pasternak
Gene Targeting: A PracticalApproach by Alexandra L. Joyner
Tier-Biotechnologie von Hermann Geldermann

Responsible for Module:
Flisikowski, Krzysztof; Dr habil. krzysztof.flisikowski@tum.de

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

Biotechnologie der Tiere 1 Vorlesung (Vorlesung, 2 SWS)
Flisikowska T, Flisikowski K
For further information in this module, please click campus.tum.de or here.

Medicine | Medizin

Module Description

ME2648: Molecular Oncology | Molekulare Onkologie

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
In the exam (90 min, free questions, grading according to 1.0; 1.3; 1.7...) the students show that they are able to structure their knowledge of the cell and molecular biological mechanisms of cancer development and metastasis and to present the essential aspects.
No aids may be used in the examination. The questions test the competence in reproduction (central questions of the module such as molecular signaling pathways, recognition and retrieval of intra- and intercellular communication pathways), association (linking
transfer (problem-oriented application of learned regulatory mechanisms or research approaches to new related or other research areas) and application of the acquired molecular biological knowledge to unknown problems. The exam can be repeated at the end of the following semester if the student fails, with the opportunity to repeat the lecture.

In addition, the module must include a scientific paper. This paper is about the in-depth, independent, elaboration of the theoretically developed topics. The topic of the term paper will only be assigned after passing the exam and the term paper must be handed in at a fixed date.
In contrast to the exam, which only examines theoretical knowledge, the term paper requires the free choice of an original publication from current research on each of the 10 topics of the lecture (see below). Students must be able to work autonomously in order to promote their studies; this includes, for example, the ability to classify, discuss and evaluate current research results. In particular, the students must carry out detailed literature research. Students are also required to take responsibility for their own time management and planning. Correctness, originality and formal execution are evaluated in their entirety as a course achievement. The module is passed if the exam is passed and the study performance has been successfully completed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of biochemistry, molecular biology and genetics are the basis for understanding the lectures. Attending other modules is not required.

Content:
1.) Characteristics of tumor progression (problems of modern tumor research, definitions, significance of the tumor microenvironment, Hallmarks of Cancer, properties of transformed cells in experiment); 2) causes of tumor development (stem cells and tumor formation, wnt/ hedgehog self-renewal, mutations, repair, cellular response to mutagens); 3) oncogenes (experiments of Rous, Rubin, Temin, Weinberg, definitions, functional classes of oncogenes and examples); 4.) tumor suppressor genes (definitions, Knudson two hit hypothesis, PTEN, cell cycle control points, pRB, p53, MDM2, apoptosis); 5.) epigenetics (definitions, histone modifications, DNA methylation, pRb, CpG Islands, examples, experiments of Mary Hendrix); 6.) Cell environment (components of a tumor, tumor stroma as therapeutic target, extracellular matrix: components and meaning, cell/ECM interactions, cell-cell contacts); 7th) Mechanisms of the metastasis cascade (steps of the cascade, angiogenesis, angiogenic switch, invasion, wound healing and cancer, tumor-associated macrophages, epithelial-mesenchymal transition, seed and soil hypothesis, role of proteases, metastatic niche; marker genes; metastasis models in the mouse); 8th) proteases/ proteolytic network (physiological and pathophysiological functions of proteases and protease inhibitors, regulation of proteases, splitting mechanisms, the proteolytic balance, protease families, proteases as prognostic markers, development of synthetic protease inhibitors, clinical trials, optimization of synthetic protease inhibitors, the cancer degradome); 9th) specific methodology of molecular oncology (in vivo models, biochemical/molecular detection methods of proteases and protease inhibitors, zymography, knock-out systems, siRNA, shRNAi, viral vector systems, in vitro migration and invasion models); 10th) Deepening of the above-mentioned areas (discussion of current publications from relevant journals, development of a deeper understanding of the learned mechanisms).

Intended Learning Outcomes:
The students know and understand molecular mechanisms of tumor progression, i.e. from tumor development to metastasis. They are able to understand the complex intracellular and extracellular control loops in their importance for the interactions between tumor and healthy tissue. With the knowledge acquired in this module, the students bring with them the theoretical prerequisites necessary for starting a project activity in research (e.g. master's or doctoral thesis). They are able to link original publications with the skills acquired in the module on molecular oncology and thus test their knowledge in an application-oriented way.
In addition, they can analyze and discuss original publications from current research and weigh up their scientific significance. They can also plan extensive literature searches and carry them out successfully and independently within a tight time frame.

Teaching and Learning Methods:
The module consists of a lecture and a term paper; in the lecture, the theoretical foundations of molecular oncology are developed with the help of blackboard pictures, in dialogue with the students. A relatively economical use of PowerPoint slides is used to illustrate difficult issues.

Students deepen their knowledge through intensive study of lecture material, especially their own notes and selected literature, as well as through self-study and presentation of questions and answers on the topics. The lecture can be attended in the WS or SS.
By means of experimental examples from the history of science as well as current publications, the students recognize the process of gaining knowledge in this field. Through numerous references in the lecture, the students learn a critical position on how to deal with research results and their translation (e.g. into the clinic).
In the following, the students deepen their newly acquired knowledge by means of the term paper. In private study they look for suitable literature and analyze it in detail. They have to evaluate the plausibility of the chosen experimental approaches, as well as the quality of the presented data and the way of evaluation and presentation. In contrast to classical learning, students have to consider the decisive questions and not just learn solutions by heart.

Media:
Development of the topics on the basis of blackboard pictures with the help of PowerPoint presentations. Lecture slides are made available as pdf before each lecture via the eLearning platform "moodle".

Reading List:
There is no textbook available that covers all contents of this module. In addition to other literature it is receommend:
Cell and Molecular Biology. G. Karp. Wiley Verlag, 4th edition, ISBN: 0-471-65665-8.
The Biology of Cancer. R. A. Vineyard. Garland Science, 2nd edition, ISBN: 978-0-8153-4220-5.

Responsible for Module:
Krüger, Achim; apl. Prof. Dr.: achim.krueger@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Onkologie I (Vorlesung, 2 SWS)
Krüger A [L], Krüger A

Molekulare Onkologie I Hausarbeit (Seminar, 2 SWS)
Krüger A [L], Krüger A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3207: Nutrition and Microbe-Host Interactions | Nutrition and Microbe-Host Interactions

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination requirements of the module "Nutrition and Mirobe-host Interactions" consist of a written examination (90 min, open questions and multiple choice). The examination can be based on any subject of the lectures and the corresponding seminar. The written exam will assess whether the student has attained an advanced level of knowledge about the diversity and functions of the mammalian gut microbial ecosystem and the role of dietary and microbial triggers in regulation of host health. No supporting material is allowed. The seminar (course work), consisting of theoretical input and practical exercises (teamwork), pertains to the sequence-based analysis of microbial communities.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in physiology, microbiology, bio functionality and immunology.

Content:
This lecture and seminar series teaches deep insight into the diversity and functions of the mammalian gut microbial ecosystem (intestinal microbiota) in close interaction with the host and with dietary factors. Particular attention will be drawn to the development of the microbiota throughout life as well as underlying cross-talk mechanisms with the mucosal immune system with a particular focus on chronic inflammatory disorders, enteric infections and metabolic disorders.

Intended Learning Outcomes:
After successful participation in the lecture and the seminar, students comprehend the diversity and functions of the mammalian gut microbial ecosystem and are able to estimate the role of

dietary and microbial triggers in regulation of host health. They are able to use this knowledge to critically assess recent findings.

Teaching and Learning Methods:
Lecture (reiteration and extension of topics of the lecture by studying independently), seminar (teamwork, practical implementation of theoretical knowledge)

Media:

Reading List:
Microbial Inhabitants of Humans: Their Ecology and Role in Health and Disease. Cambridge University Press, 2005, ISBN: 0 521 84158 5

Responsible for Module:
Haller, Dirk; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Microbe-host interaction and nutrition in health and disease (seminar) (Seminar, 2 SWS)
Haller D [L], Coleman O, Haller D, Lagkouvardos I, Omer H, Schmöller I

Microbe-host interaction and nutrition in health and disease (lecture) (Vorlesung, 2 SWS)
Haller D [L], Haller D, Schmöller I
For further information in this module, please click campus.tum.de or here.

Engineering | Technik

Module Description

WZ2583: Bioinformatics / Genomics | Bioinformatik / Genomik

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Prüfungsdauer (in min.): 90.
Das Modul schließt mit einer benoteten Klausur (90 min) ab. In der Klausur zeigen die Studierenden, dass sie die theoretischen Grundlagen der Modellierung und Simulation biologischer Makromoleküle und Methoden der Genomanalyse verstanden haben und auf unbekannte Fragestellungen übertragen können.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Keine

Content:
Modellierung und Simulation biologischer Macromoleküle: Anwendungsorientierte Einführung in computergestützte Methoden zur strukturellen Modellierung biologischer Makromoleküle und deren Anwendung in den Bereichen Wirkstoff- und Proteindesign: Molekulare Modelle: Molekulare Kraftfelder, Docking- und Proteinfaltungsscoringfunktionen. Algorithmen: Optimierungsmethoden, systematische Suchverfahren, stochastische Ansätze, Molekulardynamik. Methoden der Genomanalyse: Analyse von DNA Sequenzen, Genomsequenzierung, Genvorhersage, Operonstrukturen, alternatives Spleißen, RNA Strukturen, microRNA, Repeats, Pseudogene, krankheitsrelevante Mutationen

Intended Learning Outcomes:
Modellierung und Simulation biologischer Macromoleküle:

Die Studenten sind mit den Grundzügen der Methoden zur Modellierung und Simulation biologischer Makromoleküle vertraut. Sie kennen die anwendungsorientierten Unterschiede zwischen verschiedenen molekularen Modellen und Algorithmen und sind in der Lage, die passenden Modelle/Algorithmen für eine gegebene Anwendung auszuwählen.

Methoden der Genomanalyse:
Die Studierenden kennen wichtige Konzepte und Methoden der Genomanalyse und sie sind in der Lage ein breites Spektrum relevanter Methoden der Genomanalyse zu beurteilen und ausgewählte Methoden der Genomanalyse praktisch anzuwenden.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung

Media:
Powerpoint Presentation

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:
Frischmann, Dimitri; Prof. Dr. rer. nat.

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

Bioinformatik f. Biowissenschaften II (Vorlesung, 2 SWS)
Frischmann D [L], Frischmann D
For further information in this module, please click campus.tum.de or here.

Module Description

LS20010: Biopharmaceutical Technology | Biopharmaceutical Technology

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
In the 90-minute written module exam (Klausur), students must answer 20-30 questions related to the learning outcomes. No aids are required. The exam uses assignment tasks, short free-text tasks, multiple choice questions, and sketches to explain. For example, students must solve short calculation problems. Furthermore, students have to suggest suitable biopharmaceutical drugs for therapeutic case studies. In other questions they have to check the suitability of a process for an exemplary target.
Students will explain the fundamentals of different separation steps and principles of operation of different apparatus. In addition, they have to answer questions related to the applicability of different unit operations by solving short calculation exercises. They have to suggest operating conditions or modify operation conditions to improve the process performances.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in chemistry, physical chemistry, and physics.
Furthermore, prior knowledge of biochemistry, bioprocess technology and molecular biotechnology technology is required. Recommended but not strictly required is knowledge in bio process engineering.

Content:
This module consists of two lectures, covering different parts of biopharmaceutical technology:
In the lecture “Vertiefende Kapitel der Bioprozesstechnik” the production of common biotechnologically produced drugs, e.g. hormones, vaccines, gene therapeutics, antibodies and advanced therapy medicinal products are introduced. The special precautions to be taken in biotechnological production in the pharmaceutical environment will be discussed. Case studies

will be used to address specific production systems (e.g., batch, continuous, personalized, and industrial).
The lecture “Trennverfahren für biogene Substanzen” covers the engineering aspects of the separation of biomolecules in pharmaceutical, biotechnology, and chemical industries.
In biotechnology, the recovery and purification of biogenic substances from complex mixtures such as bacterial suspensions is a cost-intensive and complex process. This lecture provides insights into the fundamentals and principles of operation of the unit operations used downstream processing of biomolecules. Specific examples are used to discuss the chemical-physical characteristics of biomolecules and to describe conflicting goals in the purification of biogenic substances. In particular, the following topics are covered:
• Cell disruption
• Sedimentation and Centrifugation
• Filtration
• Liquid-liquid extraction
• Chromatography
• Precipitation
• Bioseparation process development and examples of downstream processes

Intended Learning Outcomes:
After attending this module course, students will be able,
• to understand the special requirements of biotechnological production of medicinal products and to plan the production process accordingly,
• to understand production of the different classes of biotechnological drugs and therapies: upstream, downstream, logistics, fill & finish, and analytics,
• to choose industrial scale reactors and operating modes for the production of different types of biomolecules,
• to explain the sequence of process steps for the isolation and separation of biogenic substances,
• to evaluate the applicability of different unit operations (e.g. filtration, centrifugation, extraction, precipitation, chromatography) in different steps of the separation process,
• to select equipment for different separation steps,
• to know the advantages of advanced integrated process concepts and single-use equipment,
• to explain the production of advanced therapy medicinal products (ATMPs).

Teaching and Learning Methods:
In the lecture " Vertiefende Kapitel der Bioprozesstechnik", representatives from industry and various TUM chairs present biotechnological, pharmaceutical production using case studies.
In the weekly lecture " Trennverfahren für biogene Substanzen", both PowerPoint and blackboard presentations and short films are used in the lecture. Independent study of the relevant literature is also recommended.

Media:
In the lectures Powerpoint and blackboard are used. Short films demonstrating process concepts and equipment will be presented.

Reading List:
Melin (2007): Membranverfahren; Stahl (2004): Industrie-Zentrifugen; Harrison (2002) Bioseparations Science and Engineering; Carta (2010): Protein Chromatography: Process Development and Scale-Up
Sahm, H., G. Antranikian, K.-P. Stahmann, und R. Takors, (Hrsg.) 2012. Industrielle Mikrobiologie Springer-Spektrum

Responsible for Module:
Minceva, Mirjana, Prof. Dr.-Ing. habil. mirjana.minceva@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Trennverfahren für biogene Substanzen (Vorlesung, 2 SWS)
Minceva M [L], Minceva M

Vertiefende Kapitel der Bioprozesstechnik (Vorlesung, 2 SWS)
Sönnichsen C [L], Henkel M, List M, Schmitz F, Sönnichsen C
For further information in this module, please click campus.tum.de or here.

Module Description

LS20040: Biopharmaceutical process technology | Biopharmazeutische Verfahrenstechnik

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
In the 90-minute written module exam (Klausur), students must answer 20-30 questions related to the learning outcomes. A non-programmable calculator as aid is allowed. The exam uses assignment tasks, short free-text tasks, multiple choice questions, and sketches to explain. For example, students must solve short calculation problems. Furthermore, students have to suggest suitable biopharmaceutical drugs for therapeutic case studies. In other questions they have to check the suitability of a process for an exemplary target.
Students will explain the fundamentals of different separation steps and principles of operation of different apparatus. In addition, they have to answer questions related to the applicability of different unit operations by solving short calculation exercises. They have to suggest operating conditions or modify operation conditions to improve the process performances.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in chemistry, physical chemistry, and physics.
Furthermore, prior knowledge of biochemistry, bioprocess technology and molecular biotechnology technology is required. Recommended but not strictly required is knowledge in bio process engineering.

Content:
This module consists of two lectures, covering different parts of biopharmaceutical technology:
In the lecture “Vertiefende Kapitel der Bioprozesstechnik” the production of common biotechnologically produced drugs, e.g. hormones, vaccines, gene therapeutics, antibodies and advanced therapy medicinal products are introduced. The special precautions to be taken in biotechnological production in the pharmaceutical environment will be discussed. Case studies

will be used to address specific production systems (e.g., batch, continuous, personalized, and industrial).
The lecture “Trennverfahren für biogene Substanzen” covers the engineering aspects of the separation of biomolecules in pharmaceutical, biotechnology, and chemical industries.
In biotechnology, the recovery and purification of biogenic substances from complex mixtures such as bacterial suspensions is a cost-intensive and complex process. This lecture provides insights into the fundamentals and principles of operation of the unit operations used downstream processing of biomolecules. Specific examples are used to discuss the chemical-physical characteristics of biomolecules and to describe conflicting goals in the purification of biogenic substances. In particular, the following topics are covered:
• Cell disruption
• Sedimentation and Centrifugation
• Filtration
• Liquid-liquid extraction
• Chromatography
• Precipitation
• Bioseparation process development and examples of downstream processes

Intended Learning Outcomes:
After attending this module course, students will be able,
• to understand the special requirements of biotechnological production of medicinal products and to plan the production process accordingly,
• to understand production of the different classes of biotechnological drugs and therapies: upstream, downstream, logistics, fill & finish, and analytics,
• to choose industrial scale reactors and operating modes for the production of different types of biomolecules,
• to explain the sequence of process steps for the isolation and separation of biogenic substances,
• to evaluate the applicability of different unit operations (e.g. filtration, centrifugation, extraction, precipitation, chromatography) in different steps of the separation process,
• to select equipment for different separation steps,
• to know the advantages of advanced integrated process concepts and single-use equipment,
• to explain the production of advanced therapy medicinal products (ATMPs).

Teaching and Learning Methods:
In the lecture " Vertiefende Kapitel der Bioprozesstechnik", representatives from industry and various TUM chairs present biotechnological, pharmaceutical production using case studies.
In the weekly lecture " Trennverfahren für biogene Substanzen", both PowerPoint and blackboard presentations and short films are used in the lecture. Independent study of the relevant literature is also recommended.

Media:
In the lectures Powerpoint and blackboard are used. Short films demonstrating process concepts and equipment will be presented.

Reading List:
Melin (2007): Membranverfahren; Stahl (2004): Industrie-Zentrifugen; Harrison (2002) Bioseparations Science and Engineering; Carta (2010): Protein Chromatography: Process Development and Scale-Up
Sahm, H., G. Antranikian, K.-P. Stahmann, und R. Takors, (Hrsg.) 2012. Industrielle Mikrobiologie Springer-Spektrum

Responsible for Module:
Minceva, Mirjana, Prof. Dr.-Ing. habil. mirjana.minceva@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Trennverfahren für biogene Substanzen (Vorlesung, 2 SWS)
Minceva M [L], Minceva M

Vertiefende Kapitel der Bioprozesstechnik (Vorlesung, 2 SWS)
Sönnichsen C [L], Henkel M, List M, Schmitz F, Sönnichsen C
For further information in this module, please click campus.tum.de or here.

Specialised Modules | Vertiefungsbereich

Applied Modules | Praktische Vertiefungsmodule

Biomolecules | Biomoleküle

Module Description

WZ1176: Practical Course Chemistry of Biogenic Resources | Forschungspraktikum Chemie Biogener Rohstoffe [PC CBR]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The students write an internship report (graded) in which they present their experimental work including the theoretical background and they evaluate it scientifically. The report should contain between 15 and 25 pages. In addition, the supervisors may request an oral presentation (ungraded) about the practical work.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
At least basic lectures and internships in the field of chemistry and / or life sciences

Content:
Research internship on current research topics of the Chair of Chemistry of Biogenic Resources. Preferably experimental work in the laboratory, but desk studies are also possible. Typical topics are the conversion of biogenic raw materials through chemical, enzymatic or fermentative processes.

Intended Learning Outcomes:
Students acquire in-depth knowledge of special topics in the chemistry of biogenic raw materials and associated chemical and biotechnological working methods. After completing the internship,

they have at least acquired the basic skills to evaluate results scientifically. In addition to methodological skills, independent and autonomous planning and action are encouraged.

Teaching and Learning Methods:
Laboratory experiments under guidance, partly independently planned; independent search and evaluation of technical literature

Media:
Laboratory, laboratory equipment, technical literature

Reading List:
Relevant specialist literature will be announced to the students on the basis of the individual topic at the beginning of the internship

Responsible for Module:
Doris Schieder doris.schieder@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungsprakikum Chemie Biogener Rohstoffe (Praktikum, 15 SWS)
Sieber V [L], Al-Shameri A, Hupfeld E, Kolaitis G, Köllen T, Rühmann B, Schieder D, Schmermund L, Schulz M, Sieber V, Siebert D, Steiger M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2172: Functional Proteomics | Forschungspraktikum Funktionelle Proteomanalyse

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
BSc Abschluss ist erforderlich.
Besuch der VS Proteomics - analytische Grundlagen und biomedizinische Anwendungen wird empfohlen.

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

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

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

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

Media:
Experimentelle Protokolle

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

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

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

Module Description

WZ2230: Advanced Laboratory Course "Protein Technology" | Forschungspraktikum Protein Engineering

Version of module description: Gültig ab winterterm 2009/10

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 260	**Self-study Hours:** 110	**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:
keine

Content:
Praktische Einführung in das Protein-Engineering unter Anleitung durch Mitarbeit an einem aktuellen Forschungsprojekt in einem Labor am Lehrstuhl für Biologische Chemie.

Intended Learning Outcomes:
Nach der Teilnahme an diesem Forschungspraktikum ist der Studierende in der Lage, Methoden und Konzepte des Protein-Engineerings anhand eines aktuellen Forschungsprojekts zu verstehen und anzuwenden.

Teaching and Learning Methods:
Labor

Media:

Reading List:

Responsible for Module:
Skerra, Arne; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Protein-Engineering (Forschungspraktikum, 20 SWS)
Skerra A [L], Skerra A, Anneser M, Brandt C, Mayrhofer P, Schlapschy M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2234: Biochemistry of Membrane Proteins | Forschungspraktikum Membranproteinbiochemie

Version of module description: Gültig ab winterterm 2012/13

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

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

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

Repeat Examination:
Next semester

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

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

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

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

Intended Learning Outcomes:

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

Teaching and Learning Methods:

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

Media:

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

Reading List:

Scientific primary literature, online articles

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of organic chemistry and biochemistry required; participation in MSc lecture "Chemical Peptide and Protein Synthesis" and MSc seminar "Principles of peptide/protein synthesis and peptides in biomedicine and protein misfolding diseases" recommended.

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

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

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

Media:
Experimental protocols and scientific articles

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Protein-Protein Wechselwirkungen (Seminar, 2 SWS)
Kapurniotu A

Peptiddesign und Mechanismen der Proteinaggregation und Zelldegeneration (Seminar, 1 SWS)
Kapurniotu A

Peptidchemie und -biochemie (Praktikum, 16 SWS)
Kapurniotu A, Calzi A, Dalla Volta B, Naltsas D, Wunderlich H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2273: Practical Course in Phytopathology | Forschungspraktikum Phytopathologie

Version of module description: Gültig ab summerterm 2012

Module Level:	Language:	Duration:	Frequency:
Master	German/English	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
10	300	100	200

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

Description of Examination Method:
A detailed internship report (preferably in English) in conjunction with an accurately kept laboratory book serves to verify the knowledge acquired during the internship and the performance of the practical work. In the internship report, students show whether they are able to place the practical work in the scientific-theoretical context and whether they are able to adequately present and interpret the results of their research. Furthermore, the results should be discussed appropriately, e.g. by including scientific publications from the relevant subject area. A concluding presentation about the project in English rounds off the internship.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of molecular plant sciences and cell biology

Content:
Insight into the problem-oriented work with modern methods of life sciences (co-immunoprecipitation, qRT-PCR, GoldenGate cloning, etc.) Acquisition of a profound understanding and ability to apply research methods in the agrobiosciences. Insights into the scientific approach to questions from relevant research projects, e.g. MAMP recognition, molecular evolution of plant defence, plant susceptibility factors. Learning how to present research results.

Intended Learning Outcomes:
After participating in the module course, students are able to create experimental solutions for current problems in phytopathological research. By working on and participating in current research projects, students gain a deeper understanding of how results are to be evaluated against the experimental background. In addition to methodological skills, primarily in molecular biological,

protein biochemical and bioinformatics methods, independent action and autonomous decision-making are encouraged. The performance of laboratory experiments forms the basis for the acquisition of technical competence.

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

Media:
Protocols and scientific literature

Reading List:
Introductory technical literature on the respective topics and methods is made available in the form of publications.

Responsible for Module:
Ralph Hückelhoven hueckelhoven@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Agrobiowissenschaften Pflanze/Phytopathologie (Forschungspraktikum, 10 SWS)
Hückelhoven R, Hausladen J, Schempp H, Stegmann M, Maroschek J, Müller M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2441: Research Project Biopolymer Chemistry | Forschungspraktikum Chemie der Biopolymere

Version of module description: Gültig ab summerterm 2012

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

Reading List:
Scientific primary literature, online articles

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Die benotete Laborleistung umfasst die Erstellung eines Protokolls (50% der Benotung) und die Bewertung der praktischen Tätigkeit (50% der Benotung). Im mindestens 20-seitigen Protokoll weisen die Studierenden nach, dass sie in der Lage sind die analytischen, biochemischen und molekularbiologischen Fragestellungen zu verstehen und dadurch die gewonnen Ergebnisse in strukturierter und verständlicher Weise wissenschaftlich korrekt darzustellen und zu interpretieren. Die Benotung der praktischen Tätigkeit umfasst folgende Kriterien: Planung der Experimente, Fachwissen, Arbeitsweise, Effizienz, Belastbarkeit, Auffassungsgabe, Zuverlässigkeit, Selbständigkeit, Flexibilität, Engagement.

Repeat Examination:
Next semester / End of Semester

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

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

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

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

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

Media:

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum BiNa (Forschungspraktikum, 10 SWS)
Schwab W, Hoffmann T

Forschungspraktikum BiNa (Forschungspraktikum, 10 SWS)
Schwab W, Hoffmann T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ9901: Practical Course "Biomolecules" | Forschungspraktikum "Biomoleküle"

Version of module description: Gültig ab summerterm 2015

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2014

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

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

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

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

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

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

Repeat Examination:

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

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

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

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

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

Media:
scientific articles, textbooks for advanced students

Reading List:
scientific original publications

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

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

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

Module Description

WZ2585: Molecular Methods in Bioanalytics | Kompaktkurs Molekulare Methoden der Bioanalytik

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Die Prüfungsleistung erfolgt anhand einer wissenschaftlichen Ausarbeitung (25-30 Seiten), wobei sich jeweils zwei Studierenden einem Thema widmen. Um die Einzelleistung bewerten zu können, werden die angefertigten Kapitel indiziert.

Die Durchführung der Laborexperimente bildet die Grundlage zur Erlangung der fachlichen Kompetenz. Die Studierenden zeigen anhand der wissenschaftlichen Ausarbeitung (Einleitung, Material und Methoden, Ergebnisse, Diskussion etc.), dass sie in der Lage sind, die wesentlichen Aspekte der Versuche strukturiert und reflektiert darzustellen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine

Content:
Der Kompaktkurs soll praxisorientierte Einblicke in die Entwicklung und Anwendung bioanalytischer Methoden vermitteln.

Beispiele für Übungsthemen: Aufbau, Optimierung und Anwendung eines Immunoassays; Aufbereitung und Analyse biologischer Proben in der Massenspektrometrie Bewertung immuntoxischer Effekte im Phagozytose-Assay, Yeast-Screen zum Nachweis endokriner Disruptoren, etc.

Intended Learning Outcomes:
Nach Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, weitgehend selbständig einfache Experimente zu konzipieren, um bioanalytische Fragestellungen zu beantworten. Neben methodischen Fähigkeiten in der Bioanalytik wird selbständiges agieren und eigenverantwortliche Entscheidung gefördert.

Teaching and Learning Methods:
Lehrtechnik: Übung und Praktikum; Lernaktivitäten: Bearbeitung analytischer Fragestellungen. Optimierung bioanalytischer Methoden; Üben von labortechnischen Fertigkeiten; Zusammenarbeit in Zweiergruppen; Konstruktives diskutieren und kritisieren eigener Experimente; Lehrmethode: Fragend-entwickelnde Methode

Media:
Tafelarbeit, PowerPoint

Reading List:
Folienskript; aktuelle Literatur zu den spezifischen Themen

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:
Kompaktkurs Molekulare Methoden der Bioanalytik 1+2 (Übung, 5 SWS)
Küster B [L], Kramer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2587: Practical Course and Seminar Biomolecular Spectroscopy | Kompaktkurs und Seminar Biomolekulare Spektroskopie

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
Die Prüfungsleistung des Moduls wird in Form einer Laborleistung erbracht. Die Bestandteile der Laborleistung sind ein schriftliches Protokoll zu jedem Versuch, in dem das entsprechende Spektroskopieverfahren beschrieben, die erhaltenen Daten ausgewertet und diskutiert werden. Zusätzlich muss jeder Teilnehmer die Ergebnisse aus einem Versuch in einer Präsentation (Seminarvortrag, 15 min) mit anschließender Diskussion einem wissenschaftlichen Publikum vorstellen. Außerdem muss für jeden der vier Versuche der/die Teilnehmer*in ein 60 minütiges Kolloquium mit besser oder gleich 4.0 bestehen. Der/die Teilnehmer*in erhält somit jeweils eine Durchschnittsnote aus vier Kolloquien, eine aus den vier Bewertungen für die praktische Durchführung sowie eine Durchschnittsnote aus vier Protokollnoten. Die Gesamtnote ergibt sich aus dem Mittel dieser drei Durchschnittsnoten und der Note aus dem Seminarvortrag. Das schriftliche Versuchsprotokoll muss dem entsprechenden Versuchsbetreuer spätestens 3 Wochen nach Praktikumsende ausgedruckt ausgehändigt werden.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Es werden keine anderen Module als Teilnahmebedingung vorausgesetzt. Theoretische und praktische Kenntnisse der Grundlagen der Proteinbiochemie sowie der Proteinspektroskopie sind empfohlene Voraussetzungen.
Der Praktikumstermin wird nach Absprache mit den Teilnehmerinteressenten/-innen (mind. 4, max. 8 Studierende) festgelegt.

Content:
Im Rahmen dieses Moduls (Praktikums) lernt der/die Studierende vier spektroskopische Methoden zur biomolekularen Charakterisierung von Proteinen kennen: UV/Vis-Absorptions-, Fluoreszenz- und Circulardichroismus-Spektroskopie sowie die Oberflächenplasmon-Resonanzspektroskopie.

UV/VIS-Absorptionspektroskopie:
• Messung und Vergleich von Standardspektren
• Denaturierung und Faltung von Proteinen
• Quantifizierung von Protein/Nukleinsäure-Gemischen
• Proteinbestimmung durch Absorptionsmessung bei 205 nm
• Aufnahme einer Denaturierungskinetik
• Messung eines Chromoproteins
• Konzentrationsbestimmung verschiedener gelöster Substanzen
Fluoreszenzspektroskopie:
• Aufnahme von Fluoreszenz-Anregungsspektren und Fluoreszenz-Emissionsspektren
• Bestimmung einer Fluoreszenz-Quantenausbeute
• Untersuchungen zum Fluoreszenz-Quenching

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an diesem Modul sind die Studierenden in der Lage,

• biomolekulare UV/VIS-Absorptionsvorgänge sowie den Aufbau und die Funktion eines UV/VIS-Spektralphotometers zu verstehen
• UV/VIS-Spektren typischer Biomoleküle zu verstehen, zu analysieren und zu bewerten
• UV/VIS-Bestimmungsmethoden für wichtige Metabolite und Biopolymere zu entwickeln

• den Aufbau und die Funktion eines Lumineszenz-Spektralphotometers zu verstehen
• Fluoreszenzeigenschaften sowie -spektren typischer Biomoleküle zu verstehen, zu analysieren und zu bewerten
• Fluoreszenz-Bestimmungsmethoden für wichtige Metabolite und Biopolymere sowie Fluoreszenz-Testmethoden für biomolekulare Komplexierungsreaktionen zu entwickeln

• Chiralität und Circulardichroismus (CD) bei typischen Biomolekülen sowie den Aufbau und die Funktion eines CD-Spektralphotometers zu verstehen
• CD-Spektren typischer Biomoleküle zu erklären, zu analysieren sowie zu bewerten
• die Analyse der Sekundärstruktur sowie der Temperaturstabilität eines Proteins mittels CD-Spektroskopie durchzuführen, zu verstehen und zu bewerten

• die SPR-Technologie sowie den Aufbau und die Funktion eines SPR-Geräts zu verstehen
• SPR-Sensorgramme zu verstehen, zu analysieren und zu bewerten

• Experimente zur biophysikalischen Charakterisierung von Biomolekülen mittels Spektroskopie zu entwickeln

Teaching and Learning Methods:
Bei der Lehrveranstaltung handelt es sich um ein Praktikum, in dem die Teilnehmer*innen selbständig im Labor experimentelle spektroskopische Versuche entsprechend einer Versuchsvorschrift durchführen und somit ihre labortechnischen Fertigkeiten üben können. Ein/e Versuchsbetreuer*in steht bei jedem Versuch zur Verfügung und dient als Ansprechpartner*in. Zum Verständnis der theoretischen Grundlagen ist zudem das Studium einschlägiger Fachliteratur notwendig, was durch einen Fragenkatalog zu jedem Versuch unterstützt wird. Die Versuchsdaten müssen selbständig ausgewertet sowie aufgearbeitet werden.
Im abschließenden Seminar soll die Präsentation der aufgearbeiteten Ergebnisse (z. B. mittels PowerPoint) erfolgen. Für den Vortrag werden dem Teilnehmer*innen Hinweise und Hilfestellungen zur Vorbereitung und Durchführung einer Präsentation wissenschaftlicher Ergebnisse gegeben.

Media:
Die spektroskopischen Verfahren und Versuche werden detailliert in einem Praktikumsskript beschrieben, das den Teilnehmern mind. 3 Wochen vor Praktikumsbeginn zur Verfügung gestellt wird. Die Teilnehmer*innen müssen dieses Skript lesen, die Inhalte verstehen und umsetzen sowie die wesentlichen Informationen daraus wiedergeben können. Das Seminar beinhaltet eine Präsentation der Ergebnisse (z. B. PowerPoint; Projektor).

Reading List:
Lottspeich et al., "Bioanalytik", Spektrum 2012.
Creighton, "The Biophysical Chemistry of Nucleic Acids and Proteins", Helvetian Press 2010.
Schmidt, “Optische Spektroskopie”, Wiley-VCH 2000.

Responsible for Module:
Skerra, Arne; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Kompaktkurs "Biomolekulare Spektroskopie" (Praktikum, 5 SWS)
Skerra A [L], Mirwald A, Schlapschy M, Skerra A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0227: Research Internship Chemical Biology | Research Internship Chemical Biology

Version of module description: Gültig ab summerterm 2021

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

Module Description

WZ8105: Practical Course Enzyme Optimization | Praktikum Enzymoptimierung

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 121	**Self-study Hours:** 61	**Contact Hours:** 60

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

Description of Examination Method:
The intended learning outcomes are verified by a two-piece “Laborleistung” in the form of a written report and a oral presentation. The written laboratory report serves to deepen the scientific documentation and evaluation competences in the field of enzyme engineering. The presentation serves to test the presentation competence of scientific topics in front of an audience.
The written report contains a description of the three experiments and measurements carried out during the practical course, divided into introduction, execution/evaluation and insights gained (discussion).
Important additions are the respective theoretical basics incl. literature study and the necessary calculations.

The report represents 90 % and the presentation 10 % of the overall grade of the practical course.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for successful participation are knowledge in molecular biology, microbiology, protein chemistry and enzyme engineering.
Proof of the necessary previous training is a prerequisite for successful completion of the internship. Students who have taken the module "Enzyme Engineering" are exempt from this requirement. We reserve the right to check the prerequisites.

Content:
This course is intended to impart the molecular biological and protein chemical methods for the optimization of enzymes by means of two relevant examples. Essential contents are:

1. rational/computer-based approach: local (random) mutagenesis based on sequence comparisons, structural analyses and computer models,
2. purely evolutionary approach: local mutagenesis and recombination. In both approaches, assay methods are established, robots are used for high-throughput analysis and encapsulation methods for enzyme screening are applied.
3. application of optimized enzymes for simple technical conversions (enzyme immobilization, product quantification, enzyme recycling).

Intended Learning Outcomes:
After participating in the course, the students will be able to perform various methods for enzyme optimization and to practically execute the essential elements (variant production, assay construction and screening, operation of necessary hardware) as well as to design simple enzymatic processes.
In addition, they can scientifically evaluate and document their results in the field of enzyme engineering.

Teaching and Learning Methods:
The practical training takes place as a block event in Straubing (4 SWS). The experiments are carried out independently in small groups (maximum 3 persons). The contents of the module are discussed and queried at the beginning of each practical training day. The practical course following the lecture offers concrete possibilities for learning and applying standard methods used in enzyme optimization.

Media:
A script of the practical course will be made available to the students in time. At the beginning of each day during the practical course, the upcoming work steps will be discussed using PowerPoint slides and blackboard notes, and questions will be answered.

Reading List:
Recommendations:
"Directed Enzyme Evolution: Screening and Selection Methods” (Methods in Molecular Biology) and “Directed Evolution Library Creation: Methods and Protocols” (Methods in Molecular Biology), both Frances H. Arnold, George Georgiou (publisher), Springer, Berlin
“Protein Engineering Protocols” (Methods in Molecular Biology), Katja M. Arndt and Kristian M. Muller (publisher), Springer, Berlin

Responsible for Module:
Volker Sieber (sieber@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

WZ2933: Theoretical and Practical Protein Crystallography | Theorie und Praxis der Proteinkristallographie

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Klausur (90 Min.) und Laborleistung (Protokoll).
Eine Klausur dient der Überprüfung der erlernten Kompetenzen. Die Lernenden zeigen in einer Klausur, ob sie die erarbeiteten Informationen beschreiben, interpretieren und auf ähnliche Sachverhalte übertragen sowie die unterschiedlichen Informationen zu einem neuartigen Ganzen verknüpfen können. Der Lehrende gibt den Termin der Prüfungsleistung (Klausur) zu Beginn der Lehrveranstaltung bekannt. Das in der Vorlesung erworbene theoretische Wissen wird im anschließenden Praktikum durch angeleitete Experimente weiter vertieft und angewendet. Nach Abschluss des Praktikums fertigt jeder Lernende eigenständig ein Protokoll an, in dem alle experimentellen Befunde beschrieben, ausgewertet und diskutiert werden. Die Modulnote errechnet sich zu 2/3 aus der Klausurnote und zu 1/3 aus der Praktikumsnote. Beide Teilleistungen müssen bestanden sein.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind grundlegende theoretische und praktische Kenntnisse der Proteinbiochemie (z.B. Grundvorlesung Biochemie und Biochemisches/ Proteinchemisches Grundpraktikum).

Content:
Vorlesung: Kristallisation von Proteinen, Röntgenstrahlungsquellen und -detektoren, Beugung von Röntgenstrahlung, Symmetrie und Raumgruppen, reziprokes Gitter, Strukturfaktor, Fourier-Transformation, Patterson-Methode, Phasenproblem und Generierung der Elektronendichtekarte, Konstruktion, Verfeinerung und Validierung von Strukturmodellen.

Praktikum: Kristallisation von Proteinen mittels Dampfdiffusionstechniken, Auswertung von Kristallisationsexperimenten, Erfassung von Kristallmorphologie und Symmetrie, selektive Anfärbung von Proteinkristallen, Manipulation von Kristallen und Vorbereitung für die Datensammlung, Vermessung der Beugungsmuster und Indizierung der Reflexe, Reduktion und Skalierung der Röntgenbeugungsdaten, Lösung des Phasenproblems durch Molekularen Ersatz, Verfeinerung des Strukturmodells, Software-basierte Strukturvalidierung, publikationsreife Visualisierung von Proteinstrukturen, Nutzung von Strukturdatenbanken, Einführung in die wichtigsten Software-Pakete und Internetserver.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, die Grundlagen der Strukturaufklärung von Proteinen zu verstehen und eine Strukturbestimmung eines Proteins durchzuführen. Zu dem erworbenen Wissen zählen die Kristallisation von Proteinen, die Beugung von Röntgenstrahlung, die Interpretation des Beugungsdatensatzes, Lösungsmöglichkeiten für das Phasenproblem sowie die Konstruktion, Verfeinerung und Validierung von Strukturmodellen. Praktische Fähigkeiten beinhalten die Kristallisation von Proteinen, die Aufnahme und Bearbeitung von Röntgen-Beugungsdaten bis zur Konstruktion und Verfeinerung eines Strukturmodells.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung (2 SWS) & Praktikum (1 Wo.)
Lernaktivität: Studium der Literatur; Übung von technischen und experimentellen Fertigkeiten
Lehrmethode: Präsentation und Experiment

Media:
Die Vorlesung erfolgt mit graphischer Präsentation (Projektor und Powerpoint) sowie Tafelanschrieb. Während des Praktikums wird im Labor des Lehrstuhls experimentell gearbeitet.

Reading List:
Rhodes, "Crystallography Made Crystal Clear: A Guide for Users of Macromolecular Models", Academic Press 2006. Drenth, "Principles of Protein X-Ray Crystallography", Springer 2006. McPherson, "Introduction to Macromolecular Crystallography", John Wiley & Sons 2009. Rupp, "Biomolecular Crystallography", Garland Science 2010.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Theorie der Proteinkristallographie (Vorlesung, 2 SWS)
Skerra A [L], Eichinger A

Praxis der Proteinkristallographie (Praktikum, 3 SWS)
Skerra A [L], Skerra A, Eichinger A

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

Moduls after consulting "Biomolecules" | Module nach Rücksprache "Biomoleküle"

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of organic chemistry and biochemistry required; participation in MSc lecture "Chemical Peptide and Protein Synthesis" and MSc seminar "Principles of peptide/protein synthesis and peptides in biomedicine and protein misfolding diseases" recommended.

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

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

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

Media:
Experimental protocols and scientific articles

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Peptiddesign und Mechanismen der Proteinaggregation und Zelldegeneration (Seminar, 1 SWS)
Kapurniotu A

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

Peptidchemie und -biochemie (Praktikum, 16 SWS)

Kapurniotu A, Calzi A, Dalla Volta B, Naltsas D, Wunderlich H
For further information in this module, please click campus.tum.de or here.

Cells | Zellen

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Mit der erfolgreichen Ablage der Prüfungsteile weisen die Studierenden die Befähigung nach, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Das Manuskript zum Praktikum dient zur Vorbereitung für das Praktikum.

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

Gewichtung Laborleistung:Präsentation = 6:4.

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

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

Module Description

WZme2677: Researchperiod Blood-forming Stem Cells | Forschungspraktikum blutbildender Stammzellen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 20	**Contact Hours:** 280

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

Description of Examination Method:
Daily, active participation in the internship is expected. A presentation (30 min, graded) serves to test the theoretical skills learned in the internship. The students show in the lecture if they are able to structure the learned knowledge and present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations. The lecture grade is a sub-grade of the module (30%). To check the understanding as well as the ability to describe, evaluate and interpret the experiments carried out during the practical training, a protocol has to be kept, which is checked by a certificate (graded). The protocol forms the 2nd sub-grade of the module (70%). The examination of the cell biological working techniques learned in the practical course and their application to new questions takes place during the work (ungraded).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good knowledge of cell biology and biochemistry is required to better understand the internship.

Content:
During the internship, basic knowledge about examinations of haematopoietic stem and progenitor cells and stromal cells will be taught. Contents are among other things isolation of haematopoietic stem cells and stromal (niche) cells by means of flow cytometric methods, development of different cell culture methods for the determination of function and quality of haematopoietic stem and progenitor cells, molecular methods of the investigation of signaling pathways in rare cell types (immunofluorescence, flow cytometry), and an introduction to in vivo methods for the determination of stem cell function.

Intended Learning Outcomes:
After participating in the module courses, students will have a basic theoretical understanding and expertise of hematopoietic stem cells. Furthermore, they have learned and practiced basic cell biological working techniques. They should have learned,
- to understand (stem) cell biological questions and working techniques and to develop technical questions themselves.
- to understand the relationship between stem and progenitor cells and stroma (niche) cells.
- to apply the acquired knowledge to more in-depth questions.
- to understand the most important experiments on the basic topics of molecular cell biology and to be able to master them in terms of handling (technical and manual).
- to apply basic experimental know-how including safety and material knowledge (e.g. mastery of sterile working techniques and phenotypic identification of different cell populations), both for known trained experiments and for unknown experiments to be deduced from the literature.
The module should also help to develop problem-solving skills, and promote interest in cell biology, hematological problems and the importance of somatic stem cells.

Teaching and Learning Methods:
Event type/teaching technique: Lecture, practical course Teaching method: Lecture; in practical course, instructional talks, demonstrations, experiments, partner work, discussion of results.
Learning activities: Study of literature and practical course script; practice of laboratory skills and cell biological work techniques; cooperation with practical course partners; preparation of work protocols and a summary of the entire course (with presentation of results and discussion).

Media:
Powerpoint,
script (download possibility for lecture material), practical course script

Reading List:
EThere is no textbook available that covers all contents of this module. It is recommended as a basis or as a supplement:
Helgason, C.D., Miller, C.L. Basic Cell Culture Protocols. Methods in Molecular Biology, Springer Protocols, 4. Auflage (ISBN 978-1-62703-128-8)

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

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

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

Module Description

WZ0513: Research Project Cell Biology | Forschungspraktikum Zellbiologie

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

Content:
In diesem Forschungspraktikum werden einzelne Aspekte aktueller Forschungsprojekte bearbeitet. Die Themen werden auf aktuelle experimentelle Fragestellungen abgestimmt. Methodisch stehen Techniken zur Aufklärung oder Nutzung der Signaltransduktion, primär in humanen Zellkulturmodellen im Vordergrund.
Beispiele wären:
- Etablierung von Tumorzellinien (Genome editing, Reporter etc)
- Tumorsphäroid-Modelle im Live cell imaging
- Untersuchung der Zell-Wirkstoff-Interaktion

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

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

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

Media:
Skriptum

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

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

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

Module Description

WZ1817: Research Project Molecular Fungal Genetics | Forschungspraktikum Molekulare Pilzgenetik

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Regular, active participation in the practical course is expected. The accomplishments in the lab will be graded, including the preparation and execution of the experiments, necessary calculations, the documentation and analysis in form of a lab journal (written report) as well as the interpretation of the results. The students demonstrate with the lab journal that they are able to correctly structure and reflect the critical aspects of their experiments. The accomplishments in the lab will be extended by a final oral presentation (30 min) of the research rationale & results to the other members of the group at the end of the lab course to test the communicative competences of the students.

Repeat Examination:
End of Semester

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

Content:
In the lab course (6-week laboratory internship, full-time), the students will participate in ongoing research projects of the group under supervision of experienced lab members. Foci will be the molecular biology, gene regulation and physiology of filamentous fungi. In particular the handling of model organisms, their molecular, physiological and biochemical characterization and modification will be conveyed. Independent literature research will be taught and performed to deepen the knowledge basis regarding the specific topics of interest.

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

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

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

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

Media:

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

Responsible for Module:
Benz, Johan Philipp, Prof. Dr. rer. nat. benz@hfm.tum.de

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

Module Description

WZ2376: Research Project on Pathogenic Bacteria | Forschungspraktikum Pathogene Bakterien

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum pathogene Bakterien (Forschungspraktikum, 10 SWS)
Neuhaus K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2377: Research Project on Food Hygiene | Forschungspraktikum Molekulare Lebensmittelhygiene

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Laboratory assignment: Regular presence in the research laboratory is indispensable. Attendance times are determined by the experimental design to be carried out by the student and agreed with the supervisor. The students show through the planning of experiments, experimental performance of experiments and evaluation that they have learned advanced experimental methods of molecular food hygiene and the handling of food pathogenic bacteria. As a graded written examination, a practical course protocol in the form of a scientific publication will be prepared, which also takes relevant original literature into account. The experimental results of the research internship will be presented in an ungraded short lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module: Microorganisms as pathogens

Content:
The topic of the research package will be determined individually in consultation with the students and is part of a research pre-project on molecular food hygiene currently being worked on at the chair. The following techniques can be taught, depending on the topic: Safe working with pathogenic bacteria (S2- S3** level); mutagenesis; transcriptional analysis (qRT-PCR; microarrays, deep sequencing of transcriptomes); expression of regulatory proteins and toxins; gel mobility shifts; toxin detection and monitoring of virulence gene expression in vivo (IVIS system)

Intended Learning Outcomes:
The skills acquired by the students relate to (i) experimental microbiological and molecular biological techniques, (ii) the correct keeping of a laboratory journal, (iii) the critical interpretation

of their own results using known literature data and (iv) the presentation of research results in the form of a scientific publication. An essential learning outcome is the practice of microbiological work under the safety requirements of a pathogen laboratory.

Teaching and Learning Methods:
Teaching technique: practical training.
Teaching method: Individual teaching conversations, experiments.
Learning activities: Design of experiments, practising laboratory skills, keeping laboratory protocols, studying literature, summarising and discussing results in a research protocol, preparing and giving a presentation.

Media:
none

Reading List:
individual depending on the research topic

Responsible for Module:
Siegfried Scherer siegfried.scherer@mytum.de

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

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

Module Description

WZ2540: Research Project Microbial Physiology and Gene Regulation | Forschungspraktikum Mikrobielle Physiologie und Genregulation

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Die Anwesenheitszeiten ergeben sich aus der vom Studierenden durchzuführenden und mit dem Betreuer abzusprechenden Versuchsplanung. Die Studierenden zeigen durch Versuchsplanung, experimentelle Versuchsdurchführung, Ergebnisprotokollierung und -auswertung, dass sie fortgeschrittene experimentelle Methoden der bearbeiteten Forschungsthematik erlernt haben. Am Ende des Forschungspraktikums werden die experimentellen Ergebnisse in einem unbenoteten Kurzvortrag präsentiert. Als benotete schriftliche Prüfungsleistung wird ein Praktikumsprotokoll erstellt. Das Praktikumsprotokoll soll in der Form wie eine wissenschaftlichen Publikation aufgebaut sein, die Versuchsplanung und –durchführung beschreiben, die wesentlichen erhaltenen Ergebnisse unterfüttert durch aussagekräftige Abbildungen/Tabellen übersichtlich darstellen und diese unter Bezugnahme auf relevante Originalliteratur nachvollziehbar interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind gute Grundkenntnisse in Mikrobiologie und Biochemie, grundlegende mikrobiologische und biochemische Arbeitstechniken, sowie Teilnahme am Modul Organismische und Molekulare Mikrobiologie oder vergleichbare Vorkenntnisse.

