The Elective Course Catalog lists individual courses offered in the Master of Science Biology program, including course instructors, descriptions of course contents and qualification goals. Courses are grouped according to subject, according to lectures, practical courses and seminars (in that order). Practical research courses (lab rotations) are not listed individually since they vary according to current topics in faculty research groups.

## Contents: Elective Course Catalog

# Physical Anthropology and Environmental History



| **Lecture: Functional Anatomy and Archaeobiology (winter term)** | |
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| Instructor: | Prof. Dr. Gisela Grupe, Dr. Marina Vohberger |
| Course content: | Fundamentals of biophysics: causal histogenesis, trajectory theory, principals of hydrostatics. Comparative primate functional anatomy. Evolutionary adaptations of the dentition and the locomotor apparatus, energy balance. Evolution of human bipedalism. |
| Qualification Goals: | The students are introduced to biophysics with a focus on the mineralized tissues and the adaptation to bending, pressure and shearing moments. They become familiar with the basic principles of the evolution of functional morphology and become equipped with the prerequisites necessary to evaluate evolutionary changes in form and function including energetic requirements.<br>Students are equipped with the basic knowledge prerequisite to scientific research in this topic. |
| **Lecture: Archaeometry (including field trip: excavation) (summer term)** | |
| Instructor: | Prof. Dr. Gisela Grupe, Dr. Marina Vohberger |
| Course content: | Students will learn how to decipher the determining factors responsible for the evolution and development of populations through time and space based upon the recognition of indices provided by the molecular and crystalline composition of archaeological and forensic skeletal material. Methods which are |

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| | routinely applied to modern tissues are adapted for the application to archaeological/forensic tissues. A discussion of the relevant parameters including nutrition, economic endeavours, migration analysis, genealogical relationships and aspects specific to environmental conditions (i.e. climate reconstruction) is performed. |
| **Lecture: Historische Umweltforschung, summer term (rotating topics each semester)** | |
| Instructor: | Prof. Dr. Gisela Grupe |
| Course content: | Contents are determinants of human population development in space and time as well as cultural aspects of everyday life history with their biologically available results.<br>Course language: German (also available for bachelor's and teaching degree students) |
| Qualification Goals: | The students are introduced to the biology of the human population and its development. Students will be equipped with advanced knowledge prerequisite to scientific research in this topic, including forensic anthropology. |
| **Lecture: Biologische Spurenkunde, winter term (rotating topics each semester)** | |
| Instructor: | Prof. Dr. Gisela Grupe |
| Course content: | Methods of forensic and legal science introduced by members of the Institute of Legal Medicine and anthropologists.<br>Course language: German (also available for bachelor's and teaching degree students) |
| Qualification Goals: | The students are introduced to the biology of the human population and its development. Students will be equipped with advanced knowledge prerequisite to scientific research in this topic, including forensic anthropology. |
| Qualification Goals: | The students are introduced to the archaeometry of mineralized vertebrate tissues. Besides the communication of methods, students are trained in hypothesis building, choice of adequate methods, and interdisciplinary discussion of scientific questions arising both from the natural and social sciences.<br>Students will be equipped with advanced knowledge prerequisite to scientific research in this topic, including forensic anthropology. |

| **Practical course: Functional Anatomy and Archaeobiology (winter term)** | |
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| Instructor: | Prof. Dr. Gisela Grupe, Dr. Marina Vohberger |

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| Course content: | Osteological record of adult and subadult human archaeological skeletons. Comparative functional anatomy of primates assessed by skeletons of representatives of relevant primate taxa. Focus: Functional morphology of skulls and jaws and evolutionary implications, functional morphology of the postcranial skeletons with regard to energy expenditure and locomotion, evolution of human bipedalism, morphological features associated with the domestication of vertebrates. |
| Qualification Goals: | Students are able to transfer theoretical knowledge to practical applications with regard to the complexity of form and function.<br>Students can apply theoretical and practical knowledge to approach evolutionary questions in independent work.<br>Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions |
| **Practical course: Archaeometry (including field trip: excavation) (summer term)** | |
| Instructor: | Prof. Dr. Gisela Grupe, Dr. Marina Vohberger |
| Course content: | The practical portion of the course involves the extraction of the various biological components from bone finds as well as the complementary interpretation of the data won during the different procedures, and also the identification of decomposition artefacts.<br>Lab work in particular: Extraction and amplification of DNA, adaptation of the methodology to degraded DNA in archaeological and forensic finds; extraction of collagen, structural carbonate, structural phosphate, and apatite from archaeological mineralized hard tissues and quality control (state of preservation, e.g. by amino acid analysis); interpretation of stable isotopic data (C, N, O, Sr) measured in these components, non-invasive diagnosis (X-raying); histology of mineralized tissues for the diagnosis of individual data such as age at death and detection of decomposition phenomena. |
| Qualification Goals: | Students are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments, conscientious documentation of lab procedures