Content:
Im Rahmen des Forschungspraktikums arbeiten die Teilnehmer unter Anleitung an aktuellen Forschungsprojekten der Arbeitsgruppen des Lehrstuhls für Mikrobiologie. Inhaltliche Schwerpunkte sind Molekularbiologie, Genregulation und Mikrobielle Physiologie. Es werden spezielle Methoden des praktischen Arbeitens mit Mikroorganismen, der molekularbiologischen Charakterisierung und Modifizierung, der wachstumsphysiologischen und/oder enzymatischen

Charakterisierung vermittelt. Durch Eigenstudium von fachwissenschaftlicher Literatur werden vertiefte Kenntnisse zur jeweils bearbeiteten Thematik erworben.

Intended Learning Outcomes:
Durch das forschungsnahe Praktikum unter Anleitung haben die Studierenden folgende Fähiglkeiten erworben:
- relativ eigenständiges mikrobiologisches/molekularbiologisches Arbeiten.
- Erfahrung unter Bedingungen des Laboralltags
- Ein breites experimentelles Know-how von angewandten mikrobiologischen, genetischen und/ oder biochemischen Spezialmethoden inklusive Sicherheits- und Materialwissen verstehend nachvollzogen und handlungsmäßig beherrschen.
-Ein hohes Maß an Selbständigkeit im Planen und Durchführen von Experimenten.
- Fähigkeit zur Führung von aussagekräftigen, nachvollziehbaren Laborprotokollen.
- Kritisches und kreatives Denken vertieft sowie Fähigkeiten zum Lösen von Problemen erweitert.
- Kompetenz zur sorgfältigen Durchführung und Protokollierung von Laborexperimenten, kritischen Hinterfragung von Versuchsdaten und übersichtlichen schriftlichen Darstellung von Experimentalergebnissen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborpraktikum, Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder; Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern..
Lernaktivitäten: Literaturstudium, experimentelles Arbeiten; Anfertigen eines aussagekräftigen, nachvollziehbaren Laborprotokolls; Vorbereitung von Kurzpräsentationen von Ergebnissen.

Media:

Reading List:
Wissenschaftliche Fachliteratur nach Bedarf.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Mikrobielle Physiologie und Genregulation (Forschungspraktikum, 10 SWS)
Liebl W, Ehrenreich A, Edelmann H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2542: Research Project Microbial Diversity and Molecular Phylogeny | Forschungspraktikum Mikrobielle Diversität und Molekularphylogenie

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Die Anwesenheitszeiten ergeben sich aus der vom Studierenden durchzuführenden und mit dem Betreuer abzusprechenden Versuchsplanung. Die Studierenden zeigen durch Versuchsplanung, experimentelle Versuchsdurchführung, Ergebnisprotokollierung und -auswertung, dass sie fortgeschrittene experimentelle Methoden der bearbeiteten Forschungsthematik erlernt haben. Am Ende des Forschungspraktikums werden die experimentellen Ergebnisse in einem unbenoteten Kurzvortrag präsentiert. Als benotete schriftliche Prüfungsleistung wird ein Praktikumsprotokoll erstellt. Das Praktikumsprotokoll soll in der Form wie eine wissenschaftlichen Publikation aufgebaut sein, die Versuchsplanung und –durchführung beschreiben, die wesentlichen erhaltenen Ergebnisse unterfüttert durch aussagekräftige Abbildungen/Tabellen übersichtlich darstellen und diese unter Bezugnahme auf relevante Originalliteratur nachvollziehbar interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind gute Grundkenntnisse in Mikrobiologie und Biochemie, grundlegende mikrobiologische und biochemische Arbeitstechniken, sowie Teilnahme am Modul Organismische und Molekulare Mikrobiologie oder vergleichbare Vorkenntnisse.

Content:
Im Rahmen des Forschungspraktikums arbeiten die Teilnehmer unter Anleitung an aktuellen Forschungsprojekten der Arbeitsgruppen des Lehrstuhls für Mikrobiologie. Es werden spezielle Methoden des praktischen Arbeitens mit Mikroorganismen und der Anwendung von Methoden zur Identifizierung, molekularbiologischen Charakterisierung und systematischen Einordnung von Mikroorganismen vermittelt. Inhaltliche Schwerpunkte sind Mikrobielle Diversität, Molekularbiologie

und Molekularphylogenie. Durch Eigenstudium von fachwissenschaftlicher Literatur werden vertiefte Kenntnisse zur jeweils bearbeiteten Thematik erworben.

Intended Learning Outcomes:
Durch das forschungsnahe Praktikum unter Anleitung haben die Studierenden folgende Kopmetenzen erworben:
-relativ eigenständiges mikrobiologisches/molekularbiologisches Arbeiten
-Erfahrung unter Bedingungen des Laboralltags
-breites experimentelles Know-how angewandter mikrobiologischen, genetischen und/oder biochemischen Spezialmethoden inklusive Sicherheits- und Materialwissen verstanden, nachvollzogen und handlungsmäßig beherrscht.
-hohes Maß an Selbständigkeit im Planen und Durchfüren von Experimenten
-Fähigkeit zur Führung von Aussagekräftigen, nachvollziehbaren Laborprotokollen
-Kritisches und kreatives Denken verstärkt sowie Fähigkeiten zum Lösen von Problemen erweitert
- Kompetenz zur sorgfältigen Durchführung und Protokollierung von Laborexperimenten, kritischen Hinterfragung von Versuchsdaten und übersichtlichen schriftlichen Darstellung von Experimentalergebnissen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborpraktikum, Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder; Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern..
Lernaktivitäten: Literaturstudium, experimentelles Arbeiten; Anfertigen eines aussagekräftigen, nachvollziehbaren Laborprotokolls; Vorbereitung von Kurzpräsentationen von Ergebnissen.

Media:

Reading List:
Wissenschaftliche Fachliteratur nach Bedarf.

Responsible for Module:
Liebl, Wolfgang; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Mikrobielle Diversität und Molekularphylogenie (Forschungspraktikum, 10 SWS)
Liebl W, Ehrenreich A, Baudrexl M, Edelmann H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2557: Research Project Soil Microbiology | Forschungspraktikum Bodenmikrobiologie

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Die Prüfung ist eine Laborleistung. Sie setzt sich zusammen aus einem praktischen Laborteil mit etwa 150 Zeitstunden. In diesem werden nach wissenschaftlichem Standard Daten gewonnen, die dann auszuwerten sind. Um die angestrebte Forschungskompetenz nachzuweisen ist im Anschluss an das Praktikum ein Bericht (Umfang 8-12 Seiten) anzufertigen, der den Standards einer wissenschaftlichen Publikation nahekommt (Titel, Einleitung, Material und Methoden, Ergebnisse, Diskussion, Literatur). Der Bericht wird um eine Präsentation (20 min) ergänzt, um die kommunikative Kompetenz bei der Darstellung von wissenschaftlichen Themen vor einer Zuhörerschaft zu überprüfen.

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

Repeat Examination:
Next semester / End of Semester

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

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

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

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

Media:
Mitarbeit im Labor, Dialog mit Betreuenden

Reading List:
nach Absprache mit den Betreuenden

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Bodenmikrobiologie (Forschungspraktikum, 10 SWS)
Pritsch K (Weikl F)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2927: Research Project Molecular Microbial Enzymology | Forschungspraktikum Molekulare Mikrobielle Enzymatik

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Die Anwesenheitszeiten ergeben sich aus der vom Studierenden durchzuführenden und mit dem Betreuer abzusprechenden Versuchsplanung. Die Studierenden zeigen durch Versuchsplanung, experimentelle Versuchsdurchführung, Ergebnisprotokollierung und -auswertung, dass sie fortgeschrittene experimentelle Methoden der bearbeiteten Forschungsthematik erlernt haben. Am Ende des Forschungspraktikums werden die experimentellen Ergebnisse in einem unbenoteten Kurzvortrag präsentiert. Als benotete schriftliche Prüfungsleistung wird ein Praktikumsprotokoll erstellt. Das Praktikumsprotokoll soll in der Form wie eine wissenschaftlichen Publikation aufgebaut sein, die Versuchsplanung und –durchführung beschreiben, die wesentlichen erhaltenen Ergebnisse unterfüttert durch aussagekräftige Abbildungen/Tabellen übersichtlich darstellen und diese unter Bezugnahme auf relevante Originalliteratur nachvollziehbar interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind gute Grundkenntnisse in Mikrobiologie und Biochemie, grundlegende mikrobiologische und biochemische Arbeitstechniken, sowie Teilnahme am Modul Organismische und Molekulare Mikrobiologie oder vergleichbare Vorkenntnisse.

Content:
Im Rahmen des Forschungspraktikums arbeiten die Teilnehmer unter Anleitung an aktuellen Forschungsprojekten der Arbeitsgruppen des Lehrstuhls für Mikrobiologie. Es werden spezielle Methoden des praktischen Arbeitens mit Mikroorganismen, der molekularbiologischen Charakterisierung und Modifizierung und/oder der Proteinreinigung und -charakterisierung vermittelt. Inhaltliche Schwerpunkte sind Molekularbiologie und Enzymatik. Durch Eigenstudium

von fachwissenschaftlicher Literatur werden vertiefte Kenntnisse zur jeweils bearbeiteten Thematik erworben.

Intended Learning Outcomes:
Durch das forschungsnahe Praktikum sind die Studierenden in der Lage unter Anleitung relativ eigenständig mikrobiologische/molekularbiologische Arbeiten durchzuführen. Nach der Absolvierung dieses Moduls haben die Studierenden folgende Kompetenzen erworben:
" Durch die Mitarbeit an einem Forschungsprojekt Erfahrung unter Bedingungen des Laboralltags .
" Ein breites experimentelles Know-how. Die angewandten mikrobiologischen, genetischen und/oder biochemischen Spezialmethoden können inklusive Sicherheits- und Materialwissen verstanden und nachvollzogen werden und werden handlungsmäßig beherrscht.
" Es ist hohes Maß an Selbständigkeit im Planen und Durchführen von Experimenten erreicht.
" Die Fähigkeit zur Führung von Aussagekräftigen, nachvollziehbaren Laborprotokollen.
" Kritisches und kreatives Denken weiter verstärkt sowie Fähigkeiten zum Lösen von Problemen entwickelt.
- Kompetenz zur sorgfältigen Durchführung und Protokollierung von Laborexperimenten, kritischen Hinterfragung von Versuchsdaten und übersichtlichen schriftlichen Darstellung von Experimentalergebnissen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborpraktikum, Individuelle Anleitung im experimentellen Arbeiten durch erfahrene Labormitglieder; Kritische Besprechung von Experimentalergebnissen mit den Betreuern und Arbeitsgruppenleitern..
Lernaktivitäten: Literaturstudium, experimentelles Arbeiten; Anfertigen eines aussagekräftigen, nachvollziehbaren Laborprotokolls; Vorbereitung von Kurzpräsentationen von Ergebnissen.

Media:

Reading List:
Wissenschaftliche Fachliteratur nach Bedarf.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Mikrobielle Enzymatik (Forschungspraktikum, 10 SWS)
Liebl W, Baudrexl M, Edelmann H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3926: Research Project Molecular Biology of Intestinal Microbiota | Forschungspraktikum Molekularbiologie intestinaler Mikrobiota

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
The module is graded to validate the learning objective – i.e. confirmation of a small method- and research-oriented project, partly supervised and self-guided and its utilization - according to good scientific practice. This includes a corresponding achievement in the lab, documented in the form of an internship report with accompanying presentation as conclusion. --- An internship report (about 20 pages) has to be handed in and a presentation about the completed lab work has to be held with final discussion (about 20 minutes lecture time, excl. Discussion). Both, description and documentation of the experimental procedures, analysis and description of individual experiments according to good scientific practice are checked, and the communicative competence are assessed, regarding the scientific subject, questions about results or experimental approaches used for sample material, the processing of the samples, and the data evaluation. The module is passed when graded for the protocol of at least “sufficient”.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Exercises in Microbiology or similar

Content:
*DNA isolation from complex microbiomes
*Analysis of DNA
*PCR
*gel cleanings
*sterile working
*growing anaerobic bacteria
*Library making

*Sequencing using NGS

Intended Learning Outcomes:
Within a larger research project (usually microbiota of the intestines and their functional research), students are able to work on a subject-restricted project (eg with reference to specific samples, organisms or processes to be optimized) largely scientifically (laboratory and bioinformatic evaluation, usually 80:20), documented and evaluated in writing according to good scientific practice (lab book or final report), and presented in a scientific presentation (about 20 minutes in a laboratory seminar or similar). In particular, students learn to extract nucleic acids from samples (e.g., stool, skin, human and animal internal organs, bacterial cultures, etc.) quantitatively and without inhibitors. The isolated nucleic acids are enzymatically treated according to their nature (DNA, RNA), so that they lead to experimental libraries to be sequenced. Depending on the sequencing technology used (DNAseq, RNAseq, RIBOseq, etc., if appropriate using low-content samples), this includes fragmentation, tagmentation, ligation, PCR, phosphorylation, exo- and endonuclease treatment, density gradient centrifugation, etc. Students learn to accompany the process with quality control (QC) to obtain high-quality libraries and avoiding contaminations. The QC includes using conventional agarose gels, PAGE, capillary electrophoresis (BioAnalyzer or similar), dye-based assays (Qbit, etc.), etc. Furthermore, the students learn about suitable control reactions (mock, negative, positive) and how their results should be considered in data evaluation. In summary, you have an understanding of the experimental procedures for Next Generation Sequencing. To analyze the data, you will get to know bioinformatic software pipelines, which will be used depending on the question, the samples and the method of library production: IMNGS.org, Rhea, Bioconductor, usegalaxy.org, quiime2, RDP, MEGA-X, SILVA, KEGG, EcoliWiki, etc. For further discussion of the results, students are able to search in databases for literature and for gene data (eg scholar.google.com, NCBI, Genbank, and other). --- As mentioned, the focus varies according to the specific project and may also include the cultivation of bacteria under anaerobic conditions, ie. sterile and contamination-free work on an anaerobic workbench.

Teaching and Learning Methods:
Introduction into the laboratorium with a supervising scientist in a one-to-one basis, after that autonomous work in the lab after consultation. Self studies on how to conduct searches in literature and sequence data bases, data evaluation under supervision, conduction a report after consultation.

Media:
Publications of international journals about the topics

Reading List:
Current literature, for instance, Bazanella et al. (2017) Randomized controlled trial on the impact of early-life intervention with bifidobacteria on the healthy infant fecal microbiota and metabolome. Am J Clin Nutrition, 106(5): 1274–1286, https://doi.org/10.3945/ajcn.117.157529
and references therein about the methods used

Responsible for Module:
Neuhaus, Klaus; PD Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekularbiologie intestinaler Mikrobiota
10 SWS

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

Module Description

WZ9902: Practical Course "Cells" | Forschungspraktikum "Zellen"

Version of module description: Gültig ab summerterm 2015

Module Level:	Language:	Duration:	Frequency:
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

ME2624-2: Classical and Molecular Virology Course | Praktikum der klassischen und molekularen Virologie

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 120	**Contact Hours:** 120

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

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

Repeat Examination:

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

Content:
Die Studierenden lernen die grundlegenden Techniken der klassischen und molekularen Virologie in der Praxis und der Theorie kennen. Zusätzlich gibt jeder Student einen Vortrag auf Englisch zu praktikumsrelevanten Themen des jeweiligen Kurses. Im Eigenstudium sollen die Studierenden diese Vorträge vorbereiten und zusätzlich ein schriftliches Handout für Ihre Kollegen generieren, welches als Zusammenfassung die wichtigsten Punkte des Vortrags beinhalten soll.
Die wesentlichen Techniken des Praktikums und Studienleistungen beinhalten das Erlernen von gerichtete Mutagenese viraler Genome, Anzucht und Direktnachweise von Viren, Nachweis viraler Nukleinsäuren, Analyse der Sedimentationseigenschaften viraler Partikel, Teste zum Nachweis von Antikörpern gegen Viren, Analyse der Immunreaktion auf Virusinfektionen, Durchfluss-zytometrische Analysen von humanen Zellen, immunohistochemische Analyse von Lebern und lymphatischen Organen und die transkriptionale Analyse von chronisch entzündeten Organen.

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

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

Media:
Skriptum, Power Point Präsentation

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum der klassischen und molekularen Virologie (Praktikum, 8 SWS)
Baer de Oliveira Mann C, Deng L, Ebert G, Möhl-Meinke B, Pichlmair A, Vincendeau M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1818: Fungal Genetics Exercise | Pilzgenetische Übung

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
Regular, active participation in the practical course is expected. In the course of the exercise, data are gathered that will be used to write a final course result protocol. The students demonstrate by writing this 10-25-page course journal that they are able to correctly structure and reflect the critical aspects of their experiments. In the course journal, also aspects such as activity/productivity, creativity and independence during the course work will be evaluated and will be part of the final grade.

Repeat Examination:

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

Content:
During the theoretical part of the exercise, the course content will be taught individually and in group settings. In particular aspects such as: General developmental and cell biology of filamentous fungi; Relevance of fungi in basic and applied science; Fungi as pathogens of man, animals and plants.
During the practical part of the exercise, the focus will be on the following topics: Molecular manipulation of filamentous fungi; Cloning of transformation constructs and fungal transfection; Analysis of resulting progeny by fluorescent microscopy; Employing classical genetics techniques in crossings; Characterization of a series of unknown metabolic mutants by physiological and biochemical assays; Sugar analytic by HPAEC-PAD.

Intended Learning Outcomes:
Upon completion of the module, students will have gained basic knowlegde regarding the biology of filamentous fungi and their relevance for basic and applied science. The students will furthermore have understood how to approach scientific questions (educated experimental planning, execution, analysis and interpretation). They will have learned how to apply molecular and genetic techniques using filamentous fungi to manipulate model organisms towards the elucidation of the functioning of eukaryotic cells. These techniques are also the basic concept for current biotechnological and industrial applications.

Teaching and Learning Methods:
In this exercise, which consists of a theoretical and a practical part, lab-technical skills will be acquired and practised in group settings by way of practical teaching methods, such as experiments. These skills include: Dealing with scientific questions and solution finding by experimental approaches, and constructive discussion and critical reflection of own experiments.

Media:
Course script and Powerpoint slides

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Pilzgenetische Übung (Übung, 5 SWS)
Benz J [L], Benz J, Karl T, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2077: Internship Cell-Based Methods in Tumor Biology | Praktikum Zellbasierte Methoden der Tumorbiologie

Version of module description: Gültig ab summerterm 2014

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 10	**Contact Hours:** 80

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

Description of Examination Method:
Die Prüfung ist eine Laborleistung, die aus dem praktischen Arbeiten, dem Testat und dem Abschlussprotokoll besteht. Die Gesamtnote des Moduls ergibt sich aus dem Ergebnis für diese drei Teile, wobei die Gewichtung (Praktisches Arbeiten : Testat : Abschlussprotokoll) im Verhältnis (2:1:1) ist.

Im praktischen Teil werden im Durchschnitt pro Tag von den Studierenden je zwei Versuche/ Messungen durchgeführt (die z.T. aufeinander methodisch aufbauen, bedingt durch Zellkultur-Verfahren).
Die erlernten Methoden, die durchgeführten Experimente, ihre Auswertung und Interpretation werden in schriftlicher Form als Protokoll dokumentiert, nach dem Grund-Aufbau eines wissenschaftlichen Fachartikels (Umfang 10 Seiten, benotet). Weiterhin wird durch den Betreuer der Kenntnisstand zum Ende des Praktikums erhoben, dieses mündliche Testat (20 Minuten) dient der Überprüfung der erworbenen Kompetenzen. Eine aktive Teilnahme am Praktikum wird vorausgesetzt.

Repeat Examination:

(Recommended) Prerequisites:
Besuch des Moduls "Molekulare Zellbiologie der Tumorentstehung"

Content:
Das Forschungspraktikum orientiert sich inhaltlich an den beiden Vorlesungen des Moduls "Molekulare Zellbiologie der Tumorentstehung". Die Forschungsmethoden, die in der aktuellen biomedizinischen Grundlagenforschung zur Anwendung kommen, sollen eingeführt und demonstriert werden. Der Schwerpunkt liegt auf zellbiologischen Verfahren, insbesondere der

Zell- und Gewebekultur etablierter und primärer Tumorzellen murinen und humanen Ursprungs, adhärent sowie in Suspensionskultur. Steriles, sorgfältiges Arbeiten an der Sterilbank, die gängigen Verfahren (Passagierung, Erhebung der Zellzahl, Einfrieren/Auftauen von Zellen, Kulturbedingungen, Etablierung von Primärkulturen, Transfektionsmethoden, Isolierung von Zellklonen, mikroskopische Analyse, Herstellung von Proteinlysaten aus Zellen, Testung auf Mykoplasmen-Kontamination) sollen erlernt werden. Grundkenntnisse über die Isolierung, Charakterisierung und genetische Manipulierung von Tumorzellen sollen vermittelt werden.

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss dieses Moduls sind die Studierenden in der Lage grundlegende zellbiologische Arbeitstechniken auszuüben und zellbiologische Experimentalansätze zu entwickeln. Außerdem können sie das erworbene Wissen zu zellbiologischen Fragestellungen und Arbeitstechniken auf vertiefte Fragestellungen anwenden.

Teaching and Learning Methods:
Veranstaltungsform / Lehrtechnik: Anleitungsgespräche und -anweisungen, Demonstrationen, Experimente, Ergebnisbesprechungen, Vorstellung der Resultate in der Gruppe, kritische Lektüre von englischsprachiger Fachliteratur, Vortrag, Anfertigung eines Protokolls.

Media:
Praktikumsskript

Reading List:
"Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Aktuelle Fachliteratur wird je nach Thema des Praktikums vom Betreuer ausgegeben. Als Grundlage oder zur Ergänzung wird empfohlen: 1) Biology of Cancer, Robert Weinberg, Garland Science 2006; ISBN: 0815340761
2) Lehrbuch der Molekularen Zellbiologie, Alberts et al., Wiley VCH, 2007. ISBN: 3527311602
3) The Mouse in biomedical research. James G. Fox (Ed.). Academic Press, 2007. ISBN: 9780123694546
4) Mouse Models of Human Cancer. Eric C. Holland (Editor), Wiley-VCH, 2004. ISBN: 978-0-471-44460-2"

Responsible for Module:
Klaus-Peter Janssen (klaus-peter.janssen@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

WZ0407: Research Project on Beneficial Properties of the Early Life Microbiota | Research Project on Beneficial Properties of the Early Life Microbiota

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The type of assessment for this module is a laboratory assignment (Laborleistung). The goal of this module is to teach you how to design and conduct independent research in a supportive environment. Your proposal will take the form of asking a hypothesis-driven research question based on existing literature/data, that you then attempt to answer once you start the experimental component of the module. Additionally, we wish to prepare you for applying for a career in science. The project will be partly supervised and self-guided in the lab – according to good scientific practice, and this lab work and your conduct in the lab will account for 40% of the overall mark. Your internship report resulting from your lab work, should be written in the form of a scientific research paper, and should include the following sections (accounting for 50% of the overall mark)

(i) Title
(ii) Abstract
(iii) (Materials and Methods
(iv) Results
(v) Discussion.

There is a strict word limit of 6000 (+10%). This does not include figure legends or references.
Your report will be assessed on the following:
• Abstract
• Introduction
• Materials and Methods
• Quality of Results
• Presentation of Results
• Data Handling
• Discussion

• Future Work Suggestions
• References
• Written Expression

You will also give a 15-minute presentation (+ 5 minutes scheduled for questions) on your research project. The goal of this exercise is to get you thinking about how to present your work to a non-expert audience. Your presentation will be assessed on the following (10% of overall mark):
• Context and communication of science
• Clarity
• Structure
• Oral delivery and visual aids
• Conclusions and answering questions

The module is passed when at least 40 out of a total of 100 points have been granted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's in Molecular Biotechnology or Biology or Biochemistry, or other relevant area

Content:
Practical work in a microbiome research lab, which may involve a combination of wet and dry lab approaches. For more info see www.halllab.co.uk.

Intended Learning Outcomes:
You will work within a larger research project – which will involves understanding how certain early life microbiota members adapt and are beneficial in the infant gut environment. You may focus on understanding complete microbial communities or drill down to examine certain microbiota members e.g. Bifidobacterium. Other aspects may involve developing and optimising cutting-edge methods for isolating microbes and also undertaking studies to probe certain aspects of beneficial microbial function e.g. production of novel anti-microbials and/or immune stimulation. For more details see www.halllab.co.uk.
Participants should be able to recognize, understand and apply laboratory techniques. They are able to analyze the data produced and to evaluate data with appropriate supervision. Participants should think of own research ideas building up on the research internship (future outlook).

Teaching and Learning Methods:
Introduction to the lab and training in appropriate methods by a Hall lab team member, followed by individual working and teamwork. Problem solving training and experimental design and data analysis will also be developed over the course of the project.

Media:
Blogs and potential for peer-reviewed scientific publication(s)

Reading List:
• Kiu R, Treveil A, Harnisch LC, Caim S, Leclaire C, van Sinderen D, Korcsmaros T, Hall LJ. Bifidobacterium breve UCC2003 induces a distinct global transcriptomic programme in neonatal murine intestinal epithelial cells. iScience. 2020. 23(7):101336
• Puengel D, Treveil A, Dalby MJ, Caim S, Colquhoun IJ, Booth C, Ketskemety J, Korcsmaros T, van Sinderen D, Lawson MAE/Hall LJ. Bifidobacterium breve UCC2003 exopolysaccharide modulates the early life microbiota by acting as a potential dietary substrate. Nutrients. 2020. 12(4), 948
• Lawson MAE/O'Neill IJ, Kujawska M, Wijeyesekera A, Flegg Z, Chalklen L, Hall LJ. Breast-milk derived human milk oligosaccharides promote Bifidobacterium interactions within a single ecosystem. ISME J. 2020: 14(2):635-648
• Dalby MJ & Hall LJ. Recent advances in understanding the neonatal microbiome. F1000Research. 2020, 9 (F1000 Faculty Rev):422.
• O'Neill I/Schofield Z, Hall LJ. Exploring the role of the microbiota member Bifidobacterium in modulating immune-linked diseases. Emerging Topic in Life Sciences. 2017; 1(4) 333-349

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project on Beneficial Properties of the Early Life Microbiota (Forschungspraktikum, 16 SWS)
Hall L (Kujawska M, Zenner C)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0408: Research Project on Microbiota-Associated Pathobionts | Research Project on Microbiota-Associated Pathobionts

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The type of assessment for this module is a laboratory assignment (Laborleistung). The goal of this module is to teach you how to design and conduct independent research in a supportive environment. Your proposal will take the form of asking a hypothesis-driven research question based on existing literature/data, that you then attempt to answer once you start the experimental component of the module. Additionally, we wish to prepare you for applying for a career in science. The project will be partly supervised and self-guided in the lab – according to good scientific practice, and this lab work and your conduct in the lab will account for 40% of the overall mark. Your internship report (dissertation) resulting from your lab work, should be written in the form of a scientific research paper, and should include the following sections (accounting for 50% of the overall mark)

(i) Title
(ii) Abstract
(iii) (Materials and Methods
(iv) Results
(v) Discussion.

There is a strict word limit of 6000 (+10%). This does not include figure legends or references.
Your dissertation will be assessed on the following:
• Abstract
• Introduction
• Materials and Methods
• Quality of Results
• Presentation of Results
• Data Handling
• Discussion

• Future Work Suggestions
• References
• Written Expression

You will also give a 15-minute presentation (+ 5 minutes scheduled for questions) on your research project. The goal of this exercise is to get you thinking about how to present your work to a non-expert audience. Your presentation will be assessed on the following (10% of overall mark):
• Context and communication of science
• Clarity
• Structure
• Oral delivery and visual aids
• Conclusions and answering questions

The module is passed when at least 40 out of a total of 100 points have been granted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's in Molecular Biotechnology or Biology or Biochemistry, or other relevant area

Content:
Practical work in a microbiome research lab, which may involve a combination of wet and dry lab approaches. For more info see www.halllab.co.uk.

Intended Learning Outcomes:
You will work within a larger research project – which will involves understanding how certain microbiota members may cause disease in humans and animals. You may focus on certain microbiota members, that while at low levels do not cause harm, under certain conditions may overgrow and cause infection – i.e. pathobionts including Clostridium and Klebsiella. Other aspects may involve isolating these pathobionts from clinical samples and studying the virulence factors that these microbes may encode and produce and antimicrobial resistance determinants. For more details see www.halllab.co.uk.
Participants should be able to recognize, understand and apply laboratory techniques. They are able to analyze the data produced and to evaluate data with appropriate supervision. Participants should think of own research ideas building up on the research internship (future outlook).

Teaching and Learning Methods:
Introduction to the lab and training in appropriate methods by a Hall lab team member, followed by individual working and teamwork. Problem solving training and experimental design and data analysis will also be developed over the course of the project.

Media:
Blogs and potential for peer-reviewed scientific publication(s)

Reading List:
• Chen Y, Brook TC, Soe CZ, O'Neill I, Alcon-Giner C, Leelastwattanagul O, Phillips S, Caim S, Clarke P, Hoyles L/Hall LJ. Preterm infants harbour diverse Klebsiella populations, including atypical species that encode and produce an array of antimicrobial resistance- and virulence-associated factors. Microbial Genomics. 2020. doi.org/10.1099/mgen.0.000377
• Dalby MJ & Hall LJ. Recent advances in understanding the neonatal microbiome. F1000Research. 2020, 9 (F1000 Faculty Rev):422.
• Alcon-Giner C/Leggett RM, Heavens D, Caim S, Brook TC, Kujawska M, Hoyles L, Clarke P, Clark MD/Hall LJ. Rapid MinION profiling of preterm microbiota and antimicrobial resistant pathogens. Nature Microbiology. 2019. doi:10.1038/s41564-019-0626-z
• Kiu R, Brown J, Bedwell H, Leclaire C, Caim S, Pickard D, Dougan G, Dixon R, Hall LJ. Genomic analysis on broiler-associated Clostridium perfringens strains and caecal microbiome profiling reveals key factors linked to poultry Necrotic Enteritis. Animal Microbiome. 2019: 1(12).
• Kiu, R & Hall, LJ. An update on the human and animal enteric pathogen Clostridium perfringens. Emerging Microbes & Infections. 2018. 7:141.

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project on Microbiota-Associated Pathobionts (Forschungspraktikum, 16 SWS)
Hall L (Kujawska M, Zenner C)
For further information in this module, please click campus.tum.de or here.

Moduls after consulting "Cells" | Module nach Rücksprache "Zellen"

Module Description

WZ2539: Seminar on Microbial Effectors | Proseminar Mikrobielle Wirkstoffe

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
In the oral examination (30 min) the students show that they are able to present and competently discuss a previously agreed microbiological topic on microbial active ingredients in a PowerPoint presentation in a clear and understandable way and to summarize the essential points of the topic in writing as a handout. The quality and clarity of the lecture/handout and the competence of the discussion of questions on the topic are included in the grade with a weighting of 70:30.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of the basics of microbiology (lecture General Microbiology), human biology and biochemistry is required.

Content:
In this module current topics from the field of production and mode of action of mikrob. active ingredients, for example toxins, bacteriocins, antibiotics, pathogenicity factors and pathogenicity mechanisms of bacterial pathogens.

Intended Learning Outcomes:
After completing this module, students are able to
"Gain new up-to-date knowledge on basic topics of microbiology using various pathogenic microorganisms.
"Acquire the ability to present scientific contents of microbiology in an understandable form.
" To promote critical and creative thinking and to develop skills for professional discourse.

"To promote interest in microbiology, microbiological problems and the importance of microorganisms for humans and the environment.
The acquired knowledge prepares students for independent preparation of scientific lectures and their presentation.

Teaching and Learning Methods:
Event type/teaching technique: seminar; teaching method: seminar presentations by the participants; subsequent discussion of the presentations.
Learning activities: study of literature, preparation of presentations, critical examination of contents and presentation performance through discussion with the lecturer.

Media:
Presentations using PowerPoint, handouts.

Reading List:
Individually selected primary literature.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Proseminar - mikrobielle Wirkstoffe [MID WZ2539] (Seminar, 2 SWS)
Liebl W
For further information in this module, please click campus.tum.de or here.

Organisms | Organismen

Module Description

WZ0371: Practical: Animal Biotechnology | Biotechnologie der Tiere (P)

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**Total Hours:** 54	**Self-study Hours:** 24	**Contact Hours:** 30

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

Description of Examination Method:
Prüfungsdauer (in min.): 20.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Practical introduction to methods in embryology, cell culture, genetic analysis, genome manipulation

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Angelika Schnieke (angelika.schnieke@mytum.de)

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

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

Version of module description: Gültig ab winterterm 2019/20

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

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

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

Repeat Examination:

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

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

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

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

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

Reading List:
Orginal research literature and reviews.

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

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

Module Description

LS20036: Research Project Host-Parasite-Interaction and Immunobiology of Parasitic Infections | Forschungspraktikum Wirts-Parasit-Interaktion und Immunbiologie Parasitärer Infektionen

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Laborleistung (aktive und regelmäßige Teilnahme) erbracht. Die aktive Teilnahme beinhaltet die korrekte Benutzung der Laborgeräte, eine effiziente Planung und protokollgetreue Durchführung der Experimente, sowie Dokumentation und statistische Analyse der erhobenen Daten.
Der anzufertigende Praktikumsbericht (Umfang # 25 Seiten: Titelblatt, Abstract, Einleitung, Fragestellung/Hypothesen, Material/Methoden, Ergebnisse und Diskussion, Literatur) dient zur Überprüfung der Fähigkeit zur Beschreibung, Auswertung und Interpretation der im Praktikum durchgeführten Experimente zum Thema Host-Parasite-Interactions. Die im Praktikum durchgeführten und im Protokoll beschriebenen Experimente oder Datenanalysen sind darüber hinaus in Form eines Vortrags (15min, in englischer Sprache) 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 (Aktive Teilnahme, Praktikumsbericht und Präsentation, gewertet im Verhältnis 5:3:2) wird eine Note vergeben.

Im Rahmen des Forschungspraktikums weisen Studierende die folgenden Fähigkeiten nach: strukturierte Planung der Versuche, sorgsame und genaue Versuchsdurchführung, korrekte Dokumentation von Ergebnissen und Datenanalyse, statistische Betrachtung der Daten und kritische Diskussion und Evaluation der erzielten Ergebnisse.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnisse der Immunologie und Mikrobiologie, sowie molekulare Methoden

Content:
Parasiten waren schon vor uns da! - und unser Verständnis zur Interaktion zwischen Parasit und Wirt ist noch immer nicht ausreichend tief. Im Forschungspraktikum arbeiten Studierende unter Anleitung an laufenden Forschungsprojekten der Arbeitsgruppe Infection Pathogenesis. Methodisch können sich die Forschungsprojekte mit der Isolation und Kultur verschiedener parasitärer Entwicklungsstadien, Viabilitäts- und Motilitätstests, Immunzell-Kokulturen, diagnostischen und molekulare Methoden, Antigenisolation und – Separation, Immunassays zur Serokonversion sowie mit Antworten des angeborenen und erworbenen Immunsystems befassen.

Intended Learning Outcomes:
Das Ziel dieses Moduls ist es, dass Studierenden ein Verständnis für die verschiedenen Arten und Folgen der Interaktion zwischen Parasiten und der Immunantwort des Wirts entwickeln.
Nach der erfolgreichen Teilnahme am Forschungspraktikum sind die Studierenden in der Lage Forschungsfragen in experimentelle Ansätze zu transferieren, Experimente korrekt methodisch umzusetzen und zu protokollieren und haben ein tiefes Verständnis im Umgang mit experimentellen Daten (Interpretation, Limitierungen, Fehlersuche). Methodische Fähigkeiten um Parasite-Host-Interactions aufzudecken, wie zB. Diagnostik, die Haltung von Parasiten in in vitro Kulturen, und funktionelle Assays mit Wirtsimmunzellen und Parasiten werden gefördert. Zusätzlich wird die Kompetenz erworben sicher und verantwortungsvoll mit Erregern der Risikogruppe 2 umzugehen und damit eine Grundlage für Arbeiten im Pathogenlaboren gelegt.

Teaching and Learning Methods:
Literaturarbeit, Anleitungsgespräche, praktische Laborarbeit unter Anleitung und mit Erregern der Risikogruppe 2 mit Fokus auf sterile und sichere Arbeitstechniken in der Zellkultur und parasitologischen Labormethoden, Dokumentation, Datenanalyse und Diskussion, Ergebnispräsentation.

Media:

Reading List:
Die wissenschaftliche Fachliteratur wird projektspezifisch ausgegeben.

Responsible for Module:
Ebner, Friederike, Prof. Dr. rer. nat. friederike.ebner@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

WZ0003: Internship Reproductive Biotechnology | Forschungspraktikum Biotechnologie der Reproduktion

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Internship Report/Presentation

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
B.Sc. Life Sciences; basic knowledge of molecular biology and immunology

Content:
During the internship the student will work on an independent sub-project in the field of reproductive biotechnology/immunology and learn different scientific methods. The subproject is integrated into a larger overall project. Depending on the project, techniques of molecular biology, cell biological, animal breeding and embryological methods will be learned. The student will expand his/her knowledge in the fields of embryology, stem cell biology, immunology and molecular biology.

Intended Learning Outcomes:
After participation in the module course students are able to apply molecular biological, cell biological, embryological and immunological methods and analyse data.

Teaching and Learning Methods:
Practice laboratory skills, prepare and give a presentation

Media:

Reading List:

Responsible for Module:
Benjamin Schusser benjamin.schusser@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Reproduktion (Forschungspraktikum, 10 SWS)
Schusser B [L], Bauer B, Schusser B, Sid H

Forschungsprojekt Biotechnologie der Reproduktion (Projekt, 5 SWS)
Schusser B [L], Schusser B, Sid H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1817: Research Project Molecular Fungal Genetics | Forschungspraktikum Molekulare Pilzgenetik

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Regular, active participation in the practical course is expected. The accomplishments in the lab will be graded, including the preparation and execution of the experiments, necessary calculations, the documentation and analysis in form of a lab journal (written report) as well as the interpretation of the results. The students demonstrate with the lab journal that they are able to correctly structure and reflect the critical aspects of their experiments. The accomplishments in the lab will be extended by a final oral presentation (30 min) of the research rationale & results to the other members of the group at the end of the lab course to test the communicative competences of the students.

Repeat Examination:
End of Semester

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

Content:
In the lab course (6-week laboratory internship, full-time), the students will participate in ongoing research projects of the group under supervision of experienced lab members. Foci will be the molecular biology, gene regulation and physiology of filamentous fungi. In particular the handling of model organisms, their molecular, physiological and biochemical characterization and modification will be conveyed. Independent literature research will be taught and performed to deepen the knowledge basis regarding the specific topics of interest.

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

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

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

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

Media:

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

Responsible for Module:
Benz, Johan Philipp, Prof. Dr. rer. nat. benz@hfm.tum.de

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

Module Description

WZ2256: Practical Course in Molecular Physiology | Forschungspraktikum Molekulare Physiologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 100	**Contact Hours:** 200

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

Description of Examination Method:
Prüfungsdauer (in min.): 30 mündlicher Vortrag + praktisch (SL), Gewichtung 1/2.
Die Gesamtnote des Moduls wird aus zwei Einzelbewertungen errechnet. Hierzu zählen: (1) Die Studienleistung während des Praktikumszeitraums mit Fokus auf den praktischen Übungen im molekularbiologischen-, und -physiologischen Labor, Verständniskontrolle durch individuelle Gespräche. (2) Eine schriftliche Zusammenfassung am Ende des Praktikums über die dargelegten theoretischen Inhalte und Ergebnisse.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse klassische Physiologie und expressionelle Regulation

Content:
6 weeks at the facilities of the institute
....
basic techniques in molecular physiology

Intended Learning Outcomes:
! Diese Angabe fehlt für das Modulhandbuch !
! Bitte unbedingt unter Benennung des Moduls an michael.scharmann@wzw.tum.de melden !

Teaching and Learning Methods:
Lehrtechnik: Praktikum. Lehrmethode: Vorträge, Gruppenarbeit, Referate. Lernaktivitäten: Relevante Literaturrecherche; Studium von Literatur; Üben von labortechnischen Fertigkeiten; Vorbereiten und Durchführen von Präsentationen

Media:
Flipchart, Tafelarbeit, PowerPoint, Folien

Reading List:
Freitext

Responsible for Module:
Michael Pfaffl (michael.pfaffl@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Physiologie, MolBiotechM (Forschungspraktikum, 10 SWS)
Berner J, Donhauser L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2273: Practical Course in Phytopathology | Forschungspraktikum Phytopathologie

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 100	**Contact Hours:** 200

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

Description of Examination Method:
A detailed internship report (preferably in English) in conjunction with an accurately kept laboratory book serves to verify the knowledge acquired during the internship and the performance of the practical work. In the internship report, students show whether they are able to place the practical work in the scientific-theoretical context and whether they are able to adequately present and interpret the results of their research. Furthermore, the results should be discussed appropriately, e.g. by including scientific publications from the relevant subject area. A concluding presentation about the project in English rounds off the internship.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of molecular plant sciences and cell biology

Content:
Insight into the problem-oriented work with modern methods of life sciences (co-immunoprecipitation, qRT-PCR, GoldenGate cloning, etc.) Acquisition of a profound understanding and ability to apply research methods in the agrobiosciences. Insights into the scientific approach to questions from relevant research projects, e.g. MAMP recognition, molecular evolution of plant defence, plant susceptibility factors. Learning how to present research results.

Intended Learning Outcomes:
After participating in the module course, students are able to create experimental solutions for current problems in phytopathological research. By working on and participating in current research projects, students gain a deeper understanding of how results are to be evaluated against the experimental background. In addition to methodological skills, primarily in molecular biological,

protein biochemical and bioinformatics methods, independent action and autonomous decision-making are encouraged. The performance of laboratory experiments forms the basis for the acquisition of technical competence.

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

Media:
Protocols and scientific literature

Reading List:
Introductory technical literature on the respective topics and methods is made available in the form of publications.

Responsible for Module:
Ralph Hückelhoven hueckelhoven@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Agrobiowissenschaften Pflanze/Phytopathologie (Forschungspraktikum, 10 SWS)
Hückelhoven R, Hausladen J, Schempp H, Stegmann M, Maroschek J, Müller M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2384: Research Project 2 Molecular Biology of Plant | Forschungspraktikum 2 - Molekularbiologie der Pflanzen

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Time allowed (in min.): 30 oral tests + graded test report.
To check the comprehension as well as the ability to describe, evaluate and interpret the experiments carried out during the practical training, a protocol has to be kept, which is checked and graded. In a colloquium, students demonstrate their ability to structure the acquired knowledge and to present the essential aspects of molecular biology of plants. They should be able to describe, interpret and combine the acquired information in a meaningful way and apply it to similar situations. The overall grade of the module consists of the protocol grade and the colloquium grade (1:1).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For a better understanding of the contents imparted during the internship, a profound knowledge of the biological and molecular basics is required; in addition, in-depth experimental experience in plant sciences and a completed bachelor thesis are prerequisites

Content:
Das Praktikum führt die Teilnehmer vertieft an aktuelle Themen und Methoden der molekularen Pflanzenbiologie heran. Die Teilnehmer arbeiten dabei zusammen mit Wissenschaftlern Hand in Hand an aktuellen Forschungsprojekten des Lehrstuhls. Das Praktikum wird für verschiedene Themenbereiche angeboten. Themenbereiche sind die Streßphysiologie der Pflanzen, der pflanzliche Xenobiotika-Metabolismus, pflanzliche Peroxisomen und Zellteilung. Die Festlegung des Themas erfolgt nach Absprache.

Streßphysiologie: Gegenwärtig werden am Lehrstuhl die pflanzliche Reaktion auf Trockenstreß, Salzstreß und Starklichtstreß untersucht. Aktuell spielen in diesem Zusammenhang die Wurzel-Sproß-Kommunikation unter Streßbedingungen und Abscisinsäure-vermittelte Signaltransduktion bzw. Anpassungsreaktionen in Wildtyp und speziellen Mutanten eine wichtige Rolle. Techniken: In vivo-Imaging Verfahren (Detektion von Luciferaseaktivität mit zellulärer Auflösung, Thermokamera, Calcium-Imaging), transiente Expression im Protoplastensystem, Konfokalmikroskopie, SDS-PAGE, Western Blot, Klonierung.

Programmierter Zelltod: Gegenwärtig wird in der Arbeitsgruppe Gietl die Funktion der KDEL-Cystein Endopeptidasen in Entwicklung und Pathogen-Abwehr, sowie ihr Transport innerhalb der Zelle untersucht. Techniken: Pflanzenanzucht; Inokulierung mit biotrophen, semi-biotrophen und nekrotrophen Pilzen, Beurteilung des Befallsstadiums; Untersuchung von Reporterlinien bzw. ko-Mutanten; Mikroskopie, Konfokalmikroskopie; Proteinuntersuchungen (Hochregulierung der KDEL-Cystein Endopeptidasen, Immunpräzipitation, Aktivitätsmessung.

Xenobiotika-Metabolismus: Fremdstoffe (Xenobiotika) werden in der Pflanze modifiziert und vielfach an hydrophile Substanzen wie Zuckermoleküle und Glutathion konjugiert. Im Rahmen des Praktikums werden grundlegende analytische Methoden wie HPLC, Hefetransformation, Klonierungen und Enzymassays verwendet. An der Glutathionkonjugation beteiligte Pflanzenenzyme werden in Hefe als Modellsystem exprimiert und ihre Funktion bei der Pestiziddetoxifikation untersucht.

Zellteilung: Die Arbeitsgruppe Assaad untersucht Zellteilung, Zellwandbildung, Membranverkehr und Allokationsentscheidungen in Arabidopsis thaliana. Mit Methoden der Molekulargenetik, Zellbiologie und Biochemie wird die Regulierung des Wachstums in Antwort auf unterschiedliche Stressbedingungen untersucht. Zum Einsatz kommen Techniken wie Mutantenanalyse, Kartierung, positionelle Klonierung, Live Imaging und Immunolokalisierung anhand von Konfokalmikroskopie und Immunopräzipitation.

Intended Learning Outcomes:
By participating in the research internship, students acquire in-depth theoretical knowledge and a specific understanding of
"questions of molecular plant biology
"Modern working techniques of plant physiology
You will then be able to apply the acquired knowledge to in-depth questions, to competently apply modern working techniques of plant physiology and to experiment with plants, especially with Arabidopsis

Teaching and Learning Methods:
The internship introduces the participants to current topics and methods of molecular plant biology. The participants work hand in hand with scientists on current research projects of the chair. The internship is offered for different topics. Topics are stress physiology of plants, plant xenobiotic metabolism, plant peroxisomes and cell division. The topic will be determined by arrangement.

Stress Physiology: Currently, the department is investigating the plant response to drought stress, salt stress and high intensity light stress. Currently, root-sprout communication under stress conditions and abscisic acid-mediated signal transduction or adaptation reactions in wild type and special mutants play an important role in this context. techniques: In vivo imaging techniques (detection of luciferase activity with cellular resolution, thermal camera, calcium imaging), transient expression in the protoplast system, confocal microscopy, SDS-PAGE, western blot, cloning.

Programmed cell death: Currently, the Gietl group is investigating the function of KDEL-cysteine endopeptidases in development and pathogen defense, as well as their transport within the cell. Techniques: Plant growth; inoculation with biotrophic, semi-biotrophic and necrotrophic fungi, assessment of the stage of infestation; investigation of reporter lines or co-mutants; microscopy, confocal microscopy; protein studies (upregulation of KDEL-cysteine endopeptidases, immunoprecipitation, activity measurement.

Xenobiotic metabolism: Foreign substances (xenobiotics) are modified in the plant and often conjugated to hydrophilic substances such as sugar molecules and glutathione. During the practical course basic analytical methods such as HPLC, yeast transformation, cloning and enzyme assays are used. Plant enzymes involved in glutathione conjugation are expressed in yeast as a model system and their function in pesticide detoxification is investigated.

Cell division: The Assaad group studies cell division, cell wall formation, membrane traffic and allocation decisions in Arabidopsis thaliana. Using methods from molecular genetics, cell biology and biochemistry, the regulation of growth in response to different stress conditions is studied. Techniques such as mutant analysis, mapping, positional cloning, live imaging and immunolocalization using confocal microscopy and immunoprecipitation are applied.

Media:
Presentations via PowerPoint, blackboard writing,
Internship script (PowerPoint presentations can be downloaded)

Reading List:
Weiler and Nover: General and molecular botany. Thieme publishing house.
Peter Schopfer and Axel Brennicke: Plant Physiology. Spektrum Akademischer Verlag.
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag
Bob Buchanan, Wilhelm Gruissem and Russell L. Jones: Biochemistry & Molecular Biology of Plants. John Wiley & Sons
Professional articles from scientific journals (adapted to the chosen working topic).

Responsible for Module:
Grill, Erwin; Prof. Dr. rer. nat.

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

Assaad-Gerbert F, Wiese C
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The examination consists of a project report (approx. 15-20 pages), which is to be submitted at the end of the module and is graded. The report contains a short introduction to the topic, the scientific research questions, the applied material and methods, the results and a discussion of the results in the context of current literature.

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in molecular genetics and plant breeding. Previous practical experience with molecular techniques and/or handling of plants is an advantage.

Content:
The individual projects that students will work on encompass current topics of plant breeding and address different aspects of ongoing research projects. The projects cover the acquisition of scientific methods and comprise molecular genetic laboratory and/or modern phenotyping methods for agronomic traits. Depending on the individual project, different molecular techniques are applied (e.g. DNA extraction from plant material, PCR, DNA cloning and sequencing, analysis of molecular markers, gene expression analysis). We also offer topics related to drought stress in field or greenhouse experiments with a strong focus on application in crop plants, where physiological and agronomic traits are assessed. In projects with a focus on phenotyping, students will learn how to plan and conduct field or greenhouse experiments and how specific phenotypes are measured. During the project, the appropriate scientific analysis and interpretation of the data will be addressed, which includes e.g. statistical data analysis, mapping of genes/QTL, characterization of genes, literature work.

A list of current projects is available at www1.ls.tum.de/plantbreeding/. Upon agreement own topics can be suggested.

Intended Learning Outcomes:
In the research project "Molecular Plant Breeding" the students will learn to design experiments in the lab or greenhouse/field in individual case studies. They gain experience in planning and conducting the experiments, organizing the work and analyzing experimental data. Upon successful completion of the research project, students are able to scientifically analyze, interpret, discuss and present their obtained results in the context of current literature.

Teaching and Learning Methods:
Depending on the individual project, the students will gain and practice laboratory skills and/or knowledge on handling of plants in greenhouse/field experiments through hands-on lab practicals and/or hands-on phenotyping methods. Through instruction by their advisor, they will learn to define specific scientific questions related to their individual topic, to find solutions to solve these questions and to discuss the results. By preparing an oral presentation and a final written report, students learn how to adequately describe their experiments, how to structure the results and how to discuss the results in view of current literature.

Media:
Experimental studies related to current research projects, current literature

Reading List:
Project-specific current literature will be provided for each project.
General:
- Grotewold, Chappell and Kellogg: Plant Genes, Genomes and Genetics. Wiley-Blackwell, 2015. ISBN: 978-1-119-99887-7
- Brown: Genomes 4. Garland Science, 2017. ISBN 978-0-815-345084
- Abraham Blum: Plant Breeding for Water-limited Environments, Springer Science + Business Media S.A.; ISBN-10:1441974903

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Pflanzenzüchtung (Forschungspraktikum, 10 SWS)
Eggels S, Lin Y, Würstl L
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2012

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

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

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

Repeat Examination:
Next semester / End of Semester

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

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

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

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

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

Media:
Lab work, literature search, internet search.

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

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

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

Module Description

WZ2474: Research Project in Molecular Physiology | Forschungspraktikum Molekulare Physiologie

Version of module description: Gültig ab summerterm 2023

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

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

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

Regelmäßige Teilnahme während des Praktikums ist erforderlich. Eine schriftliche Zusammenfassung der praktischen Arbeit mit theoretischem Hintergrund dient der Überprüfung der im Praktikum erlernten Kompetenzen. Die Studierenden sollen das Erarbeitete in angemessener wissenschaftlicher Weise dokumentieren und das dabei erlernte Wissen zu strukturieren und in wesentlichen Aspekten darzustellen. Innerhalb der Arbeitsgruppe oder im institutsinternen Seminar wird über die Arbeit ein Vortrag gehalten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine Angabe

Content:
Zellisolierung, Zellkultur, Gewebekultur, Extraktion von NS und Proteinen, Transcriptomics, Expressionsanalytik (real-time RT-PCR), Proteinanalytik mittels EIA, Blot-Techniken, Nutzung von Datenbanken, Sequenzanalyse, Bioinformatik, Biostatistik, etc.

Intended Learning Outcomes:
Die Studierenden erlangen nach Teilnahme am Modul Fähigkeiten und Fertigkeiten für das molekularbiologische Arbeiten im Labor. Darüber hinaus erhalten Sie die Fähigkeit, die eigenen experimentellen Ergebnisse kritisch nach Varianzursachen zu hinterfragen. Sie

erlangen Kenntnisse über die korrekte Dokumentation der Ergebnisse. Im Vortrag sowie im Praktikumsbericht legen sie einen schriftlichen Bericht hierüber ab, der besonders klar aufzeigt, dass eine Strukturierung nach wissenschaftlichen Themen von der chronologischen Herangehensweise unterschieden werden muss.

Teaching and Learning Methods:
Lehrtechnik: Laborarbeit
Lehrmethode: Einzelarbeit, Experimente
Lernaktivitäten: Literaturrecherche, Durchführung von Experimenten, Kritische Beurteilung der Ergebnisse, Suche nach Varianzursachen, Zusammenfassung im schriftlichen und mündlichen Vortrag

Media:
Eigene Laborarbeit, Datenerfassung, Auswertung, Präsentationen mittels Powerpoint

Reading List:

Responsible for Module:
Zehn, Dietmar; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Physiologie, BiologieM (Forschungspraktikum, 10 SWS)
Zehn D, Pfaffl M

Forschungspraktikum Molekulare Physiologie, BiologieM (Forschungspraktikum, 10 SWS)
Zehn D, Pfaffl M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2545: Research Project Animal Biotechnology | Forschungspraktikum Biotechnologie der Tiere

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

Media:
Presentations using PowerPoint
Internship report

Reading List:
Project relevant literature

Responsible for Module:
Flisikowska, Tatiana; Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Tiere (Forschungspraktikum, 10 SWS)
Fischer K, Flisikowska T, Flisikowski K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2629: Research Project Chemical Genetics | Research Project Chemical Genetics

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology, biochemistry, genetics and chemistry. Practical experience with basic lab working techniques such as pipetting and working under sterile conditions. Successful completion of the lecture Plant Biotechnology.

Content:
Chemical Genetics is a novel interdisciplinary approach in which small molecules are used to identify proteins responsible for the expression of a specific phenotype (forward chemical genetics) or to affect the function of a specific protein and assess the morphological, physiological and molecular consequences within the organism (reverse chemical genetics). Chemical genetic

approaches are not only useful in basic research questions, they can also directly lead to the development of drugs and agrochemicals.
This module will teach students a subset of the following techniques by participating in a research project in the lab:
- Storage and handling of a chemical library;
- Design of a chemical genetic screen;
- Set up of a chemical genetic screen in conformity with the required quality standards;
- Phenotype-based small molecule screening in Arabidopsis thaliana
- Phenotype-based small molecule screening horticulturally relevant plant species;
- Expression marker-based small molecule screens;

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

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

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

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

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

Responsible for Module:
Sieberer, Tobias, Dr. nat. techn. tobias.sieberer@tum.de

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

Module Description

WZ2631: Research Project Molecular Ecology and Evolutionary Biology of Plants | Forschungspraktikum Molekulare Ökologie und Evolutionsbiologie der Pflanzen

Version of module description: Gültig ab summerterm 2013

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

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

Description of Examination Method:
By writing a written report on the research project, the students show that they are able to structure the data they have compiled themselves, present it convincingly and evaluate it methodically. In addition, the students give a lecture of about 20 minutes in which they show that they are able to summarize and present the results in a comprehensible way. They should show that they are able to connect questions from the auditorium to the theoretical context in a coherent way, both in terms of subject matter and content, and to convey them in a comprehensible manner. The module grade consists of the minutes (80%) and the presentation (20%)

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in genetics/botany/evolutionary biology

Content:
Participation in ongoing research projects or work on own molecular genetic topics.
Within the scope of practical activities, important and scientifically relevant working methods and methods of research in molecular ecology/molecular phylogenetics are taught.

Intended Learning Outcomes:
After attending the module course, students will have in-depth practical knowledge of working methods in molecular ecology or phylogenetics. They have learned to plan, set up and independently carry out a project, including scientific literature research. They have acquired the ability to work in a critical scientific manner, including data evaluation and presentation of results at scientific events.

Teaching and Learning Methods:
Focus on practical activities in the laboratory under supervision, followed by independent work with the learned methods and discussion of results

Media:
Practical exercises in the laboratory

Reading List:
Neis-Beeckmann, P. 2009. "Molecular Biology for Dummies: The Stuff That Life Is Made Of" -- Knoop, V. & Mueller, K. 2009. "Genes and Family Trees: A Handbook on Molecular Phylogenetics", 2nd ed. -- Hall, B.G., 2011. "Phylogenetic Trees Made Easy: A How-to Manual," 4th ed.

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

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

Module Description

WZ2687: Research Project Mapping Neural Circuits Underpinning Behavior | Forschungspraktikum Neuronale Netzwerke und Verhalten

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
The exam consists of a lab report and a digital lab book (labfolder). At the end of the practical period, the student will present their project during lab meeting in form of a ppt or similar presentation. In addition, participation in experimental work is expected.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
general principles and some practical experience in neurobiology, genetics, molecular biotechnology is expected

Content:
Depending on the aim of the research project, different methods and question will be in focus. For instance: • behavioral analysis in adult flies or larvae using videotracking, matlab analysis, optogenetics etc.
• histology of brain and/or gut, immunostainings, genetics with GAL4/UAS
• confocal microscopy
• Image analysis using ImageJ software
• single sensilla recordings and odor stimulation
• statistical analysis with GraphPad or R
• conceptual discussion and literature searches to understand and propose ideas, results, hypotheses

Intended Learning Outcomes:
upon successful participation students can
• use neurogenetics in the model system Drosophila (i.e. Drosophila chemosensation)

• analyze fly behavior with optogenetics, mutants, video analysis, ctraxx program
• interpret and develop the results and suggest further experiments
* carry out some simple electrophysiology and/or imaging experiments

Teaching and Learning Methods:
different methods such as neurogenetics with D. melanogaster, behavioral analysis, molecular biology, optogenetics, mutant analysis, imaging, electrophysiology will be used by the student.

Media:
databases (z.B. Pubmed); ePaper; Labfolder; direkte Interaktion mit Betreuer

Reading List:
papers, protocols etc. will be provided by the supervisor

Responsible for Module:
Ilona Grunwald Kadow grunwald@wzw.tum.de

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

Module Description

WZ9903: Practical Course "Organisms" | Forschungspraktikum "Organismen"

Version of module description: Gültig ab summerterm 2015

Module Level:	Language:	Duration:	Frequency:
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Moduls after consulting "Organisms" | Module nach Rücksprache "Organismen"

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Mit der erfolgreichen Ablage der Prüfungsteile weisen die Studierenden die Befähigung nach, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Das Manuskript zum Praktikum dient zur Vorbereitung für das Praktikum.

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

Gewichtung Laborleistung:Präsentation = 6:4.

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

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

Module Description

WZ0003: Internship Reproductive Biotechnology | Forschungspraktikum Biotechnologie der Reproduktion

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Internship Report/Presentation

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
B.Sc. Life Sciences; basic knowledge of molecular biology and immunology

Content:
During the internship the student will work on an independent sub-project in the field of reproductive biotechnology/immunology and learn different scientific methods. The subproject is integrated into a larger overall project. Depending on the project, techniques of molecular biology, cell biological, animal breeding and embryological methods will be learned. The student will expand his/her knowledge in the fields of embryology, stem cell biology, immunology and molecular biology.

Intended Learning Outcomes:
After participation in the module course students are able to apply molecular biological, cell biological, embryological and immunological methods and analyse data.

Teaching and Learning Methods:
Practice laboratory skills, prepare and give a presentation

Media:

Reading List:

Responsible for Module:
Benjamin Schusser benjamin.schusser@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie der Reproduktion (Forschungspraktikum, 10 SWS)
Schusser B [L], Bauer B, Schusser B, Sid H

Forschungsprojekt Biotechnologie der Reproduktion (Projekt, 5 SWS)
Schusser B [L], Schusser B, Sid H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0467: Practical Course on Experimental Genetics of Mammals | Forschungspraktikum Experimentelle Genetik der Säugetiere

Version of module description: Gültig ab winterterm 2009/10

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 260	**Self-study Hours:** 110	**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:
keine

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:
LaborProjektarbeit unter Anleitung, bei Bedarf Englisch

Media:

Reading List:

Responsible for Module:
Martin Habré de Angelis (hrabe@mytum.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

WZ1817: Research Project Molecular Fungal Genetics | Forschungspraktikum Molekulare Pilzgenetik

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Regular, active participation in the practical course is expected. The accomplishments in the lab will be graded, including the preparation and execution of the experiments, necessary calculations, the documentation and analysis in form of a lab journal (written report) as well as the interpretation of the results. The students demonstrate with the lab journal that they are able to correctly structure and reflect the critical aspects of their experiments. The accomplishments in the lab will be extended by a final oral presentation (30 min) of the research rationale & results to the other members of the group at the end of the lab course to test the communicative competences of the students.

Repeat Examination:
End of Semester

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

Content:
In the lab course (6-week laboratory internship, full-time), the students will participate in ongoing research projects of the group under supervision of experienced lab members. Foci will be the molecular biology, gene regulation and physiology of filamentous fungi. In particular the handling of model organisms, their molecular, physiological and biochemical characterization and modification will be conveyed. Independent literature research will be taught and performed to deepen the knowledge basis regarding the specific topics of interest.

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

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

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

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

Media:

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

Responsible for Module:
Benz, Johan Philipp, Prof. Dr. rer. nat. benz@hfm.tum.de

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

Module Description

WZ2378: Research Project on Molecular Microbial Biodiversity and Taxonomy | Forschungspraktikum Molekulare mikrobielle Diversität und Taxonomie

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	Language: German/English	Duration: one semester	Frequency: winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 20	**Contact Hours:** 280

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

Description of Examination Method:
pass/fail credit requirement: Regular attendance in the research laboratory is indispensable. Attendance times are determined by the experimental design to be carried out by the student and agreed with the supervisor. The students show through the design of experiments, the experimental performance of experiments and the evaluation that they have learned advanced experimental methods for microbial biodiversity and taxonomy. The graded step-by-step examination will be documented in the form of a scientific publication, which will also include relevant original literature. The experimental results of the research internship will be presented in an ungraded short lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Practical and theoretical knowledge in general microbiology and molecular genetics

Content:
The topic of the research package will be determined individually in consultation with the students and is part of a research project on microbial biodiversity and taxonomy currently being carried out at the chair. The following techniques can be taught, depending on the topic: Safe work with pathogenic bacteria; genome sequence analysis of bacteria (Illumina technology), culture-dependent biodiversity analysis based on Fourier transform infrared spectroscopy; culture-independent biodiversity analysis based on 16S rDNA; description of new bacterial species and genera.

Intended Learning Outcomes:
Competencies to be acquired refer to (i) experimental microbiological and molecular biological techniques, (ii) the correct keeping of a laboratory journal, (iii) the critical interpretation of one's own results including the known literature data and (iv) the presentation of research results in the form of a scientific publication. An essential learning outcome is the practice of microbiological work under the safety requirements of a pathogen laboratory.

Teaching and Learning Methods:
Teaching technique: practical training.
Teaching method: Individual teaching conversations, experiments.
Learning activities: Design of experiments, practising laboratory skills, working under time and responsibility pressure, keeping laboratory protocols, studying literature, summarising and discussing results in a research protocol, preparing and giving a presentation.

Media:
none

Reading List:
Individual depending on the research topic

Responsible for Module:
Siegfried Scherer Siegfried.Scherer@wzw.tum.de

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

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

Module Description

WZ2380: Research Project Plant Systems Biology | Forschungspraktikum Pflanzensystembiologie

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
Following this six week practical training, each participant writes a research report (20 - 30 pages) and presents(20 - 30 min.) his results at the progress report meeting of the department in German or English language. Besides scientific criteria also the graphic representation of the results figures following publication quality guidelines (Adobe Photoshop, Adobe Illustrator) will be paid attention to. The students can decide themselves on a date for handing in the report, to ensure that sufficient time is available for compiling it.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of plant biology, morphology and cell biology is recommended. Basic techniques for working in the molecular biology laboratory is strongly recommended such as clean pipetting.

Content:
The practical training teaches profound skills in one of the following techniques: (I) gene expression analysis (evaluation of microarray data, quantitative real time PCR, reporter gene analysis in intact organisms), (II) cell biology (confocal microscopy, analysis of different cell compartments using GFP-fusion proteins etc.) or (III) biochemistry (expression and purification of recombinant proteins from bacteria, functional assays). The participants are being introduced into current topics in molecular plant biology, that are being worked on in the department.

Intended Learning Outcomes:
Following participation in the practical course, students will have detailed practical and technical knowledge to answer systems biology problems in biology, specifically but not exclusively in plant biology.

Teaching and Learning Methods:
Form of studies/study techniques: Study of the lecture script, lecture comments and appropriate literature. Preparation of a written report with publication quality figures. Working with time pressure. Meeting deadlines.

Media:
Working with the handout. Basic skills in using one of the two softwares, Adobe Photoshop or Adobe Illustrator. Working independently on a fluorescence microscope or other state-of-the-art equipment.

Reading List:
Plant Physiology (Taiz/Zeiger) 5th edition. Molecular Biology of the Cell (Alberts).

Responsible for Module:
Schwechheimer, Claus; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum I, II, III und IV (PlaSysBiol PR I, II, III, IV) – M.Sc. (Forschungspraktikum, 10 SWS)
Schwechheimer C [L], Schwechheimer C, Hammes U, Denninger P, Graf A, Sala J, Schröder P, Zappone D
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab winterterm 2011/12

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

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

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

Repeat Examination:

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

Content:
Anleitung zum eigenständigen wissenschaftlich theoretischen und praktischen Arbeiten

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

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

Teaching and Learning Methods:
Zeigen von praktischem Arbeiten im Labor

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

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

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

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

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

Module Description

WZ2474: Research Project in Molecular Physiology | Forschungspraktikum Molekulare Physiologie

Version of module description: Gültig ab summerterm 2023

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

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

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

Regelmäßige Teilnahme während des Praktikums ist erforderlich. Eine schriftliche Zusammenfassung der praktischen Arbeit mit theoretischem Hintergrund dient der Überprüfung der im Praktikum erlernten Kompetenzen. Die Studierenden sollen das Erarbeitete in angemessener wissenschaftlicher Weise dokumentieren und das dabei erlernte Wissen zu strukturieren und in wesentlichen Aspekten darzustellen. Innerhalb der Arbeitsgruppe oder im institutsinternen Seminar wird über die Arbeit ein Vortrag gehalten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine Angabe

Content:
Zellisolierung, Zellkultur, Gewebekultur, Extraktion von NS und Proteinen, Transcriptomics, Expressionsanalytik (real-time RT-PCR), Proteinanalytik mittels EIA, Blot-Techniken, Nutzung von Datenbanken, Sequenzanalyse, Bioinformatik, Biostatistik, etc.

Intended Learning Outcomes:
Die Studierenden erlangen nach Teilnahme am Modul Fähigkeiten und Fertigkeiten für das molekularbiologische Arbeiten im Labor. Darüber hinaus erhalten Sie die Fähigkeit, die eigenen experimentellen Ergebnisse kritisch nach Varianzursachen zu hinterfragen. Sie

erlangen Kenntnisse über die korrekte Dokumentation der Ergebnisse. Im Vortrag sowie im Praktikumsbericht legen sie einen schriftlichen Bericht hierüber ab, der besonders klar aufzeigt, dass eine Strukturierung nach wissenschaftlichen Themen von der chronologischen Herangehensweise unterschieden werden muss.

Teaching and Learning Methods:
Lehrtechnik: Laborarbeit
Lehrmethode: Einzelarbeit, Experimente
Lernaktivitäten: Literaturrecherche, Durchführung von Experimenten, Kritische Beurteilung der Ergebnisse, Suche nach Varianzursachen, Zusammenfassung im schriftlichen und mündlichen Vortrag

Media:
Eigene Laborarbeit, Datenerfassung, Auswertung, Präsentationen mittels Powerpoint

Reading List:

Responsible for Module:
Zehn, Dietmar; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Physiologie, BiologieM (Forschungspraktikum, 10 SWS)
Zehn D, Pfaffl M

Forschungspraktikum Molekulare Physiologie, BiologieM (Forschungspraktikum, 10 SWS)
Zehn D, Pfaffl M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2517: Research Project Plant Developmental Genetics 1 | Forschungspraktikum Entwicklungsgenetik der Pflanzen 1

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The students work experimentally in the laboratory under supervision. Common techniques of plant developmental genetics are applied in practice (e.g. crosses, cloning, PCR, etc) and documented in a protocol booklet. The students also work out the scientific background of the experiments to be carried out. They therefore regularly participate in the seminars of the working group. The results are presented and discussed in a short lecture (20 min).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of genetics and molecular and cell biology is required.

Content:
The students work experimentally in the laboratory as members of a working group consisting of the group leader, PhD students and postdocs, technical staff and, if necessary, students. Under supervision a task from the field of plant developmental genetics formulated at the beginning is worked on. A laboratory record must be kept of the experimental plan, the work performed and the results obtained. At the end, the students prepare 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. They take part in the regular seminars of the working group.

Intended Learning Outcomes:
After completing the laboratory internship, the students are able to perform basic experimental techniques in the field of plant developmental genetics and cell biology. They have gained basic experience in the recording and presentation of scientific results.

Teaching and Learning Methods:
Personal supervision of the 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:
Original literature and review articles.

Responsible for Module:
Schneitz, Kay Heinrich, Prof. Dr. kay.schneitz@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Entwicklungsgenetik der Pflanzen 1 (Forschungspraktikum, 10 SWS)
Schneitz K, Boikine R, Freifrau von Thielmann A, Lesniewska B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2629: Research Project Chemical Genetics | Research Project Chemical Genetics

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in plant molecular biology, biochemistry, genetics and chemistry. Practical experience with basic lab working techniques such as pipetting and working under sterile conditions. Successful completion of the lecture Plant Biotechnology.

Content:
Chemical Genetics is a novel interdisciplinary approach in which small molecules are used to identify proteins responsible for the expression of a specific phenotype (forward chemical genetics) or to affect the function of a specific protein and assess the morphological, physiological and molecular consequences within the organism (reverse chemical genetics). Chemical genetic

approaches are not only useful in basic research questions, they can also directly lead to the development of drugs and agrochemicals.
This module will teach students a subset of the following techniques by participating in a research project in the lab:
- Storage and handling of a chemical library;
- Design of a chemical genetic screen;
- Set up of a chemical genetic screen in conformity with the required quality standards;
- Phenotype-based small molecule screening in Arabidopsis thaliana
- Phenotype-based small molecule screening horticulturally relevant plant species;
- Expression marker-based small molecule screens;

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

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

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

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

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

Responsible for Module:
Sieberer, Tobias, Dr. nat. techn. tobias.sieberer@tum.de

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

Module Description

WZ2630: Research Project Plant Growth Regulation | Forschungspraktikum Wachstumsregulation der Pflanzen

Version of module description: Gültig ab summerterm 2015

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 108	**Contact Hours:** 192

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

Description of Examination Method:
Following the regular and active participation in a six week practical course (at least 32 hours/ week) the students hand in a research report. By preparing the written report the students demonstrate the ability to summarize the key aims of the performed experiments in the field of plant growth regulation, to present the acquired results in a concice and coherent manner and to interpret and discuss the experimental data in the context of available literature.
The grading will be also based on the level of active participation and experimental/ intellectual skills during the lab work. The final grade is an averaged grade from the written report (60%) and the level of of in-course participation (40%).

Repeat Examination:

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

Content:
As primary resource of biomass plants grow by continuous formation of modular organs. The net growth is the result of different growth parameters including the rate of organ formation, the size of the single organs and the overall amount of formed organs. Moreover it is strongly dependent on environmental conditions (nutrients, water, light and temperature) and the germplasm (constitution of limiting genetic factors and overall genome structure). Plant growth optimization is thus multifactorially conditioned process and strongly dependent on the specific utilization of the crop.

The present research project deals with the molecular characterization of genetic factors which act limiting on the different growth parameters mentioned above. Using modern genetic, chemical genetic and molecular biological approaches known and novel important yield affecting loci are identified and positioned in the established regulatory network.

Intended Learning Outcomes:
Upon completion of this module students are able to understand and assess methods and aims to optimize plant growth of different crop species particularly in characterizing regulatory pathways affecting leaf formation rate, elongation growth and architecture of shoots. They are capable of independently carrying out lab-based experiments with methods of molecular biology, biochemistry, plant physiology and/or genetics and can interpret the results. The module aims to prepare students for a master thesis in the respective research field.

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

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

Reading List:
Plant Physiology and Development (2014) L. Taiz and E. Zeiger, Sinauer Associates Inc.,U.S.; Plant Biotechnology and Agriculture: Prospects for the 21st Century (2011) A. Altman and P. M.Hasegawa, Academic Press.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Wachstumsregulation der Pflanzen (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Sieberer T, Andrade Galan P, Ramirez V, Yang S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2761: Molecular genetics of Plant-Microbe Symbiosis 1 | Forschungspraktikum Molekulare Genetik der Pflanzen-Mikrobien Symbiose 1

Version of module description: Gültig ab winterterm 2017/18

Module Level: Bachelor	**Language:**	**Duration:**	**Frequency:**
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

Responsible for Module:
Caroline Gutjahr, Prof. Dr. caroline.gutjahr@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project - Molecular genetics of plant-microbe symbiosis 1b (Forschungspraktikum, 10 SWS)
Gutjahr C

Research Project - Molecular genetics of plant-microbe symbiosis 1c (Forschungspraktikum, 10 SWS)
Gutjahr C

Research Project - Molecular genetics of plant-microbe symbiosis 1a (Forschungspraktikum, 10 SWS)
Gutjahr C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1185: Plant Epigenetics and Epigenomics | Plant Epigenetics and Epigenomics

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
The examination consists of a presentation (20 min) followed by discussion (10 min). The presentation should summarize and interpret the results obtained from analyzing published epigenomic datasets using the computational skills aquired during the Computer Practical sessions. The presentation is a means to measure the student's ability to understand a technical/ scientific subject, to analyze and evaluate facts and factors of influence, to summarize the subject and present it to an audience, and to conduct a discussion about the presented subject

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of genetics, cell biology, statistics

Content:
The course will cover:
- Components and functions of the plant epigenome: DNA methylation, histone modifications
- Measuring epigenomes: array-based and NGS based bulk and single cell technologies
- Analyzing plant epigenomic data: Array and NGS based computational tools for bulk and single cells
- Plant epigenome and environmental variation
- Plant epigenome and genetic variation
- Epigenetic inheritance in plants: Mitotic and meiotic inheritance
- Current perspectives on the agricultural and evolutionary implications of epigenetic inheritance in pl

Intended Learning Outcomes:
Students will be able to:
- Interpret the molecular components of epigenomes
- Interpret functions of epigenomes
- Identify the sources of population level epigenomic variation
- Explain modern measurement technologies
- Distinguish the conceptual background of different computational tools
- Apply computational tools to epigenomic data
- Analyze the implications of epigenetic and epigenomics
- Carry out presentation skills

Teaching and Learning Methods:
The following teaching methods will be used:
- Lectures: The goal of the lectures is to provide an in-depth overview of the main concepts, approaches and research questions in plant epigenetics and epigenomics.

- Computer tutorial: The goal of the computer tutorials is to reinforce the lecture contents with hands-on experience. The main aims are: 1) to get hands-on experience with the type of epigenomic datasets that is routinely generated in this field; 2) to get hands-on experience with software tools for the analysis of epigenomic datasets; 3) to be able to evaluate the output from these software tools, and to use the output as a way to answer concrete biological research questions.

- Seminars: The goal of the seminars is to discuss recent scientific literature in plant epigenetic and epigenomics . The aim is to demonstrate how the concepts, approaches and research questions presented in the course provide a means to decode complex scientific articles in this field.

Media:
PowerPoint presentations, software practicals

Reading List:
Hand-outs

Responsible for Module:
Johannes, Frank; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Plant Epigenetics and Epigenomics (Vorlesung, 3 SWS)
Johannes F

Plant Epigenetics and Epigenomics - Computer Practical (Praktikum, 2 SWS)
Piecyk R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1818: Fungal Genetics Exercise | Pilzgenetische Übung

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
Regular, active participation in the practical course is expected. In the course of the exercise, data are gathered that will be used to write a final course result protocol. The students demonstrate by writing this 10-25-page course journal that they are able to correctly structure and reflect the critical aspects of their experiments. In the course journal, also aspects such as activity/productivity, creativity and independence during the course work will be evaluated and will be part of the final grade.

Repeat Examination:

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

Content:
During the theoretical part of the exercise, the course content will be taught individually and in group settings. In particular aspects such as: General developmental and cell biology of filamentous fungi; Relevance of fungi in basic and applied science; Fungi as pathogens of man, animals and plants.
During the practical part of the exercise, the focus will be on the following topics: Molecular manipulation of filamentous fungi; Cloning of transformation constructs and fungal transfection; Analysis of resulting progeny by fluorescent microscopy; Employing classical genetics techniques in crossings; Characterization of a series of unknown metabolic mutants by physiological and biochemical assays; Sugar analytic by HPAEC-PAD.

Intended Learning Outcomes:
Upon completion of the module, students will have gained basic knowlegde regarding the biology of filamentous fungi and their relevance for basic and applied science. The students will furthermore have understood how to approach scientific questions (educated experimental planning, execution, analysis and interpretation). They will have learned how to apply molecular and genetic techniques using filamentous fungi to manipulate model organisms towards the elucidation of the functioning of eukaryotic cells. These techniques are also the basic concept for current biotechnological and industrial applications.

Teaching and Learning Methods:
In this exercise, which consists of a theoretical and a practical part, lab-technical skills will be acquired and practised in group settings by way of practical teaching methods, such as experiments. These skills include: Dealing with scientific questions and solution finding by experimental approaches, and constructive discussion and critical reflection of own experiments.

Media:
Course script and Powerpoint slides

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Pilzgenetische Übung (Übung, 5 SWS)
Benz J [L], Benz J, Karl T, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1577: Research Project 'Biotechnology of Horticultural Crops' | Research Project 'Biotechnology of Horticultural Crops'

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
The students conduct a six-week research project in the lab. The work-schedule can be adjusted to the curriculum of the students. After the practical work, a report (approximately 15 to 20 pages) has to be prepared and handed in usually within 4 weeks after the laboratory work has been concluded. By preparing a report the students demonstrate the ability to summarise 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 of the report is based on the accuracy and correctness of the results (50%) and the quality of presentation and evaluation of the data (50%), particularly 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 development. Practical experience with basic lab working techniques such as pipetting and working under sterile conditions. Successful completion of the lecture(s) Crop Biotechnology and/or Plant Biotechnology.

Content:
The students work on a research project in the lab on one of the following topics:
a) plant hormone signalling
b) impact of environmental cues on plant growth and development
c) heterologous expression of plant proteins
Methods and techniques applied in the framework of the course will depend on the individual project and may include: cloning, plant transformation, PCR, qPCR, Western blot analysis, protein

expression and purification, assays for enzymatic activity, EMSA, chromatin IP, fluorescence and electron microscopy, phenotypic characterisation of plants, cold or heat stress assays, ion leakage assays, dose response assays and quantification of metabolites and nutrients by chromatographic and spectroscopic techniques. Statistical methods are applied for data evaluation. Many of these techniques are applicable to other (non-plant) organisms.

Intended Learning Outcomes:
Upon completion of this module students:
- have acquired competence in several laboratory techniques related to biotechnology in horticultural crops including cloning of genes, heterologous expression of plant proteins and generation and analysis of transgenic plants
- can perform experiments in an efficient, time saving manner
- can evaluate data and apply statistical tests
- are able to design experiments with all necessary controls and interpret the results
- have increased their competence in scientific reading and writing
- can display scientific data in publication quality

Teaching and Learning Methods:
Close theoretical and practical supervision combined with autonomous lab work. Reading original research articles. Reading and application of laboratory protocols. Discussion of the protocols and the underlying principles of the experiments. Writing of a laboratory book. Written documentation of the experiments and results.

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

Reading List:
The literature depends on the individual project and will be provided ahead of the course.

Responsible for Module:
Rozhon, Wilfried; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Biotechnologie gartenbaulicher Kulturen (Forschungspraktikum, 10 SWS)
Poppenberger-Sieberer B, Dündar G, Sieberer T
For further information in this module, please click campus.tum.de or here.

Medicine | Medizin

Module Description

WZ2750: Course block: Neurobiology of isolated tissue | Blockpraktikum: Neurobiologie am isolierten Gewebe

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
The module-related examinations will be a scientific report in which the students should explain the theoretical background and the applied techniques. Furthermore, they shall show that they are able to plan, conduct and evaluate experiments using scientific standards and rules.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in physiology and neurobiology are required. Prior attending of the lectures 'Human and animal physiology', 'Neurobiology' and 'Sensory physiology' is recommended.

Content:
4 weeks intracellular labelling of neurons in chicken brain slices, 1 week whole-cell patch-clamp, 1 week optical imaging

Intended Learning Outcomes:
Upon completion of the module, students are able: a) to discuss the theoretical background for the conducted experiments, b) to evaluate different electrophysiological techniques for their usefulness in experiments with isolated tissue, c) to conduct electrophysiological in vitro experiments. This includes preparing the tissues, different methods for the analysis of neural networks (single cell recordings, optical imaging, tracing) and histological processing. Furthermore, students will know different methods for data analysis, statistics and graphical presentation of results.

Teaching and Learning Methods:
Laboratory

Media:
study of specialist literature, practice laboratory skills

Reading List:
'Neuroscience: Exploring the brain'; specialist literature will be provided during tha course.

Responsible for Module:
Prof. Dr. Harald Luksch

Courses (Type of course, Weekly hours per semester), Instructor:
Blockpraktikum: Neurobiologie am isolierten Gewebe (Praktikum, 16 SWS)
Weigel S [L], Weigel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2753: Course block: Neurobiology of intact animals | Blockpraktikum: Neurobiologie am intakten Organismus

Version of module description: Gültig ab summerterm 2016

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

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

Description of Examination Method:
The module-related examinations will be a scientific report in which the students should explain the theoretical background and the applied techniques. Furthermore, they shall proof that they are able to plan, conduct and evaluate experiments using scientific standards and rules.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in physiology and neurobiology are required. Prior attending of the lectures 'Human and animal physiology', 'Neurobiology' and 'Sensory physiology' is recommended.

Content:
3 weeks extracellular recordings of neurons in the auditory midbrain (IC) of mice, generation of acoustic stimuli and data analysis with Matlab®. At the beginning of the course students will have to present a short talk on a topic relevant for neuronal processing of sound.

Intended Learning Outcomes:
Upon completion of the module, students are able: a) to apply (under supervision) basis techniques for electrophysiological recordings in in-vivo preparation of the mouse and chicken.
b) Furthermore, students will know different methods for data analysis, statistics and methods of stimulus generation for auditory and visual neuroscience experiments with Matlab®.

Teaching and Learning Methods:
Laboratory

Media:
study of specialist literature, practice laboratory skills

Reading List:
Neuroscience: Exploring the brain'; specialist literature will be provided during tha course.

Responsible for Module:
PD Dr Uwe Firzlaff, Prof. Harald Luksch

Courses (Type of course, Weekly hours per semester), Instructor:
Blockpraktikum: Neurobiologie am intakten Organismus (Praktikum, 8 SWS)
Firzlaff U [L], Firzlaff U
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
The internship is of continuous assessment therefore attendance is compulsory throughout. A lab book must be written to demonstrate their understanding for and the ability to describe, evaluate and interpret the practical experiments. The achievement of the learning objective should be documented by preparing an internship report in the form of a small scientific work (about 10 pages) and an oral presentation. The final grade is an averaged score from the marks of the motivation (15%), the practical work (50%), the oral presentation (15%) and the internship report (20%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modul WZ2413: Vertiefende Pharmakologie für Studierende der Biowissenschaften (Master)

Content:
Molecular and cellular mechanisms of cardiac insufficiency, leading to innovative therapies for cardiovascular disease.
Main focuses:
• Development of tissue-specific viral systems for the manipulation of non-coding RNAs.
• Cardiomyocyte reprogrammed stem cells from patients as cardiac disease models in vitro.
• Examination of the non-coding transcriptome in non-myocytic cells of the myocardium.
• Characterization of IncRNAs and circRNAs in disease context.
• Characterization of adrenoceptor variance and secreted factors that facilitate cell-to-cell communication in the myocardium.

Intended Learning Outcomes:
After the successful participation in the research internship, students are able to carry out experimental methods concerning cardiovascular basic research. They have learned to perform sterile techniques and apply new techniques in molecular biology. In addition, they are able to handle either fluorophore-assisted confocal microscopy,2-photon-microscopy, FACS, viral vector systems or electrophysiological recordings and to evaluate the results. Finally, the students will know how to create, perform and implement a scientific paper.

Teaching and Learning Methods:
Teaching Technology: lab intership
Learning Activities:
• Practice of technical and laboratory skills
• Editing problems and finding solutions
• Work with other students
• Preparation and implementation of presentations
• Production of reports
Teaching Methods
• experimental work
• Individual / group work
• Presentation
During the intership, the necessary knowledge is acquired by practicing technical and laboratory skills and editing problems and finding solutions through mediation of the Department faculty members and staff. The work will be carried out alone or in groups. Students are encouraged to substantively discuss the issues and learn how to prepare and implement presentations and scientific reports by visiting the Department's own seminars and under the guidance of Department staff members.

Media:

Reading List:

Responsible for Module:
Engelhardt, Stefan; Prof. Dr.med.

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

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

Module Description

ME2436: Research Project Molecular Oncology | Forschungspraktikum Molekulare Onkologie

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
Duration of the examination (in min.): Minutes as academic achievement + 30 oral.
The ability to present and interpret the experiments carried out during the practical training is tested in the form of a presentation in the supervising lecturer's working group (30 min, graded, 25%). The experiments must also be documented and discussed in the form of a protocol. The protocol serves to check the ability to describe, evaluate and interpret the experiments performed in the practical course (15-25 pages, 75% graded) according to the IMRAD structure of a scientific publication (introduction, Mat&Meth, results, discussion).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The attendance of the module "Molecular Oncology" is required.

Content:
The internship will be carried out in the research group of Prof. Dr. rer. nat. Achim Krüger at the Klinikum rechts der Isar of the TUM, Institute for Experimental Oncology and Therapy Research. The tasks for the internship are based on the current research focus.
The experiments may include current and new molecular (e.g. DNA cloning, vector construction) and cell biological (e.g. transfection and infection of mammalian cells) and biochemical (RNA and protein purification and analysis) methods as well as specific techniques in tumor biology (e.g. proliferation, migration, invasion assays, immunohistochemistry).

Intended Learning Outcomes:
After successful completion of the module, students possess basic experimental knowledge and are able to independently apply modern working techniques in biochemistry, molecular biology,

histology, cell culture, transcriptomics and proteomics. By working in the laboratory in a current field of molecular oncology, current research topics are understood and solutions to problems are developed independently. The skills and techniques learned can be easily transferred to other areas of expertise.

After completing the module, students will know the specific requirements for the preparation of a protocol in molecular oncology. They can carry out experiments, apply the methods learned, collect and evaluate data and present them in a lecture.

Teaching and Learning Methods:
Event type/teaching technique: Practical training; teaching methods in practical training: instructional talks and instructions, demonstrations, experiments, discussion of results, group meetings, technical literature, lecture, preparation of minutes

Media:
Lecture: Presentations using PowerPoint
Protocol: Text as Word file, graphics as Excel or PowerPoint files

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

Responsible for Module:
Achim Krüger achim.krueger@lrz.tu-muenchen.de

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

Module Description

ME60855: Research Project viral gene transfer | Forschungspraktikum Viraler Gentransfer

Version of module description: Gültig ab summerterm 2022

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

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

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

Repeat Examination:

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

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

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

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

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

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

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

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

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

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

Module Description

WZ0463: Practical Course in Neurogenetics | Forschungspraktikum Neurogenetik

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
A written report (graded) is used to check the theoretical skills learnt. In the report, the students show whether they are able to write scientifically and present the essential aspects of their research internship. The report grade constitutes 50% of the module's overall grade, with 50% being the student's practical work. This includes activities that are necessary for the creation and analysis of mouse models for neuropsychiatric diseases, depending on the chosen field, e.g. performing PCR analyses, various behavioural tests, histochemical staining, etc.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's degree. Theoretical knowledge in genetics is required.

Content:
Participation in current research projects in the field of Neurogenetics
(Development of the central nervous system, pathoetiology of diseases of the central nervous system)

Intended Learning Outcomes:
Student obtain knowledge about design, running and analysing of research projects in the field of Neurogenetics in the lab.

Teaching and Learning Methods:
Internship Teaching method: during the internship instructional talks, demonstrations, experiments, partner work, discussion of results.

Learning activities: practical course script and literature; practicing laboratory skills and genetic work techniques; cooperation with practical course partners; preparation of protocols.

Media:
Lab 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 daniela.vogt@helmholtz-muenchen.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Neurogenetik (Forschungspraktikum, 16 SWS)
Wurst W, Deussing J, 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

WZ2249: Practical Course in Molecular Nutritional Medicine | Forschungspraktikum Molekulare Ernährungsmedizin

Version of module description: Gültig ab summerterm 2014

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship (Forschungspraktikum) (Forschungspraktikum, 20 SWS)
Klingenspor M
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

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

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

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

Media:

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

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

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

Forschungspraktikum Ernährung und Immunologie (Forschungspraktikum, 16 SWS)
Haller D [L], Haller D, Aguanno D, Coleman O, Krammel T, Metwaly A, Ocvirk S, Omer H, Rath E, Schmöller I, Schwamberger S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2428: Research Internship Molecular Cell Biology of Tumorigenesis | Forschungspraktikum Molekulare Zellbiologie der Tumorentstehung

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
Time allowed (in min.): 20 min (oral test).
The students present the methods applied as well as the results achieved in the course of the internship in the form of a lecture in the working group seminar (20 min, graded). The experiments, their evaluation and interpretation will also be documented and discussed in written minutes, following the basic structure of a scientific article (10-20 pages, graded). The final grade is made up equally of the sub-grades for the lecture, the practical work and the practical training protocol (1:1:1).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Visit of the module "Molecular cell biology of tumorigenesis

Content:
The content of the research lab is based on the two lectures of the module "Molecular Cell Biology of Tumor Development": the development and progression of tumors is taught on a molecular genetic, biochemical and cell biological basis. Current laboratory methods from biochemistry, molecular biology, mouse genetics, tumor immunology and cell culture technology are learned and, as far as possible within the framework of the practical course, applied independently. Evaluation (including standard statistical methods) and critical interpretation of the experiments form a further part of the practical course.

Intended Learning Outcomes:
By participating in the module, students are able to perform basic cell biological, biochemical, molecular biological experimental procedures that are currently used in experimental cancer

research. In addition to practical experimental knowledge, students are also able to plan experiments in a meaningful way, to evaluate them independently and to interpret them critically. In addition, the presentation and communication of research results is learned and deepened through the practical lecture and the practical protocol.

Teaching and Learning Methods:
Form of event / teaching technique: Instructional talks and instructions, demonstrations, experiments, discussion of results, presentation of the results in the group, critical reading of English-language specialist literature, lecture, preparation of minutes.

Media:
Presentations via Powerpoint

Reading List:
There is no textbook available that covers all contents of this module. Current technical literature will be handed out by the supervisor depending on the topic of the internship. The following is recommended as a basis or supplement: 1) Biology of Cancer, Robert Weinberg, Garland Science 2006; ISBN: 0815340761
2) Textbook on Molecular Cell Biology, Alberts et al., Wiley VCH, 2007 ISBN: 3527311602
3) The Mouse in biomedical research. James G. Fox (Ed.). Academic Press, 2007. ISBN: 9780123694546
4) Mouse Models of Human Cancer. Eric C. Holland (Editor), Wiley-VCH, 2004. ISBN: 978-0-471-44460-2

Responsible for Module:
Klaus-Peter Janssen klaus-peter.janssen@lrz.tum.de

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

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

Module Description

WZ2454: Research Internship Molecular Pathology and organ-specific Carcinogenesis | Forschungspraktikum Molekulare Pathologie und organspezifische Karzinogenese

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
Duration of the examination (in min.): Protocol as study achievement + 30 min presentation.
The ability to present and interpret the experiments carried out during the practical training is tested in the form of a presentation in the supervising lecturer's working group (30 min, ungraded). The experiments must also be documented and discussed in the form of a protocol. The protocol serves to check the ability to describe, evaluate and interpret the experiments carried out during the practical training (10-20 pages, graded). The overall mark for the module consists of 20% lecture and 80% protocol.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Attendance of the module "Molecular pathology and organ-specific carcinogenesis" is required.

Content:
The internship is carried out in the working group of a lecturer participating in the lectures "Molecular Pathology" or "Organ-Specific Molecular Carcinogenesis" at the Institute of Pathology of the Technische Universität München or at the Institutes of Pathology or Radiobiology of Helmholtz Zentrum München in Neuherberg. The tasks for the internship are based on the current research focus of the lecturers and take up a partial aspect of the lectures. Basic techniques of molecular pathology and molecular biology are used in the experiments.

Intended Learning Outcomes:
In the practical training basic experimental knowledge and modern working techniques are taught. By working in the laboratory in a current field of molecular pathology or organ-specific

carcinogenesis, the students are able to understand current research topics and develop solutions to problems independently. The skills and techniques learned can also be transferred to other fields.

Teaching and Learning Methods:
Event type/teaching technique: Practical training; teaching methods in practical training: instructional talks and instructions, demonstrations, experiments, discussion of results, group meetings, technical literature, lecture, preparation of minutes

Media:
Lecture: Presentations using PowerPoint
Protocol: Text as Word file, graphics as Excel or PowerPoint files

Reading List:
Current literature provided by the supervisor of the internship

Responsible for Module:
Birgit Luber luber@lrz.tum.de

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

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

Module Description

WZ2464: Research Project Neurobiology of Isolated Networks | Forschungspraktikum Neuronale Netzwerkanalyse

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
Regelmäßige, aktive Teilnahme ist erforderlich. Die Studierenden werden sich anhand von Eigenrecherche mit geeigneter Literatur auf die jeweils untersuchten Aspekte der visuellen und multimodalen Verarbeitung vorbereiten; die Studierenden werden in die Lage versetzt, in Übereinstimmung mit heute gültigen wissenschaftlichen Standards Versuche zu planen, durchzuführen und auszuwerten. Im Anschluß an das Praktikum wird der Kompetenzzuwachs in Form eines Protokolls schriftlich abgeprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Physiologie und Neurobiologie auf dem Niveau der Vorlesung "Neurobiologie" sind nötig. Der vorherige Besuch dieser Vorlesung wird empfohlen.

Content:
In dem Praktikum werden wissenschaftliche Vorgehensweisen zur Analyse neuronaler Netzwerke am Beispiel von in vitro Präparationen des Hühnerhirns theoretisch und praktisch vorgestellt. Dies beinhaltet elektrophysiologische Versuche an Nervenzellen in Hirnschnitten. Die Studenten werden nach einer Einarbeitungszeit die Versuche selbständig durchführen, auswerten und die Ergebnisse präsentieren.

Intended Learning Outcomes:
Ziel ist das Erlernen von Techniken zur Durchführung elektrophysiologischer Versuche an in vitro Präparaten. Dies beinhaltet die Herstellung von in vitro Präparaten, Techniken zur Analyse neuronaler Netzwerke (z.B. Einzelzellableitung, Optical Imaging, Tracing) sowie histologische

Aufbereitungen. Darüber hinaus werden Auswertmethoden, statistische Methoden und die grafische Darstellung von Ergebnissen erlernt.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborlehre
Lehrmethode: Fragend-entwickelnde Methode,Einzelarbeit, praktische Demonstrationen, eigenständige Labortätigkeit, Experiment. Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Bearbeiten von Problemen und deren Lösungsfindung, Üben von labortechnischen Fertigkeiten, Produktion von wissenschaftlichen Berichten..

Media:
Ein Skript zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte).

Reading List:
Als grundlegendes Lehrbuch wird "Neuroscience: Exploring the brain" von Baer empfohlen. Spezialliteratur steht dem Studenten im Labor zur Verfügung.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Neuronale Netzwerkanalyse (Forschungspraktikum, 10 SWS)
Luksch H, Weigel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2477: Research Project Molecular Virology | Forschungspraktikum Molekulare Virologie

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	Language: German/English	Duration: one semester	Frequency: winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 100	**Contact Hours:** 200

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

Description of Examination Method:
The student works experimentally in the laboratory as a member of a working group consisting of the group leader, PhD students and postdocs, technical staff and students, if applicable. He/she works under supervision on a task from the field of virology formulated for him/her at the beginning. He/she will keep a laboratory record of the experimental plan, the work performed and the results obtained. At the end the student prepares a protocol (graded), in which he/she demonstrates that he/she is able to describe the materials and methods, describe and summarize the results obtained and discuss them briefly in comparison with the relevant literature, in which the topic is introduced, the methods and materials are described, the results are presented and briefly discussed in comparison with relevant literature. He/she will participate in the regular seminars of the working group.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Knowledge of molecular biology is required. Basic knowledge in cell biology, immunology and virology is recommended.

Content:
The student works experimentally in the laboratory as a member of a working group consisting of the group leader, PhD students and postdocs, technical staff and students, if applicable. He/she works under supervision on a task from the field of virology formulated for him/her at the beginning. He/she will keep a laboratory record of the experimental plan, the work performed and the results obtained. At the end, the student prepares a protocol in which the topic is introduced, the methods and materials are described, the results are reproduced and briefly discussed in comparison with relevant literature. She/he participates in the regular seminars of the working group.

Intended Learning Outcomes:
After completing the laboratory internship, the student will be able to perform basic experimental techniques in the fields of virology, microbiology and cell biology. She/he has gained first experiences in protocol taking and presentation of scientific results.

Teaching and Learning Methods:
Direct, personal instruction for practical work in the laboratory. Private study of literature.

Media:
Internship, discussion in the working group, own oral presentation, transcript of the elaborated results in form of a short scientific paper (protocol)

Reading List:
Depending on topic, original literature and review articles

Responsible for Module:
Ulrike Prof. Dr. Protzer (protzer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Virologie (Praktikum, 2,5 SWS)
Protzer U, Bauer T, Ebert G, Pichlmair A, Vincendeau M
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

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

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

Repeat Examination:
Next semester / End of Semester

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

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

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

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

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

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

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

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

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

Module Description

WZ2687: Research Project Mapping Neural Circuits Underpinning Behavior | Forschungspraktikum Neuronale Netzwerke und Verhalten

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
The exam consists of a lab report and a digital lab book (labfolder). At the end of the practical period, the student will present their project during lab meeting in form of a ppt or similar presentation. In addition, participation in experimental work is expected.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
general principles and some practical experience in neurobiology, genetics, molecular biotechnology is expected

Content:
Depending on the aim of the research project, different methods and question will be in focus. For instance: • behavioral analysis in adult flies or larvae using videotracking, matlab analysis, optogenetics etc.
• histology of brain and/or gut, immunostainings, genetics with GAL4/UAS
• confocal microscopy
• Image analysis using ImageJ software
• single sensilla recordings and odor stimulation
• statistical analysis with GraphPad or R
• conceptual discussion and literature searches to understand and propose ideas, results, hypotheses

Intended Learning Outcomes:
upon successful participation students can
• use neurogenetics in the model system Drosophila (i.e. Drosophila chemosensation)

• analyze fly behavior with optogenetics, mutants, video analysis, ctraxx program
• interpret and develop the results and suggest further experiments
* carry out some simple electrophysiology and/or imaging experiments

Teaching and Learning Methods:
different methods such as neurogenetics with D. melanogaster, behavioral analysis, molecular biology, optogenetics, mutant analysis, imaging, electrophysiology will be used by the student.

Media:
databases (z.B. Pubmed); ePaper; Labfolder; direkte Interaktion mit Betreuer

Reading List:
papers, protocols etc. will be provided by the supervisor

Responsible for Module:
Ilona Grunwald Kadow grunwald@wzw.tum.de

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

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

Module Description

WZ2412: Immunology Research Internship | Forschungspraktikum Immunologie

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
The practical work of the students is graded. The application of the techniques, the laboratory working methods and the keeping of a laboratory journal are evaluated. The understanding of experimental questions and methods from basic immunological research as well as the ability to process scientific data will be assessed by the students by writing a protocol (graded). The overall mark of the laboratory performance is composed of the two individual marks (mark practical work + mark internship protocol) in equal parts.

Repeat Examination:
Next semester / End of Semester

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

Content:
This research internship is a work on a current project in one of the institute's research groups. The projects at the Institute represent basic immunological research in humans and mice with the aim of a greater understanding of immune responses against pathogens or misdirected immune responses in case of allergy and autoimmunity. With the help of the basic knowledge of immunology acquired in the module 'Immunology 1', specific scientific problems in this environment shall be analysed and evaluated in order to develop own solutions. During the internship the students are involved in the general seminars of the institute and the corresponding research group.

Intended Learning Outcomes:
After completion of this module, students are able to independently develop and perform experimental approaches for the investigation of selective immunological questions. Based on

the basic knowledge of immunology acquired in the module 'Immunology 1' they are able to understand and analyse specific scientific problems, plan experimental approaches and carry out the experiments independently.

Teaching and Learning Methods:
The module consists of a research internship in one of the Institute's working groups. The students work on a smaller research project. The immunological and other working methods to be applied for the project are taught by responsible supervisors. To fully understand the scientific background, students are encouraged to study original scientific papers.

Media:

Reading List:
original scientific papers

Responsible for Module:
Dirk Busch dirk.busch@mikrobio.med.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Immunologie (Praktikum, 10 SWS)
Buchholz V, Busch D, Gerhard M, Mejias Luque R, Prazeres da Costa C, Schumann K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ9904: Practical Course "Medicine" | Forschungspraktikum "Medizin"

Version of module description: Gültig ab summerterm 2015

Module Level:	Language:	Duration:	Frequency:
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

ME2624-2: Classical and Molecular Virology Course | Praktikum der klassischen und molekularen Virologie

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 8	**Total Hours:** 240	**Self-study Hours:** 120	**Contact Hours:** 120

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

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

Repeat Examination:

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

Content:
Die Studierenden lernen die grundlegenden Techniken der klassischen und molekularen Virologie in der Praxis und der Theorie kennen. Zusätzlich gibt jeder Student einen Vortrag auf Englisch zu praktikumsrelevanten Themen des jeweiligen Kurses. Im Eigenstudium sollen die Studierenden diese Vorträge vorbereiten und zusätzlich ein schriftliches Handout für Ihre Kollegen generieren, welches als Zusammenfassung die wichtigsten Punkte des Vortrags beinhalten soll.
Die wesentlichen Techniken des Praktikums und Studienleistungen beinhalten das Erlernen von gerichtete Mutagenese viraler Genome, Anzucht und Direktnachweise von Viren, Nachweis viraler Nukleinsäuren, Analyse der Sedimentationseigenschaften viraler Partikel, Teste zum Nachweis von Antikörpern gegen Viren, Analyse der Immunreaktion auf Virusinfektionen, Durchfluss-zytometrische Analysen von humanen Zellen, immunohistochemische Analyse von Lebern und lymphatischen Organen und die transkriptionale Analyse von chronisch entzündeten Organen.

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

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

Media:
Skriptum, Power Point Präsentation

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum der klassischen und molekularen Virologie (Praktikum, 8 SWS)
Baer de Oliveira Mann C, Deng L, Ebert G, Möhl-Meinke B, Pichlmair A, Vincendeau M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3211: Research Internship | Research Internship [RI]

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
The student's performance is evaluated, as documented in the lab notebook and the internship report (max. 20 pages), by the following criteria:
-understanding of the research question and ability to develop the project
-ability to learn and apply new methods
-skills in self-directed experimental design
-precision and accuracy in data acquisition and data management
-ability to study and work autonomously
-data analyses and evaluation

Repeat Examination:

(Recommended) Prerequisites:
Module Research Methods
Module Basics in Computational Biology
Module Integrated Lab Course

shedule:

1. The students search themselves one TUM internal supervisor from the given list of classes no matter if the planned research Internship is going to be TUM internal or TUM external. They do so by contacting a chair of TUM School of Life Sciences that already has a class connected to each one of the offer-nodes within the module-node of WZ3211 in TUMonline. If a preferred supervisor's classes and exam is already listed a topic or supervisor needs no further approval by the Examination Board.

If there should be another potential TUM internal supervisor whose chair is not yet part of the list of classes and/or exams, the students can ask for an extension of the list by the preferred supervisor writing a conclusive e-mail to recognition.co@ls.tum.de.

2. The students decide whether they want to do an internal OR an external internship and register for the supervisor's class connected to the respective offer-node (internal/external).

3. It will be the TUM internal supervisor who will (re-)read the report and finally submits the grade and the title.

Content:
The scientific questions addressed by laboratories on the TUM campus or at external research facilities hosting our master students for the research internship deal with nutrition-related research, either on the fundamental or applied level, using biochemistry, molecular biology, nutrition physiology, metabolism, microbiology, food chemistry, nutrition medicine, genetics, clinical studies, epidemiology and public health. The internship is the first opportunity for our students to apply their theoretical and practical knowledge acquired during the first two semesters to a specific research question in the framework of a project in the host laboratory.

Intended Learning Outcomes:
After successful finalization of the module, our students have acquired theoretical and practical skills to tackle scientific questions and conduct research tasks under guidance by a supervisor. They have gained hands-on experience in the design of experiments in life science laboratories, or the development of study protocols in clinical study units. They are experienced in sensible and reproducible application of known and new methods, understand the technical background of the applied technologies and gained insights into quality control procedures in scientific research. They have learned to document the day-by-day progress of their work in a comprehensible manner that allows independent recapitulation of the applied methods, the acquired data and the results obtained. In a written report, outlined as a scientific manuscript, they can explain the scientific context of their research project, explain the detailed application of methods, document and analyze the acquired data, judge upon the reliability and reproducibility of the results, and evaluate and interpret these results in relation to published work. They are able to explain the goals, experimental design and essential outcome of their research internship to their peers and supervisor in short and concise oral presentations, and in written reports.

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 summarize the goals of their research project and the main findings in short oral presentations, using PowerPoint or equivalent presentation tools. Within this setting, the project progress is discussed and plans to further develop the project in the given time frame are developed.

Media:

Reading List:
Review articles and original research articles related to the topic of the research internship. The supervisor assists the student to find the relevant papers and recommends specialized textbooks.

Responsible for Module:
Klingenspor, Martin; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship (6 weeks) Human Biology - Master (Forschungspraktikum, 15 SWS)
Annahazi A

External: Research Internship (6 weeks) Molecular Nutritional Medicine (Prof. Klingenspor) - Master (Forschungspraktikum, 1 SWS)
Bader B, Bruder J, Fromme T, Klingenspor M

Research Internship (6 weeks) Brewing and Beverage Technology (Prof. Becker) - Master (Forschungspraktikum, 15 SWS)
Becker T [L], Becker T

External: Research Internship (6 weeks) Brewing and Beverage Technology (Prof. Becker) - Master (Forschungspraktikum, 1 SWS)
Becker T [L], Becker T

Research Internship (6 weeks) Livestock Biotechnology (Prof. Schnieke) - Master (Forschungspraktikum, 15 SWS)
Fischer K, Flisikowska T, Flisikowski K

External: Research Internship (6 weeks) Livestock Biotechnology (Prof. Schnieke) - Master (Forschungspraktikum, 1 SWS)
Flisikowski K

Research Internship (6 weeks) Nutrition and Immunology (Prof. Haller) - Master (Forschungspraktikum, 15 SWS)
Haller D [L], Aguanno D, Coleman O, Ecker J, Haller D, Kießling S, Krammel T, Metwaly A, Ocvirk S, Omer H, Rath E, Schmöller I, Schwamberger S, Smith K

External: Research Internship (6 weeks) Nutrition and Immunology (Prof. Haller) - Master (Forschungspraktikum, 1 SWS)
Haller D [L], Aguanno D, Coleman O, Haller D, Metwaly A, Omer H, Schmöller I, Schwamberger S

Research Internship (6 weeks) Molecular Nutritional Medicine (Prof. Klingenspor) - Master (Forschungspraktikum, 15 SWS)
Klingenspor M [L], Bruder J, Fromme T, Schnabl K

External Research Internship (6 weeks) Molecular Immunology (Prof. Knolle) (Vorlesung, 1 SWS)
Knolle P

Research Internship (6 weeks) Molecular Immunology (Prof. Knolle) (Forschungspraktikum, 15 SWS)
Knolle P [L], Knolle P

Research Internship (6 weeks) Bewegung, Ernährung und Gesundheit (Forschungspraktikum, 15 SWS)
Köhler K

Research Internship (6 weeks)_Microbiome (PhD Schirmer) - Master (Forschungspraktikum, 15 SWS)
Schirmer M

Research Internship (6 weeks) Pediatric Nutritional Medicine (Prof. Heiko Witt) - Master (Forschungspraktikum, 15 SWS)
Skurk T, Witt H

External: Research Internship (6 weeks) Pediatric Nutritional Medicine (Prof. Heiko Witt) - Master (Forschungspraktikum, 1 SWS)
Skurk T, Witt H

Research Internship (6 weeks) Nutritional Systems Biology (Prof. Somoza) - Master (Forschungspraktikum, 15 SWS)
Somoza V

Research Internship (6 weeks) Metabolic Programming (Prof. Uhlenhaut) - Master (Forschungspraktikum, 15 SWS)
Uhlenhaut N [L], Friano M, Greulich F, Schweiger M, Spanier B, Strickland B

External: Research Internship (6 weeks) Metabolic Programming (Prof. Uhlenhaut) - Master (Forschungspraktikum, 1 SWS)
Uhlenhaut N [L], Greulich F, Spanier B, Uhlenhaut N
For further information in this module, please click campus.tum.de or here.

Modules after consulting "Medicine" | Module nach Rücksprache "Medizin"

Module Description

WZ3214: Experimental Immunology and Pathology | Experimental Immunology and Pathology

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Aufgrund des Pandemiegeschehens wird die alternative Prüfungsform "unbeaufsichtigte schriftl. Fernprüfung" (WZ3214o) angeboten.

Students have to hand in 6 lab reports (appx. 20 pages) covering the topics presented in the lab course including
mouse dissection, histopathology, genotyping, immune phenotyping, gene expression analysis and microbiological
analysis. The students demonstrate with the reports that they have gained deeper knowledge and understanding of
the specific methodologies, lab equipment and measurement methodologies and can analyse data with the use of
appropriate software tool as well as statistics. They show that they are able to complete extensive laboratory tasks,
know how to evaluate and interpret data and results and identify possible sources of error.
In the written examination students demonstrate theoretical knowledge on the methodologies used in the lab and
underlying medical, biochemical and analytical processes by answering questions without helping material.
The final grade is an averaged grade from the written examinations (8.34 % each/ overall 50%) and from the lab
reports (8.34 % each/ overall 50%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in immunology

Content:
The practical lab course demonstrates the use of an animal model of intestinal inflammation in biomedical research.
Starting with mouse dissection, different techniques and methodologies to analyze disease-associated alterations at
the organ- and cellular level are applied including: histopathology, genotyping, immune phenotyping, gene
expression analysis and microbiological analysis.

Intended Learning Outcomes:
Students acquire detailed and differentiated knowledge on the laboratory work with animal models of diseases and
are able to assess the possibilities and limits of these techniques. They apply relevant research methodologies and
are able to link scientific questions on disease outcomes to research technologies and immunological/ physiological
alterations.
Upon completion of the module, students have improved their practical laboratory working and scientific writing
skills.

Teaching and Learning Methods:
Within the module, students attend short lectures on the background of the methods used in the lab course, prior to
their practical work in the lab. Within the practical lab course the students work in teams of two students. Each part
of the internship is supervised individually.

Media:

Reading List:

Responsible for Module:
Haller, Dirk; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Experimental Immunology and Pathology (Übung, 5 SWS)
Haller D [L], Aguanno D, Coleman O, Kisling S, Omer H, Schmöller I, Schwamberger S, Smith K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2462: Research Project Neurobiology of Intact Animals | Forschungspraktikum Neurobiologie am intakten Organismus

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
Regelmäßige, aktive Teilnahme ist erforderlich. Die Studierenden werden sich anhand von Eigenrecherche mit geeigneter Literatur auf die jeweils untersuchten Aspekte der visuellen, auditorischen 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:
Erfolgreiche Teilnahme an den Vorlesungen "Tierphysiologie" sowie an entweder der Vorlesung "Neurobiologie" oder "Sinnesphysiologie" sind nötig. Der vorherige Besuch dieser Vorlesungen wird empfohlen.

Content:
2 Wochen extrazelluläre Ableitungen am IC der Maus, 2 Wochen extrazelluläre Ableitungen am OT des Huhns, 2 Wochen Verhaltenstraining bei Hühnern. Die Studenten werden nach einer Einarbeitungszeit die Versuche selbständig durchführen, auswerten und die Ergebnisse intern präsentieren.

Intended Learning Outcomes:
Studenten werden verschiedene Methoden zur Untersuchung von neuronalen Antworten kennen, Operationen an verschiedenen Modellorganismen kennen und unter Anleitung durchführen können, Auswerteverfahren kennen und durchführen können, Verhaltensexperimente konzipieren, durchführen und auswerten können.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Laborlehre
Lehrmethode: Fragend-entwickelnde Methode,Einzelarbeit, praktische Demonstrationen, eigenständige Labortätigkeit, Experiment. Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Bearbeiten von Problemen und deren Lösungsfindung, Üben von labortechnischen Fertigkeiten, Produktion von wissenschaftlichen Berichten..

Media:
Ein Skript zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte).

Reading List:
Als grundlegendes Lehrbuch wird "Neuroscience: Exploring the brain" von Baer empfohlen. Spezialliteratur steht dem Studenten im Labor zur Verfügung.

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

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

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

Module Description

WZ0408: Research Project on Microbiota-Associated Pathobionts | Research Project on Microbiota-Associated Pathobionts

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The type of assessment for this module is a laboratory assignment (Laborleistung). The goal of this module is to teach you how to design and conduct independent research in a supportive environment. Your proposal will take the form of asking a hypothesis-driven research question based on existing literature/data, that you then attempt to answer once you start the experimental component of the module. Additionally, we wish to prepare you for applying for a career in science. The project will be partly supervised and self-guided in the lab – according to good scientific practice, and this lab work and your conduct in the lab will account for 40% of the overall mark. Your internship report (dissertation) resulting from your lab work, should be written in the form of a scientific research paper, and should include the following sections (accounting for 50% of the overall mark)

(i) Title
(ii) Abstract
(iii) (Materials and Methods
(iv) Results
(v) Discussion.

There is a strict word limit of 6000 (+10%). This does not include figure legends or references.
Your dissertation will be assessed on the following:
• Abstract
• Introduction
• Materials and Methods
• Quality of Results
• Presentation of Results
• Data Handling
• Discussion

• Future Work Suggestions
• References
• Written Expression

You will also give a 15-minute presentation (+ 5 minutes scheduled for questions) on your research project. The goal of this exercise is to get you thinking about how to present your work to a non-expert audience. Your presentation will be assessed on the following (10% of overall mark):
• Context and communication of science
• Clarity
• Structure
• Oral delivery and visual aids
• Conclusions and answering questions

The module is passed when at least 40 out of a total of 100 points have been granted.

Repeat Examination:
Next semester

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

Content:
Practical work in a microbiome research lab, which may involve a combination of wet and dry lab approaches. For more info see www.halllab.co.uk.

Intended Learning Outcomes:
You will work within a larger research project – which will involves understanding how certain microbiota members may cause disease in humans and animals. You may focus on certain microbiota members, that while at low levels do not cause harm, under certain conditions may overgrow and cause infection – i.e. pathobionts including Clostridium and Klebsiella. Other aspects may involve isolating these pathobionts from clinical samples and studying the virulence factors that these microbes may encode and produce and antimicrobial resistance determinants. For more details see www.halllab.co.uk.
Participants should be able to recognize, understand and apply laboratory techniques. They are able to analyze the data produced and to evaluate data with appropriate supervision. Participants should think of own research ideas building up on the research internship (future outlook).

Teaching and Learning Methods:
Introduction to the lab and training in appropriate methods by a Hall lab team member, followed by individual working and teamwork. Problem solving training and experimental design and data analysis will also be developed over the course of the project.

Media:
Blogs and potential for peer-reviewed scientific publication(s)

Reading List:
• Chen Y, Brook TC, Soe CZ, O'Neill I, Alcon-Giner C, Leelastwattanagul O, Phillips S, Caim S, Clarke P, Hoyles L/Hall LJ. Preterm infants harbour diverse Klebsiella populations, including atypical species that encode and produce an array of antimicrobial resistance- and virulence-associated factors. Microbial Genomics. 2020. doi.org/10.1099/mgen.0.000377
• Dalby MJ & Hall LJ. Recent advances in understanding the neonatal microbiome. F1000Research. 2020, 9 (F1000 Faculty Rev):422.
• Alcon-Giner C/Leggett RM, Heavens D, Caim S, Brook TC, Kujawska M, Hoyles L, Clarke P, Clark MD/Hall LJ. Rapid MinION profiling of preterm microbiota and antimicrobial resistant pathogens. Nature Microbiology. 2019. doi:10.1038/s41564-019-0626-z
• Kiu R, Brown J, Bedwell H, Leclaire C, Caim S, Pickard D, Dougan G, Dixon R, Hall LJ. Genomic analysis on broiler-associated Clostridium perfringens strains and caecal microbiome profiling reveals key factors linked to poultry Necrotic Enteritis. Animal Microbiome. 2019: 1(12).
• Kiu, R & Hall, LJ. An update on the human and animal enteric pathogen Clostridium perfringens. Emerging Microbes & Infections. 2018. 7:141.

Responsible for Module:
Hall, Lindsay; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Research Project on Microbiota-Associated Pathobionts (Forschungspraktikum, 16 SWS)
Hall L (Kujawska M, Zenner C)
For further information in this module, please click campus.tum.de or here.

Engineering | Technik

Module Description

CS0280: Research Internship Method and Process Development for Biotechnology | Forschungspraktikum Methoden- und Prozessentwicklung für die Biotechnologie [PraktMPB]

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Following the internship, an internship report is to be written as an examination performance, which on the one hand demonstrates the ability to write scientifically and on the other hand the understanding of the experimental work carried out. The report should follow the IMRAD structure of a scientific publication. (Introduction, material and methods, results and discussion). The length is between 10 and 25 pages, depending on the topic worked on.
In addition, an ungraded presentation of 20 minutes on the results obtained with discussion in the plenum with the supervising lecturers and expert audience should be held to check the communicative competence and presentation of the content.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Attending the lectures “Enzym Engineering” or “Technical Biocatalysis”, both offered in Garching, is beneficial but not mandatory

Content:
The methods and content taught during the practical course depend on the current research topics at the chair. Basically, process, method and apparatus development in the chemical-biotechnological environment are taught, especially for fermentations and enzyme-catalyzed processes.
Exemplary is the topic "Microfluidic high-throughput screening of enzymes" (location Garching). Here, students learn, among other things:

• Driving microfluidic unit operations such as encapsulation of particles, injection of a continuous phase into droplets (picoinjection), fusion of 2 droplets or fluorescence-based screening of droplets in high throughput (for example of enzyme activity assays).
• Determine optimal process parameters to operate microfluidics for the desired research question
• Design of microfluidic chips using AutoCAD to achieve desired functions
• Analysis of microfluidic generated Big-Data using Python

The internship can be completed - depending on the topic - at campus Garching or TUM Straubing campus.

Intended Learning Outcomes:
By participating in the research internship (6 weeks, whole day), students acquire an in-depth understanding of technical operations and functionalities of biotechnologically relevant apparatus, as well as the ability to develop new methods for chemo-enzymatic processes. The focus is on technical aspects, such as development of new processes, unit operations or identification of optimal process parameters.
The students work preferably in the context of current research projects of the Chair of Chemistry of Biogenic Resources. Through the internship, they gain an insight into the current state of knowledge of the specific field and expand their skills for the targeted planning and execution of research and development work.

Teaching and Learning Methods:
At the beginning, the students are to familiarize themselves with the topic independently in order to obtain an overview of the methods and their application potential for the underlying research question. On this basis, students are to create a processing plan to address the research question. The practical research work will first be carried out under the guidance of the supervisors to ensure that the peculiarities of the sensitive (optical) devices are sufficiently known and that all safety measures (e.g. laser protection or biological safety) are ensured. Subsequently, students should be capable of independent operation of the devices/processes used.
The results produced and the further procedure will be discussed immanently with the supervisors so that hypothesis-guided work and analysis competence are practiced and the dynamic nature of the research process is made clear.

Media:
Presentations by means of PowerPoint and on whiteboard, case descriptions of comparable scientific work as well as computer-aided programs

Reading List:

Responsible for Module:
Prof. Volker Sieber

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Methoden- und Prozessentwicklung für die Biotechnologie (Forschungspraktikum, 16 SWS)
Kolaitis G, Köllen T, Sieber V, Steiger M
For further information in this module, please click campus.tum.de or here.

Module Description

LS30069: Research Internship Precision Fermentation & Microbial Food Protein | Forschungspraktikum Precision Fermentation & Microbial Food Protein

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Das Modul wird durch die Ableistung des 7-wöchigen Forschungspraktikums abgeschlossen (Vollzeit). Die unbenoteten Studienleistungen in Form einer Laborleistung werden mit einem schriftlichen Projektbericht als Zusammenfassung der wissenschaftlichen Ergebnisse (max. 15 Seiten), sowie einer kurzen mündlich vorgetragenen Präsentation (ca. 10 Minuten) erbracht. Die schriftliche Arbeit und die Präsentation können in deutscher oder englischer Sprache verfasst werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnis über allgemeine Grundlagen der Biotechnologie sowie ein Interesse an biotechnologischen Prozessen und modernen Fragestellungen der Biotechnologie werden vorausgesetzt. Abhängig von der thematischen Ausrichtung des Forschungspraktikums und des Projekts können verschiedene Vorkenntnisse von Vorteil sein. Die detaillierten Voraussetzungen (falls zutreffend) zur erfolgreichen Teilnahme am Forschungspraktikum werden zwischen Studierendem und Betreuendem vor Aufnahme des Forschungspraktikums individuell abgestimmt.

Content:
Das Praktikum bietet den Studierenden die Gelegenheit, das bereits erworbene theoretische und praktische Wissen im Rahmen eines Forschungspraktikums auf eine konkrete Forschungsfrage der Cellular Agriculture anzuwenden. Es handelt sich um individuelle Forschungspraktika, die verschiedenen Themen, Fachrichtungen und Methodenspektren zugeordnet werden können.
Die Durchführung des Forschungspraktikums findet in den Laboren der Professur für Cellular Agriculture statt. Für die gesamte Zeit des Forschungspraktikums werden die Studierenden

von einem unserer Mitarbeitenden intensiv betreut. Ein Fokus liegt zudem darauf, nach einer Einführung, das Thema eigenständig zu bearbeiten, und dabei ebenfalls Vorschläge für die weiterführende Bearbeitung des Themas einzubringen. Die Studierenden können somit Ihre Erfahrungen in der eigenverantwortlichen Bearbeitung eines Forschungsthemas verstärken, und den Verlauf des Praktikums selbst aktiv mitgestalten.

Im Forschungspraktikum Precision Fermentation & Microbial Food Protein können verschiedene Produkte (alternative Lebensmittelproteine, selbstassemblierende Proteine, natürliche und teilsynthetische Proteine und Polymere zum Bioscaffolding, Wachstumsfaktoren, verschiedene Metabolite etc.) thematisiert werden. Hierzu können unter anderem folgende übergeordnete Methoden und Arbeitsansätze in den Forschungsthemen behandelt werden:

Molekularbiologische Methoden:
- Molekulare Bioprozesskontrolle für bakterielle Kultivierungen (Konstruktion von Stämmen mit natürlichen, synthetischen oder teilsynthetischen Regulationsmechanismen zur Expressionskontrolle eines Zielproteins)
- Stammentwicklung und Optimierung für hocheffiziente rekombinante Proteinproduktionssysteme

Methoden der Bioprozesstechnik:
- Entwicklung optimierter Bioprozesse durch gezielte Medienauswahl und Nährstoffzugabe (Fed-Batch Entwicklung)
- Prozessmodellierung, Soft-Sensoren und Künstliche Intelligenz in der Bioprozesskontrolle und Optimierung

Intended Learning Outcomes:
Es handelt sich um individuelle Forschungspraktika, die verschiedenen Themen, Fachrichtungen und Methodenspektren zugeordnet werden können. Nachfolgende Lernziele sollen jedoch übereinstimmend für alle Forschungspraktika an der Professur für Cellular Agriculture erreicht werden.

Nach erfolgreichem Abschluss des Moduls:

- haben die Studierenden einen Einblick in das Forschungsfeld der Cellular Agriculture, der Herstellung biotechnologischer Alternativen zu konventionellen landwirtschaftlichen Produkten, gewonnen, und können grundsätzliche wissenschaftliche Fragestellungen benennen und erklären

- sind die Studierenden in der Lage, theoretisches Wissen und theoretisch erlernte Methoden für konzeptionelle und/oder praktische Aufgabenstellungen anzuwenden, und somit wissenschaftliche Fragestellungen unter Anleitung eines Betreuenden zu bearbeiten

- im Rahmen des bearbeiteten Themas für die Planung und Durchführung der Experimente selbstständig zu agieren und eigenverantwortlich Entscheidungen zu treffen

- den täglichen Verlauf ihrer Arbeit nach gängigen Regel zu dokumentieren, dass die angewandten Methoden und Ergebnisse nachvollzogen werden können

- in Feedbackgesprächen erreichte Zwischenergebnisse klar zu kommunizieren
und angemessene Vorschläge für die weiterführende Bearbeitung des Themas auszuarbeiten und wiederzugeben

- in einem schriftlichen Bericht das von Ihnen bearbeitete Thema in den wissenschaftlichen Kontext des Forschungsfelds einzusortieren, und die eingesetzten Methoden im Detail zu erläutern, sowie die gewonnenen Ergebnisse zu dokumentieren, analysieren, interpretieren und bewerten.

Teaching and Learning Methods:
Das Modul findet als Blockpraktikum statt. Zu Beginn werden zunächst in Form eines Anleitungsgesprächs der Inhalt des Forschungspraktikums, die thematische Einordnung sowie die zugrundeliegenden Prinzipien der individuellen Experimente besprochen, und einführende Literatur zur Verfügung gestellt. Eine weiterführende eigenständige Literaturrecherche kann, je nach Thema insbesondere zu Beginn des Forschungspraktikums, erforderlich sein. Die Durchführung des Forschungspraktikums findet in den Laboren der Professur für Cellular Agriculture statt.
Für die gesamte Zeit des Forschungspraktikums werden die Studierenden von einem unserer Mitarbeitenden intensiv betreut. Hierbei finden regelmäßigen Besprechungen statt, in denen der Fortschritt besprochen und Pläne für die weitere Entwicklung der Praktikumsinhalte innerhalb des vorgegebenen Zeitrahmens entwickelt werden. Nach einer praktischen Einführung in die Experimente und Methoden zu Beginn des Forschungspraktikums sollen die folgenden Versuche möglichst eigenständig durchgeführt werden. Auch die zeitliche Planung der Versuche werden die Studierenden eigenständig durchführen. Die Studierenden dokumentieren Inhalt, Ergebnisse und Ablauf des Forschungspraktikums, wobei der Schwerpunkt auf der detaillierten Beschreibung der angewandten Forschungsmethoden, der Datenerfassung und den Auswertungen liegen soll.

Media:
Wissenschaftliche Fachartikel, Anleitungen und Dokumentationen werden für die Einarbeitung in die Thematik zur Verfügung gestellt. Für die individuelle Versuchsplanung können Tafel- bzw. Flipchartanschriebe zum Einsatz kommen. Die abschließende mündliche Präsentation soll durch geeignete Methoden und Folien (bspw. Powerpoint) begleitet werden.

Reading List:
Wissenschaftliche Fachartikel zur Einarbeitung in Thematik und Methodik werden zur Verfügung gestellt. Eine weiterführende eigenständige Literaturrecherche kann, je nach Thema insbesondere zu Beginn des Forschungspraktikums, erforderlich sein.

Responsible for Module:
Henkel, Marius, Prof. Dr.-Ing. marius.henkel@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Precision Fermentation & Microbial Food Protein (Forschungspraktikum, 10 SWS)
Henkel M [L], Henkel M, Noll P, Treinen C
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

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 120	**Contact Hours:** 180

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

Description of Examination Method:
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 explicability 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 Softwaretools.

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

WZ2172: Functional Proteomics | Forschungspraktikum Funktionelle Proteomanalyse

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
BSc Abschluss ist erforderlich.
Besuch der VS Proteomics - analytische Grundlagen und biomedizinische Anwendungen wird empfohlen.

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

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

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

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

Media:
Experimentelle Protokolle

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

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Protein- und Wirkstoffmodellierung (Forschungspraktikum, 10 SWS)
Di Pizio A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2597: Research Project Pharmaceutical Bioprocess Engineering | Forschungspraktikum Pharmazeutische Bioprozesstechnik

Version of module description: Gültig ab summerterm 2013

Module Level:	Language:	Duration:	Frequency:
Credits:* 10	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

Forschungspraktikum Pharmazeutische Bioprozesstechnik (Forschungspraktikum, 12 SWS)
Först P [L], Gruber S, Hilmer M

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

Module Description

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

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The grade is based on the report by the student who will describe in max. 20 pages the analysis of a genomic dataset or of a mathematical model by means of stochastic simulations. The report consists in the description of methods, statistical analyses and discussion of the results. The report serves as a basic scientific document summarizing the pipeline of analysis, possible pitfalls and bias in the results, as well as a general conclusion about the chosen scientific question.

Repeat Examination:
End of Semester

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

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

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

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

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

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

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

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

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

Module Description

WZ3000: Research Training for Molecular Biotechnology | Forschungspraktikum Molekulare Bioprozesstechnik

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Die Prüfungsleistung erfolgt in Form einer Laborleistung.
Bewertet werden a) die praktische Arbeit (240 h), b) das Protokoll sowie c) ein abschließender Vortrag.
Die Studierenden zeigen damit, dass sie in der Lage sind, die wesentlichen Aspekte ihres Teilprojekts strukturiert und reflektiert darzustellen und das theoretische Wissen auf die praktische Fragestellung anzuwenden.
Die Gewichtung beträgt 1:1:1.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Grundlegendes Verständnis für Verfahrenstechnik, Trenntechnik, Trocknungstechnik; Proteintechnologie (themenabhängig); Grundlegende Erfahrung im Bereich Labor-/Technikumsarbeit; Grundlegende Erfahrung im Bereich Literaturrecherche (Englischkenntnisse)

Content:
Die Studierenden arbeiten zusammen mit einem Betreuer/einer Betreuerin (Mitarbeiter(in) der Professur) an dessen/deren wissenschaftlicher Arbeit. Hierbei wird den Studierenden ein einfaches, abgeschlossenes Teilprojekt gestellt, welches sie im Rahmen von experimentellen Arbeiten in Labor und Technikum sowie theoretischen Arbeiten unter direkter Anleitung des Betreuers/der Betreuerin bearbeiten.
Mögliche Themenbereiche (im Rahmen aktueller Forschungsprojekte): (1) Trenntechnik, (2) Trocknungstechnik (3) In-situ Bildgebung (4) Strukturierung von Lebensmitteln

Intended Learning Outcomes:
Nach diesem Modul sind die Studierenden in der Lage ein einfaches, abgeschlossenes Teilprojekt eines Forschungsvorhabens, beispielsweise aus den Bereichen Bioprozesstechnik, Trenntechnik, Trocknungstechnik oder Charakterisierung von Biosystemen, zu bearbeiten und ihre Ergebnisse schriftlich und mündlich zu präsentieren.

Teaching and Learning Methods:
Experimentelle Arbeiten in Labor und Technikum; Theoretische Berechnungen und Simulationen, Ergebnisauswertung, Ergebnisaufbereitung und literaturbasierte Ergebnisdiskussion; Projektbezogene Literaturrecherche; Erstellung eines Projektberichts; Vorbereitung und Durchführung einer Präsentation

Media:
Wissenschaftliche Fachartikel

Reading List:
Wissenschaftliche Primärliteratur

Responsible for Module:
Först, Petra; Prof. Dr.-Ing. petra.foerst@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum Molekulare Bioprozesstechnik (Forschungspraktikum, 16 SWS)
Ambros S, Bittner R, Kalinke I, Kürzl C, Reiter M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ8058: Immunoinformatics | Immunoinformatik

Version of module description: Gültig ab summerterm 2012

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

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

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

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
keine

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

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

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

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

Media:
Präsentation, Skript zur Vorlesung, Praktikumsanleitungen

Reading List:
Literaturempfehlungen werden in der Vorlesung gegeben.

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

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

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

Module Description

WZ9905: Practical Course "Engineering" | Forschungspraktikum "Technik"

Version of module description: Gültig ab summerterm 2015

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:*	**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:
F-Pr Lebensmittelchemie für Master MBT (Forschungspraktikum, 10 SWS)
Dawid C [L], Somoza M
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination of the module is carried out in the form of a laboratory performance.
which consists of the following elements: activity in the laboratory, lab report (~10 pages) with evaluation and
discussion and presentation (30 minutes) in a ratio of 3:3:1.
In it, the students demonstrate the ability to design models in computational neuroscience, code computer programs,
analyze data and visualize data. They also demonstrate the ability to present their data to other computational
neuroscientists, and synthesize what they learned in a concise written up record of their work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students are expected to have some mathematical knowledge (linear algebra, differential equations) and some
programming skills (Matlab, Python or C/C++).

Content:
Minimum of 6-8 weeks research project in laboratory with hands on training in the analysis of neuroscience data and
the building of network models.
Depending on the aim of the research project, different methods and questions will be in focus. For instance:
- simulating network models in Julia, Python or Matlab
- designing differential equation descriptions of network interactions

- mathematical analysis based on dynamical systems
- image analysis using ImageJ software
- statistical analysis with Julia, Python or Matlab
- dimensionality reduction techniques of high-dimensional data
- extracting model parameters from experimental data
- conceptual discussion and literature searches to understand and propose ideas, results, hypotheses

Intended Learning Outcomes:
Upon successful participation the students are able to:
- Analyze neuroscience data from electrophysiological or calcium imaging recordings
- Build network models of connected excitatory and inhibitory neurons in numerical simulations
- Include synaptic plasticity rules in the network models for the self-organization of network connectivity
- Analyze the output of the networks in terms of activity and connectivity
- Interpret the numerical results to make predictions for experiments
- Work in the laboratory independently

Teaching and Learning Methods:
Students will work in the lab and learn from PhD students.
They will be given detailed instructions and sample numerical code to perform the simulations.
They will read scientific literature to determine new parameters for their models.
They will learn mathematical methods for writing down differential equations, analyzing them using dynamical
systems and visualizing them from PhD students and sample code from related projects.
They will have weekly meetings with their other PhD students and give regular presentations on their progress to get feedback.
They will get regular help with checking their code and analysis.

Media:

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Models in Computational Neuroscience (M.Sc.) (Forschungspraktikum, 10 SWS)
Gjorgjieva J, Dauphin A, Dwulet J, Onasch S, Parkinson-Schwarz J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2297: Protein and Drug Design | Praktikum Protein- und Wirkstoffmodellierung

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The examination of the module is carried out in the form of a laboratory performance, which consists of a report (~10 pages). Students will perform exercises covering topics of drug and protein design (chemical space analyses, pharmacophore modelling, ligand-protein docking simulations, Molecular Dynamics simulations). Writing the report allows students to reflect explicitly once again on what they have learned, which leads to a consolidation of knowledge. In it, the students will demonstrate their acquired competencies in running simulations, completing and analysing modelling jobs, interpreting the results, and present them in writing. For each exercise, students will be evaluated for the successful performance of calculations (40%), the description of methodology and results (40%), and the interpretation of results in the context of the knowledge to be gained (20%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module “Modeling and simulations of biological macromolecules” (WZ2235)

Content:
This course covers main computational approaches in drug and protein design, ranging from small molecule to protein analyses. Students will be provided with exercises addressing the following topics:
- Representation of chemical structures, fingerprints and molecular descriptors.
- Chemical datasets and descriptor-based chemical space analysis.
- Ligand-protein interactions and pharmacophore modelling.
- Ligand-protein interactions and molecular docking.
- Rigid vs. flexible ligand docking.

- Artificial intelligence for structure prediction: AlphaFold models and AlphaFold2 database.
- 3D protein visualization and analysis.
- Molecular Dynamics simulations.
- Molecular Dynamics trajectory analysis.

Intended Learning Outcomes:
After successful completion of the module, students will be able to work with various programs dedicated to computer-aided drug design and protein modeling and simulations, and will be able to apply them independently to appropriate scientific problems:
- Perform chemical space analyses
- Develop pharmacophore models
- Run ligand-protein docking simulations using different software
- Design a Virtual Screening Pipeline
- Run Molecular Dynamics simulations
- Perform basic analyses of MD trajectories

Teaching and Learning Methods:
Each topic will be introduced by a lecture that introduces theory and main applicability, a tutorial that show all passages will follow and finally the exercises will be performed by the students under the supervision of the instructor(s).
As a practical course, the content will be transmitted through the experimental learning – learning-by-doing. The students will be exposed to concrete experience and reflective observation, by performing the simulations and analyzing the results. This will allow to develop practical skills but also ‘abstract conceptualization’, learning from the experience (Kolb’s Experiential Learning Theory).
I will combine different teaching methods to ‘inform’ (frontal lecturing, drawing graphics in the blackboard), ‘process’ (individual work, sandwich method, think-pair-share) and ‘evaluate’ (by writing the final report) acquired knowledge.
For most topics, the same exercise will be assigned to all students. However, when applicable (e.g., in the case of docking software), different tutorials will be assigned so that students can share and compare the results obtained with different methods. This will allow students to experience individual and team work activities.

Media:
Lecture slides, exercise tutorial instructions, research articles.

Reading List:
Chemoinformatics: A Textbook, Johann Gasteiger and Thomas Engel, Wiley
Molecular Modeling and Simulation, Tamar Schlick, Springer
Molecular Modelling. Principles and Applications, Andrew R. Leach, Prentice Hall
Molecular Design, Gisbert Schneider, Wiley

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

Courses (Type of course, Weekly hours per semester), Instructor:
Protein and Drug Design (Praktikum, 3 SWS)
Di Pizio A
For further information in this module, please click campus.tum.de or here.

Module Description

MW1741: Simulation Exercises in Biology and Biotechnology 1 (MSE) | Simulationspraktikum in Biologie und Biotechnologie 1 (MSE)

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
Die angestrebten Lernergebnisse werden durch Übungsleistungen in Form von praktischen Rechenaufgaben, die von den Studierenden selbstständig bearbeitet werden, überprüft.

Repeat Examination:
Next semester

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

Content:
Das Praktikum führt in die Benutzung von Software, die für die theoretische Analyse von Analyse- und Designaufgaben in Biologie und Biotechnologie benötigt wird, ein. Das Praktikum führt in den ersten Stunden in die Software MATLAB ein und erläutert die grundlegende Vorgehensweise zur Erstellung einfacher Programme.
Anschließend werden Aufgaben zur selbstständigen Bearbeitung ausgegeben. Die Lösungen der Aufgaben werden von den Studierenden im Rahmen eines Vortrages vorgestellt.

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul sind die Studierenden in der Lage, einfache Programme und Funktionen zu erstellen und zu simulieren.

Teaching and Learning Methods:
Der Stoff wird anhand von praktischen Aufgaben vermittelt (learning-by-doing).

Media:
Für das Praktikum werden den Studierenden die Aufgaben in schriftlicher Form zur Verfügung gestellt. Die Musterlösungen werden dann gemeinsam mit den Studierenden besprochen.

Reading List:
Zur Verfügung stehen Bücher und Manuals zu MATLAB.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Simulation in Biologie & Biotechnologie 1, 2SWS
Hannes Löwe (h.loewe@tum.de)
For further information in this module, please click campus.tum.de or here.

Module Description

MW1976: Simulation Exercises in Biology and Biotechnology 2 (MSE) | Simulationspraktikum in Biologie und Biotechnologie 2 (MSE)

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
Die angestrebten Lernergebnisse werden durch Übungsleistungen in Form von praktischen Rechenaufgaben, die von den Studenten selbstständig bearbeitet werden, überprüft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind mathematische Kenntnisse, wie sie in Bachelorstudiengängen an wissenschaftlichen Hochschulen vermittelt werden. Empfohlen wird die Teilnahme am Simulationspraktikum Teil 1.

Content:
Das Praktikum führt ein in theoretische Möglichkeiten von Analyse- und Designaufgaben in der Biotechnologie. Grundkenntnisse in der Software MATLAB werden vorausgesetzt. Thematisch werden die nummerische Lösung von Differentialgleichungen komplexer biologischer Netzwerke, stochastische Verfahren zur Simulation von biochemischen Reaktionen, die Flussanalyse und die Analyse eines Reaktormodells für einen biotechnologischen Prozess behandelt.
Die Aufgaben werden zur selbstständigen Bearbeitung ausgegeben. Die Lösungen der Aufgaben werden von den Studierenden im Rahmen eines Kolloquiums vorgestellt.

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul sind die Studierenden in der Lage, umfangreichere Programme und Funktionen zu erstellen und mathematische Modelle zu simulieren.

Teaching and Learning Methods:
Der Stoff wird anhand von praktischen Aufgaben vermittelt (learning-by-doing).

Media:
Für das Praktikum werden den Studierenden die Aufgaben in schriftlicher Form zur Verfügung gestellt. Die Musterlösungen werden dann gemeinsam mit den Studierenden besprochen.

Reading List:
Zur Verfügung stehen Bücher und Manuals zu MATLAB.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Simulation in Biologie & Biotechnologie 2, 2SWS
Hannes Löwe (h.loewe@lrz.tum.de)
For further information in this module, please click campus.tum.de or here.

Modules after consulting "Engineering" | Module nach Rücksprache "Technik"

Module Description

WZ5063: Basics in Programming | Grundlagen des Programmierens

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 135	**Contact Hours:** 45

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

Description of Examination Method:
The learning outcome is assessed by an examination (120 minutes).

The exam consists of two parts. In the first part, general theoretical basics of programming are tested in writing. The students work on questions regarding the understanding of data structures and the possibilities of influencing the programme flow (control flow). In the second part, they solve programming tasks on the computer using the Python 3.10+ programming language. Competences such as importing, transforming, illustrating and saving, with relevance in a scientific environment, are tested.

The processing time of the theoretical part is set at approx. 30 minutes, the programming task at approx. 90 minutes. This ratio is also reflected in the weighting of the two parts. Thus, the theoretical part accounts for 30% of the grade and the programming task for 70%.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
No previous experience is required.

Content:
Das Modul Grundlagen des Programmierens behandelt folgende Themen in Vorlesung und Übungsaufgaben:
- Einteilung der verschiedenen Programmierparadigmen
- Aufbau eines Programms

- Schleifen
- Konditionalsätze
- Kontrollstrukturen
- Aufrufen von Funktionen
- Entwicklung von Funktionen
- Strukturierung von Daten
- Einlesen von Datensätzen
- Verarbeiten von Datensätzen
- Graphische Darstellung von Datensätzen
- Durchsuchen von Datensätzen
- Umgang mit Bibliotheken

Intended Learning Outcomes:
After participating in the module courses, students have the ability to develop simple programs and the skill to write them in the Python 3.10+ programming language. These serve as examples for the acquisition of competence in importing, transforming, illustrating and storing data, with relevance in the scientific environment.

Teaching and Learning Methods:
In the lecture Fundamentals of Programming, students are taught the theoretical basics by means of a classical lecture. Small program examples are shown within the lecture. The chosen document type, Jupyter Notebook, enables the simultaneous presentation of script, program code and result presentation in one document.
The focus of the module lies in the exercise Fundamentals of Programming, in which the students deepen the learned contents by solving application-related problems on the computer. Here the students create programs in JupyterLab 3+ with Python 3.10+. Programming can take place in group work or alone. For more complex tasks, students present their solutions to fellow students and discuss the approaches together. A collection of tasks is provided. The programs created can be discussed with the lecturers.

Media:
Both the presentation and the exercises are made available to the students as Jupyter Notebook. In addition to a "classic" script, Jupyter Notebook offers the possibility to develop and execute additional programme code in this document.

Reading List:
Python 3 | The comprehensive manual by Johannes Ernesti, Peter Kaiser | ISBN 978-3-8362-7926-0
http://openbook.rheinwerk-verlag.de/python/
Further current literature will be announced at the beginning of the module.

Responsible for Module:
Gaßner, Günther, M.Sc. guenther.gassner@tum.de Schmid, Philip, M.Sc. philip.schmid@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen des Programmierens (Vorlesung, 3 SWS)
Voigt T [L], Voigt T (Gaßner G, Nophut C)
For further information in this module, please click campus.tum.de or here.

Theoretical Modules | Theoretische Vertiefungsmodule

Biomolecules | Biomoleküle

Module Description

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

Version of module description: Gültig ab winterterm 2015/16

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in statistics

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

Intended Learning Outcomes:
Upon successful completion of the module students are familiar with advanced data analysis methodologies and hands-on competence on the latest available tools for the analysis of high throughput data sets. They have basic knowledge on what information can be found and where, as well as how can the information be
accessed/retrieved.

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

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

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

Responsible for Module:
Bernhard Küster kuster@tum.de

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

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

Module Description

CH3039: Bioorganic Chemistry | Bioorganische Chemie

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
Next semester

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

Content:
In den semesterbegleitenden Vorlesungen inkl. Übugnen werden die folgenden Themen behandelt:
- Einführung in Terminologie „Bioorganische Chemie“ als interdisziplinäre Schnittstelle von Chemie, Biologie, Medizin und Analytik
- Präsentation der Meilensteine und Forschungshighlights der letzten 15-20 Jahre
- Wiederholung von Grundlagen der ribosomalen und nichtribosomalen Proteinsynthese mit dem Schwerpunkt wie die Natur Peptide herstellt

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

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

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung mit begleitender Übung (3 SWS). Die Vorlesungsmaterialien können von der Homepage des Dozenten heruntergeladen werden. Die Vorlesung selbst erfolgt mit PowerPoint-Folien (inklusive Abbildungen und Animationen) sowie zusätzlichen Tafelanschriften. Zitate und Hinweise auf aktuelle Publikationen werden während der Vorlesung gegeben, so dass Studierende auch weiterführende Originalliteratur hinzuziehen können. Das Skript und die Tafelanschriften sind für eine erfolgreiche Teilnahme ausreichend. Der

Dozent fasst zusätzlich am Anfang jeder Stunde den Stoff der letzten Vorlesung zusammen und klärt, falls notwendig, vorhandene Fragen. Am Ende jeder Vorlesung und zusätzlich bei relevanten Folien der PowerPoint Präsentation, werden sogenannte „take home messages“ formuliert und weitere Fragen geklärt.

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

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

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

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

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

Module Description

WZ1335: Chemical Biology | Chemical Biology

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The acquisition of competence will be evaluated in a final written exam (90 min). The performance in the final exam will be the only basis of the grade. The written test will include extracts (figures and texts) of a scientific article published in the same year that has not been the object of a case study during the lecture. The concepts and technologies used in the article are direct applications or extensions of those learnt in the lecture.
In this test, students demonstrate that they can extract the significance of a modern chemical biology experiment reported in the specialized scientific literature. They need to be able to critically comment on the purpose of an experiment, to put it in the context of the approaches learnt during the lectures and to propose additional experiments based on the examples detailed during the lecture.

In addition, there is the option of taking a voluntary mid-term assignment as course work in accordance with APSO §6, 5. For this, a presentation (10 min) is to be prepared. The presentation will cover a selected chemical biology article and will not be graded itself. 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:
Next semester

(Recommended) Prerequisites:
keine Angaben

Content:
Every chapter of the lecture will present the theoretical concept of the considered scientific approach, which will be illustrated by recent examples of applications found in the specialized literature. Students will be invited to deepen their understanding of the relevance of the approach for particular biological questions by reading at home the full articles where the examples stem from.
The content of the lecture will be divided in the 5 following parts:
1) Introduction to chemical biology a) Definitions and scope b) Introduction to biorthogonal chemistry and bottom-up proteomics
2) Biomolecule bulk labelling in situ a) Metabolic insertion b) Moiety specific labelling c) Cross-linking
3) Biomolecule precise labelling in situ a) Genetic code expansion b) Ligand-directed chemistry c) Proximity photo- labelling d) Chemical knock-down (PROTACs)
4) Native target deconvolution a) Target deconvolution techniques b) Proteomics-aided drug discovery
5) Spatial and temporal control of molecule activity a) Synthetic chemistry in situ b) Photopharmacology

Intended Learning Outcomes:
After the successful completion of the module, students understand the most important concepts of the chemical biology field (such as chemical tools for labelling, ligation, enrichment). Equipped with this knowledge they are able to critically read the chemical biology scientific literature and to choose the chemical biology approach relevant to the biological question they want to ask.

Teaching and Learning Methods:
Lecture

Media:
Powerpoint

Reading List:
No textbook covers the wide-spread content of the lecture. Students will be directed towards reviews to be found in the scientific literature for each chapter during the lecture.

Responsible for Module:
Wilhelm, Stephanie, Dr. rer.nat. stephanie.wilhelm@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Chemical Biology (Vorlesung, 3 SWS)
Küster B [L], Wilhelm S
For further information in this module, please click campus.tum.de or here.

Module Description

CS0076: Enzyme Engineering | Enzym Engineering

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

Responsible for Module:
Prof. Volker Sieber

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

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

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

Module Description

WZ2593: Enzymatic Reaction Mechanisms | Enzymatische Reaktionsmechanismen

Version of module description: Gültig ab summerterm 2013

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

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

Description of Examination Method:
The learning outcomes will be examined in a 90-minutes test with relevant questions about selected enzymatic reaction mechanisms. The students shall be able to describe and to reflect known mechanisms. Furthermore the students shall be able to classify and to develop unknown reaction mechanisms further in a conceptual manner. (calculator is allowed)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for the successful participation are skills in enzyme kinetics as well as profound knowledge in chemical reaction basics.

Content:
Despite a manageable amount of proteinogenic amio acids and enzymatically important cofactors, the multitude of enzyme catalyzed reactions are very versatile. This module gives a broad spectrum about enzymatic reaction mechanisms of many different enzyme classes. Based on this knowledge, the module conveys ways how new and artificial enzyme catalyzed conversion can be developed. Furthermore, recent examples will give a picture how enzymatic reaction can be used within chemical synthesis routes.

Intended Learning Outcomes:
After attending the lecture the students are able to understand chemical reactions that are catalyzed by enzymes. Furthermore they can estimate, which chemical reaction can be possibly achieved enzymatically, and how to proceed to establish new and artificial enzyme catalyzed reactions. Attending the seminar deepens the knowledge obtained in the lecture. Knowledge obtained in the lecture will be applicable to selected examples. Furthermore the students will

be trained to present scientific results in short presentations before the audience as well as to evaluate topics, which have been and haven’t been covered in the lecture, touching the following subject areas:
1. Chemical reactions, that are catalyzed by enzymes
2. Which principals are used by enzymes to catalyze chemical reactions
3. Derivation of enzymatic reaction mechanisms by means of known and unknown reaction mechanisms

Teaching and Learning Methods:
In the lecture (2 SWS), PPT presentations and board writings will be used to introduce and to explain selected enzyme reaction mechanisms.
In the seminar, the students independently compile and develop specific enzymatic reaction mechanisms. The students will present this knowledge to the audience and discuss the findings with their colleagues. Furthermore, the whole module (lecture and seminar) will convey knowledge how far enzymatic reaction mechanisms can be modified to create new and artificial enzyme catalyzed conversions. The slides will be supplied online after each lecture and seminar.

Media:
PPT, board writings, Handouts.

Reading List:
Perry A. Frey und Adrian D. Hegeman, Enzymatic Reaction Mechanisms, Oxford Univ Press, 2006

Responsible for Module:
Volker Sieber (sieber@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

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

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organische Chemie; Biochemie

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

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

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

Media:
Folien / Powerpoint / Tafelarbeit

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

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

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

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

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

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

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
keine

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

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

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

Media:
Vorlesungsskript

Reading List:

Responsible for Module:
Dieter Langosch langosch@tum.de

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

Module Description

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

Version of module description: Gültig ab summerterm 2013

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

Responsible for Module:
Arne Skerra skerra@tum.de

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

Module Description

WZ2226: Project Seminar Membrane Proteins | Projektseminar Membranproteine

Version of module description: Gültig ab winterterm 2012/13

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

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Hauptfach Biochemie oder Proteinbiochemie im Masterstudium

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

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

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

Media:
wissenschaftliche Fachartikel

Reading List:
wissenschaftliche Primärliteratur

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

Reading List:
Script for the lecture

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

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

Intensivkurs Proteomics (Übung, 3 SWS)
Küster B [L], Küster B, Ludwig C, Schneider A, The M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2539: Seminar on Microbial Effectors | Proseminar Mikrobielle Wirkstoffe

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
In the oral examination (30 min) the students show that they are able to present and competently discuss a previously agreed microbiological topic on microbial active ingredients in a PowerPoint presentation in a clear and understandable way and to summarize the essential points of the topic in writing as a handout. The quality and clarity of the lecture/handout and the competence of the discussion of questions on the topic are included in the grade with a weighting of 70:30.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Knowledge of the basics of microbiology (lecture General Microbiology), human biology and biochemistry is required.

Content:
In this module current topics from the field of production and mode of action of mikrob. active ingredients, for example toxins, bacteriocins, antibiotics, pathogenicity factors and pathogenicity mechanisms of bacterial pathogens.

Intended Learning Outcomes:
After completing this module, students are able to
"Gain new up-to-date knowledge on basic topics of microbiology using various pathogenic microorganisms.
"Acquire the ability to present scientific contents of microbiology in an understandable form.
" To promote critical and creative thinking and to develop skills for professional discourse.
"To promote interest in microbiology, microbiological problems and the importance of microorganisms for humans and the environment.

The acquired knowledge prepares students for independent preparation of scientific lectures and their presentation.

Teaching and Learning Methods:
Event type/teaching technique: seminar; teaching method: seminar presentations by the participants; subsequent discussion of the presentations.
Learning activities: study of literature, preparation of presentations, critical examination of contents and presentation performance through discussion with the lecturer.

Media:
Presentations using PowerPoint, handouts.

Reading List:
Individually selected primary literature.

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Proseminar - mikrobielle Wirkstoffe [MID WZ2539] (Seminar, 2 SWS)
Liebl W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2580: Protein Engineering | Protein-Engineering

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

Content:
In diesem Modul werden die wissenschaftlichen Methoden und Arbeitstechniken des Protein-Engineerings auf theoretischer Grundlage diskutiert. Schwerpunkte sind die gentechnische Produktion von Proteinen in Bakterien (cytoplasmatisch und periplasmatisch), Verfahren zur ortsgerichteten Mutagenese, Herstellung von Genbibliotheken, Selektions- und Screening-Methoden sowie Verfahren zur Bestimmung der Affinität zwischen Proteinen (z.B. Antikörpern, Rezeptoren) und ihren Liganden oder Wechselwirkungspartnern sowie ggf. der enzymatischen Aktivität. Des weiteren wird im Modul das Potential gentechnisch hergestellter Proteine als neue

Generation von biologischen Arzneimitteln erläutert. Die pharmakologischen Eigenschaften (Affinität zu medizinisch relevanten Zielstrukturen, Effektorfunktionen, Plasma-Halbwertszeit) können durch Protein-Engineering wie auch mit proteinchemischen Methoden gezielt manipuliert werden. Anhand aktueller Fallbeispiele (Insulin, Wachstumsfaktor, humanisierte Antikörper usw.) wird die Entwicklung und Optimierung innovativer Biopharmazeutika mittels Protein-Engineering dargestellt.

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

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

Media:
Die Vorlesungen erfolgt mit graphischen Präsentationen (Projektor und PowerPoint). Die Folien werden den Studierenden in elektronischer Form zugänglich gemacht.

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

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

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

Methodische Grundlagen des Protein-Engineerings (Vorlesung, 1 SWS)

Skerra A [L], Schlapschy M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0056: Technical Biocatalysis | Technische Biokatalyse

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The learning outcomes will be examined in a 90-minutes written test. With this exam, the students prove that they are able to realize and understand problems occurring in applied biocatalysis concerning enzyme immobilization and large-scale supply of enzymes, for example. Moreover they are able to solve those problems within a limited period of time. The answers will require calculations, written text and optional multiple choice answering. Use of one calculator during the exam is permitted.

The exercise does not include an examination of its own. Rather, the exercise is intended to help prepare students for the exam of the lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites for the successful participation is knowledge about enzymatic processes, molecular biology, bioprocess engineering and general fundamental principles of organic and inorganic chemistry.

Content:
The lecture technical biocatalysis will give a broad overview of the use of enzymes in industrial processes and current examples will convey a detailed insight into the technically important aspects. Main contents are:
Industrial relevant enzyme properties, essential enzyme classes and their mechanisms, whole cell catalysis vs. enzymatic catalsysis, biocatalysis vs. classical chemical catalysis, methods for enzyme immobilization, enzymes in aqueous and in non-aqueous systems, enzymatic reactions combined with chemical reactions, large-scale supply of enzymes.

Intended Learning Outcomes:
After attending the module, the students are able to evaluate the application of enzymes in different chemical and technical processes. They are able to understand and to reflect the behavior and the limitations of enzymes within those processes and they are able to plan sensible strategies to establish chemical conversions biocatalytically, as well as suggesting technical scenarios for new biocatalytical processes.

Teaching and Learning Methods:
The module consists of a lecture (2 SHPW). The lecturer uses PowerPoint slides and board writings to convey theoretical groundwork and technical important aspects for the application of enzymes in industrial processes. The PPT slides are supplied online after each lecture.

The exercise is carried out with the help of PowerPoint presentations and blackboard writing. Students present any homework on the blackboard or with the help of a PowerPoint presentation. The exercise serves to deepen the topics covered in the lecture and serves the students during exam preparation. The topics of the lecture will be taken up and explained and illustrated by means of exemplary exam questions to make it easier for the students to prepare for the exam.

Media:
The lecture presentation will be held with powerpoint and adobe acrobat reader and black board writings. The students will gain access to all of the necessary slides via moodle.

Reading List:
Reinhard Renneberg, Darja Süßbier, Biotechnologie für Einsteiger, 3. Auflage, Spektrum Verlag Heidelberg 2010
A. Liese, K. Seelbach, C. Wandrey, Industrial Biotransformations, Wiley-VCH, 2006
Wolfgang Aehle, Enzymes in Industry, Wiley-VCH-Verlag Weinheim, 2007,
Drauz, Gröger, May, Enzyme Catalysis in organic Synthesis 3rd Ed., Wiley-VCH, 2012
Klaus Buchholz, Volker Kasche, Uwe T. Bornscheuer, Biocatalysts and Enzyme Technology, Wiley-VCH, 2005
Wim Soetaert, Erick J. Vandamme, Industrial Biotechnology, Wiley-VCH, 2010

Responsible for Module:
Volker Sieber (sieber@tum.de) Jörg Carsten (Joerg.carsten@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zur Vorlesung Technische Biokatalyse (Übung, 1 SWS)
Sieber V [L], Kolaitis G, Steiger M

Technische Biokatalyse (Vorlesung, 2 SWS)
Sieber V [L], Sieber V, Kolaitis G, Steiger M
For further information in this module, please click campus.tum.de or here.

Modules after consulting "Biomolecules" | Module nach Rücksprache "Biomoleküle"

Module Description

CH4790: Advances in Cryo-Electron Tomography | Advances in Cryo-Electron Tomography

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
The assessment will be done in the form of an 25 minutes oral examination. The aim for the students is to demonstrate their ability to know and understand the basics of cryo-EM, the functional relationships between microscope and image formation and its application to three-dimensional image processing.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
No prerequisits necessary.

Content:
1.Essentials of the methodology, instrumentation and electron optics; 2.Contrast, dose and image formation; 3.A small excursion into reciprocal space - Mr. Tompkins meets Mr. Fourier; 4.Microscope operation, alignments, optical setups and image recording; 5.“A picture is worth a thousand words” – basics of image analysis; 6.The nitty-gritty of specimen preparation (cells frozen in time); 7.Micromachining with the focused ion beam – “cold cuts of cells”; 8.Markers, fiducials and tags – Useful little helpers; 9.Tomography – The best practice to get a tomogram; 10.Three-dimensional (3D) reconstruction – Secrets and solutions; 11.3D image analysis – “Beating the noise, boosting the signal” – Sub-tomogram averaging and classification; 12.Segmentation and visualization – Mr. Tompkins in a 3D-Wonderland

Intended Learning Outcomes:
We will offer a lecture series and a guide on how to do cryo-electron tomography as of today. We explain and show how cryo-ET has advanced, what is now state-of-the-art and what can be expected in the future. Mr. Tompkins, the protagonist of a series of popular science books by the Russian physicist George Gamow, will accompany us on our fantastic voyage to the inner space of cells by cryo-ET. Tomography on frozen-hydrated cells is a formidable tool to visualize cells with the transmission electron microscope (TEM) in three dimensions (3D) and at molecular resolution. Cryo-electron tomography has a lot in common with cryo-electron microscopy (cryo-EM) and single-particle analysis (SPA). However, there are decisive differences and one is quite apparent: tomography allows imaging of molecules in cells quasi in vivo, while in SPA molecules are investigated separate and apart from their cellular hosts and their interacting partners, thus in vitro. Tomography therefore can be used to image the cellular proteome and to study the biogenesis of molecules and proteins as well as their degradation in their native environment. Moreover, protein and functional networks and the intricate connections of biological pathways can be visualized and examined directly within the cellular context.
The aim of this lecture series and the practicals is to build the basis to understand and perform cryo-electron tomography in both theory and practice. After succesful completion of the module, students are able to: 1. to know and understand the basics of cryo-electron microscopy and tomography in theory and praxis; 2. to know and understand processes and workflows in cryo-EM/ET; 3. to remember fundamental principles of the image formation in EM and to explain the underlying physical basics; 4. to know and understand methods for three-dimensional image processing and to apply them on their own;

Teaching and Learning Methods:
Lecture course and practical course; Lecture and practicals

Media:
PowerPoint, films, remote microscope demonstration and operation, whiteboard

Reading List:
1. Electron Tomography - Methods for Three-Dimensional Visualization of Structures in the Cell. Edited by Joachim Frank: Springer; 2006. 2. Plitzko JM and Baumeister W. Chapter 7 – Cryo-electron tomography (CET). In Science of Microscopy. Edited by Peter Hawkes and John Spence: Springer; 2006, 1: 535-604. (new edition expected 2018)

Responsible for Module:
Plitzko, Jürgen Michael; Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advances in cryo-electron tomography – “Mr. Tompkins explores the cryo-world’s wonders” (CH4790) (Vorlesung, 2 SWS)
Plitzko J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0453: Methods in Protein Biochemistry | Methoden der Proteinbiochemie

Version of module description: Gültig ab summerterm 2012

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 27	**Self-study Hours:** 12	**Contact Hours:** 15

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

Description of Examination Method:
Time allowed (min.): 90.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in microbiology, genetics and biochemistry

Content:
In this lecture, a fictitious example is used to explain step by step the way to produce a protein recombinantly in microorganisms.
First of all, the legal requirements to be observed when handling genetically modified organisms are discussed.
The main part of the lecture then focuses on the methods used in the laboratory to genetically modify microorganisms to express a foreign gene. Here, the focus is especially on achieving high yields and the resulting economic considerations when implementing the method in a production process.
Furthermore, the fundamentals of fermentation are discussed and strategies for its optimal use on a technical scale are discussed.
A chapter on protein purification rounds off the lecture and is at the same time the transition to the practical course "Methods in Protein Biochemistry", which is a useful supplement to the lecture and focuses on protein purification.

Intended Learning Outcomes:
After this internship the students are able to formulate a project plan with the goal of producing and purifying a recombinant protein on a technical scale.

Teaching and Learning Methods:
with media support
The lecture will be recorded on video and is available for download in the TUM learning platform.

Media:

Reading List:
The lecture script can be found on the central learning platform of TUM.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Methoden der Proteinbiochemie (Vorlesung, 1 SWS)
Gütlich M
For further information in this module, please click campus.tum.de or here.

Cells | Zellen

Module Description

WZ2626: Applied Microbiology | Angewandte Mikrobiologie

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Regular and active student participation is expected. A written exam (60 min, graded) serves as proof of the theoretical knowledge acquired in the lecture courses. In the exam, the students demonstrate their ability to structure the body of acquired knowledge, e.g. about metabolic pathway-based compound conversion and its consequences for biotechnology and environment or about the effects of changes/manipulations in the metabolism on biosynthetic performance (see anticipated learning goals), and to summarize the important aspects of the study matter. The students should be able to describe, interpret, combine in a meaningful way the information learnt, and to transfer this knowledge to similar issues.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good background knowledge in organic chemistry and biochemistry is of advantage for a better understanding of the lecture courses.

Content:
Basic knowledge about metabolic pathways (biosynthetic and degradative capabilities) in microorganisms is repeated and extended in the lecture courses. Furthermore, advanced-level knowledge about the metabolism of microorganisms, in particular prokaryotic microorganisms, and about the application of microorganisms in biotechnological processes is tought. The contents include central metabolism and connected biotechnologically relevant biosynthetic pathways for primary and secondary metabolites, as well as for biopolymer production. Further contents are degradation pathways for sugars, polysaccharides, lignin, proteins, nucleic cids, xenobiotica. Selected examples help to illustrate the applications of organisms and/or their enzymes as well

as the optimization of microorganisms and their metabolism for improved production processes in biotechnology.

Intended Learning Outcomes:
After completion of the courses of this module the students have acquired an advanced level of theoretical understanding about the metabolic capabilities of microorganisms and their application potential in biotechnological processes.
The module should further help develop the ability to solve problems, and boost the students' interest for microbiological issues and for the important role of microorganisms for mankind and the environment.

The students are able to
" understand interconnections between metabolic pathways and conversion of compounds by microorganisms.
" understand, by virtue of selected examples, the effects of changes/manipulations in the metabolism on biosynthetic performance.
" understand, by virtue of selected examples, the effects and consequences of degradation processes in biotechnology and environment.
" apply the acquired knowledge to in-depth problems.

Teaching and Learning Methods:
Form/technique of teaching: lecture courses. Teaching method: oral lecture.
Learning activities: study of lecture handout scripts and own notes.

Media:
Presentations unsing PowerPoint,
Handout script (download option for lecture material).

Reading List:
There is no textbook available that comprehensively covers all content matter of this module.
Some aspects are covered in the following books:
Fuchs G. (Hrsg.) Allgemeine Mikrobiologie. 8. Auflage, 2007. Georg Thieme-Verlag Stuttgart.
Antranikian G. (Hrsg.) Angewandte Mikrobiologie. 2006. Springer-Verlag Berlin Heidelberg.

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

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

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

Module Description

WZ2582: In vitro Models in Cell Biology | In vitro-Modelle der Zellbiologie

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Die Studierenden zeigen anhand der benoteten Klausur (60 min), ob sie in der Lage sind verschiedene Methoden zur Untersuchung zellulärer Signalübertragung zu erläutern und bezüglich ihrer Einsatzbereiche gegeneinander abzugrenzen. Darüber hinaus müssen sie zur Lösung zellbiologischer Fragestellungen geeignete Methoden auswählen, die Auswahl begründen und die daraus resultierende wissenschaftliche Aussagekraft bewerten. Die Klausurnote bildet die Gesamtnote des Moduls.
Die Vorlesung wird ergänzt durch Arbeitskreise (4-6 Personen), in denen einzelne Themen bzw. Fragestellung der Vorlesung intensiver bearbeitet werden. Die Studierenden diskutieren die Resultate ihrer Arbeitskreise in Kurzpräsentationen (10 min pro Gruppe). Diese Präsentationen werden nicht benotet (Studienleistung).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zur erfolgreichen Teilnahme am Modul wird das Basiswissen Zellbiologie aus dem BSc-Studium Molekulare Biotechnologie vorausgesetzt. Für das Modul wesentliche Grundlagen werden im einführenden Abschnitt "Signaltransduktion" nochmals aufgegriffen und vertieft.

Content:
In der Vorlesung werden methodische Ansätze zur Aufklärung zellulärer Signaltransduktion vorgestellt und an ausgewählten Beispielen erläutert. Im Anschluss an ein einführendes Repetitorium auf BSc-Niveau zum Thema Signaltransduktion werden im Schwerpunkt experimentelle Strategien/Techniken zur Aufklärung zellulärer Signalwege nicht nur vorgestellt (z.B. Charakterisierung und Nachweis molekularer Interaktion in vitro, PTM-Assays, Genexpressionsanalyse etc.), sondern anschließend auch deren Potential und Limitierungen

an ausgewählten Fallbeispielen diskutiert. Dito, wird mit dem zweiten Schwerpunktthema „Zellkulturen“ verfahren. Insbesondere werden hier Aspekte der Zellkultur hervorgehoben, die Einfluss auf Resultate/Schlussfolgerungen der zellbiologischen Experimente zeitigen können (Themen: Zelllinien, Seneszenz, Immortalisierung, Kultursysteme, Einzelzellanalyse etc.). Darüber hinaus haben die Studierenden die Möglichkeit das Repertoire der Vorlesung durch selbst gewählte Themen zu erweitern. Diese Themen werden in Arbeitskreisen von 4-5 anhand aktueller Literatur aufbereitet und in Form einer 10-minütigen Präsentation mit anschließender Diskussion präsentiert.

Intended Learning Outcomes:
Nach Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, aus dem Methodenspektrum zur Erforschung der zellulären Signaltransduktion geeignete Strategien auszuwählen, zu kombinieren und gezielt einzusetzen.
Sie können die Auswirkung technischer Manipulationen/Applikationen auf zelluläre Reaktionen, insbesondere auf Signalwege einschätzen und diesen Aspekt bei der Konzeption von Experimenten sowie der Interpretation der Resultate entsprechend berücksichtigen.

Teaching and Learning Methods:
Lernaktivitäten: Interaktiver Austausch und Anregung zur Diskussion in der Vorlesung, Studium von Vorlesungsskript, -mitschrift und Literatur; Zu selbst gewählten Themen und Fragestellungen arbeiten die Studierenden in kleinen Gruppen und stellen ihre gemeinsamen Ergebnisse als Kurz-Präsentation vor.

Media:
Präsentationen mittels PowerPoint (Downloadmöglichkeit für Vorlesungsmaterial); Tafelarbeit

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Das Präsentationsmaterial wird durch spezifische Literaturhinweise für die einzelnen Themen ergänzt.

Responsible for Module:
Küster, Bernhard; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
In vitro-Modelle der Zellbiologie (Vorlesung, 3 SWS)
Kramer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2375: Evolution of Pathogens | Evolution von Krankheitserregern

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Die Studierenden zeigen in einer benoteten Klausur (60 min), dass sie das in der Vorlesung und in den Übungen erworbene Wissen zu grundlegenden mikrobiellen Evolutionsprozessen (z.B. molekulare Quellen der Variabilität bakterieller Genome, Darwin'sche Selektionsprozesse, neutrale Evolution nach Kimura) auf Problemstellungen der Evolution von Krankheitserregern anwenden können. Sie zeigen in der Klausur, dass sie in der Lage sind, in begrenzter Zeit und ohne Hilfsmittel den Erwerb und die nachfolgende Evolution von Pathogenitätsfaktoren (wie beispielsweise Toxine, Pathgenitätsinseln) sowie die molekularen Evolutionsprozesse, welche der de novo Entstehung, Adaptation sowie der Verbreitung von Antibiotikaresistenzen zugrunde liegen, kritisch modellieren und diskutieren zu können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Kenntnisse in Allgemeiner Mikrobiologie, Molekularer Bakteriengenetik und Biologie pathogener Bakterien.

Content:
Teil 1, Einführung in die Evolutionsbiologie: Methoden der Evolutionsforschung, Entstehung von Variabilität in Individuen, Fixierung von Allelen in Populationen.
Teil 2, Bakterielle Genome und Populationsstrukturen: Bakterielle Genome als Ergebnis fixierter Mutationen, Typisierung bakterieller Populationen, Infraspezifische phylogenetische Populationsanalyse.
Teil 3, Evolution von Antibiotikaresistenzen: Wirkungen von Antibiotika, Ökologie des mikrobiellen Resistoms, Mechanismen der Antibiotikaresistenz, Evolution von Antibiotikaresistenzen.
Teil 4, Ökologie als angewandte Evolutionsbiologie: Ökologische Rahmenbedingungen, Invertebraten und Vertebraten als Wirte, Wirtswechsel, Populationsökologie, Virulenzgentransfer

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

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss dieses Moduls kennen die Studierenden die grundlegenden Methoden der Evolutionsforschung sowie experimentell belegte Evolutionsprozesse bei Prokaryonten und sind in der Lage ihr Wissen auf molekularbiologische und epidemiologische Daten (z.B. Antibiotikaresistenzevolution, Populationen von Pathogenen) anzuwenden. Darüber hinaus sind die Studierenden in der Lage experimentell nicht reproduzierbare Konzepte aus der vergleichenden Biologie (z.B. Sequenzvarianzen, Existenz von Pathogenitätsinseln, reduzierte Genome) vor dem Hintergrund der in der Vorlesung erlernten, experimentell verifizierten Evolutionsprozesse zu interpretieren und Evolutionshypothesen zu formulieren. Diese Fähigkeit wird durch kritische Lektüre von Fallstudien aus der Literatur und deren Diskussion in der Gruppe eingeübt.

Teaching and Learning Methods:
Lehrtechniken: Vorlesung mit begleitender Übung.
Lehrmethode: Vortrag, Fallstudien, interaktiver Diskurs mit Studenten während der Vorlesung.
Lernaktivitäten: Auswendig lernen; Lösen von Übungsaufgaben; Studium von anspruchsvoller Originalliteratur als Hausaufgabe; Präsentation in Kurzform in den Übungen; gemeinsame kritische Analyse der in den Originalarbeiten angewendeten Problemlösungsstrategien in der Gruppe.

Media:
Tafelanschrieb, Powerpoint Präsentationen, Vorlesungsfolien

Reading List:
Leider existiert kein Lehrbuch, die Qellen des unterrichteten Stoffs sind daher auf den Vorlesungsfolien zum Selbststudium angegeben. Als Unterstützung wird folgendes allgemeines Lehrbuch zur Evolutionsbiologie empfohlen: Barton et al (2007) Evolution. Cold Spring Haror, New York.

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

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

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

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

Description of Examination Method:
Prüfungsdauer (in min.): 60 schriftlich.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (60 min, benotet) dient der Überprüfung der in der Vorlesung erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind Kenntnisse der Grundlagen der Mikrobiologie (Vorlesung Allgemeine Mikrobiologie). Zum besseren Verständnis sind gute Kenntnisse in organischer Chemie und Biochemie vorteilhaft.

Content:
Übersicht über Erkrankungen durch Pilze, Pathogenitätsfaktoren auf molekularer Ebene, Mykotoxine, Allergene bei Pilzen, Antimykotika und ihre Wirkmechanismen, Resistenzmechanismen, Materialschädigung und Lebensmittelverderb durch Schimmelpilze, Chemie der antimyzetischen Maßnahmen.

Intended Learning Outcomes:
Nach der Teilnahme an dem Modul besitzen die Studierenden einen breiten Überblick und zum Teil vertiefte theoretische Kenntnisse über filamentöse Pilze und Hefen und ihre Rolle als pathogene Mikroorganismen, Interaktionen zwischen Pathogen und Wirt, sowie die Rolle von Pilzen bei Material- und Lebensmittel-schädigenden Vorgängen. Sie sollen

" in der Lage sein, wichtige pilzliche Krankeitserreger einschließlich der durch sie verursachten Krankeitsbilder zu benennen.
" beispielhaft molekulare Mechanismen von Pathogenitätsfaktoren, Antibiotikawirkung und -resistenz zu benennen und erläutern können.
" ein Verständnis über die Möglichkeiten zurr Behandlung von Infektionen durch Pilze entwickeln.
" lernen, das erworbene Wissen auf vertiefte Fragestellungen anwenden.
Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an Mikrobiologie fördern.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung Lehrmethode: Vortrag, Demonstrationen
Lernaktivitäten: Studium von Vorlesungsskript und -mitschrift, ggf. Literaturstudium.

Media:
Präsentationen mittels Powerpoint, praktische Demonstrationen

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

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de) Köberle, Martin, Dr. rer. nat. martin.koeberle@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Mykopathologie (Vorlesung, 2 SWS)
Liebl W [L], Köberle M
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

Module Description

WZ2372: Pathogenic Microorganisms | Mikroorganismen als Krankheitserreger

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Lecture and practical course General Microbiology

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

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

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

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

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

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

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

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

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

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

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

Einführung in Biologie pflanzenpathogener Mikroorganismen (Vorlesung, 1 SWS)

Durner J

Einführung in die Biologie humanpathogener Bakterien (Vorlesung, 2 SWS)
Hall L
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2402: Microbial Toxins in Food | Mikrobielle Toxine in der Nahrung

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
Die Studierenden weisen in einer benoteten Klausur (60 min) nach, dass sie in der Lage sind in begrenzter Zeit und ohne Hilfsmittel ihr Fachwissen über mikrobielle Toxinbildner, deren Habitaten und Toxinen darzustellen. Zudem sollen sie grundlegende toxikologische Arbeitstechniken beschrieben sowie toxikologische Probleme mikrobieller Herkunft in ihrer Bedeutung für die Lebensmittelsicherheit einordnen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Anatomie, Physiologie und Biochemie.

Content:
Vermittlung toxikologischer und analytischer Grundlagen. Darstellung relevanter Bakterien-, Pilz- und Algentoxine: Ökologie der Toxinbildner; biochemische und pathophysiologsiche Wirkungen der Toxine; Vorkommen in der Nahrungskette ("carry over"); Prophylaxemaßnahmen, gesetzliche Reglementierungen.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das grundlegende theoretische Verständnis und Fachwissen über mikrobielle Toxinbildner, deren Habitaten und deren Toxine. Weiterhin haben sie grundlegende toxikologische Arbeitstechniken (z.B. Zellkulturversuche, LC-MS/MS) erlernt und geübt. Sie können toxikologische Probleme mikrobieller Herkunft analysieren und bewerten.
Das Modul soll weiterhin Fähigkeiten zum Lösen von Problemen entwickeln helfen, sowie das Interesse an mikrobiellen Toxinen und deren Bedeutung für die Lebensmittelsicherheit fördern.

Teaching and Learning Methods:
Vorlesung und Übungen im Labor

Media:
PowerPoint

Reading List:

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

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

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A good background knowledge in organic chemistry and biochemistry is of advantage for a better understanding of the lecture courses.

Content:
In the courses of this module, basic knowledge about the phylogenetic and metabolic diversity of microorganisms and their role for the environment, mankind and biotechnology, is repeated and extended with advanced-level knowledge. The contents include for example cell-cell-communication and developmental processes in particular with prokaryotic microorganisms, systematics and phylogeny, adaptation of m icroorganisms to their habitats, the role of microorganisms in selected habitats, in global element cycles, and in selected technical processes (e.g., wastewater treatment). In seminar presentations, changing groups of microorganisms and

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

Intended Learning Outcomes:
After completion of the courses of this module the students have acquired an advanced level of theoretical understanding about relationships among microorganisms, the adaptation of microorganisms to various environmental conditions, the role of their metabolic capabilities for mankind and nature, and about the processes of cell-cell-communication and cellular differentiation. They should be able to
" understand and critically discuss various methods of identification, differentiation and taxon affiliation in microbial systematics.
" understand the diversity of microbes and microbial communities in natural habitats.
" understand, by virtue of selected examples, the interconnections between metabolic pathways and the conversion of substances by microorganisms and the environment.
" to work independently on a topic in the field of microbial diversity and to present and discuss the gained knowledge competently and in a well understandable way to an audience.
" apply the acquired knowledge to in-depth problems.
The module should further help develop the ability to solve problems, and boost the students' interest for microbiological issues and for the important role of microorganisms for mankind and the environment.

Teaching and Learning Methods:
Form/technique of teaching: lecture courses. Teaching method: oral lecture.
Learning activities: study of lecture handout scripts and own notes. Preparation, presentation and discussion of short lectures by students.

Media:
Presentations unsing Powerpoint,
Handout script (download option for lecture material).

Reading List:
There is no textbook available that comprehensively covers all content matter of this module.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Proseminar - mikrobielle Diversität (Seminar, 2 SWS)
Liebl W

Mikrobielle Diversität und Entwicklung (Vorlesung, 2 SWS)
Liebl W, Ehrenreich A
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Die Studierenden zeigen in einer benoteten Klausur (60 min), dass sie einen Einblick in das breite Spektrum der
mikrobiologischen Diagnostik gewonnen haben und einschätzen können, welche Aussagekraft verschiedene Methoden für die Identifizierung und Differenzierung diverser Mikroorganismen haben. Dafür sind keine Hilfsmittel zulässig.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzung sind Kenntnisse der Grundlagen der Mikrobiologie (Vorlesung Allgemeine Mikrobiologie).

Content:
Übersicht über moderne Methoden der Identifizierung und Differenzierung von Pilzen und ihre Anwendungsmöglichkeiten: klassische kulturelle Methoden, molekularbiologische Methoden, physikalische-chemische Methoden, immunologische Methoden.

Intended Learning Outcomes:
Durch die Teilnahme an dem Modul gewinnen die Studierenden einen Einblick in das breite Spektrum der mikrobiologischen Diagnostik, einschließlich ihrer jeweiligen Vorzüge bzw. Einschränkungen in der Praxis. Sie lernen einzuschätzen, welche Methoden für welche Mikroorganismen geeignet sind und welche Aussagekraft welche Methoden bei der Identifizierung und Differenzierung verschiedener Keime besitzen.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung Lehrmethode: Vortrag, Demonstrationen
Lernaktivitäten: Studium von Vorlesungsskript und -mitschrift, ggf. Literaturstudium.

Media:
Präsentationen mittels Powerpoint, praktische Demonstrationen

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

Responsible for Module:
Wolfgang Liebl (wliebl@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Moderne Methoden mikrobiologischer Diagnostik (Vorlesung, 2 SWS)
Köberle M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2496: Molecular and Medical Virology | Molekulare und Medizinische Virologie

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
Die Modulprüfung besteht aus einer Klausur (90min, benotet) in der die Studierenden grundlegende und vertiefte Kenntnisse der Virologie abrufen und anwenden sollen.
Die Prüfungsleistung wird am Ende des 2. Vorlesungssemesters (SS) erbracht. Die Wiederholungsklausur findet in der vorlesungsfreien Zeit zu Beginn des darauf folgenden WS Semesters statt.
In der Prüfung soll nachgewiesen werden, dass Grundlagen der Virologie inkl. molekularer und medizinisch relevanter Aspekte verstanden und wichtige funktionelle Zusammenhänge der Virus-Wirt-Interaktion analysiert werden können.
Das Beantworten der Fragen erfordert teils eigene Formulierungen und teils Ankreuzen von vorgegebenen Mehrfachantworten. Es sind keine Hilfsmittel erlaubt.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Kenntnisse der Molekularbiologie und Grundkenntnisse in Zellbiologie und Immunologie

Content:
Allgemeine Themen der molekularen Virologie (z.B. Viruseintritt in Wirtszellen, Replikationsstrategien von RNA und DNA Viren, Expressionskontrolle, Virusassembly), Virusfamilien (z.B. Toga-, Flavi, Herpes-, Myxo, Hepatitis-, Retroviren); medizinische Aspekte der Virologie (z.B. angeborene und adaptive Immunreaktionen gegen Viren, Immunevasion, Impfungen, Emerging viruses, onkogene Transformation, virale Vektoren)

Intended Learning Outcomes:
Nach dem Besuch des Moduls versteht der Studierende die grundlegenden Prinzipien der Virologie, kennt die Merkmale bedeutender Virusfamilien und die wichtigsten Mechanismen der Virus-Wirt-Beziehung

Teaching and Learning Methods:
Vorlesungen mit Unterstützung durch PowerPoint Präsentationen, die Folien werden zum Download bereitgestellt

Media:

Reading List:
Flint et al., Principles of Virology I and II, ASM Washington
Modrow et al., Molekulare Virologie, Spektrum Verlag 2010

Responsible for Module:
Protzer, Ulrike; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare und medizinische Virologie (Teil 1 und 2) (Vorlesung, 2 SWS)
Protzer U [L], Protzer U, Baer de Oliveira Mann C, Ebert G, Kosinska A, Möhl-Meinke B, Pichlmair A, Vincendeau M, Wettengel J
For further information in this module, please click campus.tum.de or here.

Organisms | Organismen

Module Description

WZ2589: Animal Biotechnology | Biotechnologie der Tiere 1+2

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In a graded written exam (90 min), the students show whether they are able to describe and compare methods for the generation of genetically modified cells and animals in a differentiated manner. They demonstrate that they can use this knowledge in a targeted manner to address scientific questions and to apply the knowledge they have acquired in an exemplary manner.
The written exam tests whether the students know what types of stem cells are isolated for, know their possible applications in research and biomedicine, and know what the challenges are in cell, tissue and organ transplantation. Students demonstrate that they can independently develop approaches to address theoretical problems in regenerative medicine.

Repeat Examination:
Next semester

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

Content:
The lecture will first teach different methods for generating genetically modified mammalian cells and mammals. These include microinjection, the use of viral vectors, transposons, RNAi, nucleases, nuclear transfer, genome editing (Crispr/Cas9), precise genetic manipulation by homologous recombination, and derivation of pluripotent stem cells in the different animal species and in humans. For each method, the advantages and disadvantages will be discussed and examples of applications will be presented (for example: generation of pharmaceutical proteins, generation of animal models for human diseases).

In the second part of the lecture, different approaches in regenerative medicine are taught, including xenotransplantation, allo- and autologous transplantation, and stem cell therapy with adult and pluripotent stem cells. Knowledge is acquired in the differentiation, de-differentiation and trans-differentiation of cells. The advantages and disadvantages of different therapeutic strategies are discussed and current examples of medical applications are given. Where relevant, ethical and social aspects will be addressed.

Intended Learning Outcomes:
After participating in the module courses, students will have the basic theoretical understanding and expertise in genetic engineering methods to generate transgenic animals for biomedical applications and have basic knowledge in regenerative medicine. They are able to:
" understand genetic engineering issues and working techniques and develop technical questions on their own. " to what extent xeno-transplantation is a realistic option for cell, tissue or organ transplantation and what genetic modification is required in animals for this purpose.
" how pluripotent stem cells can be specifically differentiated and which cells can be used for autologous or allogeneic transplantation and what the limitations are.
" they are able to apply the acquired knowledge to in-depth questions.
"They are able to identify the best possible techniques for specific questions and possibly implement them experimentally.

Teaching and Learning Methods:
Type of event/teaching technique: Lecture
Learning activities: Study of lecture notes, lecture transcript

Media:
Script (download option for lecture material)

Reading List:
Transgenic Animal Technology: A Laboratory Handbook by Carl A. Pinkert
Principles of Cloning by Jose Cibelli et al.
Molekulare Biotechnologie by Bernard Glick & Jack Pasternak
Gene Targeting: A PracticalApproach by Alexandra L. Joyner
Tier-Biotechnologie von Hermann Geldermann

Responsible for Module:
Flisikowski, Krzysztof; Dr habil. krzysztof.flisikowski@tum.de

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

Biotechnologie der Tiere 1 Vorlesung (Vorlesung, 2 SWS)
Flisikowska T, Flisikowski K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1696: Crop Genomics | Crop Genomics

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Crop Genomics (Vorlesung mit integrierten Übungen, 4 SWS)
Ouzunova M, Mayer K, Haberer G, Urzinger S (Guffanti F)
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0308(2): Developmental Genetics | Entwicklungsgenetik

Version of module description: Gültig ab summerterm 2012

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:**
Credits:* 3	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse der Biologie (insbesondere Zellbiologie und Genetik)

Content:

Intended Learning Outcomes:
Am Ende der Veranstaltung sollen die Studenten
1.) Kenntnisse über die grundlegenden zellbiologischen Vorgänge der tierischen Entwicklungsbiologie besitzen;
2.) die Prinzipien der molekularen Regulation dieser Prozesse benennen und erklären können

Teaching and Learning Methods:
VortragVorlesung auf Deutsch (Folien auf englisch);Vorlesung mit Fragen (im Verlauf oder am Ende der Vorlesung);Skript zur Nacharbeit während Vorlesung - kurz vor Prüfung online

Media:
1.) Molekulare Prinzipien der Entwicklungsbiologie: laterale Inhibition Organisationszentren Rechts-Links-organisation Epitheliale-Mesenchymale Transformation
2.) Molekulare Grundlagen essentieller entwicklungsbiologischer Prozesse: Befruchtung Implantation Gastrulation Achsenbildung Differenzierungsprozesse Stammzellbiologie - Altern
3.) Molekulare Grundlagen der Organogenese: Nervensystem Sinnesorgane Darm Lunge Pankreas Knochen (Extremitäten) Muskeln

Reading List:
1.) Developmental Biology, Gilbert, 9th edition; Sinauer Associates 2.) Vorlesungsskript, verteilt in Vorlesung, kurz vor Prüfung online

Responsible for Module:
Wolfgang Wurst (w.wurst@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Entwicklungsgenetik (Vorlesung, 2 SWS)
Wurst W, Hrabé de Angelis M, Beckers J, Vogt-Weisenhorn D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2480: Plant Developmental Genetics 2 | Entwicklungsgenetik der Pflanzen 2

Version of module description: Gültig ab summerterm 2012

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

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

Description of Examination Method:
Time allowed (in min.): 30 oral (VO) + 20 oral (SE).
Regular, active participation in the courses is expected. The examination will be in the form of a written examination and a presentation. The written exam (30 min) serves to test the theoretical skills learned in the lecture. In the written exam, students show whether they are able to structure the knowledge they have acquired and present the essential aspects. They should be able to describe and interpret the acquired information, combine it meaningfully and transfer it to similar situations. In the seminar (20 min) the acquired skills are tested in practice and the presentation style is worked on. The average of the exam grade and seminar grade forms the overall grade of the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
For a better understanding of the lecture a good knowledge of genetics, molecular biology and cell biology is required.

Content:
The lecture provides in-depth knowledge of plant developmental genetics. The contents are: Photomorphogenesis, flower induction, meristem identity, flower organ identity, flower organogenesis, gametophyte, fertilization process, parental control of embryogenesis. In the seminar, students discuss and present central and newer aspects of plant developmental genetics using relevant original literature.

Intended Learning Outcomes:
After participating in the module, students will have a basic understanding of selected plant development processes. They will be able to understand, analyse and evaluate developmental genetic approaches and findings in context and to present these aspects in an understandable way to a group of scientists. They can also transfer these skills to other biological questions and/or organisms. Furthermore, this module is intended to promote interest in developmental genetics and developmental biology problems and issues.

Teaching and Learning Methods:
Event type/teaching technique: Lecture, presentation.
Learning activities: Study of lecture notes, lecture notes, and literature. Processing of the podcasts. Presentation and critical classification of original literature.

Media:
Presentations via PowerPoint,
Script, audio and video podcasts (possibility to download 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:
Smith, A.M., Coupland, G., Dolan, L., Harberd, N., Jones, J., Martin, C., Sablowski, R., Amey, A. (2010) "Plant Biology", Garland Science, UK.
Leyser, O., Day, S. (2003) "Mechanisms in Plant Development", Blackwell Publishing, Oxford, UK.

Responsible for Module:
Kay Schneitz schneitz@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Entwicklungsgenetik der Pflanzen 2 (Vorlesung, 2 SWS)
Schneitz K [L], Schneitz K

Journal Club Entwicklungsgenetik der Pflanzen (Seminar, 2 SWS)
Schneitz K, Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0626: Genetics and Genomics | Genetics and Genomics

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In the written examination (60 min, Klausur) students demonstrate by answering questions under time pressure and without helping material their theoretical understanding of components, processes, mechanisms and methods to study crop and livestock genetics and genomics.
In the seminar presentation of 30-45 min (depending on the article) students show their ability to present a scientific research article in a concise way to a peer group. The presentation will be evaluated based on scientific correctness, precise summary and discussion of strengths, weaknesses and the methodology of the research, clearly designed slides and interesting as well as clear presentation style.

The goals of the module have been reached and the module has been passed when the total grade of written exam and presentation (3:2) is better than 4.1.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamental knowledge in genetics and molecular biology is highly recommended. The participants should have passed one or more bachelor level lectures in genetics, genomics, systems biology or developmental genetics.

Content:
The module is organized into topical sections, moving from classical genetics to modern genomics.

1) Classical Genetics:
a) Cell cycle, mitosis, meiosis
b) Mendel laws, genetic linkage
c) DNA as basis of inheritance

d) Transcription, translation
e) Transcription factor- and chromatin-based gene regulation
f) Mutations, regulatory variation, phenotypic variation, genotype-phenotype map

2) Genomics:
a) Genome sequencing
b) Genome assembly, Genome annotation
c) DNA-seq, WGBS, ATAC-seq, RNA-seq, HIC, ChIP-seq, single cell sequencing
d) Decomposing the genotype-phenotype map (QTL mapping, GWAS, systems genetics)
e) Population/Quantitative genomics
f) Evolutionary genomics

Intended Learning Outcomes:
At the end of the module the students can:
1) identify the key research questions and goals in the field of genetics and genomics
2) name the major molecular and technological tools used in genetics and genomics
3) explain how these tools are currently applied to crop (plant) and livestock (animal) research
4) critically analyze published results in these area of crop and livestock genetics and genomics
5) present the content of published results to their peers

Teaching and Learning Methods:
Teaching method:
The module is organized into topical sections, moving from classical genetics to modern genomics. Each section consists of lectures (2 SWS), providing the necessary conceptual/theoretical background. The content of each section is reinforced by seminars (2 SWS), in which students analyze, present and discuss selected research papers on current research covering these topics. The research papers are chosen to illustrate how the concepts and tools discussed in the lectures are applied to solve concrete research questions in crop (plant) and livestock (animal) research. Where necessary the lectures and seminars will emphasize key differences in the genetics and genomics of plants and animals.

Lectures:
The lectures will provide the conceptual/theoretical background of Genetics and Genomics. Focus will be on displaying and extracting the key research questions and tools used in these fields.

Seminars:
In the seminars, the students will analyze published articles in the field of plant and livestock Genetics and Genomics, with a particular focus on key crop (e.g. maize, rice, tomato) and livestock (e.g. cow, pig, chicken) species. The students will be able to assess how the basic research questions and tools introduced in the lectures are applied to specific breeding goals in the agricultural sector.

Learning Activity:
Study and critically analyze scientific articles in crop and livestock Genetics and Genomics

Summarize and present the content of scientific articles to a peer group
Discuss the content of scientific articles with a peer group

Media:
Presentations with PowerPoint, videos, black board

Reading List:
LECTURE:
Anthony Griffith et al, Introduction to genetic analysis, 2015 11th edition (or newer)
James Watson et al, Molecular Biology of the Gene, 2014 7th edition (or newer)
Hartl and Clark, Principles of Population Genetics 4th Edition (2007);
Charlesworth and Charlesworth, Elements of Evolutionary Genetics (2010).
Original articles used to increase the content of the lecture will be cited on the PowerPoint slides.

SEMINAR:
Original articles will be distributed to the individual speakers in the first seminar session.

Responsible for Module:
Johannes, Frank; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Genetics and Genomics (Vorlesung, 2 SWS)
Johannes F [L], Johannes F, Tellier A

Genetics and Genomics (Seminar, 2 SWS)
Johannes F [L], Johannes F, Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1035: Host-Parasite-Interaction | Host-Parasite-Interaction

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The module is rated via written examination, Klausur, (essay exam, no multiple choice, without the use of learning aids, (100 % of the grade; 90 min). The exam tests the ability of the students to transfer the deep knowledge of principles of molecular plant pathogen interaction on new scientific questions. Students have to show their ability to design experiments suitable to test a given hypothesis from molecular host-parasite interactions. Students have to show in how far they are able to extract scientific progress from original data or experiments presented in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of Plant Sciences and Phytopathology at the B.Sc. Level

Content:
In this modul, students reach a deep understanding of plant-pathogen interaction at the molecular level. This comprises pattern-triggered immunity, effector-triggered susceptibility, effector-triggered immunity and translational research. This is not restricted to model plants but extends to crops and fills the gap between basic research and applied plant sciences in breeding and biotechnology for disease resistance. In interactive learning structures with small groups, we train reading and understanding of original literature (Journal Club). In the practical course, we learn real time PCR, plant immune response assays, transient transformation of plants, cell biology of plant defense reactions, etc.

Intended Learning Outcomes:
Education to become a molecular plant pathologist, who is able to judge and design approaches for increasing disease resistance in model and crop plants.
Upon successful completion of the module, students are able

- to understand the molecular basis of plant pathogen interactions in depth.
- to transfer theoretical background and definitions of molecular host parasite interactions.
- to analyze plant immune responses.
- to collect new theoretical knowledge from literature and understand innovative technologies in plant immunity and susceptibility.
- to carry out key molecular methods for quantification of plant immune reactions and disease susceptibility (e.g. real time PCR, reactive oxygen measurement, transient transformation of plants, cell biology of plant defense reactions) in hands-on experience
- to generate experimental design and carry out evaluation of plant disease resistance tests in model and crop plants.

Additionally, students are able to process and present complex information from original literature.

Teaching and Learning Methods:
In the lecture students gain knowledge about theoretical background of plant parasite interactions, which is extracted and focussed by the lecturers from review literature. In the exercise, students practise in small groups key methods for quantification of plant immune reactions and disease susceptibility. They make hands-on experience, practise the use of molecular methods and devices, document their data under guidance and discuss them with group members and supervisors. In the journal club, students are guided in small groups how to critically read original research papers, digest information and present most central findings from a recent original paper.

Media:
PowerPoint

Reading List:
Buchanan 2015: Biochemistry & Molecular Biology of Plants. Review literature provided

Responsible for Module:
Hückelhoven, Ralph; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Host-Parasite-Interaction (Übung, 2 SWS)
Hückelhoven R, Müller M, Stegmann M, Steidele C

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

Host-Parasite-Interaction (Vorlesung, 1 SWS)
Hückelhoven R, Steidele C
For further information in this module, please click campus.tum.de or here.

Module Description

LS20007: Introduction to Computational Neuroscience | Introduction to Computational Neuroscience

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	Language: English	Duration: one semester	Frequency: winter/summer semester
Credits:* 7	**Total Hours:** 210	**Self-study Hours:** 120	**Contact Hours:** 90

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

Description of Examination Method:
In a graded final 20 minute presentation (slides, e.g. with Power Point) the students present their project work, where they aim for reproducing results from a scientific paper with methods of computational neuroscience, that are taught in the lecture and practiced in the tutorials. In addition, the students should synthesize the relevant findings of the paper and critically discuss the modeling choices of the authors, following examples that are given throughout the lecture.

Repeat Examination:
Next semester

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

Content:
Introduction to programming with python

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

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

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

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

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

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

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

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

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

Onasch S

Introduction to Computational Neuroscience – Exercise (M.Sc.) (Übung, 2 SWS)
Onasch S
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination of the module is carried out in the form of a laboratory performance.
which consists of the following elements: activity in the laboratory, lab report (~10 pages) with evaluation and
discussion and presentation (30 minutes) in a ratio of 3:3:1.
In it, the students demonstrate the ability to design models in computational neuroscience, code computer programs,
analyze data and visualize data. They also demonstrate the ability to present their data to other computational
neuroscientists, and synthesize what they learned in a concise written up record of their work.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students are expected to have some mathematical knowledge (linear algebra, differential equations) and some
programming skills (Matlab, Python or C/C++).

Content:
Minimum of 6-8 weeks research project in laboratory with hands on training in the analysis of neuroscience data and
the building of network models.
Depending on the aim of the research project, different methods and questions will be in focus. For instance:
- simulating network models in Julia, Python or Matlab
- designing differential equation descriptions of network interactions

- mathematical analysis based on dynamical systems
- image analysis using ImageJ software
- statistical analysis with Julia, Python or Matlab
- dimensionality reduction techniques of high-dimensional data
- extracting model parameters from experimental data
- conceptual discussion and literature searches to understand and propose ideas, results, hypotheses

Intended Learning Outcomes:
Upon successful participation the students are able to:
- Analyze neuroscience data from electrophysiological or calcium imaging recordings
- Build network models of connected excitatory and inhibitory neurons in numerical simulations
- Include synaptic plasticity rules in the network models for the self-organization of network connectivity
- Analyze the output of the networks in terms of activity and connectivity
- Interpret the numerical results to make predictions for experiments
- Work in the laboratory independently

Teaching and Learning Methods:
Students will work in the lab and learn from PhD students.
They will be given detailed instructions and sample numerical code to perform the simulations.
They will read scientific literature to determine new parameters for their models.
They will learn mathematical methods for writing down differential equations, analyzing them using dynamical
systems and visualizing them from PhD students and sample code from related projects.
They will have weekly meetings with their other PhD students and give regular presentations on their progress to get feedback.
They will get regular help with checking their code and analysis.

Media:

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Models in Computational Neuroscience (M.Sc.) (Forschungspraktikum, 10 SWS)
Gjorgjieva J, Dauphin A, Dwulet J, Onasch S, Parkinson-Schwarz J
For further information in this module, please click campus.tum.de or here.

Module Description

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

Version of module description: Gültig ab winterterm 2022/23

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

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

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

Repeat Examination:
Next semester

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

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

degradation, signaling pathways of substrate perception, biotechnological applications of enzyme and small-molecule production, as well as application of fungi in the agricultural industry.
In the practical/seminar part of the course, selected topics will be discussed in more detail by student presentations and with the help of practical examples. In addition, an excursion to the Clariant Sunliquid demonstration plant in Straubing is planned, where bioethanol is being produced from fungal conversion of biomass.

Intended Learning Outcomes:
After successful participation in the module, the students will have advanced knowledge of the biotechnological applications of fungi for the production and development of natural and artificial biocompounds.
They will be able to:
• recapitulate the fungal metabolic capabilities
• comprehend and name the fundamental signaling pathways for metabolic adaptation
• using selected examples, classify the respective enzyme systems and their functions in anabolic/catabolic reactions
• understand the molecular techniques for genome manipulation and strain development and discuss them
• critically assess the pros and cons of the presented production systems.
Moreover, the module is intended to help develop problem-solving skills as well as to foster the interest for eukaryotic microbiology, it's advantages and disadvantages, and the importance particularly of filamentous fungi for environment and industry.

Teaching and Learning Methods:
Teaching technique: Lecture - teaching method: presentation; development of general concepts on the chalkboard
In the demonstration: teaching method: talk, demonstration; learning activity: research of relevant literature, prepare and give a talk, contructive discussion of the contents

Media:
PowerPoint presentation; chalkboard work; original research papers; lab demonstrations

Reading List:
Unfortunately no text book is available that covers all the contents of the course, but the following sources are good for basics and as additional reading:
- Money, Nick, 2007, “Triumph of the Fungi: A Rotten History”, Oxford Univ. Press
- Hudler, G.W., 1998, “Magical mushrooms, mischievous molds”, Princeton University Press
- Kendrick, Bryce, 2000, “The Fifth Kingdom”, 3rd ed., Focus Pub/R Pullins Co
- Kavanagh, Kevin, 2011, „Fungi – Biology and Applications”, Wiley-VCH
- Arora, D.K., 2004, “Fungal Biotechnology in Agricultural, Food, and Environmental Applications – Mycology Series; Vol. 21”, Marcel Dekker, Inc.
- Kück, U. et al., 2009, “Schimmelpilze – Lebensweise, Nutzen, Schaden, Bekämpfung“, Springer
- Kubicek, C.P., 2013, “Fungi and Lignocellulosic Biomass“, Wiley-Blackwell

Responsible for Module:
Benz, Johan Philipp; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Biologie biotechnologisch relevanter Pilze (Vorlesung mit integrierten Übungen, 4 SWS)
Benz J [L], Benz J, Tamayo Martinez E
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2221: Methods in Biotechnology | Methods in Biotechnology (Seminar)

Version of module description: Gültig ab summerterm 2013

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 2	**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:
Methods in Biotechnology (Seminar, 2 SWS)
Flisikowska T, Fischer K
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2371: Molecular Plant Physiology 2 | Molekulare Pflanzenphysiologie 2

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen benoteten Klausur und in Form einer mündlichen Präsentation, die im Rahmen des Seminars stattfindet, erbracht. Die Modulnote wird aus der
Klausurnote (50%) und der Note der mündlichen Präsentation (50%) berechnet.

Die Studierenden zeigen in der Klausur (90 min), dass sie in der Lage sind, die vorgestellten experimentellen Ansätze zum Verständnis der molekularen Mechanismen der Wechselwirkungen zwischen Pflanze und abiotischen Faktoren zu beschreiben und die dabei erhaltenen Versuchsdaten kritisch zu interpretieren. Weiterhin zeigen die Studierenden in der Klausur ihre Fähigkeit, experimentelle Ansätze zur Aufklärung der zugehörigen molekularen Mechanismen selbst zu entwerfen. Dafür sind keine Hilfsmittel zulässig.

In der mündlichen Präsentation, die insgesamt 45 Minuten umfasst und aus einem 30 minütigen Vortrag (PowerPoint-Präsentation) und einer 15 minütigen Diskussion besteht, müssen die Studierenden nachweisen, dass sie in der Lage sind, den Inhalt einer typischen internationalen wissenschaftlichen Studie aus dem Gebiet des Seminars zu erfassen und diesen verständlich und didaktisch sinnvoll aufbereitet zu präsentieren. Dabei weisen die Studierende nach, dass sie auch das theoretische Umfeld der Studie sowie die methodischen Ansätze und die Prinzipien der experimentellen Techniken verstanden haben und nachvollzierbar erläutern können. In der Diskussion zeigen die Studierenden, dass sie in der Lage sind, in einen wissenschaftlichen Diskurs einzutreten und Standpunkte begründet zu vertreten oder zu widerlegen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum Verständnis der vermittelten Inhalte sind ein solides Wissen und praktische Erfahrung in der Molekularbiologie, Biochemie und Pflanzenphysiologie zwingend erforderlich. Ein Besuch des Moduls Molekulare Pflanzenphysiologie 1 ist nicht notwendig.

Content:
In diesem Modul stehen die molekularen Mechanismen der Wechselwirkungen zwischen Pflanze und abiotischen Faktoren im Vordergrund. Abiotischer Stress ist der bedeutendste Faktor, der das Pflanzenwachstum und die Nahrungsproduktion limitiert. Als abiotische Faktoren werden Trockenstress, Salzstress, Sauerstoffmangel, Strahlung (UV-Strahlung, Starklicht), Schwermetalle und Xenobiotika behandelt. Vorgestellt werden induzierte Veränderungen im Metabolismus und beteiligte Signaltransduktionswege sowie Vermeidungs- und Anpassungsstrategien. Besonderes Augenmerk wird dabei auf einzelne stresstolerante Arten oder Ökotypen mit einer Toleranz gegen z.B. Salz oder Schwermetalle und ihre besonders effektiven Anpassungsstrategien gerichtet.
Im Seminar setzen sich die Studierenden mit aktuellen Forschungsarbeiten auf dem Gebiet der Stressphysiologie auseinander und arbeiten den Bezug dieser Forschungsergebnisse zum Inhalt der Vorlesung heraus.

Intended Learning Outcomes:
Lernergebnisse:
Nach dem erfolgreichen Abschluss dieses Moduls besitzen die Studierenden vertiefte Kenntnisse über:
" Analytik und experimentelle Ansätze
" die Bedeutung abiotischer Stressfaktoren für das Pflanzenwachstum
" molekulare Mechanismen der Transduktion des Stresssignals
" Anpassungsstrategien
" Darstellung und Interpretation wissenschaftlicher Daten
" Sichtung und Präsentation wissenschaftlicher Literatur
Das vermittelte Wissen kann in verschiedenen Bereichen sowohl der grundlagen- als auch anwendungsorientierten Pflanzenwissenschaften eingesetzt werden. Die Studierenden sind in der Lage, die Ansprüche zu definieren, die Pflanzen für eine erhöhte Toleranz gegenüber abiotischem Streß erfüllen müßten und können daraus erfolgversprechende Strategien zur Generierung bzw. Evaluierung stresstoleranter Pflanzen entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung und Seminar
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Interaktion Lehrender - Studierende, Präsentation durch die Studierenden

Media:
Präsentationen mittels Powerpoint, Tafelanschrieb,
Skript (Downloadmöglichkeit für Vorlesungsmaterial)

Reading List:
Ernst-Detlef Schulze, Erwin Beck, Klaus Müller-Hohenstein: Pflanzenökologie. Spektrum Akademischer Verlag
Peter Schopfer und Axel Brennicke: Pflanzenphysiologie. Spektrum Akademischer Verlag.
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag
Park S. Nobel: Physicochemical and Environmental Plant Physiology. Academic Press
Bob Buchanan, Wilhelm Gruissem and Russell L. Jones: Biochemistry & Molecular Biology of Plants. John Wiley & Sons
Fachartikel aus wissenschaftlichen Zeitschriften. Vertiefende Literatur zu einzelnen Arbeitsthemen werden von den Studierenden referiert.

Responsible for Module:
Erwin Grill (Erwin.Grill@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2385: Molecular Plant Physiology 1 | Molekulare Pflanzenphysiologie 1

Version of module description: Gültig ab summerterm 2019

Module Level: Master	Language: German	Duration: one semester	Frequency: summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer schriftlichen benoteten Klausur und in Form einer mündlichen Präsentation, die im Rahmen des Seminars stattfindet, erbracht. Die Modulnote wird aus der
Klausurnote (50%) und der Note der mündlichen Präsentation (50%) berechnet.

Die Studierenden zeigen in der Klausur (90 min), dass sie in der Lage sind die in dem Modul vorgestellten experimentellen Ansätze zum Verständnis des Wasser- Schwefel- und Stickstoffhaushalts der Pflanzen zu beschreiben und die dabei erhaltenen Versuchsdaten kritisch zu interpretieren. Weiterhin zeigen die Studierenden in der Klausur ihre Fähigkeit, experimentelle Ansätze zur Aufklärung der zugehörigen molekularen Mechanismen selbst zu entwerfen. Dafür sind keine Hilfsmittel zulässig.

In der mündlichen Präsentation, die insgesamt 45 Minuten umfasst und aus einem 30 minütigen Vortrag (PowerPoint-Präsentation) und einer 15 minütigen Diskussion besteht, müssen die Studierenden nachweisen, dass sie in der Lage sind, den Inhalt einer typischen internationalen wissenschaftlichen Studie aus dem Gebiet des Seminars zu erfassen und diesen verständlich und didaktisch sinnvoll aufbereitet zu präsentieren. Dabei weisen die Studierende nach, dass sie auch das theoretische Umfeld der Studie sowie die methodischen Ansätze und die Prinzipien der experimentellen Techniken verstanden haben und nachvollzierbar erläutern können. In der Diskussion zeigen die Studierenden, dass sie in der Lage sind, in einen wissenschaftlichen Diskurs einzutreten und Standpunkte begründet zu vertreten oder zu widerlegen

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum Verständnis der vermittelten Inhalte sind ein solides Wissen und praktische Erfahrung in der Molekularbiologie, Biochemie und Pflanzenphysiologie zwingend erforderlich.

Content:
In diesem Modul werden die zentralen Themenkreise Pflanzlicher Wasserhaushalt, Lipidmetabolismus und Schwefelhaushalt behandelt.
Schwerpunkte der Vorlesung sind dabei: chemische und physikalische Eigenschaften von Wasser; das Wasserpotential-Konzept; Transportwiderstände und Regulationsprozesse auf dem Weg des Wassers aus der Bodenlösung in die Pflanze und von dort aus in die Atmosphäre; Aquaporine; Meßmethoden; Biochemie der Cuticula und der epicuticulären Wachse; biogeochemischer Schwefelzyklus, Schwefelaufnahme und -assimilation; Biosynthese zentraler Schwefelverbindungen; Phytochelatine; Schwefelverbindungen und biotische Interaktionen; Entgiftung von Xenobiotika; Stickstoffaufnahme, -assimilation und -transport in der Pflanze; Symbiosen mit Luftstickstoff-fixierenden Partnern; stickstoffhaltige Verbindungen und biotische Interaktionen.
Im Seminar setzen sich die Studierenden mit aktuellen Forschungsarbeiten auf dem Gebiet des pflanzlichen Wasser-, Schwefel- beziehungsweise Stickstoffhaushalts auseinander und arbeiten den Bezug dieser Forschungsergebnisse zum Inhalt der Vorlesung heraus.

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss des Moduls besitzen die Studierenden vertiefte Kenntnisse über:
" Analytik und experimentelle Ansätze
" den pflanzlichen Wasserhaushalt
" Struktur und Biochemie pflanzlicher Oberflächen
" den pflanzlichen Schwefelhaushalt
" den pflanzlichen Lipidstoffwechsel
" die kritische Sichtung wissenschaftlicher Publikationen
" Präsentationstechniken
Das vermittelte Wissen kann in verschiedenen Bereichen sowohl der grundlagen- als auch anwendungsorientierten Pflanzenwissenschaften eingesetzt werden.
Die Studierenden können die Belastbarkeit experimenteller Ansätze beurteilen und selbst Ansätze der Beforschung entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung und Seminar.
Lernaktivitäten: Studium von Vorlesungsskript, -mitschrift, Interaktion Lehrender - Studierende

Media:
Präsentationen mittels Powerpoint, Tafelanschrieb,
Skript (Downloadmöglichkeit für Vorlesungsmaterial)

Reading List:
Ernst-Detlef Schulze, Erwin Beck, Klaus Müller-Hohenstein: Pflanzenökologie. Spektrum Akademischer Verlag
Peter Schopfer und Axel Brennicke: Pflanzenphysiologie. Spektrum Akademischer Verlag.
Lincoln Taiz and Eduardo Zeiger: Plant Physiology. Spektrum Akademischer Verlag
Park S. Nobel: Physicochemical and Environmental Plant Physiology. Academic Press
Bob Buchanan, Wilhelm Gruissem and Russell L. Jones: Biochemistry & Molecular Biology of Plants. John Wiley & Sons

Responsible for Module:
Dr. Alexander Christmann (christma@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar: Molekulare Pflanzenphysiologie I (Seminar, 2 SWS)
Grill E, Christmann A

Molekulare Pflanzenphysiologie I [WZ2385] (Vorlesung, 2 SWS)
Grill E, Christmann A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2420: Molecular Genetics | Molekulare Genetik

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	Language: German/English	Duration: one semester	Frequency: summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the exam (60 min.) the students document knowledge in molecular genetics, which reaches beyond basic background. They demonstrate the understanding of relevant scientific approaches.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Lectures and seminars in genetics, cell biology, genomics, developmental genetics of plants and animals

Content:
The lecture deals with current issues in molecular genetics based on selected examples from original work published by international groups in leading scientific journals. The students gain insight into topical questions, methods and genetic models and they learn how developing lines of investigation, based on basic knowledge, lead to new findings.
The lecture leads the students closely to modern molecular genetics. The value of this lecture lies in the fact that it aims to go beyond established textbook knowledge. Particular attention is paid to the understanding of molecular genetic processes and the strategies, which are designed to elucidate them. Mechanisms and phenomena, which are not addressed in this depth in a general lecture in genetics, as for instance exceptional alleles, epistatic interactions between genes, networks etc. represent special focuses. Further attention is paid to the strategic and experimental problems, which arise with a particular scientific question.
Depending on newly arising issues or interests additional parts called “excursus“ are implemented in the lecture, for instance if a new finding becomes relevant or an old finding becomes relevant again for a particular theme. A particular excursus is not necessarily taken up every year again.

Notably, the students are requested to discuss and question the obtained knowledge. The selected issues are intended to train the students such that they acquire competence to critically analyze work in this field.
Some selected subjects:
- Forms of alleles: amorph, hypo-, hyper-, anti-, neomorph, haploinsufficiency
- Temperature sensitive mutations
- Multiple allelism
- Penetrance
- Expressivity
- Gene interaction/forms of epistasis
- Targeted mutagenesis
- Transcription factors/-suppressors
- RNAinterference
- Epigenetics
- Gene redundancy
- Polyploidy
- Horizontal Gene Transfer

Intended Learning Outcomes:
Basic demands in the field of molecular biology are introduced. The students are trained to recognize important questions therein and to think about experimental approaches for their solution. The highlighted issues allow combining approaches from classical/formal with those of molecular genetics - one of the most efficient and powerful approaches in modern biology. The students also learn to use knowledge about peculiarities of model organisms in this field. In particular, they learn that due to their biological and genetic peculiarities, different model organisms are suited to investigate different scientific questions. At the end of the lecture the students have knowledge about organisms as disparate as Drosophila melanogaster, Coenorhabditis elegans, Arabidopsis thaliana, Zea mays, Saccharomyces cerevisiae and others. The students are aware about important genetic insights gained through the analyses of these model organisms and their relevance for humans (e. g. “phenologues“). Since this lecture is mainly based on original work, they learn to understand the difficulties, problems and main features linked to outstanding scientific publications. At the same time they get insight into the field of current science and the work of international groups.

Teaching and Learning Methods:
PowerPoint presentations including special presentations of selected issues based on original publications. During the lecture the students are encouraged to take part in the discussion.

Media:
PowerPoint presentations and videos are provided for download (login information is given at the beginning of the lecture).

Reading List:

Bruce Alberts et al., Molecular Biology of THE CELL, 2014, 6th ed. (and higher), Garland Science New York.
Wilhelm Seyffert (Hrsg.), Lehrbuch der Genetik, 2003, 2te Auflg. (and higher) Spektrum Akademischer Verlag Heidelberg-Berlin.
Ben Lewin et al., GENES XI, 2014 (and higher), Jones & Barlett Learning, Burlington.
James D. Watson et al., Molecular Biology of the Gene 2008, 6th ed. (and higher), Pearson Education/Benjamin Cummings San Francisco.
Literature/Articles cited in the lecture.

Responsible for Module:

Torres Ruiz, Ramon; Apl. Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:

Molekulare Genetik [WZ2420] (Vorlesung, 2 SWS)
Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2691: Microorganisms in Food | Mikroorganismen in Lebensmitteln

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	Language: German	Duration: one semester	Frequency: summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung wird in Form einer benoteten Klausur mit der Dauer von 60 min erbracht, in der keine Hilfen zugelassen sind. Die Prüfung besteht aus Fragen, welche im Freitext beantwortet werden. Die Klausur dient der Überprüfung der in den Vorlesungen erworbenen Kompetenzen: Die Studierenden sollen zeigen, dass sie die Bedeutung von fermentierenden Mikroorganismen für industrielle Lebensmittelproduktion verstanden haben. Aspekte der Interaktion von Mikroben mit Produktionsanlagen sollen in der Klausur erklärt und ihre Bedeutung für die Lebensmittelhygiene diskutiert werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung und Übungen in Allgemeiner Mikrobiologie

Content:
Vorlesung Lebensmittelmikrobiologie und Hygiene: Vorlesung: Begleitflora und mikrobieller Lebensmittelverderb; Krankheitserreger in Lebensmitteln; Infektion und Intoxikation; Infektionsketten; Bedeutung von lebensmittelbedingten Erkrankungen; Beispiele für die Herstellung fermentierter Lebensmittel; Starterkulturen und Reifungskulturen; Gentechnisch veränderte Mikroorganismen in der Lebensmittelproduktion (Anwendungsbeispiele, Risiken, Gen-Ethik); Biologische Konservierungsverfahren (Enzyme, Schutzkulturen); Physikalische Konservierungsverfahren (Trocknung, Temperatur, Bestrahlung, Druck); Chemische Konservierungsmittel (Wirkungsweisen, Einsatz, Risiken); Mikrobiologische Qualitätssicherung (Risikoanalyse, HACCP-Konzept, Eigenkontrollen).
Vorlesung Mikrobiologie der Milch und Milchprodukte: Starter- und Reifungskulturen; Mikrobiologie der Milchen: Rohmilch, Past Milch, ESL Milch, UHT Milch, Kondensmilch. Milchpulver; -

Mikrobiologie der Sauermilcherzeugnisse: Sauermilchen, Kefir, Joghurt; Mikrobiologie der Käseherstellung: Frischkäse, Sauermilchkäse, Labkäse; Mikrobiologische Produktionsprobleme.

Intended Learning Outcomes:
Die Studierenden haben grundlegendes Fachwissen über zur Lebensmittelmikrobiologie erworben. Realistische Einschätzung der Bedeutung Lebensmittel verderbender Mikroorganismen sowie der Bedeutung lebensmittelbedingter Intoxikationen und Infektionen, Konservierungsverfahren und Qualitätssicherungskonzepte. Erwerb theoretischer Erkenntnisse zur Analyse von mikrobiologischen Produktionsproblemen in der Lebensmittelindustrie. Fähigkeit zur Interpretation mikrobiologischer Daten in der interdisziplinären Zusammenschau mit lebensmitteltechnologischen Prozessen und lebensmittelhygienischen gesetzlichen Vorgaben.

Teaching and Learning Methods:
Vorlesungsvorträge mit Lehrdialogen zur Vertiefung des Verständnisses.
Lernaktivitäten: Anfertigen einer Vorlesungsmitschrift, Studium vom Vorlesungsskript, Beantwortung von Übungsfragen, Nacharbeit des Stoffes mit dem Lehrbuch.

Media:
PowerPoint, Lehrfilme, Tafelarbeit, Script, Lernhilfe (Übungsfragen), Exkursionen mit Demonstrationen.

Reading List:
Madigan MT et al (2013) Brock Mikrobiologie, Kapitel über Lebensmittelmikrobiologie. Pearson
Krämer J, Prunge A (2017) Lebensmittelmikrobiologie. utb Verlag
Märtlbauer E, Becker H (2016) Milchkunde und Milchhygiene. utb Verlag

Responsible for Module:
Siegfried Scherer siegfried.scherer@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Mikrobiologie und Biotechnologie der Milch- und Milchprodukte (Vorlesung, 1 SWS)
Henkel M [L], Henkel M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1085: Science of Laboratory Animals | Labortierwissenschaft

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Regelmäßige, aktive Teilnahme an den Lehrveranstaltungen wird erwartet. Eine Klausur (60 min, benotet) dient der Überprüfung der in Vorlesung und Praktikum erlernten theoretischen Kompetenzen. Die Studierenden zeigen in der Klausur, ob sie in der Lage sind, das erlernte Wissen zu strukturieren und die wesentlichen Aspekte darzustellen. Sie sollen die erarbeiteten Informationen beschreiben, interpretieren, sinnvoll kombinieren und auf ähnliche Sachverhalte übertragen können. Die Klausurnote bildet die Gesamtnote des Moduls.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Zum besseren Verständnis sind Kenntnisse in Zoologie und/oder Tierwissenschaft erforderlich

Content:
Umfang, Art und Zweck von Tierversuchen in Deutschland; Ethische Abwägungen, 3-R-Prinzip; Anatomische, physiologische und ethologische Grundlagen von Labortieren; Fütterung, Haltung, Züchtung und Krankheiten von Labortieren; Hygienemaßnahmen in der Labortierhaltung; Tierschutzrecht und rechtliche Grundlagen zur Betreibung von Versuchstierhaltungen.

Intended Learning Outcomes:
Tierartgerechte Haltung und Umgang mit Labortieren unter den spezifischen Anforderungen größerer und kleinerer Forschungslaboratorien; Vorbereitung auf die Konzeption von Tierversuchen und Tierversuchsanträgen; Reduktion von Tierversuchen nach dem 3-R-Prinzip

Teaching and Learning Methods:
Vorlesung im Seminarstil

Media:
Powerpoint-Präsentationen, die den Teilnehmern zur Verfügung gestellt werden

Reading List:
Weiss, J., Maeß, J., Nebendahl,. K. (Hrsg.): Haus- und Versuchstierpflege, 2. Auflage, 2003, Enke-Verlag, Stuttgart.

Responsible for Module:
Dr. Karsten Meyer (karsten.meyer@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Labortierwissenschaften (Vorlesung, 4 SWS)
Meyer K, Paulicks B, Flisikowski K, Kliem H, Kisling S, Schwamberger S
For further information in this module, please click campus.tum.de or here.

Module Description

LS20035: Parasite Immunology | Parasite Immunology

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulleistung besteht aus einer schriftlichen, benoteten Prüfung (90min) zu den Vorlesungsthemen. Dabei belegen die Studierende ihren Kenntnisstand zu parasitären Abwehrmechanismen, Parasit-Wirts-Interaktionen, Diagnostik und Immunevasionsmechanismen. Es werden Zuordnungsaufgaben, Multiple-Choice-Fragen sowie Freitextaufgaben zu beantworten sein, ohne die Verwendung von Hilfsmitteln.

Als freiwillige Mid-Term Leistung kann zusätzlich eine Präsentation im Rahmen des Seminars absolviert werden. Bei der Fallbearbeitung arbeiten die Studierenden an einem klinischen Fall, der zu analysieren, zu bewerten und kritisch zu diskutieren ist. Die Ergebnisse der Fallbearbeitung werden in einer Präsentation (15min) vorgestellt. Die Präsentation kann als Mid Term Leistung zu 20% mit der Klausurnote verrechnet werden. Der Notenbonus wird nur auf eine bestandene Klausur (4,0 oder besser) angerechnet werden.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Kenntnisse der Immunologie und Physiologie.
Vorkenntnisse in Biochemie

Content:
- Einführung in die Parasitologie: Definition von Parasiten und deren Klassifizierung, direkte und indirekte Lebenszyklen von Parasiten, Wirt-Parasit-Interaktionen, Wirtspezifität
- Grundlagen der Immunabwehr gegen Protozoen: Abwehrmechanismen gegen Protozoen, Rolle verschiedener Immunzellen bei der Parasitenabwehr, Immunpathologien

- Grundlagen der Immunabwehr gegen Helminthen: Hyper- und Hyporeaktivität gegen parasitäre Infektionen, akute und chronische Abwehrmechanismen gegen Helminthen, immunbasierte Behandlungsstrategien
- Immunevasionsstrategien und Immunmodulation: Parasit-Wirt-Interaktion, Mechanismen der Immunmodulation durch Parasiten, concomitant immunity, Hygiene-Hypothese und Helminthenabgeleitete Therapien
- Klinische Aspekte der Parasitenimmunologie: Zoonoseerreger, immunbasierte Diagnosemethoden für Parasiteninfektionen und Behandlungsstrategien
- Immunprophylaxe: Herausforderungen der Impfstoffentwicklung, Design von Impfantigenen
- Wechselwirkungen zwischen Parasiten und dem Wirtsmikrobiom: Einfluss des Mikrobioms auf die Parasitenabwehr, Auswirkungen parasitärer Infektionen auf das Mikrobiom
- Labormethoden zur Immunbiologie der Parasiten: Kleintiermodelle, parasitäre Zyklen im Labor

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul verfügen die Studierenden über sichere Grundkenntnisse zur Klassifizierung von Parasiten, der Interaktion von Parasiten und dem Immunsystem ihrer Wirte, kennen Immunevasionsstrategien und die Bedeutung immunmodulatorischer Moleküle in der Parasit-Wirtsbeziehung. Studierende können die Bedeutung parasitärer Infektionen für Mensch und Tier einschätzen und immunbasierte Interventionsstrategien und Immunprophylaxe kritisch beurteilen.

Teaching and Learning Methods:
Vorlesung (eigenständige Nachbearbeitung anhand VL-Folien, Mitschriften, Literatur)
Seminar (Gruppenarbeit, Fallbearbeitung- und Vorstellung, Anwendung der theoretischen Hintergründe zu Immunabwehrmechanismen gegen Parasiten auf komplexe, klinische Fälle)

Media:
In den Vorlesungen wird mit Powerpoint, Slido und Tafelanschrieb gearbeitet.

Reading List:
Lucius, Loos-Frank, Lane: Biologie von Parasiten, 3. Auflage
Tracey Lamb, Immunity to Parasitic Infection

Responsible for Module:
Ebner, Friederike, Prof. Dr. rer. nat. friederike.ebner@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

WZ1185: Plant Epigenetics and Epigenomics | Plant Epigenetics and Epigenomics

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of a presentation (20 min) followed by discussion (10 min). The presentation should summarize and interpret the results obtained from analyzing published epigenomic datasets using the computational skills aquired during the Computer Practical sessions. The presentation is a means to measure the student's ability to understand a technical/ scientific subject, to analyze and evaluate facts and factors of influence, to summarize the subject and present it to an audience, and to conduct a discussion about the presented subject

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of genetics, cell biology, statistics

Content:
The course will cover:
- Components and functions of the plant epigenome: DNA methylation, histone modifications
- Measuring epigenomes: array-based and NGS based bulk and single cell technologies
- Analyzing plant epigenomic data: Array and NGS based computational tools for bulk and single cells
- Plant epigenome and environmental variation
- Plant epigenome and genetic variation
- Epigenetic inheritance in plants: Mitotic and meiotic inheritance
- Current perspectives on the agricultural and evolutionary implications of epigenetic inheritance in pl

Intended Learning Outcomes:
Students will be able to:
- Interpret the molecular components of epigenomes
- Interpret functions of epigenomes
- Identify the sources of population level epigenomic variation
- Explain modern measurement technologies
- Distinguish the conceptual background of different computational tools
- Apply computational tools to epigenomic data
- Analyze the implications of epigenetic and epigenomics
- Carry out presentation skills

Teaching and Learning Methods:
The following teaching methods will be used:
- Lectures: The goal of the lectures is to provide an in-depth overview of the main concepts, approaches and research questions in plant epigenetics and epigenomics.

- Computer tutorial: The goal of the computer tutorials is to reinforce the lecture contents with hands-on experience. The main aims are: 1) to get hands-on experience with the type of epigenomic datasets that is routinely generated in this field; 2) to get hands-on experience with software tools for the analysis of epigenomic datasets; 3) to be able to evaluate the output from these software tools, and to use the output as a way to answer concrete biological research questions.

- Seminars: The goal of the seminars is to discuss recent scientific literature in plant epigenetic and epigenomics . The aim is to demonstrate how the concepts, approaches and research questions presented in the course provide a means to decode complex scientific articles in this field.

Media:
PowerPoint presentations, software practicals

Reading List:
Hand-outs

Responsible for Module:
Johannes, Frank; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Plant Epigenetics and Epigenomics (Vorlesung, 3 SWS)
Johannes F

Plant Epigenetics and Epigenomics - Computer Practical (Praktikum, 2 SWS)
Piecyk R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2381: Plant Systems Biology (Lecture and Seminar) | Pflanzensystembiologie (Vorlesung und Seminar)

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
At the end of the module, students independently answer a list of questions within the framework of a scientific paper, for which they have four weeks to prepare.
The scientific paper tests the acquired knowledge on the basis of a real or fictitious biological problem or finding, and tries to illuminate this problem or the same finding from different perspectives in its entirety. In doing so, it actively seeks to answer biological and systems biology questions about the biological topic of auxin biology being addressed, using publicly available online resources and databases. Thus, the biochemical and genetic interaction data on auxin biology and systems biology work, especially the multiple effects of these plant hormones on growth and differentiation processes, e.g. with different -omics resources will be reviewed. The grade of this scientific paper will be included with 70% in the final grade.
In the seminar, each student presents a recent publication in the field of plant systems biology in the form of a talk (approx. 30 min). By doing so, students demonstrate that they are able to summarize scientific data, present it to an expert audience in the form of a presentation, and discuss the data presented. The quality of the presentation (quality of the illustrations, the conception of the presentation as well as the understanding, communication and discussion of the biological content) will be graded (30%).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of plant biology, morphology and cell biology is recommended.
The module is aimed at students with a background in biology, biochemistry or biotechnology. Prior knowledge of mathematics or computer science is not assumed.

The module is thematically and temporally coordinated with the exercise PlaSysBiol offered in the same period and a simultaneous participation in the exercise module is recommended; however, the modules can also be taken separately.

Content:
This module provides in-depth knowledge of the systems biology analysis of genomic, proteomic and metabolomic data (umbrella term -omics). The techniques underlying the individual approaches or resources are explained and critically evaluated in biological contexts. The focus is on transcriptional and protein interaction networks, cell biological and biochemical methods, and modeling of cell biological and developmental processes.
Thematically, the module is largely oriented towards the biology of the plant hormone auxin (auxin receptor action, auxin signal transduction, auxin transport, auxin transport regulation), which is currently best understood in terms of systems biology studies and modeling and has a non-negligible importance for plant growth. In the accompanying seminar, students will present (PowerPoint presentation) a recent paper in the field of plant systems biology. The topics build on the contents of the lecture, but go thematically further in depth or allow the transfer of the biology or methodology learned in the lecture to other topics.

Intended Learning Outcomes:
Following participation in the module, students will have detailed knowledge to answer systems biology questions, specifically, but not exclusively, in plant biology. This includes the independent identification of selected genes and gene mutants in databases, the search and evaluation of proteomic and phosphoproteomic as well as protein-protein interaction data in databases, knowledge of the most important biochemical and cell biological methods, their advantages and disadvantages and thus knowledge for the critical evaluation of available data sets.

Students will be able to summarize scientific data in a meaningful way and present it in a visually appealing way, to present it compactly to an expert audience and to discuss controversial data.

Teaching and Learning Methods:
Learning activities: Study of the lecture notes, transcript and literature. If necessary, transfer of what has been learned to the PlaSysBiol module (exercise) taking place in the same period. Development of a new topic (seminar topic). Preparation and execution of presentations. Constructive criticism of own work and the work of others. Working under time pressure. Meeting deadlines.
The module consists of a lecture (2 SWS) and a seminar (2 SWS). The seminar takes place as a block seminar following the lecture cycle. In the seminar, students present recent publications in plant systems biology in lectures. The seminar topic is chosen by the students from the environment of the material covered in the lecture.

A recent publication will be discussed and prepared together with the chair. The seminar presentation of about 30 minutes can be discussed with the chair in advance. Possible topics are systems biology work on gene expression analysis, protein-protein interaction networks, or cell biology approaches.

Media:
Lecture supported by a PowerPoint presentation or similar. The lecture notes will be made available online.

Reading List:
Plant Physiology (Taiz/Zeiger) 5th edition. Molecular Biology of the Cell (Alberts). Auxin Signaling: From Synthesis to Systems Biology (Estelle/Weijers/Ljung)

Responsible for Module:
Schwechheimer, Claus, Prof. Dr. claus.schwechheimer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzensystembiologie VL (Vorlesung, 2 SWS)
Schwechheimer C [L], Schwechheimer C, Denninger P, Hammes U

Pflanzensystembiologie SE (Seminar, 2 SWS)
Schwechheimer C [L], Schwechheimer C, Denninger P, Hammes U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2480: Plant Developmental Genetics 2 | Plant Developmental Genetics 2

Version of module description: Gültig ab winterterm 2019/20

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the oral examination (30 min.) students explain without additional helping material principles of plant developmental genetics, describe experimental strategies of plant developmental genetics and evaluate the relevance of plant developmental genetics for horticulture and plant breeding.
The grade of the exam will be the final grade of the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Genetics (WZ0703). Plant Developmental Genetics I (WZ0305). A basic understanding of genetics, molecular biology and cell biology is required.

Content:
- photomorphogenesis
- flowering time control
- floral meristem identity
- floral organ identity
- floral organogenesis
- gametophyte, apomixis
- fertilization process
- parental control of embryogenesis/seed development

Intended Learning Outcomes:
After successful completion of the module students are able to understand the basic concepts of plant developmental genetics and to evaluate their relevance for problems in horticulture and plant breeding.

Teaching and Learning Methods:
The lecture provides the theoretical background and concepts. During the exercises, in individual or group work on specific selected original literature with presentations students show their ability to understand the concepts and to critically analyse and evaluate the obtained scientific models.

Media:
PowerPoint presentations, chalkboard
Slides will be provided online in pdf format. Taped recordings of the lectures will be provided online as audio- and videopodcasts.
Current literature,

Reading List:
Taiz et.al. Plant Physiology and Development 2015 6th edition, Oxford University Press; Smith et al. Plant Biology 2010, Garland Science.
Current literature from specific journals will be announced during the lecture.

Responsible for Module:
Schneitz, Kay Heinrich; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Entwicklungsgenetik der Pflanzen 2 (Vorlesung, 2 SWS)
Schneitz K [L], Schneitz K

Journal Club Entwicklungsgenetik der Pflanzen (Seminar, 2 SWS)
Schneitz K, Torres Ruiz R
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2581: Plant Biotechnology | Pflanzenbiotechnologie

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written, supervised examination (Klausur, 90min), by answering questions under time pressure and without helping material, students demonstrate that they have obtained knowledge in the areas of plant biotechnology, plant molecular biology and plant biochemistry.
The examination assesses the theoretical background and applied knowledge obtained on up-to-date aspects of current research.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A basic knowledge in genetics, genomics, plant development, biochemistry and/or botany is highly recommended

Content:
The module consists of a lecture and a seminar part.
In the lecture, state-of-the-art methods in plant biotechnology and plant molecular biology are introduced, and advantages and disadvantages are discussed. Current challenges are highlighted.
Topics of the lecture include:
- Genetically modified plants: status, regulations, cultivation, concepts;
- Generation of genetically modified plants: methods, vector systems;
- Concepts for yield improvement;
- Concepts for quality improvement;
- New potentials derived from basic research;
- Model system Arabidopsis: development of new techniques;
- Metabolic engineering.
In the seminar part different speakers from the TUM, which are active in research in plant biotechnology or plant molecular biology, introduce cutting-edge research projects that take place

on campus. The seminar part is conceived to highlight the exciting research that currently takes place and advertise opportunities for master thesis projects.

Intended Learning Outcomes:
The students have a profound knowledge in plant biotechnology, plant biochemistry and plant molecular biology. They are aware of new technological approaches and methodology applied in the fields, including plant transformation, construct and vector design, reporter systems and essential DNA, RNA and protein techniques. They are able to comment critically and reflect on technologies and aims of plant biotechnology. They have insight into latest research developments in the respective areas, in particular also in research projects that currently take place at the TUM

Teaching and Learning Methods:
Lecture: PowerPoint presentations, short movies and use of the black board. Questions to the audience will actively encourage discussion and enable students to ask questions more freely. Seminar: Power point presentations and use of the black board. The seminar talks are followed by discussions to actively invite students to ask questions. Review papers will be provided as background reading.

Media:
Lecture: PowerPoint, black board, discussion.
Seminars: PowerPoint, black board, discussion.
PDFs of the lectures will be made available to the students. Review publications will be made available for background reading on the seminar contends.

Reading List:
Biochemistry and Molecular Biology of Plants. Buchanan, Gruissem and Jones, John Wiley & Sons, 2015

Responsible for Module:
Poppenberger-Sieberer, Brigitte; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Pflanzenbiotechnologie (Vorlesung, 2 SWS)
Poppenberger-Sieberer B

Pflanzenbiotechnologie (Seminar, 2 SWS)
Poppenberger-Sieberer B [L], Poppenberger-Sieberer B, Benz J, Assaad-Gerbert F, Avramova V, Sieberer T, Schwechheimer C, Tellier A, Hückelhoven R, Johannes F, Schneitz K, Dawid C, Ahmed M, Bienert G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2682: Sensory and Behavioral Neurogenetics | Sensory and Behavioral Neurogenetics

Version of module description: Gültig ab summerterm 2020

Module Level: Master	Language: English	Duration: one semester	Frequency: summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination consists of a written exam (90 min), where students are expected to remember and reproduce topics that were covered in the lecture (theories of behavioral analysis, methods, examples etc.) without additional aids. The exam will consist of multiple choice, free formulations, tables to be completed and interpretations of schemes etc. In addition, students will write an essay based on literature research on a topic that was discussed in the lecture. Topics will be assigned by the lecturer after discussion with the student. The module is passed, when the essay is successfully completed and the grade of the written exam is at least 4,0.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of neurobiology and genetics are obligatory.

Content:
LECTURE: once a week during the semester for two hours including a break, the lecture will cover the following topics:

• general introduction, deepening of knowledge in form, function, and networks of synaptic connections and nervous systems.
• the role of model animal systems in neuroscience
• illustration and deeper understanding of neuroscience research on the example of sample publications covering model system (including genetic models) such as worm, fly, fish, mouse, monkey, primate.
• Analysis and explanation of model specific methods such as automated behavioral analysis, in vivo imaging, electrophysiology, multiphoton microscopy, live microscopy, modeling

• Examples describing the role of internal state and behavioral context including the role of neuromodulation
• translation and general meaning of results obtained in model organisms
• evolution of neuronal networks and their translational meaning

EXERCISE: The exercise consists of a home assignment, independent literature research and writing of an essay. The topic will be assigned after consultation with the lecturer.

Intended Learning Outcomes:
Upon successful completion of the module, students:
• know important definitions and methods in neurogenetics and behavioral analysis, and why and how they are used in model organisms.
• understand the terms optogenetics, chemogenetics, calcium imaging, connectomics, system neuroscience, neuronal networks, phsychophysics, neuromodulation and can explain them.
• are able to interpret, analyse and develop results obtained in behavioral studies, neurophysiology and neuroanatomy.

Teaching and Learning Methods:
LECTURE: In the lecture material will be presented in a powerpoint presentation, which features many examples, pictures, schemes, videos. In addition, at the beginning of each lecture the content of the previous lecture will be summarized and open questions will be discussed. At the end of each lecture, a list of 'take home messages' will be given. EXERCISE: The exercise consists of a written essay that students will write over the course of several weeks following independent literature research at home. The topic of the essay will follow the topics covered in the lecture and will be assigned by the lecturer after consulting with the student. The aim is too deepen the student's knowledge in a topic of the lecture that is of particular interest to them. To this end, they will use online literature search tools such as Pubmed and Google, but also in person interviews or other sources that they deem informative. The lecturer will be available to discuss content and structure.

Media:
Pubmed, ejournals, video materials, online databases

Reading List:
Standard textbook: Eric Kandel (editor), Principles of Neural Sciences; various journal articles (list will be made available in class)

Responsible for Module:
Grunwald, Ilona; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Moduls after consulting "Organisms" | Module nach Rücksprache "Organismen"

Module Description

WZ1092: Transgenic Animals in Agriculture and in Biomedicin | Transgene Nutztiere im Agrar-Bereich und in der Biomedizin

Version of module description: Gültig ab winterterm 2010/11

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 96	**Contact Hours:** 54

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Erfolgreiche Grundlagen- und Orientierungsprüfung
Bachelor Agrarwissenschaften oder äquivalenter Abschluss

Content:
Vorlesung: Transgene Nutztiere im Agrar-Bereich und in der Biomedizin; Methoden zur Erzeugung transgener Nutztiere, Definitionen und Prinzipien sowie bestehende und zukünftige Anwendungsbereiche. Soziale und ethische Aspekte. Seminar: Auf Fachliteratur basierende Referate zu Themen der oben genannten Vorlesungen

Intended Learning Outcomes:
Ausbildung für wissenschaftliche Arbeit, Praxis, Behörden, Tierschutz

Teaching and Learning Methods:
Vorlesung, Seminar

Media:

Reading List:
Skript, Internationale Publikationen

Responsible for Module:
Angelika Prof. Dr. Schnieke (schnieke@wzw.tum.de,)

Courses (Type of course, Weekly hours per semester), Instructor:
Transgene Nutztiere im Agrar-Bereich und in der Biomedizin (Vorlesung, 4 SWS)
Schusser B [L], Flisikowski K, Schusser B, Fischer K, Flisikowska T
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1993: Laboratory Animal Science | Versuchstierkunde

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer Klausur (90 min), in der die Studierenden unterschiedliche Fragen zu versuchstierkundlichen Themen ohne Hilfsmittel beantworten sollen. Das Beantworten der Fragen erfordert teils eigene Formulierungen und teils das Ankreuzen von vorgegebenen Mehrfachantworten.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundlagen der Anatomie, Physiologie, Versuchstierkunde, BSc Biologie/Life Sciences, BSc Molekulare Biotechnologie, BSc Agrar- und Gartenbauwissenschaften, BSc Ernährungswissenschaften

Content:
In dem Modul werden folgende Themen vermittelt:
- Gesetze rund um den Tierversuch
- Belastungsbeurteilungen und Score Sheets
- Alternativmethoden zum Tierversuch
- Blutentnahme und Applikationstechniken
- Genetik und Zucht im Tierversuch
- Biotechnologische Techniken Schwein und Huhn
- Geflügel als Versuchstier
- Fledermäuse als Versuchstier
- Schlangen als Versuchstier
- Überwachung von Tierversuchseinrichtungen

- Neurologie und Verhalten von kleinen Nagern
- Handling von kleinen Nagern
- Injektionen (s.c., i.p. i.m. i.v.)
- Blutentnahmetechniken
- Orale Applikation von Substanzen

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage verschiedene Verfahren, relevante Gesetze und Methoden der Versuchstierkunde zu nennen. Die Studierenden können diese Vorschriften nach der Teilnahme des Moduls verstehen und anwenden. Die unterschiedliche Auslegung und Anwendung der Gesetze, Methoden und Tiermodelle kann durch die Studierenden eingeschätzt werden und Tierversuchsplanungen können aktiv unterstützt werden. Die Studierenden sind nach der Teilnahme dazu in der Lage ein erstes Handling der Versuchstiere Maus, Ratte und Kaninchen durchzuführen und Injektionen und Blutentnahmen unter Anleitung durchzuführen.

Teaching and Learning Methods:
Im Rahmen der Vorlesung wird Grundwissen zu den beschriebenen Inhalten vermittelt. Durch PowerPoint Präsentation werden den Teilnehmern die wichtigsten Aspekte der jeweiligen Themen veranschaulicht und im Rahmen einer anschließenden Diskussion kritisch hinterfragt.
Im Rahmen der Übung wird anhand von Maus, Ratten und Kaninchenmodellen das Handling dieser Nagerspezies geübt und Blutentnahmen, sowie Injektionenn und Applikationen von Substanzen geübt.

Media:
Präsentation (PowerPoint), Tafelarbeit, praktische Übungen

Reading List:
Vorlesungsunterlagen, Gesetzestexte, LAS-online Kurs

Responsible for Module:
Schusser, Benjamin; Prof. Dr.med.vet.

Courses (Type of course, Weekly hours per semester), Instructor:
Versuchstierkunde (Seminar, 2 SWS)
Schusser B [L], Fischer K, Flisikowski K, Kellermann K, Kisling S, Schusser B, Schwamberger S

Praktische Einführung Versuchstierkunde (Übung, 2 SWS)
Schusser B [L], Schusser B, Schwamberger S
For further information in this module, please click campus.tum.de or here.

Medicine | Medizin

Module Description

ME2759: Blood-Forming Stem Cells as a Model for Somatic Stem Cells | Blutbildende Stammzellen als Modell für somatische Stammzellen

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 128	**Contact Hours:** 22

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Der Modul ist aufgebaut aus Vorlesungen (insgesamt 1 SWS: Einleitung somatischer Stammzellen, embryologische Entwicklung des Blutsystems, verschiedene Aspekte der adulten Stammzellen, Stammzellnische, klinische Anwendungen von blutbildenden Stammzellen). Auch werden in Seminare der Kursteilnehmer aktuelle Forschnugsbeispiele aus der Literatur vorgestellt und diskutiert (0,5 SWS).
Die Prüfungsleistung stellt sich zusammen aus: Seminarvortrag (etwa 30 min + Diskussion, 40%) und die Verfassung einer Hausarbeit (60%) zur Kontrolle des Verständnisses sowie der Fähigkeit zur Beschreibung, Interprätation und Bewertung. Das Modul ist bestanden, wenn das gemittelte Ergebnis besser als 4,1 ist.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Zum besseren Verständnis dises Theorieteils sind gute Kenntnisse in Zellbiologie und Biochemie erforderlich.

Content:
Im Rahmen dieses theoretischen Moduls werden spezielle Kenntnise über somatische, und insbesondere blutbildender Stamm- und Vorläuferzellen und Stromazellen vermittelt.

Es werden 5 Vorlesungen stattfinden, und anschliessend 5, von den Studenten vorbereiteten Seminare in dem aktuelle Forschungsbeispiele präsentiert und besprochen werden sollten.

Vorlesungen
1. Einleitung in der Stammzellbiologie, somatische Stammzellen
2. Embryologische Entwicklung des Blutsystems und blutbildenden Stammzellen
3. normale Physiologie der blutbildenden Stammzellen und die Stammzellnische
4. Abnorme Physiologie der Stammzellen bei Alterung chronische Erkrankungen und Malignitäten
5. klinische Relevanz von blutbildenden Stammzellen

In den Seminaren sollen von den Teilnehmern aktuelle Forschungsergebnisse der Literatur vorbereitet, präsentiert und diskutiert werden. Dabei werden Themen wie:
1 - Stammzellidentität und Isolation
2 - Stammzellverhalten (Regeneration, Apoptose, Überleben, Proliferation, Differenzierung)
3 - Stammzellnische (Identität, Isolation, Relevanz für das Verhalten der Stammzelle)
4 - Maligne Entartungen des Blutsystems und leukämische Stammzellen
ausführlich zur Sprache kommen

Ergänzt werden die Vorlesungen und Seminare durch eine Hausarbeit (in englischer Sprache) in dem die Teilnehmer ihr Verständnisse der erworbenen Kenntnisse beschreiben, Interpretieren und bewerten.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen besitzen die Studierenden das theoretische Verständnis und spezielle Fachwissen über blutbildenden Stammzellen. Weiterhin haben sie wesentliche Konzepte somatischer Stammzellen integriert, evaluiert und in einer Hausarbeit beschrieben. Sie haben gelernt:

• die Herkunft der somatischen Stammzellen und deren Entwicklung in Embryonen zu verstehen
• grundlegende funktionelle Verhaltensweisen blutbildender Stammzellen zu verstehen
• (Stamm)zellbiologische Fragestellungen und Arbeitstechniken aus aktuelle Forschungsliteratur zu verstehen, kritisch zu evaluieren und fachliche Fragen selbst zu entwickeln.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesungen, Seminare, Hausarbeit.
Lehrmethode: Vorlesungen, Literaturrecherchen, Diskussionen, Präsentationen, Partnerarbeit (bei höheren Studentenzahlen), Ergebnisbesprechungen.
Lernaktivitäten: Studium von Literatur; Präsentation eines aktuellen Forschungsmunuscript; Anfertigung einer Hausarbeit

Media:
Original Fachliteratur, Präsentationen mittels Powerpoint, Photoshop

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt.

Responsible for Module:
Oostendorp, Robert; Apl. Prof.

Courses (Type of course, Weekly hours per semester), Instructor:
Blutbildende Stammzellen als Modell für somatische Stammzellen (Vorlesung, 1 SWS)
Oostendorp R, Schreck C
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2074: Biomolecular Food Technology | Biomolekulare Lebensmitteltechnologie

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 54	**Self-study Hours:** 24	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 90.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Beherrschung der analytischen, biochemischen und genetischen Grundbegriffe

Content:
Analytical techniques used for metabolomics (LC-ESI-MSn, etc.), smell and taste reception (biochemistry and genetics), aroma biotechnology (biosynthesis, function, metabolism, genetic engineering), chemistry, function, metabolism and bioavailability of vitamin C and E, lipid biotechnology (biosynthesis, metabolism and genetic engineering)

Intended Learning Outcomes:
Knowledge of the functional principle of modern analytical instruments, the molecular basics of smell and taste perception, vitamin function und lipid biotechnology

Teaching and Learning Methods:
Vortrag

Media:

Reading List:
Friedrich Lottspeich, Haralabos Zorbas, Bioanalytik Spektrum Akademischer Verlag, 1998; Tsung Min Kuo, Harold Gardner, Lipid Biotechnology Marcel Dekker Verlag, New York, 2002

Responsible for Module:
Wilfried Schwab (w.schwab@mytum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Biomolekulare Lebensmitteltechnologie (Vorlesung, 2 SWS)
Schwab W
For further information in this module, please click campus.tum.de or here.

Module Description

WZ22770: Biofunctionality of Food | Biofunktionalität der Lebensmittel (optional incl. Seminar)

Version of module description: Gültig ab winterterm 2012/13

Module Level:	Language:	Duration:	Frequency:
Credits:*	**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:
Biofunktionalität der Lebensmittel - Grundlagen (Vorlesung) (Vorlesung, 2 SWS)
Haller D [L], Haller D, Schmöller I

Biofunktionalität der Lebensmittel - Grundlagen (Seminar) (Seminar, 2 SWS)
Haller D [L], Haller D, Schmöller I, Schwamberger S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0219: Chemosensory Perception | Chemosensory Perception

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written examination (90 min) students demonstrate by answering questions without helping material the theoretical knowledge of the biology of taste, smell, and chemesthetic perception as well as extra-sensory processes involving chemoreceptors. To answer the questions, own wordings are necessary and sketches of biomolecules and signaling pathways.

In addition, there is the option of taking a voluntary mid-term assignments as course work in accordance with APSO §6, 5. For this, a report on a scientific publication (1 page plus summary graphic) is to be prepared. This is supplemented by a presentation to test the communicative competence in presenting the contents to an audience.
Passing the course performance will improve the module grade by 0.3 if, based on the overall impression, this better characterizes the student's performance level and the deviation has no influence on passing the examination. No retake date will be offered for the mid-term performance. In case of a repetition of the module examination, a mid-term performance already achieved will be taken into account.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in molecular bilogy, biochemistry, cell biology and physiology is required.

Content:
The basics of aroma- and taste recognition, evaluation, and analysis on a molecular level are communicated.

In detail, the following topics are discussed:- basics of human taste recognition (molecules,anatomy, morphology and function of gustatory and olfactory structures, receptors, genetic variability and its influence on sensory sensitivity, establishment of preferences and aversions, the connection between sensory perception and food preferences, extra-sensory functions of taste and odorant receptors, oral somatosensory perception, basic taste modalities, signal transduction).

Intended Learning Outcomes:
Upon completion of the module, students understand the molecular bases of taste and smell perception. The students will be able to separate those percepts from other chemosensory cues such as chemesthesis or pheromone detection. Moreover, students are familiar with the putative physiological relevance of extra-sensory chemosensory stimuli. The importance of the chemical senses for food preferences and consumption is known.

Teaching and Learning Methods:
The content of the lecture is presented by means of powerpoint presentations. Students are motivated to broaden their knowledge by reading complementary literature relevant to the topic.

The seminar will give the students the chance to follow the rapid development of chemosensory research directly by reading and discussing recent publications. Students will choose a paper and critically present it to their peers. Additional literature research for a solid introduction into the field of research is requested. The fellow students are motivated to discuss the presentations. This will deepen the understanding of the contents presented during the lecture and enable the students to critically evaluate novel results.

Media:
PowerPoint presentations will be used. The content of the lectures will be made available for download as pdf-files.

Reading List:
not specified

Responsible for Module:
Behrens, Maik; Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Chemosensory Perception (Seminar, 2 SWS)
Behrens M

Chemosensory Perception (Vorlesung, 2 SWS)
Behrens M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2693: Cognitive Neuroscience | Cognitive Neuroscience

Version of module description: Gültig ab winterterm 2018/19

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Students will demonstrate an overview of cognitive processes in the brain during a written exam (60 min.). They can describe the cellular basis and the network architecture in the brain that lead to cognitive processing, and elaborate on the scientific status quo of cortical processing during various cognitive tasks. In addition, they can evaluate and predict the consequences of lesions and pharmacological interventions in the cortex for psychological processes and mental states. Finally, they will demonstrate an overview of the various methodological approaches to study the cognitive functions in the (human) brain.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have a basic knowledge of neurobiological processes in general, at least on the level of a physiology course, better though on the level of the "neurobiology" lecture held at the WZW (or a comparable lecture series).

Content:
computation of sensory information in the mammalian cortex; differences between cortical and non-cortical structures in the forebrain of vertebrates; Structure of the Cortex, canonical circuits, processing principles in the Cortex, Models of cortical function, malfunctions of the cortex in pathological situations, Role of the prefrontal cortex, Role of the hippocampus, Cortical processing of sensory input, Sleep, Food intake, Decision making, Cravings and Addiction, Emotions, Consciousness and Free Will. In addition, we will demonstrate options for technological interactions with the brain, and give an overview of the current approaches for analysing brain functions in the behaving organism.

Intended Learning Outcomes:
After the exam, students can sketch cortical processing, derive these computations from the underlying neurobiological foundations, and explain their functions for the organism. The students will aquire special knowledge on the role of the cortex, can integrate new information into this knowledge framework, and have an overview of pathologies and the possibilities to manipulate cognitive processes.

Teaching and Learning Methods:
Teaching mode: Lecture Teaching method: Presentation. Learning activities: Reading of basic texts, preparation and review of lecture materials, internet searches, summarizing of subjects.

Media:
The powerpoint presentations of this lecture series will be made available on Moodle. Additional information (URLs, additional texts, self-assessments etc.) will be available on Moodle as well.

Reading List:
The basic textbook for this lecture is "Neuroscience. Exploring the brain" from Bears, Connors and Paradiso, published by Lippincott, Williamsn and Wilkins. However, all other modern neurobiology textbooks are also appropriate.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Cognitive Neuroscience (Vorlesung, 2 SWS)
Jacob S, Kreuzer M, Luksch H, Rammes G
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2598: Development of Vaccines against Infectious Diseases | Entwicklung von Impfstoffen gegen Infektionskrankheiten

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Regular, active participation is expected; short presentations on a given topic; The module exam will be made through a lecture.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
basic knowledge in virology and immunology

Content:
In this module, students receive an overview of
" immunological principles of vaccinology
" vaccine formulations (antigen selection, adjuvants, DNA and vector-based vaccines)
" current aspects of vaccine development (personalized vaccines, immunosenescence)
" selected examples of innovative vaccines

Intended Learning Outcomes:
At the end of the module, students will be able to
" understand and apply general concepts of vaccinology
" understand, describe and discuss basic immunological mechanisms / modes of action of vaccines
" understand and explain vaccination strategies
" understand new aspects of vaccine development and evaluate their significance
" analyze and assess current developments in the field of vaccinology

Teaching and Learning Methods:
The module consists of a seminar, students will be encouraged to study the literature and to discussion the topics
Teaching Technology: Seminar
Teaching Method: presentation, lecture, group work (discussion of the presented literature)
Learning activities: relevant material research, study of literature, preparing and conducting presentations

Media:
Power Point Präsentation

Reading List:
There is no textbook available that covers all the contents of this module; recommended basic literature: Modrow, S., Falke, D., Truyen, U., Schätzl, H. Molekulare Virologie, Springer, 3. Auflage 2010
S. J. Flint. Principles of Virology, John Wiley & Sons; Auflage: 3. Auflage 2009

Responsible for Module:
Ulrike Protzer (protzer@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Entwicklung von Impfstoffen gegen Infektionskrankheiten (Seminar, 2 SWS)
Protzer U [L], Bauer T, Moeini H, Kosinska A, Protzer U
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2108: Neuropathology | Neuropathologie

Version of module description: Gültig ab summerterm 2016

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In a graded oral examination (20 min) it is tested whether the students have understood the specifics of a brain dissection and whether they can combine the corresponding knowledge from anatomy, histology and physiology. In addition, a graded presentation (30 min) examines a topic-oriented presentation of the given topic, whereby both the presentation as a whole and the subsequent discussion are included in the evaluation. The students show that they are able to independently research a specific topic in neuropathology and to summarize and present it in a concise and understandable way. They show that they are able to point out disputed points and discuss them scientifically. In addition, the students give a non-graded report as a study achievement.

The two exams are calculated 1:1. If the student passes the examination, the module is passed from a weighted module grade of less than 4.1.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of neural cell biology and physiology is required, e.g. from the lecture "Physiology and Functional Anatomy"

Content:
In the neuropathology module, students are taught the basics of diseases of the nervous system. At the beginning of the module, an introductory session is held in which the content and organizational aspects of the module are presented.
-) Principles of pathogenetic brain changes
-) molecular mechanisms of neurological / neurophysiological diseases and their development, especially neuro-oncology

-) Basics of human neuroanatomy
-) Basics of human neurophysiology
-) Therapeutic approaches and other medical aspects of neurological and psychiatric diseases

Intended Learning Outcomes:
After successful participation in this module, students will be able to name roughly anatomically recognizable brain structures in the prepared specimen, e.g. cerebellum, midbrain, diencephalon, forebrain and ventricle. They understand the essential signaling pathways in the human brain and can recognize and name individual nerve cell types in the microscopic preparation already prepared. To a limited extent, students can assign neurophysiological processes to individual cell types and estimate their significance for neurotransmission. Students can assign the most important neurological and psychiatric diseases to specific anatomical, microscopic or physiological changes. Molecular mechanisms and resulting applications for therapy, exemplary in neuro-oncology, can be presented.
After successful participation in this module, students will be able to create a protocol in the field of neuropathology and will be familiar with the special features required for this.

In addition, after completing this module, the students will be able to give a presentation from the field of neuropathology and will master all the steps involved: Performing relevant primary literature research and summarizing related scientific data, preparing and giving a scientific presentation and discussing disputed results with the audience.

Teaching and Learning Methods:
In brain dissection, a fixed human brain is prepared for the students. This gives them a three-dimensional impression of this organ, its different tissue structures and the relative size of the individual regions. The preparation is supplemented by a microscopy course in which individual nerve cell types and nerve cell populations (nuclei) are microscopically examined and illustrated using different staining techniques. Film presentations will illustrate various clinical pictures and their phenotypic expression. In the seminar, the topics covered in the practical introductory part will be deepened and supplemented on a molecular biological level through presentations and discussions. Transfer tasks are then worked on in the context of group work. Practical application of the knowledge acquired so far primarily in group work will take place in a subsequent one-week, half-day practical course in neuropathology, in which technical and laboratory skills will be practiced.

Media:
film, presentations, discussions

Reading List:
The bibliography is adapted to the latest research results, updated every semester and made available to students at the beginning of the semester.

Responsible for Module:
Schlegel, Jürgen; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

ME2453: Molecular Pathology and Organ-Specific Carcinogenesis | Molekulare Pathologie und organspezifische Karzinogenese

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die regelmäßige Teilnahme an den Vorlesungen "Molekulare Pathologie" und "Organspezifische Molekulare Karzinogenese" ist erforderlich. Zwei Klausuren (jeweils 90 min, Single choice, benotet) dienen der Überprüfung der in den Vorlesungen erworbenen theoretischen Kompetenzen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The basic knowledge of molecular biology and genetics acquired during the bachelor's program should be sufficient for understanding the lectures. Attending other modules is not required.

Content:
The lecture "Molecular Pathology" teaches methodological basics of tissue analysis on the highest scientific level and deals with interdisciplinary aspects of pathological processes. Special emphasis is placed on oncogenes and tumor suppressor genes, cell adhesion and metastasis, signal transduction, cell cycle and apoptosis, angiogenesis, environmental carcinogenesis and cancer stem cells. This will provide an understanding of the molecular mechanisms of oncogenesis. In the lecture "Organ-Specific Molecular Carcinogenesis", basic tumor classifications are explained and organ-specific carcinogenesis is explained in detail and in an understandable way for carcinomas of the stomach, colon, liver, pancreas, mamma, lung and urogenital tract. In addition, leukemias and lymphomas, brain tumors, and endocrine tumors are covered. In addition, leukemias and lymphomas, brain tumors and endocrine tumors are treated.

Intended Learning Outcomes:
After attending the two lectures, the students will have basic knowledge of molecular pathology, molecular pathological working techniques and organ-specific molecular carcinogenesis. They should have learned to understand molecular pathological questions and working techniques and to develop solutions independently, to understand molecular mechanisms of oncogenesis and to recognize interrelationships and particularities of carcinogenesis of different organs. The module should provide an insight into human pathology and arouse interest in the diagnosis and therapy of cancer.

Teaching and Learning Methods:
Course type/teaching technique: Lecture, teaching method: lecture; learning activities: study of lecture material, lecture notes and literature

Media:
Presentations via Powerpoint,
Script (download option for lecture material)

Reading List:
There is no textbook available that covers all contents of this module. It is recommended as a basis or as a addition:
C. Wagener, O.Müller (Hsg.) Molecular Oncology, Georg Thieme Verlag, Stuttgart, 2010.

Responsible for Module:
Luber, Birgit; Apl. Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Organspezifische Molekulare Karzinogenese (Vorlesung, 2 SWS)
Luber B [L], Luber B, Azimzadeh O, Becker K, Keller G, Kuhn P, Muckenhuber A, Nawroth R, Neff F, Pellegata N, Sarker R

Molekulare Pathologie (Vorlesung, 2 SWS)
Luber B [L], Luber B, Becker K, Azimzadeh O, Keller G, Kuhn P, Mörtl S, Pellegata N, Rosemann M, Schüffler P
For further information in this module, please click campus.tum.de or here.

Module Description

ME2649: Molecular Oncology II | Molekulare Onkologie II

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfung wird in Form einer Übungsleistung abgenommen. Diese Übungsleistung setzt sich zusammen aus drei Komponenten:
a) Benotung der mündlichen Beteiligung (nach 1,0; 1,3; 1,7...) in der Veranstaltung; benotet werden 6 aus 8 Veranstaltungen nach dem Zufallsprinzip.
b) Benotung der Hausaufgabe (nach 1,0; 1,3; 1,7...) (Powerpointdarstellung)-); ; benotet werden 6 von 8 Hausaufgaben nach dem Zufallsprinzip.
c) Benotung des Vortrags (nach 1,0; 1,3; 1,7..., einmal pro Semester) dient der Überprüfung der im Modul erworbenen Kompetenzen.

Bei den Prüfungen dürfen alle möglichen Hilfsmittel eingesetzt werden. Die Bewertung der mündlichen Beteiligung erfolgt an Hand des Engagements und der Kenntnis der Studierenden bzw. deren Entwicklung im Laufe der Veranstaltung. Die Hausaufgaben werden bezüglich Vollständigkeit, Richtigkeit und didaktischer Qualität bewertet, die Vorträge entsprechend der didaktischen Aufbereitung. Die Leistung ist an die Teilnahme am Seminar verknüpft und kann im Folgesemester wiederholt werden, wenn der/die Studierende wieder einen Platz bekommt. Die Gewichtung der Leistungen mündliche Beteiligung/Hausaufgabe/Vortrag ist 5:2:3.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bestandener Abschluss der Vorlesung Molekulare Onkologie 1

Content:
Im Seminar: Einführung in die Theorie der Wissenschaft und Aufbau einer Publikation. Bearbeiten von Abstracts von Originalpublikationen aus folgenden Themenbereichen: 1.) Merkmale der Tumorprogression 2.) Ursachen der Tumorentstehung 3.) Onkogene 4.) Tumorsuppressorgene

5.) Epigenetik 6.) Umwelt der Zelle 7.) Mechanismen der Metastasierungskaskade 8.) Proteasen/Proteolytisches Netzwerk 9.) Spezifische Methodik der Molekularen Onkologie 10.) Förderung der Tumorprogression durch TIMP-1. Entwickeln und Notieren der relevanten Methodik. Als Hausaufgabe: Entwickeln einer vergleichenden Powerpointpräsentation der selbst vorgeschlagenen Experimente versus der tatsächlich durchgeführten. Präsentation der Hausaufgabe.

Intended Learning Outcomes:
Die Studierenden sind in der Lage selbständig die experimentelle Vorgehensweise zu entwickeln, die einer ihnen fremden Forschungsleistung (den Studierenden vorgegeben als englischsprachiges Abstract einer Originalpublikation) aus dem Gebiet der modernen molekularen Tumorforschung zugrunde liegen sollte. Die Studierenden erfassen in kurzer Zeit das Thema, die Fragestellung, das Neue in den Ergebnissen und die Relevanz der Forschungsleistung im Gebiet der molekularen Onkologie. Dabei sind sie in der Lage, ihr Wissen aus der Vorlesung Molekulare Onkologie 1 anzuwenden und mit den methodischen Kenntnissen früherer biochemischer und molekularbiologischer Vorlesungen und Praktika zu verknüpfen. Durch die Vertiefung und Anwendung dieser Vorkenntnisse erzielen die Studierenden die Fähigkeit, eigene methodische Herangehensweisen zu entwickeln und kritisch zu beleuchten. Durch den Vergleich der eigenen Vorschläge mit den tatsächlich von den Forschern durchgeführten Experimente (Inhalt der Hausaufgabe an Hand der Gesamtpublikation) entwickeln und verbessern die Studierenden ihre wissenschaftlichen Fähigkeiten. Im Seminargespräch erinnern die Studierenden die Lehrinhalte früherer Vorlesungen und befähigen sich, spätere Prüfungsgespräche (WPP; Doktorprüfung) routiniert anzugehen. Sie sind zudem später in der Lage, effizient wissenschaftliche Publikationen zu bewerten (Review Prozess). Neben der Fähigkeit, moderne Tumorforschung zu verstehen und zu bewerten, bringen sie somit alle Voraussetzungen mit, die für die Aufnahme einer Projekttätigkeit in der Forschung (z.B. Master-, Doktorarbeit) notwendig sind.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Seminar; gemeinsames Erarbeiten der Experimentvorschläge; Eigenstudium in der Hausarbeit.
Lehrmethode: Diskussion; Befragung
Lernaktivitäten: Studium von Vorlesungsmaterial, Teilnahme an der Diskussion (Lesen und Verstehen des Abstracts, Entwickeln der Experimentvorschläge); Anfertigen eines Notizprotokolls der Diskussion; Lesen und Verstehen der Gesamtpublikation (Eigenstudium); Ausarbeitung der Gegenüberstellung (Eigenstudium); Vortrag der Gegenüberstellung mit Diskussion.

Media:
Das Abstract wird als Auszug auf einem Blatt Papier ausgeteilt. Die Originalpublikation wird in ihrer Gesamtheit gleich nach dem Seminar über die eLearning Plattform „moodle“ zur Verfügung gestellt. Die Gegenüberstellung erfolgt mit Hilfe einer Powerpointdarstellung. Die Gegenüberstellungen aller Teilnehmer Vorlesungsfolien werden am Tag vor dem nächsten Seminar als pdf über die eLearning Plattform „moodle“ zur Verfügung gestellt.

Reading List:
Keine.

Responsible for Module:
Krüger, Achim; Apl. Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Onkologie II (Seminar, 2 SWS)
Krüger A [L], Krüger A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2427: Molecular Cell Biology of Tumorigenesis | Molekulare Zellbiologie der Tumorentstehung

Version of module description: Gültig ab summerterm 2023

Module Level: Master	Language: German/English	Duration: two semesters	Frequency: winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
A written exam (60 min, graded, without aids) at the end of the second semester serves to test the theoretical competences learned during the module. In the written exam, the students show whether they are able to structure the acquired knowledge from tumor biology and to present the essential aspects. They should be able to describe the acquired information, interpret it, combine it in a meaningful way and transfer it to similar situations.

In addition, there is the possibility to take a voluntary course achievement as a mid-term achievement according to APSO §6 para. 5. For this, an oral presentation (20 min) on a current scientific article is to be given, and a handout (2 pages) on the presentation is to be provided.
The module grade will be improved by 0.3 if the student's performance is better characterized by the overall impression and if the deviation has no influence on the passing of the examination. No retake date will be offered for the mid-term performance. In the event of a repeat of the module examination, a mid-term performance already completed will be taken into account.
The mid-term performance (lecture and handout) is intended to demonstrate the acquisition of competence in the independent and critical interpretation of current research papers from the English-language literature.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The development and progression of tumors is taught on a molecular genetic and cell biological basis. General basics of molecular cell biology are also taught, especially in the first part, while the second part focuses on translational aspects. Topics:
- Tumor Viruses
- Oncogenes, tumor suppressor genes and tumor modulators
- Signal transduction and growth factors
- Cytoskeleton, cell adhesion and cell migration
- Cell cycle and cell division
- Telomere structure, immortalization, senescence chromosomal instability.
- Apoptosis, necroptosis, necrosis, autophagy, pyroptosis and other forms of cell death.
- Angiogenesis
- Adult stem cells and "tumor stem cells", tumor metabolism
- Embryonic development of the mouse, embryonic stem cells, knock-out and knock-in technique
- Mouse models in biomedical research: Xenotransplant models, transgenesis in mice
- Tissue-specific and inducible models: Cre/LoxP, Crispr/Cas mutagenesis
- Imaging techniques in tumor research (multiphoton microscopy, MRT, PET/CT, OCT)
- Tumor-Stroma Interactions
- Basics of tumor immunology
- Basics of "rational therapy

Intended Learning Outcomes:
After successful completion of the module, students will have in-depth knowledge of cell biology and molecular biology from all aspects of tumor biology and cancer research.
They know how to move independently and confidently between clinical application and basic scientific knowledge in the field of biomedical cancer research. Students are able to independently evaluate current, English-language technical literature in the field of cancer research. Successful graduates have acquired a broad knowledge to analytically structure and experimentally solve problems in the field of cancer research, supported by practical research skills and experimental-analytical knowledge from the research internship.

Teaching and Learning Methods:
The module consists of two lectures and an tutorial. During the lecture, the learning outcomes are conveyed through lectures, supported by presentations. Students are encouraged to study the technical literature and to deal with the content of the topics. During the tutorial, moderated discussions are held to consolidate the topics learned. In addition, homework will be given during the "tutorial" to help students to understand the contents of the lecture in greater depth, for example, on the genetic basis of transgenesis in pre-clinical animal models. In addition, the students give presentations during the tutorial, including a written handout, in order to practise a technically correct verbal expression.

Media:
Presentations via PowerPoint, blackboard work; Inverted Classroom at a selected lecture date per semester; films; online feedback survey via PINGO

script (download possibility for lecture material on TUMonline) set to Moodle

Reading List:
There is no textbook available that covers all contents of this module. The following is recommended as a basis or supplement: 1) Biology of Cancer, Robert Weinberg, Garland Science 2006; ISBN: 0815340761
2) Textbook of Molecular Cell Biology, Alberts et al., Wiley VCH, 2007 ISBN: 3527311602
3) The Mouse in biomedical research. James G. Fox (Ed.). Academic Press, 2007. ISBN: 9780123694546
4) Mouse Models of Human Cancer. Eric C. Holland (Editor), Wiley-VCH, 2004 ISBN: 978-0-471-44460-2

Responsible for Module:
Janßen, Klaus-Peter, Apl. Prof. Dr. rer. nat. klaus-peter.janssen@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare Zellbiologie der Tumorentstehung (Teil 1) (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

Module Level: Master	**Language:** German	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer Klausur (90min, benotet) in der die Studierenden grundlegende und vertiefte Kenntnisse der Virologie abrufen und anwenden sollen.
Die Prüfungsleistung wird am Ende des 2. Vorlesungssemesters (SS) erbracht. Die Wiederholungsklausur findet in der vorlesungsfreien Zeit zu Beginn des darauf folgenden WS Semesters statt.
In der Prüfung soll nachgewiesen werden, dass Grundlagen der Virologie inkl. molekularer und medizinisch relevanter Aspekte verstanden und wichtige funktionelle Zusammenhänge der Virus-Wirt-Interaktion analysiert werden können.
Das Beantworten der Fragen erfordert teils eigene Formulierungen und teils Ankreuzen von vorgegebenen Mehrfachantworten. Es sind keine Hilfsmittel erlaubt.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Kenntnisse der Molekularbiologie und Grundkenntnisse in Zellbiologie und Immunologie

Content:
Allgemeine Themen der molekularen Virologie (z.B. Viruseintritt in Wirtszellen, Replikationsstrategien von RNA und DNA Viren, Expressionskontrolle, Virusassembly), Virusfamilien (z.B. Toga-, Flavi, Herpes-, Myxo, Hepatitis-, Retroviren); medizinische Aspekte der Virologie (z.B. angeborene und adaptive Immunreaktionen gegen Viren, Immunevasion, Impfungen, Emerging viruses, onkogene Transformation, virale Vektoren)

Intended Learning Outcomes:
Nach dem Besuch des Moduls versteht der Studierende die grundlegenden Prinzipien der Virologie, kennt die Merkmale bedeutender Virusfamilien und die wichtigsten Mechanismen der Virus-Wirt-Beziehung

Teaching and Learning Methods:
Vorlesungen mit Unterstützung durch PowerPoint Präsentationen, die Folien werden zum Download bereitgestellt

Media:

Reading List:
Flint et al., Principles of Virology I and II, ASM Washington
Modrow et al., Molekulare Virologie, Spektrum Verlag 2010

Responsible for Module:
Protzer, Ulrike; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Molekulare und medizinische Virologie (Teil 1 und 2) (Vorlesung, 2 SWS)
Protzer U [L], Protzer U, Baer de Oliveira Mann C, Ebert G, Kosinska A, Möhl-Meinke B, Pichlmair A, Vincendeau M, Wettengel J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2457: Neurobiology | Neurobiologie

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 60	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Aufgrund des Pandemiegeschehens hat der/die Studierende auch die Möglichkeit, an einer beaufsichtigten elektronischen schriftlichen Fernprüfung (Aufsicht mit Proctorio, 90 min.) teilzunehmen (Onlineprüfung: WZ2457o). Diese schriftliche Prüfung wird zeitgleich parallel in Präsenz angeboten (WZ2457).

Die Studierenden zeigen in einer benoteten Klausur (90 min), das sie in der Lage sind in einer begrenzten Zeit und ohne Hilfsmittel die zugrunde liegenden Mechanismen und Randbedingungen neurobiologischer Prozesse zu verstehen und darzulegen. Sie müssen neurobiologische Befunde auf ihre entwicklungsbiologischen und molekularbiologischen Ursachen zurückführen, komplexe Krankheitsbilder in ihrer Entstehung beurteilen, und physiologische Erklärungen für Gehirnleistungen darstellen. In Transferaufgaben sind sie in der Lage, auf der Basis des erworbenen Orientierungswissens der gesamten Neurobiologie Befunde einzuordnen und einzuschätzen

Repeat Examination:
Next semester

(Recommended) Prerequisites:
erfolgreiche Teilnahme an der Vorlesung "Human - und Tierphysiologie"

Content:
Basic Neuroscience: development of the nervous system, neurophysiology, biophysics, synaptic transmission, learning, emotions, speech, degenerative brain diseases, mental diseases, consciousness.

Intended Learning Outcomes:
Students will aquire a basic knowledge of the entire neuroscience spectrum, will learn to build upon that basis and to integrate new data, will have insight into current research fields.

Teaching and Learning Methods:
Veranstaltungsform/Lehrtechnik: Vorlesung
Lehrmethode: Präsentation, Vortrag, Fragend-entwickelnde Methode
Lernaktivitäten: Studium der ausgeteilten Grundlageninformationen, Nacharbeitung der vermittelten Informationen, Materialrecherche, Zusammenfassen von Dokumenten,

Media:
Ein Skript zu diesem Praktikum wird ausgeteilt bzw. als Download auf Moodle zur Verfügung gestellt. Zusätzlichen Informationen werden auf Moodle kommuniziert (URLs, weitere Texte)

Reading List:
Bear et al., Neurowissenschaften

Responsible for Module:
Luksch, Harald; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Neurobiologie (Vorlesung, 2 SWS)
Luksch H, Weigel S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2490: Neurogenetics: The Pathoetiology of the Neurological and Psychiatric Diseases | Neurogenetische Grundlagen von neurologischen und psychiatrischen Erkrankungen

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Studierenden zeigen in einer benoteten Klausur (60 min, 2 Klausuren/nach jedem Semester eine), dass sie grundlegenden Konzepte der Entwicklung des zentralen Nervensystems verstehen und zusammenfassen können. Sie sollen komplexe Sachverhalte über die molekularen Grundlagen und Entstehung von neuropsychiatrischen Erkrankungen in begrenzter Zeit aufzeigen können. Darüber hinaus sollen sie zeigen, dass sie ihr erlerntes Wissen dazu nutzen können, Fallbeispiele analysieren und beurteilen zu können.

Der Durchschnitt der beiden Klausuren ergibt dann die Gesamtnote.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Theoretische Kenntnisse in der Genetik (Entwicklungsgenetik der Tiere) sind wünschenswert.

Content:
1. Molekulare und zellbiologische Prinzipien der Entwicklung des zentralen Nervensystems: Neurogenese - Neuronale Migration - Netzwerkbildung - Synaptogenese - elektrische Maturation; 2. Morphologie und Funktion des Großhirns, Kleinhirns, Hippcampus, Basalganglien, Amygdala, Rückenmarks; 3. Erkrankungen des ZNS und deren molekularen Grundlagen: Alzheimer, Parkinson, Schizophrenie, Depression, Infektionen, Rückenmarkserkrankungen, Schlaganfall, Epilepsie, Prionerkrankungen, Erkrankungen des Hypothalamus

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung besitzen die Studierenden das grundlegende theoretische Verständnis über die Entstehung des Nervensystems. Sie sollen die Prinzipien der molekularen Regulation dieser Prozesse verstehen und diese erklären können, Kenntnisse über die Funktion und Morphologie zentraler Strukturen des ZNS besitzen und die Pathogenese (molekulare) von Erkrankungen des ZNS verstehen. Des Weiteren soll das Modul Interesse an der Neurogenetik fördern.

Teaching and Learning Methods:
Lehrmethode: Vorlesung mit fragend-entwicklender Methode
Lernaktivitäten: Studium von Literatur, Lernen von grundlegenden Prozessen, Problemlösung

Media:
Powerpoint, Skriptum auf der neuen Moodle-Plattform, Filme

Reading List:
Es ist kein Lehrbuch verfügbar, das alle Inhalte dieses Moduls abdeckt. Als Grundlage oder zur Ergänzung wird empfohlen:
Larry R. Squire Fundamental Neuroscience
Ed. by Larry R. Squire, Darwin Berg, Floyd E. Bloom et al.

Responsible for Module:
Wurst, Wolfgang; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Neurogenetik II: Grundlagen von neurologischen und psychiatrischen Erkrankungen (Vorlesung, 2 SWS)
Wurst W [L], Deussing J, Floss T, Hölter-Koch S, Vogt-Weisenhorn D, Westmeyer G

Neurogenetische Grundlagen von neurologischen und psychiatrischen Erkrankungen (Vorlesung, 2 SWS)
Wurst W [L], Deussing J, Floss T, Vogt-Weisenhorn D
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3207: Nutrition and Microbe-Host Interactions | Nutrition and Microbe-Host Interactions

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination requirements of the module "Nutrition and Mirobe-host Interactions" consist of a written examination (90 min, open questions and multiple choice). The examination can be based on any subject of the lectures and the corresponding seminar. The written exam will assess whether the student has attained an advanced level of knowledge about the diversity and functions of the mammalian gut microbial ecosystem and the role of dietary and microbial triggers in regulation of host health. No supporting material is allowed. The seminar (course work), consisting of theoretical input and practical exercises (teamwork), pertains to the sequence-based analysis of microbial communities.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in physiology, microbiology, bio functionality and immunology.

Content:
This lecture and seminar series teaches deep insight into the diversity and functions of the mammalian gut microbial ecosystem (intestinal microbiota) in close interaction with the host and with dietary factors. Particular attention will be drawn to the development of the microbiota throughout life as well as underlying cross-talk mechanisms with the mucosal immune system with a particular focus on chronic inflammatory disorders, enteric infections and metabolic disorders.

Intended Learning Outcomes:
After successful participation in the lecture and the seminar, students comprehend the diversity and functions of the mammalian gut microbial ecosystem and are able to estimate the role of

dietary and microbial triggers in regulation of host health. They are able to use this knowledge to critically assess recent findings.

Teaching and Learning Methods:
Lecture (reiteration and extension of topics of the lecture by studying independently), seminar (teamwork, practical implementation of theoretical knowledge)

Media:

Reading List:
Microbial Inhabitants of Humans: Their Ecology and Role in Health and Disease. Cambridge University Press, 2005, ISBN: 0 521 84158 5

Responsible for Module:
Haller, Dirk; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Microbe-host interaction and nutrition in health and disease (seminar) (Seminar, 2 SWS)
Haller D [L], Coleman O, Haller D, Lagkouvardos I, Omer H, Schmöller I

Microbe-host interaction and nutrition in health and disease (lecture) (Vorlesung, 2 SWS)
Haller D [L], Haller D, Schmöller I
For further information in this module, please click campus.tum.de or here.

Module Description

ME2413: Pharmacology and Toxicology for Students of Life Sciences | Pharmakologie und Toxikologie für Studierende der Biowissenschaften (Vertiefung)

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module concludes with a written exam (75 min) in the form of free questions. Two to three questions are formulated for each topic, covering the essential learning content of the module from the beginnings of drug development through the various drug classes to toxic and addictive effects. A special focus is on current drug developments in pharmacology. Through regular active participation in the course and self-study on the basis of the instructional slides provided, the students are enabled to reproduce the knowledge acquired and present the essential aspects in a structured way in a limited time and without aids. Through their own formulations, the students show in the exam whether they have reached a deeper understanding of the topics. The exam is passed if at least grade 4.0 has been achieved. A possibility for repetition is given at the end of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module WZ2522: General Pharmacology for students of life sciences (bachelor)

Content:
As part of the module the knowledge in pharmacology will be extended from the bachelor's degree. The knowledge of many novel drug classes for treatment of common and serious diseases is acquired. In a historical overview, examples of drugs from nature are learned. The development and optimization of drugs is discussed from drug design to the approval of drugs. Clinical studies and the transmissibility to humans are discussed. Additional contents includes the treatment of tumors and cancer pain, allergies and autoimmunity, infectious diseases such as HIV, heart rhythm disorders and psychoses, as well as biologicals, gene therapy, toxicology and dependence on

psychotropic substances. The seminar serves to strengthen and expand the lecture content, and provides the opportunity for practical exercises.

Intended Learning Outcomes:
After completing the module, students are able to reproduce the development of a drug from target identification through lead identification and optimization up to the approval and clinical studies. The students can name different resources for drugs and classify alternative treatment methods. They are able to remember important new drug groups, their targets and mechanisms of action. For each drug class, students can reproduce the lead compounds. They are further able to remember the most common and serious side effects and drug interactions and explain their occurrence. With this knowledge they can differentiate treatment options for common and serious diseases. Finally, students are able to detect toxic and addictive effects and select appropriate antidotes and remedies.

Teaching and Learning Methods:
The module consists of a lecture and a seminar.In the lecture the necessary knowledge is mediated through lectures and presentations by department staff. Students are encouraged to study the literature and discuss the issues with each other. In the seminars, the contents of the lecture is deepened and expanded. Different learning and teaching methods are used. E. c. Students prepare and show presentations in small groups or they answer specific questions or collaborate on selected (case) examples. Occasionally, examination questions are exercised. To prepare for each seminar a relevant material research is necessary.

Media:
PowerPoint, board work, flipchart, exercise sheets, OnlineTED, movies, downloads

Reading List:
There is no textbook available that covers all the contents of this module. Current literature is provided by the respective lecturers. As a basis or to supplement is recommended: Pharmakologie und Toxikologie: Arzneimittelwirkungen verstehen - Medikamente gezielt einsetzen von Heinz Lüllmann, Klaus Mohr und Lutz Hein (Gebundene Ausgabe - 18. Auflage von Januar 2016)

Responsible for Module:
Stefan Engelhardt (Stefan.Engelhardt@tum.de) Andrea Welling@tum.de (andrea.welling@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vertiefungsvorlesung Pharmakologie (Vorlesung, 2 SWS)
Welling A [L], Andergassen D, Avramopoulos P, Dueck A, Engelhardt S, Laggerbauer B, Lang A, Rammes G, Welling A, Wille T

Seminar für Studierende der Biowissenschaften (Master) (Seminar, 2 SWS)
Welling A [L], Andergassen D, Avramopoulos P, Dueck A, Esfandyari Shahvar D, Laggerbauer B, Lang A, Rammes G, van der Kwast R, Welling A, Wille T

For further information in this module, please click campus.tum.de or here.

Moduls after consulting "Medicine" | Module nach Rücksprache "Medizin"

Module Description

WZ2460: Current Topics in Neurobiology | Aktuelle Themen der Neurobiologie

Version of module description: Gültig ab winterterm 2018/19

Module Level:	Language:	Duration:	Frequency:
Master	English	two semesters	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Graded presentation (20-30 min.)
Students will have to prepare themselves for the general topic of the respective lesson by means of introductory texts each week; this general part will be discussed together at the beginning of the seminar. Subsequently, one student will present a more detailed text or a current publication from a high-class peer-reviewed journal; this additional information will then be discussed. The entire seminar will be held in English. The overall grade of the module is based on the students' participation and previous knowledge in the general preliminary information and discussions (30 %) as well as on their own presentation performance (categories text comprehension, completeness, structure, presentation style, handout, together 40 %) and participation in the special discussion (20 %).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of neurobiology, at least on the level of the lecture "Human and Animal Physiology", should be available. Ideally, the attendance of this seminar should be combined with the simultaneous attendance of the lecture "Neurobiology".

Content:
Basic and advanced aspects of neurobiology including methods, formal and theoretical foundations, model systems for basic research and for applied research, pharmaceutical research, molecular and molecular biological aspects of complex functions and dysfunctions These contents

are introduced basally by means of basic articles (mostly textbook excerpts, more rarely simpler reviews) and then brought up to the current state of knowledge by means of more recent, top-class published articles. The assessment of further developments in the respective research areas is explicitly made.

Intended Learning Outcomes:
Students acquire scientifically sound, basic knowledge of neurobiology and an overview of current developments in the most important research areas. After completing this seminar, students will be able to extract current research results from publications, put them into context and integrate them into their knowledge system. The topics discussed are not to be understood as a completed historical process. In particular, students will develop ideas about how research lines and processes behave with regard to their further development and will be able to understand the mechanisms of the science establishment.

Teaching and Learning Methods:
Event type/teaching technique: Seminar
teaching method: seminar, question-developing method, presentation, group work
Learning activities: studying the basic information given out, researching material, summarising documents, preparing and giving presentations, gathering information in special lectures, incorporating new information supported by question and answer sessions.

Media:
Literature will be distributed or made available for download on Moodle. Own presentations are to be created using PowerPoint or similar presentation techniques. Additional information will be communicated on Moodle (URLs, further texts)

Reading List:
The basic textbook "Neuroscience. Exploring the brain." by Bear, Connors, Paradiso from the Lippincott, Williams and Wilkins publishing house is recommended as the basic textbook, in the English version. The German edition ("Neuroscience." from Spektrum Verlag) is more expensive and not in the language used in the seminar. Other textbooks of neurobiology are also suitable for the basic contents.

Responsible for Module:
Harald Luksch Harald.Luksch@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Aktuelle Themen der Neurobiologie: Biologie und Neuroethologie der Fledermäuse (Seminar, 2 SWS)
Firzlaff U

Aktuelle Themen der Neurobiologie: Neurobionik (Seminar, 2 SWS)
Luksch H (Luksch H, Mosedale G)

Aktuelle Themen der Neurobiologie: Zelluläre und molekulare Neurophysiologie (auf Englisch)
(Seminar, 2 SWS)
Weigel S, Michel K, Bühner S
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2411: Immunology 2 | Immunologie 2

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 130	**Contact Hours:** 170

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Duration of exam (in min.): 60 written + 10 oral (presentation) + practical (SL).
Regular, active participation in the courses is expected, for the internship it is required (presence check). The theoretical knowledge and basic understanding of the
connections are tested by an exam (60 min, graded). The understanding of experimental questions and methods will be evaluated by a summarizing presentation (graded) and by writing a protocol (graded) by the students. Examination, lecture and internship protocol
The mark of the written examination of the theory counts 1-fold, the common mark of lecture and practical course protocol counts 2-fold. If the overall grade is better than 4.1, the module is considered completed and passed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Successful completion of the module 'Immunology 1

Content:
The module 'Immunology 2' is addressed to students who - based on the module 'Immunology 1' - want to deepen their knowledge of immunology. TThe basic knowledge about the mechanisms of immune defense is further developed by consideration of more complex immunological facts, such as the exact immunological processes in autoimmune diseases and tumor diseases. Furthermore, questions in the
immunological research and current research results are looked at. The lecture 'Special Immunology' deals with questions of current immunological research.
The practical course serves to get to know and apply immunological working methods in practice, such as
flow cytometry and various immunocyte assays.

Intended Learning Outcomes:
After completing this module, students are able to use the most important experimental methods to understand and/or apply for investigation of immunological questions. With the internship the students gain the ability to apply basic immunological methods such as isolation and cultivation of immune cells as well as the analysis of cells using flow cytometry, i.e. mastering this process. Attending the lecture enables the students to master even more complicated experimental approaches based on concrete scientific questions and to gain a deep insight into current immunological research areas. Attendance of lectures and practical training lay the foundation for the ability to apply the basic knowledge of immunology gained in the course of module 'Immunology 1' to unknown facts, evaluate immunological questions and possibly to develop own solutions.
The attendance of this module gives students the ability to further conduct immunological research in either a master's or doctoral thesis.

Teaching and Learning Methods:
The module consists of a lecture and a subsequent practical training. In the lecture current research topics are presented by the chair staff. The students are invited to study original scientific papers. During the practical training they learn immunological working methods, as well as the processing of questions from immunological research by means of group or partner work.

Media:
Presentations via Powerpoint, script (download possibility for lecture material), internship script

Reading List:
original scientific papers (recommended by the lecturers)

Responsible for Module:
Busch, Dirk; Prof. Dr.med.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum der Immunologie (für Biologen) (Praktikum, 8 SWS)
Andrä I, Bernard B, Bianca S, Buchholz V (Kretschmer L), D'Ippolito E, Kolb S, Kretschmer L, Mejias Luque R, Meyer H (Norman D, Bianca S), Schumann K (Bernard B, Kolb S)

Spezielle Immunologie für Biologen, Biochemiker, Molekulare Biotechnologen und Mediziner (Vorlesung, 2 SWS)
Andrä I, Buchholz V, Busch D, Friedrich V, Gerhard M, Hochrein H, Keppler S, Mejias Luque R, Meyer H, Neuenhahn M, Prodjinotho U, Rosenbaum M, Schumann K
For further information in this module, please click campus.tum.de or here.

Engineering | Technik

Module Description

MA9607: Applied statistics | Angewandte Statistik

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Modulprüfung besteht aus einer schriftlichen Prüfung (60 Minuten) mit Fragen und Berechnungen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
MA9602 - Einführung in die Statistik

Content:
Mehrfache lineare Regresssion und damit verbunden Hypothesentest, mehrfaktorielle Varianzanalyse und damit verbundene Hypothesentests, Nichtparametrische Verfahren, Planung von Versuchen, Handhabung von Daten.

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss des Moduls sind die Studierenden in der Lage, für mehrere Erklärende entsprechend des Skalenniveaus ein geeignetes statistisches Auswerteverfahren auszuwählen und anzuwenden. Die Studierenden sind in der Lage, in wissenschaftlichen Publikationen angegebenen statistischen Kennzahlen und Verfahren zu interpretieren. Sie erkennen den Zusammenhang und die Bedeutung zwischen der Planung eines Versuchs und seiner Auswertung und können Techniken im Umgang mit Daten auswählen, bewerten und anwenden.

Teaching and Learning Methods:
Die Lehrtechniken sind Vorlesung und Übung. Die erwarteten Lernaktivitäten sind Erarbeiten der Inhalte anhand der ausgegebenen Unterlagen, Rechnen von Übungsaufgaben. Eingesetzte Lehrmethoden: Vortrag, blended learning, Partnerarbeit.

Media:
Vorlesungsunterlagen, Übungsaufgaben und zusätzliches Material sowie die schriftlichen Notizen zu Vorlesungen und Übungen wird auf Moodle bereitgestellt.

Reading List:
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Thomson -Brooks/ Cole 2008 (International student edition).
Pruscha, H, Statistisches Methodenbuch, Springer.

Responsible for Module:
Petermeier, Johannes; Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Statistik (WZW) [MA9607] (Vorlesung, 2 SWS)
Petermeier J

Übungen zu Angewandte Statistik (WZW) [MA9607] (Übung, 1 SWS)
Petermeier J, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2227: Computer-Aided Drug and Protein Design | Computer-Aided Drug and Protein Design

Version of module description: Gültig ab winterterm 2009/10

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 30.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Methods for ligand and protein modelling:
Ligand-based similarity searching
Methods of protein-ligand docking
Methods of protein design

Intended Learning Outcomes:
The students are familiar with bio- and cheminformatic methods that are used in the field of computer-aided drug and protein design. They know the algorithmic and application-based differences between various methods and have learned to choose the appropriate algorithm for a given problem.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Iris Antes (antes@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

WZ2599: Analysis of High-Throughput Datasets for Biologists | Analysis of High-Throughput Datasets for Biologists

Version of module description: Gültig ab winterterm 2015/16

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Each participant writes a research paper-like report of approximately four pages. To do so, the students receive a set of raw data and specific question, which should be solved for this dataset. Based on the competences gained during the lecture and exercise the students should be able to solve the questions by processing the raw data and applying various forms of data analyses, e.g. clustering, enrichment analysis, Principle component analysis. The report has to be submitted within two weeks after the course.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in statistics

Content:
Lectures will give insight into how biological knowledge can be generated from modern omic technologies (transcriptomic, proteomic, metabolomic) and illustrate different ways of analyzing such data.
Practicals will consist of 1) how to use many freely available computing tools to work more powerfully and effectively 2) computer exercises that will enable the participants to apply statistical methods to the analysis of large scale biological data 3) gain knowledge on how to utilize existing biological databases in their research.

Intended Learning Outcomes:
Upon successful completion of the module students are familiar with advanced data analysis methodologies and hands-on competence on the latest available tools for the analysis of high

throughput data sets. They have basic knowledge on what information can be found and where, as well as how can the information be
accessed/retrieved.

Teaching and Learning Methods:
Lecture: Introduction into statistics, application of R software
Exercise: The theory taught in the lecture is substantiated and trained in the exercise on specific practical examples. This is done partially by each student on his own, partially in small groups of two or three.

Media:
Interactive whiteboard (Lecturer is programming on an interactive whiteboard, students mainly on their PC; complemented by black board writing and scientific publications (provided by the lecturer).

Reading List:
Current publications in statistics and data processing (provided by the lecturer one week before module starts

Responsible for Module:
Bernhard Küster kuster@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Analysis of High-Throughput Datasets for Biologists (Übung, 2 SWS)
Küster B [L], The M

Analysis of High-Throughput Datasets for Biologists (Vorlesung, 2 SWS)
Küster B [L], The M
For further information in this module, please click campus.tum.de or here.

Module Description

MW0019: Bioreaction Engineering | Bioreaktoren

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die angestrebten Lernergebnisse werden in Form einer 90-minütigen Klausur durch Verständnisfragen und durch Rechenaufgaben zu biologischen Stoffumwandlungen überprüft (zugelassenes Hilfsmittel: Taschenrechner). Eine schriftliche Prüfung wird durchgeführt, um die große Anzahl an Studierenden unter gleichen Rahmenbedingungen prüfen zu können. Zusätzlich hierzu ist die Durchführung von Rechenaufgaben im Rahmen einer Klausur vorteilhaft.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind Kenntnisse der Grundlagen der Bioverfahrenstechnik.

Content:
Diese Lehrveranstaltung soll die ingenieurwissenschaftliche Beschreibung biologischer Stoffumwandlungen (Wachstum, Substrataufnahme und Produktbildung von Mikroorganismen und Zellen) in technischen Systemen vertiefen. Wesentliche Inhalte sind: Modellbioreaktoren (Rührkessel und Strömungsrohr) - Formalkinetische Modelle biologischer Reaktionen - Biologische Reaktionen in Modellbioreaktoren (stationär) - Dynamisches Verhalten von Modellbioreaktoren - Abschätzung biologischer Modellparameter - Stoffflussanalyse - Messung biologischer Modellparameter - Strukturierte kinetische Modelle biologischer Reaktionen - Rührkesselreaktoren - Blasensäulen - Festbett-/Fließbettreaktoren.

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul sind die Studierenden in der Lage, biologische Reaktionen in Modellbioreaktoren (Wachstum, Substrataufnahme und Produktbildung von Mikroorganismen und Zellen) kinetisch zu analysieren und Prozessverläufe zu bewerten. Darüberhinaus sind die

Studierenden in der Lage, das Verhalten der wichtigsten Bioreaktoren im industriellen Maßstab zu verstehen.

Teaching and Learning Methods:
Die Themen der Vorlesung werden im Vortrag mit Hilfe von Powerpoint-Präsentationen theoretisch behandelt und die wesentlichen Aspekte werden wiederholt aufgegriffen und in den (zeitlich daran anschließenden) Übungen vertieft. Die Studierenden erhalten hierzu Übungsaufgaben, die in der Regel 1 Woche später vorgerechnet und diskutiert werden. Dies ermöglicht den Studierenden eine Selbstkontrolle der eigenständigen Analyse und Bewertung biologischer Stoffumwandlungsprozesse.

Media:
Die in der Vorlesung verwendeten Folien werden den Studierenden in geeigneter Form rechtzeitig zugänglich gemacht. Übungsaufgaben werden regelmäßig verteilt und in der Regel werden die Musterlösungen eine Woche später ausgegeben und mit den Studierenden diskutiert.

Reading List:
Es ist aktuell kein Lehrbuch zu allen Inhalten dieses Moduls verfügbar. Als Einführung empfiehlt sich: Horst Chmiehl: Bioprozesstechnik. Elsevier GmbH, München.

Responsible for Module:
Weuster-Botz, Dirk; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Bioreaktoren (MW 0019) (Vorlesung, 3 SWS)
Weuster-Botz D [L], Weuster-Botz D, Benner P, Caballero Cerbon D, Heins A, Oppelt A, Sampaio de Oliveira L, Thurn A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2619: Research Project: in silico Evolutionary Genetics of Plants and Pathogens | Forschungspraktikum: in silico Evolutionsgenetik von Pflanzen und Pathogenen

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 10	**Total Hours:** 300	**Self-study Hours:** 60	**Contact Hours:** 240

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The grade is based on the report by the student who will describe in max. 20 pages the analysis of a genomic dataset or of a mathematical model by means of stochastic simulations. The report consists in the description of methods, statistical analyses and discussion of the results. The report serves as a basic scientific document summarizing the pipeline of analysis, possible pitfalls and bias in the results, as well as a general conclusion about the chosen scientific question.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in bioinformatics and statistics.

Content:
Modern evolutionary biology methods and concepts is pervasive in many fields of biology such as medicine, agriculture, plant and animal breeding, or ecology. State of the art scientific project in this field require to integrate sequence data, mathematical theory and computer simulations. This practical course provides an in depth application of these principles. The students will study either genomic datasets or a mathematical model by means of stochastic simulations.
1) Content of the NGS / genomic data analysis: introduction to NGS data, type of files, download NGS data from databases, barcoding, trimming, read quality control, perform read-mapping with a reference genome, perform SNP calling, gene annotation, statistical bias in SNP calling, de novo genome assembly: de novo assembly of a simple genome, annotation of assembly.
2) Content of the mathematical model analysis: formulation of a mathematical model, coding in R, formulation of the stochastic processes involved, simulations in R, statistical analysis of simulations.

3) Exercise and practice writing a report with critical discussion.

Intended Learning Outcomes:
After the course the students are confident in using the classic tools for bioinformatics of NGS data, the Linux operating system, a computer cluster and in performing basic statistics using the software R.
When analyzing genomic data, the students know the different type of data generated by Next Generation Sequencing platforms, they know how to perform all the steps from raw data until obtaining SNP data. They master the analysis of genomic data up to SNP calling, By learning how to use different software, they know how to produce accurate data analysis from NGS sequencing data, are critical of the robustness of the results, and can write a scientific description of the pipeline of analysis.
When performing mathematical modelling and stochastic simulations, the students learn how to develop and to formulate a mathematical model to answer a question in evolutionary biology, and to consider and model the different sources of stochasticity in nature. The students are able to write the model and perform simulations in R and conduct the statistical analysis of the results.

Teaching and Learning Methods:
Learning techniques: exercise on computer, practical research project, autonomous work.
Learning activities: reading and summarizing the relevant literature, formulating a question and a path to answer, applying bioinformatics or mathematical tools, generating results and their statistical analysis, writing a report, critical assessment of the work.

Media:
Software training: Linux environment, basic command line, statistical software R, SAMtools, Trimmomatic, bwa.

Reading List:
Hartl and Clark, Principles of Population Genetics 4th Edition (2007); Hedrick, Genetics Of Populations 4th Edition (2009); Wakeley, Coalescent Theory: An Introduction (2008)

Responsible for Module:
Tellier, Aurélien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Forschungspraktikum: in silico Evolutionsgenetik von Pflanzen und Pathogenen (Forschungspraktikum, 10 SWS)
Silva Arias G, Tellier A
For further information in this module, please click campus.tum.de or here.

Module Description

IN8011: Engineering Informatics I (MSE) | Informatik I für Ingenieurwissenschaften (MSE)

Version of module description: Gültig ab winterterm 2016/17

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 75	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The exam takes the form of a written test of 90 minutes. Questions allow to assess acquaintance with concepts of Informatics and programming, small programming tasks assess the ability to conceive appropriate algorithmic solutions and realize small applications. The successful completion of homework asignments may contribute to the grade as a bonus (up to 30%). The exact details for this are announced timely at the begin of the lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
no specific pre-requisites

Content:
The lecture presents basic concepts of object-oriented programming languages and fundamental techniques of programming. Control-constructs such as iteration, recursion as well as simple concepts for structuring programs by means of classes and inheritance are examplified for a modern object-oriented language such as C++. Simple data-structures such as arrays, lists, trees and hash maps are introduced and algorithms for solving fundamental problems such as sorting and searching are presented. At the beginning there is a compact introduction to tools for scientific computing such as Maple or Matlab.

Intended Learning Outcomes:
Upon successful completion of the module participants understand the essential concepts of computer science w.r.t. programming on a fundamental, scientific, yet practical level. They are then able to solve well-posed algorithmic problems and to implement basic applications in C or a object-oriented language like C++.

Teaching and Learning Methods:
By means of a presentation, either by slides or whiteboard, the lecture transports essential concepts of
computer science and the programming language and illustrates how they can be applied to example problems.
Accompanying assignments for individual study deepen the understanding of the concepts explained in the lecture,
and train students to apply these to solve small programming tasks in the given programming language.

Media:
slide show, blackboard, possibly online programming and/or animations

Reading List:
Griffiths, David; Grffiths, Dawn
Head First C, 1st edition
O'Reilly, 2012

Shaw, Z.A
Learn C the Hard Way, 1st edition
2016

Kernighan, B.W.; Richtie, D.M.
The C Programming Language, 2nd edition
Prentice Hall, 2012

Perry, G.; Miller, D.
C Programming Absolute Beginner's Guide, 3rd edition
Pearson Education, 2015

Herold, H.; Lurz, B.; Wohlrab, J.
Grundlagen der Informatik
Pearson Studium, 2007

Responsible for Module:
Seidl, Helmut; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Informatik I für Ingenieurwissenschaften (BSc. Engineering Science) (IN8011) (Vorlesung, 2 SWS)
Mendl C, Nibbi M

Übungen zu Informatik I für Ingenieurwissenschaften (BSc. Engineering Science) (IN8011) (Übung, 3 SWS)
Mendl C, Nibbi M

For further information in this module, please click campus.tum.de or here.

Module Description

WZ8058: Immunoinformatics | Immunoinformatik

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 50	**Contact Hours:** 40

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Eine Klausur (90 min) dient zur Überprüfung des erlernten Wissens. Im Praktikum werden die in der Vorlesung vermittelten Inhalte vertieft, wobei zur Kontrolle ein Protokoll anzufertigen ist. Die Studierenden sollen Ihre Kenntnisse aus der Vorlesung praktisch anwenden und zeigen, dass sie in der Lage sind, die Resultate aus den praktischen Übungen auszuwerten, zu interpretieren und prägnant darzustellen. Die Studierenden sollen das erworbene Wissen strukturiert und auf das Wesentliche konzentriert darstellen sowie Transferaufgaben bewältigen können. Die Klausurnote bildet zusammen mit der Note für das Praktikum die Gesamtnote des Moduls. Die Gewichtung der Noten für die Klausur und das Praktikum für die finale Modulnote ist 50:50.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
keine

Content:
Sequenz- und Strukturbasierte Vorhersagemethoden in folgenden Bereichen: MHC Klasse I und II Prozessierungspfad, Epitoperkennung, B-Cell Aktivierung, Allergenität und Immunogenität. Strukturbasierte Methoden zur Modellierung von immunologisch wichtigen Proteinen (MHC, TCR, Antikörper, etc.) und deren Bindungspartner. Anwendung der besprochenen Methoden auf medizinische Fragestellungen (z.B. Immunotherapie, Impfstoffdesign). Die Veranstaltung richtet sich an Studierende der Fachrichtungen Biologie, Molekulare Biotechnologie, Bioinformatik, Biochemie, Chemie und Biophysik (Master/Bachelor 5./6. Semester).

Intended Learning Outcomes:
Die Studenten sind mit den bioinformatischen Methoden, welche im Bereich Immunoinformatik verwendet werden, vertraut. Sie kennen die algorithmischen und anwendungsbezogenen

Unterschiede zwischen verschiedenen Methoden und haben gelernt, die passenden Algorithmen für eine gegebene Anwendung auszuwählen.

Teaching and Learning Methods:
Lehrtechnik: Vorlesung; Praktikum. Lehrmethode: Vortrag; praktische Uebungen, Partnerarbeit, praktikumsbegeleitende Betreuung, Anleitungsgespräche. Lernaktivitäten: Studium von Vorlesungsmaterial und Literatur, praktisches Üben am Computer, Zusammenarbeit mit Praktikumspartner, Anfertigung von Protokollen.

Media:
Präsentation, Skript zur Vorlesung, Praktikumsanleitungen

Reading List:
Literaturempfehlungen werden in der Vorlesung gegeben.

Responsible for Module:
Iris Antes (antes@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

WZ2066: Advanced Bioinformatics | Weiterführende Bioinformatik

Version of module description: Gültig ab winterterm 2014/15

Module Level: Bachelor	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 105	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Scientific elaboration

The exam can be retaken in the following semester. Details will be announced at the beginning of the module.

In the scientific elaboration, a specific topic of the lecture (in general specified by the lecturer) is elaborated based on a literature study as well as on the methods presented in the lecture and tutorials. This elaboration includes, on the hand, the required aspects on network-based concepts for analysis and interpretation of biological data as well as on methods for the current omics technologies presented in the lectures as well as, on the other hand, the application of these methods to the specified topic. Within this elaboration in form of an extended abstract, the student demonstrates that she is able to investigate, to present, and to discuss a given scientific problem in form of a publication. In the accompanying presentation, the student demonstrates that she can present and defend her discoveries.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bioinformatik I und II; Grundlagen der Biologie; Algorithmische Grundkenntnisse

Content:
The module covers the following contents:
• Concepts and properties of graph based network analysis (Barabasi)
• Probabilistic networks
• Sequence based methods for the systematic analysis of genomic information (pro- and eukaryotes)

o SIMAP
o PEDANT
o ENCODE I and II
• Protein/protein networks
• Metabolic networks (static, transient, conditional)
• Regulatory networks / expression analysis
• Non-coding RNA
• Epigenetics
• Genetic variance and populationsbased genomewide studies (GWAS)
• High-throughput NGS sequence analysis

Intended Learning Outcomes:
Upon successful completion of the module the participants understand the importance of network concepts for the analysis and interpretation of biological data. They understand current techniques for the analysis of -omics data (genomics, proteomics, transcriptomics, metabolomics, epigenomics, etc.). They can apply network graphs to biological networks (metabolic, regulatory and protein interactions) and know the fundamentals of systems biology (qualitative and quantitative models). Students are able to independently work on and immerse into a specific topic of the module such that they can present the results in a short scientific report. Students are also able to understand their work in the context of the lecture as well as to present and to discuss their results in a scientific presentation.

Teaching and Learning Methods:
Lecture, discussion of the topics in the lecture and tutorial; supervised tutorials, discussion of assignments; working on individual topics and its presentation; web-based teamwork on lecture topics as well as on assigned topics.

Within the assignments (submission is optional) the understanding of concepts and methods presented in the lecture is deepened using specific examples. The students apply the presented methods, for example, to determine network-theoretic parameters for biological networks, to analyze genomes. Also alternative concepts and methods will be presented and discussed in the tutorials. For this an additional literature study (references given in the tutorials) is necessary. For solving given assignments as well as for preparing the discussion of these assignments as well as of lecture topics in the tutorials, web-based methods will support teamwork, so that it can be done independently from time and space.

The scientific elaboration deepens a specific topic of the lecture based on current literature. In particular, this elaboration is focused on the application of high throughput data technologies and its bioinformatics analysis, which will be conducted in groups of 2-3 teammates. Based on the fundamental findings of the teamwork, each teammate writes a scientific elaboration on an individual topic and reports it in a presentation.

Media:
Slide show (PowerPoint / Prezi), blackboard; discussion in the lecture and tutorials; teaching material on the course home page, web-based learning

Reading List:
Key reviews from the up-to-date literature (Nature, Science, Nature Genetics, Bioinformatics, a. o.)

Responsible for Module:
Baumbach, Jan, Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Module Description

MW1141: Modelling of Cellular Systems | Modellierung zellulärer Systeme

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur erbracht. Sie besteht aus Kurzfragen und Rechenaufgaben. Es wird geprüft in wieweit die Studierenden die grundlegenden Konzepte der mathematischen Modellierung und Modellanalyse bei zellulären (biologischen) Systemen verstehen und anwenden können. Es ist eine schriftliche Klausur mit einer Prüfungsdauer von 90 Minuten vorgesehen. Die Klausur wird in jedem Semester angeboten (im WS zeitnah am Beginn). Es sind keine Hilfsmittel zugelassen. Durch eine Studienleistung in Form einer Projektarbeit oder Präsentation kann die Modulnote um 0,3 verbessert werden (APSO, §6(5)).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind mathematische Kenntnisse, wie sie in Bachelorstudiengängen an wissenschaftlichen Hochschulen vermittelt werden.

Content:
Das Modul soll die Grundlagen der mathematischen Modellierung, der Analyse und der Simulation von zellulären Systemen vermitteln und vertiefen. Zu den wichtigen Prozessen gehören die Enzym-katalysierten Reaktionen, die Polymerisation von Makromolekülen und die zelluläre Signalübertragung.
Wesentliche Inhalte sind:
- Graphentheoretische Analysen,
- Aufstellen von Bilanzgleichungen für konzentrierte und verteilte Systeme,
- Analyse stöchiometrischer Netzwerke,
- Thermodynamik zellulärer Prozesse,
- Reaktionskinetiken (Enzyme, Polymerisationsprozesse, Signalübertragung),

- Stochastische Systeme

Intended Learning Outcomes:
Nach der Teilnahme an diesem Modul sind die Studierenden mit den biologischen und theoretischen Grundlagen von zellulären Systemen vertraut und in der Lage, Bilanzgleichungen für komplexe zelluläre Netzwerke zu erstellen und zu analysieren. Anhand der Modelle sind die Studierenden in der Lage das Verhalten der Netzwerke durch Simulation vorherzusagen und den gesamten biotechnologischen Prozesses zu bewerten (zeitliches Verhalten, Produktausbeuten).

Teaching and Learning Methods:
In der Vorlesung werden mathematische Ableitungen und Zusammenhänge an der Tafel mit Hilfe von Powerpoint-Präsentationen aufgezeigt. Wesentliche Aspekte werden dann wiederholt aufgegriffen und in den Übungen vertieft. Die Übungen sollen zum Teil am Rechner/Laptop durchgeführt werden, um komplexere Aufgaben, wie mathematische Modellierungen und/oder Simulationen bearbeiten zu können. Die Lösungsstrategien werden dann gemeinsam mit den Studenten besprochen, um ein vertieftes Verständnis von zellulären Systemen zu entwickeln.

Media:
Die in der Vorlesung verwendeten Folien werden den Studierenden in geeigneter Form zugänglich gemacht. Übungsaufgaben werden rechtzeitig verteilt und die Musterlösungen mit den Studierenden diskutiert.

Reading List:
Zur Verfügung stehen englischsprachige Lehrbücher, die Teilaspekte des genannten Stoffes abbilden. Zu nennen sind: Nielsen, Villadsen, Lieden: Bioreaction Engieneering Principles (Kluwer Academic Press, 2003), B. O. Palsson: Systems Biology: Properties of Reconstructed Networks (Cambridge University Press, 2006), Kremling: Systems Biology (CRC Press).

Responsible for Module:
Kremling, Andreas; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Modellierung zellulärer Systeme (MW1141) (Vorlesung, 2 SWS)
Kremling A [L], Kremling A

Modellierung zellulärer Systeme Übung (MW1141) (Übung, 2 SWS)
Kremling A [L], Kremling A, Beentjes M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ8128: Methods of Genome Analysis | Methoden der Genomanalyse

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module test involves a graded written exam.
The goal of the written exam (90 minutes) is to assess how well the students understand the basic concepts of genome analysis (like genes, regulatory sequences, operons, alternative splicing, SNPs, microRNAs, pseudogenes, repeats, orthology/paralogy) and how well they are able to reproduce them in limited time. Based on exemplary method calls, interrogation of input and output of methods, as well as the building of possible method pipelines to solve a specific bioinformatics problem, and the interpretation of method results, it is assessed how well the students are able to do bioinformatics analyses on their own, choose appropriate methods suitable to a specific problem and apply these. No electronic devices are allowed except for pocket calculators.
Students are asked to write free-text answers to questions, solve algorithmic and logical problems, and to work through a limited number of multiple-choice questions by ticking the right answer.

To pass the module at least the score 4.0 is required.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Suggested pre-requisites for participation is basic knowledge of bioinformatics, for example as taught in the TUM modules „Introduction in Bioinformatics I and II“.

Content:
The following topics are core elements of the module:
- Genome structure
- Analysis of DNA sequences
- Gene prediction
- Operon structures

- Alternative splicing
- RNA structure
- microRNAs
- Repeats
- Pseudogenes

Intended Learning Outcomes:
Upon successful completion of the module the students are able to:
• Understand and reflect in-depth important concepts of genome analysis (genes, regulatory sequences, operons, alternative splicing, SNPs, microRNAs, pseudogenes, repeats, orthology/ paralogy),
• Practically apply selected methods of genome analysis (e.g. gene prediction, prediction of microRNA binding sites, identification of DNA sequence motifs, prediction of RNA structures).

Teaching and Learning Methods:
The selected teaching approach Lecture course and the selected teaching method Oral talk are especially well suited for imparting basic concepts, methodological approaches as well as typical problems of genome informatics to students with basic knowledge of bioinformatics. In particular the exercise serves as a way to deepen the learning content of the lecture. The students are expected to prepare a scientific publication covering an already discussed topic from the lecture. In the exercise the algorithms and methods used in the publication are discussed. Where possible, the usage of the methods and the analysis of selected case studies from the publication is presented in class. Thus, also the application of the methods is trained. It will be announced before each exercise which scientific publication will be discussed. The students are encouraged to prepare the contents of the paper and familiarize their selves with the methods used. The lecturer discusses the procedures and methods in the exercise, and responds to questions and problems. Where possible, small selected case studies are solved together in the exercise, or are presented by students.

Media:
Scientific publications, presentation of slides, discussions during lectures, materials on the module Web page.

Reading List:
- Genomes 3, T.A. Brown, Garland Science, 2007
- Bioinformatics and Functional Genomics, Jonathan Pevsner, John Wiley, 2003
- Understanding Bioinformaics, M. Zvelebil and J.O.Baum, Garland Science 2008

Responsible for Module:
Frischmann, Dimitri; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Methoden der Genomanalyse: Vorlesung (Vorlesung, 2 SWS)
Frischmann D [L], Frischmann D

Methoden der Genomanalyse: Übung (Übung, 2 SWS)
Frischmann D [L], Parr M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ5326: Pharmaceutical Technology 2 | Pharmazeutische Technologie 2

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 115	**Contact Hours:** 35

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In der 60-minütigen, schriftlichen Modulprüfung müssen die Studierenden 10 - 20 Fragen zu den Lernergebnissen beantworten. Es werden keine Hilfsmittel benötigt. In der Prüfung wird mit Zuordnungsaufgaben gearbeitet, mit kurzen Freitextaufgaben, mit Multiple Choice-Fragen, mit Tabellen, die zu vervollständigen sind, und mit Skizzen, die zu erklären sind. So müssen die Studierenden z.B. anhand von technologischen Fallbeispielen Herstellprozesse zuordnen, auswählen oder optimieren. Weiterhin müssen die Studierenden geeignete Arzneiformen für therapeutische Fallbeispiele vorschlagen. In anderen Fragen müssen sie die Eignung eines Prozesses für ein beispielhaftes Ziel überprüfen. Auch möglich sind Fragen zur Funktion und Eignung von Hilfsstoffen in und für eine gegebene Arzneiform.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Zum Verständnis dieser Modulveranstaltung empfiehlt sich dringend eine erfolgreiche Teilnahme an dem Modul Pharmazeutische Technologie und Biopharmazie 1, da sowohl die Grundlagen zu den behandelten Technologien, den Arzneiformen allgemein als auch zur Biopharmazie vorausgesetzt werden.

Content:
Diese Vorlesung ist der zweite Teil des Gesamtkomplexes Pharmazeutische Technologie. Der erste Teil findet im Bachelorstudium im Wintersemester statt und behandelt die grundlegenden Arzneiformen und Techniken (wie z.B. Tabletten, Salben und Injektionen).
Im Rahmen des Moduls Pharmazeutische Technologie 2 werden nun spezielle Arzneiformen, die in der Vorlesung Pharmazeutische Technologie und Biopharmazie 1 noch nicht behandelt wurden, vorgestellt. Es werden z.B. Pellets, Zäpfchen, Ohrentropfen, therapeutische Pflaster, Mikro- und Nanopartikel, Drug Delivery Devices, Homöopathika, pflanzliche Arzneiformen, spezielle

Arzneiformen für Kinder und andere mehr durchgesprochen. Weiterhin wird die Auswahl und Funktion der Hilfsstoffe behandelt. Wege zur Rezepturfindung und -optimierung werden vorgestellt, sowie die Stabilisierung von Formulierungen und aktuelle Forschungsthemen.

Intended Learning Outcomes:
Nach der Teilnahme an dieser Modulveranstaltung sind die Studierenden in der Lage,
- alle gängigen Arzneiformen zu beschreiben.
- die Herstellung aller gängigen Arzneiformen zu skizzieren.
- Qualitätsmerkmale aller gängigen Arzneiformen zu nennen und fachgerecht zu überprüfen.
- Hilfsstoffe für alle gängigen Arzneiformen auszuwählen und deren Funktion zu erklären.
- die Herstellung und Verpackung von Arzneiformen an die Eigenschaften des in ihnen enthaltenen Arzneistoffs anzupassen.
- bestehende Herstellungsprozesse aller gängigen Arzneiformen hinsichtlich einer konkreten Fragestellung zu optimieren.
- geeignete Applikationswege und Arzneiformen für spezielle Patientenkollektive vorzuschlagen, da sie die Wechselwirkung zwischen Arzneiform und Körper kennen.
- Faktoren, die die Stabilität von Arzneiformen beeinflussen, zu benennen und Maßnahmen zur Erhöhung der Stabilität vorzuschlagen.

Teaching and Learning Methods:
In der wöchentlich stattfindenden Vorlesung wird im Vortrag sowohl mit Powerpoint als auch mit Tafelanschrieb und Kurzfilmen gearbeitet. Alle Arzneiformen werden anhand von Anschauungsmaterial vorgestellt. Der Lernerfolg wird wöchentlich mit Übungsfragen in OnlineTED überprüft. Durch anschließende Diskussion der Fragen wird das Verständnis der Studierenden zu den behandelten Themen vertieft. Begleitend dazu sind alle Informationen und das Skript in einem moodle-Kurs verfügbar. Es empfiehlt sich zudem ein selbstständiges Studium der relevanten Literatur.

Media:
Für diese Veranstaltung gibt es ein digitales Skript, das zum Download im moodle-Kurs bereitgestellt wird und maßgeblich prüfungsrelevant ist.

Reading List:
Aulton, Taylor: Aulton's Pharmaceutics
Bauer, Frömming, Führer: Lehrbuch der Pharmazeutischen Technologie
Voigt: Pharmazeutische Technologie
Herzfeldt, Kreuter: Grundlagen der Arzneiformenlehre
Herzfeldt: Propädeutik der Arzneiformenlehre
Weidenauer, Beyer: Arzneiformenlehre kompakt
Sucker, Fuchs, Speiser: Pharmazeutische Technologie
Zimmermann: Pharmazeutische Technologie
Mäder, Weidenauer: Innovative Arzneiformen
Leuenberger (Hrsg.): Physikalische Pharmazie
Fiedler: Lexikon der Hilfsstoffe

Hunnius: Lexikon der Pharmazie

Responsible for Module:
Caren Sönnichsen Caren.soennichsen@wzw.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Pharmazeutische Technologie 2 (Vorlesung, 2 SWS)
Sönnichsen C [L], Sönnichsen C
For further information in this module, please click campus.tum.de or here.

Module Description

MA9613: Statistical Computing and Data Analysis (TUM School of Life Sciences) | Statistical Computing and Data Analysis (TUM School of Life Sciences)

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
In the written exam (60 min) the students solve problems to selected statistical topics. The solution requires the application of the skilled and practiced calculations and heuristics. First the students have to identify and to classify the problem and secondly choose and apply a suitable method.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor's course in statistics

Content:
Basic statistics review
Categorical data
Analysis of variance and experimental design
Robust methods
Simple regression
Multiple regression
Specification
Model diagnostics
Lack of fit
Model selection
Nonlinear and time series regression
Survival regression
Logistic and poisson regression
Linear mixed models

Sample size and power calculations

Intended Learning Outcomes:
1) Become experienced in all facets of the R statistical package.
2) Apply data handling methods for visualization and communication.
3) Select and apply appropriate statistical methods to design and analyze experimental data.
4) Apply appropriate hypothesis tests and confidence interval procedures.
5) Perform multiple Normal linear-, mixed-effect-, time-series-, non-linear-, Poisson- and survival-regression.

Teaching and Learning Methods:
In the lectures the concepts are introduced and discussed in case studies. In the exercise classes the students solve problems and case studies on their own using the statistical package R. The problems of the case studies are chosen to provide the students guided, hands-on experience to acquire the necessary skills in the projects.

Media:
Slides, exercise sheets, R statistical package

Reading List:
Abram, B., Ledolter, J., Introduction to Regression Modeling, Thomson Brooks/Cole
Fitzmaurice, G. M., Laird, N. M., Ware, J. H., Applied longitudinal analysis, Wiley
Collett, D., Modelling Survival Data in Medical Research, Chapman & Hall CRC
Van Belle, G., Fisher, L D., Heagerty, P. J., Lumley, T., Biostatistics: a methodology for the health sciences, Wiley
Peck, R., Olsen, C., Devore, J., Introduction to Statistics and Data Analysis, Brooks/Cole Cengage Learning

Lecture notes, additional material in moodle course

Responsible for Module:
Ankerst, Donna; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises for Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Übung, 1 SWS)
Ankerst D, Neumair M

Statistical Computing and Data Analysis (TUM School of Life Sciences) [MA9613] (Vorlesung, 2 SWS)
Ankerst D, Neumair M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ0402: Structural Bioinformatics | Strukturbioinformatik [Structural Bioinformatics]

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 90	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module test involves a graded written exam.
The goal of the written exam (90 minutes) is to assess how well the students understand the basic concepts of protein structure analysis and prediction (like protein structure visualization, secondary structure assignment, tertiary structure assignment, quality of protein structure data, structural domains, signal peptides, intra protein contacts, structure function relationship) and how well they are able to reproduce them in limited time. Based on exemplary method calls, interrogation of input and output of methods, as well as the building of possible method pipelines to solve a specific bioinformatics problem, and the interpretation of method results, it is assessed how well the students are able to do bioinformatics analyses on their own, choose appropriate methods suitable to a specific problem and apply these. No electronic devices are allowed except for pocket calculators. Students are asked to write free-text answers to questions, solve algorithmic and logical problems, and to work through a limited number of multiple-choice questions by ticking the right answer.

To pass the module at least the score 4.0 is required.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundkenntnisse in der Bioinformatik (Sequenzanalyse, molekulare Evolution)
Grundkenntnisse in der Zellbiologie/Biochemie
Grundkenntnisse in der Statistik

Content:
The following topics are core elements of the module:

- protein structure visualization
- secondary structure assignment
- tertiary structure assignment
- quality of protein structure data
- structure databases
- structure comparison
- structural domains
- protein folding
- secondary structure prediction
- ab initio 3D structure prediction
- homology modelling
- threading
- signal peptides
- intra protein contacts
- structure function relationship

Intended Learning Outcomes:
The following topics are core elements of the module:
- protein structure visualization
- secondary structure assignment
- tertiary structure assignment
- quality of protein structure data
- structure databases
- structure comparison
- structural domains
- protein folding
- secondary structure prediction
- ab initio 3D structure prediction
- homology modelling
- threading
- signal peptides
- intra protein contacts
- structure function relationship

Teaching and Learning Methods:
The selected teaching approach Lecture course and the selected teaching method Oral talk are especially well suited for imparting basic concepts, methodological approaches as well as typical problems of structural bioinformatics to students with basic knowledge of bioinformatics. In particular the exercise serves as a way to deepen the learning content of the lecture. The students are expected to prepare a scientific publication covering an already discussed topic from the lecture. In the exercise the algorithms and methods used in the publication are discussed. Where possible, the usage of the methods and the analysis of selected case studies from the publication is presented in class. Thus, also the application of the methods is trained. It will be announced before each exercise which scientific publication will be discussed. The students are encouraged to

prepare the contents of the paper and familiarize their selves with the methods used. The lecturer discusses the procedures and methods in the exercise, and responds to questions and problems. Where possible, small selected case studies are solved together in the exercise, or are presented by students.

Media:
Scientific publications, presentation of slides, discussions during lectures, materials on the module Web page.age.

Reading List:
- Bourne & Weissig, Structural Bioinformatics
- Understanding Bioinformatics, M. Zvelebil and J.O.Baum, Garland Science 2008

Responsible for Module:
Frischmann, Dimitri; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Strukturbioinformatik (VO und UE) (Vorlesung, 4 SWS)
Frischmann D [L], Frischmann D, Parr M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ3096: Scientific Computing for Biological Sciences with Matlab | Scientific Computing for Biological Sciences with Matlab

Version of module description: Gültig ab summerterm 2021

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 30	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The examination consists of writing a report (10-15 pages) about a given project assigned by the lecturer, and giving a presentation on the project (10 minutes), followed by a 5 min discussion. In writing a report about their project the students will be asked to demonstrate their ability to analyze and plot data, interpret the data in the context of the biological problem and critically discuss the shortcomings of their chosen statistical method. They will be tested on their ability to summarise major factors and the conclusion of their results in a clear and concise manner. In the presentation the students will show their ability to present their results to an audience of peers and to stand a discussion about the presented content.
The final grade is an average from the written report (50%) and the presentation (50%).

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
MA9601, MA9602

Content:
The content is the workflow within the MATLAB package from loading the data, plotting and learning to program functions in MATLAB. The students will learn about the use of variables and functions. The will learn elementary descriptive techniques like bar plots, scatter plots histograms and cumulative histograms. The students will learn to use toolboxes for statistical inference and apply these toolboxes to compare distributions and means on selected data sets and for fitting functions to data to detect correlations. On selected data sets, the students will apply MATLAB methods for fourier analysis, convolution and filtering as well as for example principal component

analysis for dimensionality reduction. They will work with noisy biological data and learn how to interpret their results in the context of the data.

Intended Learning Outcomes:
The students will be able to handle biological data sets and are able to apply data analysis methods. The students are able to create plots for both analyzing and presenting data. The students will be able to handle a mathematical software package, MATLAB, and are able to find the suitable functions for statistical inference and fitting of functions.
They will be able to decide when to use fourier analysis, convolution and filtering of data. They will also know techniques for dimensionality reduction.

Teaching and Learning Methods:
The module is offered as lectures with accompanying practice sessions. In the lectures, the contents will be presented in a talk with demonstrative examples, as well as through discussion with the students. The lectures should animate the students to carry out their own analysis of the themes presented and to independently study the relevant literature. Corresponding to each lecture, practice sessions will be offered, in which exercise sheets and solutions will be available. In this way, students can deepen their understanding of the methods and concepts taught in the lectures and independently check their progress. At the beginning of the module, the practice sessions will be offered under guidance, but during the term the sessions will become more independent, and intensify learning individually as well as in small groups.

Media:
Case studies

Reading List:

Responsible for Module:
Gjorgjieva, Julijana; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Scientific computing for Biological Sciences with Matlab (UE) (Übung, 2 SWS)
Dwulet J, Parkinson-Schwarz J

Scientific computing for Biological Sciences with Matlab (VO) (Vorlesung, 2 SWS)
Dwulet J, Parkinson-Schwarz J
For further information in this module, please click campus.tum.de or here.

Module Description

WZ8119: Systems BioMedicine | Systems BioMedicine

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 105	**Contact Hours:** 75

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The module examination takes place within the framework of a project work during the semester and is carried out as a group of 3-4 participants in several phases. These include problem definition, role allocation, idea generation, criteria development, as well as decision-making, project planning and implementation. The project assignment is the development and final presentation of a systems medicine software, with which the students communicate that they have understood concepts of systems medicine and bioinformatics-driven software development. In the final presentation of 40 minutes duration, it is demonstrated that participants can present the subject matter of the elaboration in a clear and understandable manner to the course participants in the given time.
The grade is determined in equal parts by the final presentation and the written evaluation. For the latter, a documentation of the software in the form of an elaboration has to be prepared. This should have a size appropriate to the scope of the software and should not be less than 20 pages. Special attention will be paid to the choice of methodology and the comprehensive use of molecular data in the sense of data-driven systems medicine. For the awarding of grades (individual evaluation), the performance of the team members must be evident, e.g. through the division of the elaboration as well as the presentation.

In the event of an unsuccessful exam, participants will be given a one-time opportunity to make corrections to the software, paper and presentation and to repeat the final presentation.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bioinformatics I and II, Basics of Molecular Biology and Genetics, Advanced Bioinformatics; Basic programming knowledge in R and / or Python is required.

Content:
In this module, we will introduce concepts of systems biology and describe its transition to systems medicine. The focus is on bioinformatic methods and the following topics are presented, among others:

- Availability of and work with OMICS data (e.g. genomics, metagenomics, transcriptomics, epigenomics, proteomics, metabolomics and lipidomics.Goals of precision and personalized medicine.
- Complex diseases (cancer, multiple sclerosis, ...).
- Network medicine
- Cancer genomics and identification of relict mutations
- De novo endophenotyping and patient stratification.
- Drug target and biomarker discovery
- disease subtyping
- drug repositioning
- Privacy-aware machine learning

Intended Learning Outcomes:
Upon successful completion of this module, participants will understand systems medicine methods for the analysis of complex diseases and can apply this knowledge in practice.
They can evaluate the use of basic concepts of systems biology and assess the application OMICs technologies for disease-oriented basic research using primary literature. Participants understand the paradigms of personalized and precision medicine and their role in systems medicine. Participants have further understood the basic concepts of genotype-phenotype relation and acquired deeper knowledge of genetic and epigenetic factors contributing to disease development. This knowledge enables the participants in practice to, for instance, select and apply the appropriate methods for stratifying patients with respect to systemic properties of the disease. Finally, participants will gain insights into current progress in the field and learn to apply methods for support in treatment selection as well as to generate hypothesis in support of therapy development based on molecular data.

Teaching and Learning Methods:
Lecture, Exercises and project work

Lecture with active participation of the students; tutorial, presentation and discussion of exercises; Group work on various topics with guided implementation of a software tool including its presentation.

Web based learning (Moodle)

Media:
PowerPoint presentation, Diskussion in the lecture and in the exercises

Reading List:
Key publications from current literature on the role of bioinformatics in systems medicine

Responsible for Module:
List, Markus, Ph.D. markus.list@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Systems BioMedicine (Übung, 3 SWS)
List M [L], Hoffmann M, List M, Pauling J, Schirmer M, Wilhelm M

Systems BioMedicine (Vorlesung, 2 SWS)
List M [L], List M, Pauling J, Schirmer M, Wilhelm M
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2045: Introduction to Bioinformatics II | Bioinformatik für Biowissenschaften II

Version of module description: Gültig ab summerterm 2023

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Prüfungsdauer (in min.): 60.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Teilnahme an Vorlesung und Übung Einführung in die Bioinformatik I

Content:
Einführung in grundlegende Konzepte und Methoden in der Bioinformatik (Fortsetzung der Einführung in die Bioinformatik I). Themenschwerpunkte sind u.a.:

- Genvorhersagen
- Grundlagen der Proteinstrukturen
- Grundlagen von Phylogenie und molekularer Evolution
- Grundlagen der Genregulation und der entsprechenden Algorithmen
- Grundlagen metabolischer Netzwerke und ihrer Analyse
- Eigenschaften biologischer Netzwerke
- Einführung Datenbanken und Datenintegration in den Biowissenschaften

Intended Learning Outcomes:
Grundlegende Kenntnis wichtiger Konzepte und Methoden der Bioinformatik
Fähigkeit Ergebnisse ausgewählter bioinformatischer Werkzeuge zu bewerten

Teaching and Learning Methods:
Vortrag

Media:

Reading List:
Understanding Bioinformatics, Marketa Zvelebil, Jeremy O. Baum, Garland. 2007; Bioinformatics, David Mount, 2nd ed, 2004, Cold Spring Harbour Laboratory Press; Bioinformatik Eine Einführung, Arthur M. Lesk, Spektrum Akademischer Verlag (2002)

Responsible for Module:
Frischmann, Dimitri; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Bioinformatik f. Biowissenschaften II (Vorlesung, 2 SWS)
Frischmann D [L], Frischmann D

Übung zur Vorlesung Bioinformatik f. Biowissenschaften II (Übung, 2 SWS)
Frischmann D [L], Parr M
For further information in this module, please click campus.tum.de or here.

Moduls after consulting "Engineering" | Module nach Rücksprache "Technik"

Module Description

WZ5063: Basics in Programming | Grundlagen des Programmierens

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 135	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
The learning outcome is assessed by an examination (120 minutes).

The exam consists of two parts. In the first part, general theoretical basics of programming are tested in writing. The students work on questions regarding the understanding of data structures and the possibilities of influencing the programme flow (control flow). In the second part, they solve programming tasks on the computer using the Python 3.10+ programming language. Competences such as importing, transforming, illustrating and saving, with relevance in a scientific environment, are tested.

The processing time of the theoretical part is set at approx. 30 minutes, the programming task at approx. 90 minutes. This ratio is also reflected in the weighting of the two parts. Thus, the theoretical part accounts for 30% of the grade and the programming task for 70%.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
No previous experience is required.

Content:
Das Modul Grundlagen des Programmierens behandelt folgende Themen in Vorlesung und Übungsaufgaben:
- Einteilung der verschiedenen Programmierparadigmen
- Aufbau eines Programms

- Schleifen
- Konditionalsätze
- Kontrollstrukturen
- Aufrufen von Funktionen
- Entwicklung von Funktionen
- Strukturierung von Daten
- Einlesen von Datensätzen
- Verarbeiten von Datensätzen
- Graphische Darstellung von Datensätzen
- Durchsuchen von Datensätzen
- Umgang mit Bibliotheken

Intended Learning Outcomes:
After participating in the module courses, students have the ability to develop simple programs and the skill to write them in the Python 3.10+ programming language. These serve as examples for the acquisition of competence in importing, transforming, illustrating and storing data, with relevance in the scientific environment.

Teaching and Learning Methods:
In the lecture Fundamentals of Programming, students are taught the theoretical basics by means of a classical lecture. Small program examples are shown within the lecture. The chosen document type, Jupyter Notebook, enables the simultaneous presentation of script, program code and result presentation in one document.
The focus of the module lies in the exercise Fundamentals of Programming, in which the students deepen the learned contents by solving application-related problems on the computer. Here the students create programs in JupyterLab 3+ with Python 3.10+. Programming can take place in group work or alone. For more complex tasks, students present their solutions to fellow students and discuss the approaches together. A collection of tasks is provided. The programs created can be discussed with the lecturers.

Media:
Both the presentation and the exercises are made available to the students as Jupyter Notebook. In addition to a "classic" script, Jupyter Notebook offers the possibility to develop and execute additional programme code in this document.

Reading List:
Python 3 | The comprehensive manual by Johannes Ernesti, Peter Kaiser | ISBN 978-3-8362-7926-0
http://openbook.rheinwerk-verlag.de/python/
Further current literature will be announced at the beginning of the module.

Responsible for Module:
Gaßner, Günther, M.Sc. guenther.gassner@tum.de Schmid, Philip, M.Sc. philip.schmid@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen des Programmierens (Vorlesung, 3 SWS)
Voigt T [L], Voigt T (Gaßner G, Nophut C)
For further information in this module, please click campus.tum.de or here.

Module Description

MW0018: Bioprocesses | Bioprozesse

Version of module description: Gültig ab winterterm 2020/21

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 105	**Contact Hours:** 45

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die angestrebten Lernergebnisse werden durch Verständnisfragen und Rechenaufgaben schriftlich überprüft (zugelassenes Hilfsmittel: Taschenrechner). Die Prüfungsdauer beträgt 90 Minuten. Kreditpunkte werden für das erfolgreiche Ablegen der Modulprüfung vergeben.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Voraussetzungen für die erfolgreiche Teilnahme sind Kenntnisse der Grundlagen der Bioverfahrenstechnik.

Content:
Diese Lehrveranstaltung gibt einen Überblick über die technische Nutzung biologischer Stoffumwandlungen anhand konkreter Prozessbeispiele. Schwerpunkte sind industrielle biologische Verfahren zur Gewinnung von Wertstoffen. Wesentliche Inhalte sind: Bioprozessentwicklung   Umweltbiotechnologie   Verfahren zur Herstellung von Grundchemikalien Herstellung von Feinchemikalien   Proteinherstellung mit Mikroorganismen und mit Gewebezellen Ökonomie biotechnologischer Produktionsprozesse.

Intended Learning Outcomes:
Nach der Teilnahme an dieser Modulveranstaltung sind die Studierenden in der Lage, die Entwicklung von Bioprozessen und biotechnologische Produktionsverfahren in der industriellen Anwendung zu verstehen und zu bewerten.

Teaching and Learning Methods:
Die Inhalte des Moduls werden in der Vorlesung (2 SWS) mit Hilfe von Powerpoint-Präsentationen theoretisch vermittelt. Wesentliche Inhalte werden wiederholt aufgegriffen und in den Übungen (1

SWS) vertieft. Die Beiträge industrieller Dozenten werden im Anschluss an den Vortrag jeweils intensiv diskutiert.

Media:
Die in der Vorlesung verwendeten Folien werden den Studierenden in geeigneter Form rechtzeitig zugänglich gemacht. Übungsaufgaben werden regelmäßig verteilt und in der Regel werden die Musterlösungen eine Woche später ausgegeben und mit den Studierenden diskutiert.

Reading List:
Es ist kein Lehrbuch zu allen Inhalten dieses Moduls verfügbar. Als Einführung empfiehlt sich: Horst Chmiehl: Bioprozesstechnik. Elsevier GmbH, München.

Responsible for Module:
Weuster-Botz, Dirk; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Bioprozesse (MW0018) (Vorlesung, 3 SWS)
Weuster-Botz D [L], Weuster-Botz D, Blums K, Herrmann F, Thurn A
For further information in this module, please click campus.tum.de or here.

Module Description

WZ2679: Advanced methods for the structural modeling of biological systems (Lecture) | Fortgeschrittene Methoden zur strukturellen Modellierung biologischer Systeme (Vorlesung)

Version of module description: Gültig ab winterterm 2015/16

Module Level:	**Language:**	**Duration:**	**Frequency:**
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Scientific Project Drafting | Wissenschaftliche Projektplanung

Module Description

WZ22101: Scientific Project Drafting | Wissenschaftliche Projektplanung

Version of module description: Gültig ab winterterm 2012/13

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 5	**Total Hours:** 150	**Self-study Hours:** 120	**Contact Hours:** 30

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
60 min oral examination. The examination is conducted by two university teachers, one of whom is the planned topic presenter and examiner for the thesis. The 2nd examiner is also from campus and should be distant from the subject. The examination begins with the presentation of the planned thesis by the examinee, e.g. by presenting written documents or a presentation of about 20 minutes by the examinee.
This is followed by a disputation, which scrutinises the presentation. It is also possible that, based on the expected topic of the Master's thesis, further questions on associated and basic 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 scrutinise a scientific question to a large extent independently and to record and structure it in its complexity, starting with a hypothesis and ending with a written report and to show a plan for the solution. He or she can present the project to scientists and engage in a scientific discussion. Students know which theoretical and planning requirements are necessary for the practical implementation of such a project.

Teaching and Learning Methods:
Teaching method: Preliminary talk with the topic presenter about the question, task, relevant technical literature. Exchange with experts on site. Learning method: Consolidation of the knowledge required for the final thesis through self-study. Creation of a robust project plan through a deep examination of the subject matter in dialogue with the topic presenter.

Media:
Scientific publications, scientific communication

Reading List:
Specific scientific publications in the field of interest. Basic literature on e.g. statistical methods.

Responsible for Module:
Studienfakultät Biowissenschaften

Courses (Type of course, Weekly hours per semester), Instructor:

For further information in this module, please click campus.tum.de or here.

Master's Thesis | Master's Thesis

Module Description

WZ5907: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 100	**Contact Hours:** 800

Number of credits may vary according to degree program. Please see Transcript of Records.

Description of Examination Method:
Die Prüfungsleistung besteht aus einer schriftlichen Master`s Thesis. Die Bearbeitungsdauer der Thesis beträgt 6 Monate ab offizieller Vergabe des Themas durch den Prüfungsausschuss. Mit der Erstellung der Master`s Thesis demonstrieren die Studierenden, dass sie in der Lage sind, eine neue wissenschaftliche Fragestellung aus ihrem jeweiligen Fachbereich zu identifizieren und zielführende Experimente zur Lösung dieser Frage zu konzipieren. Sie zeigen, dass sie eine praktischen Forschungsarbeit eigenständige durchführen und unter Berücksichtigung entsprechender wissenschaftlicher Methoden lösungsorientiert bearbeiten können.

Das Masterkolloquium folgt der, vom Prüfungsausschuss akzeptierten, Master`s Thesis spätestens 2 Wochen nach Bekanntgabe des Ergebnisses und dauert 30 Minuten. Anhand des Kolloquiums wird geprüft, ob die Studenten die Inhalte der Masterarbeit eigenständig, präzise und anschaulich darstellen können. Die Studierenden sollen zeigen, dass sie mit rhetorischer Sicherheit überzeugend auftreten können, und die Fragen im Themenkontext beantworten und wissenschaftliche diskutieren können. Die Studierenden haben insgesamt 15 Minuten Zeit ihre Thesis vorzustellen. Daran schließt sich eine Diskussion an, die sich auf das weitere Fachgebiet des Masterstudiengangs im Kontext zum Thema der Masterarbeit erstrecken kann.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Die Master's Thesis soll das letzte Modul im Masterstudiengang sein, weshalb grundlegend alle Module im Master vorausgesetzt werden können.

Content:
Im Rahmen der Master‘s Thesis bearbeiten die Studierenden ein eigenes Forschungsthema an einem Lehrstuhl der Studienfakultät oder einem fachnahen Forschungsinstitut. Grundsätzlich kommen hier als Prüfer und „Themengeber“ alle Lehrpersonen, die Lehre im Curriculum des Studiengangs anbieten, in Frage.
Die Studierenden bearbeiten selbstständig eine wissenschaftliche Fragestellung, werten ihre Ergebnisse aus und bewerten diese mit geeigneten wissenschaftlichen Methoden. Die Vorgehensweise und Ergebnisse werden in der schriftlichen Ausfertigung der Master‘s Thesis zusammengefasst und in einem Vortag einem Fachpublikum vorgestellt.

Intended Learning Outcomes:
Nach Abschluss der Master`s Thesis sind die Studenten in der Lage:
- ein neuartiges Forschungsprojekt zu identifizieren
- wissenschaftliche Fragestellungen präzise zu formulieren
- einen realistischen Zeitplan aufzustellen und einzuhalten
- ein Forschungsprojekt eigenständig durchzuführen
- die Versuche und Ergebnisse im wissenschaftlichen Kontext des gewählten Fachgebietes einzubetten
- die gewonnenen Schlussfolgerungen im Vergleich zu den in der Literatur vertretenen Ansichten zu diskutieren
- einen wissenschaftlichen Text zur Darstellung eigener Forschungsergebnisse zu verfassen, der den formalen Standards der jeweiligen Fachdisziplin entspricht
- eigene wissenschaftliche Ergebnisse einem Fachpublikum vorzustellen und zu diskutieren

Teaching and Learning Methods:
Die Studierenden wählen ihr Master`s Thesis Projekt in enger Abstimmung mit dem aufnehmenden Lehrstuhl oder Institut. Die Studierenden führen die wissenschaftlichen Arbeiten unter der Anleitung des jeweiligen Fachbetreuers eigenständig durch und dokumentieren ihre erzielten Ergebnisse gemäß den wissenschaftlichen Standards. Die schriftliche Ausarbeitung der Master’s Thesis erfolgt eigenständig durch die Studenten in enger Abstimmung und unter Rücksprache mit dem jeweiligen Fachbetreuer. Der Master’s Thesis folgt ein Masterkolloquium mit Präsentation und Disputation der Thesis.

Media:

Reading List:
Literatur durch eine entsprechende wissenschaftliche Recherche ist von der Themenwahl abhängig.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Master's Thesis
For further information in this module, please click campus.tum.de or here.

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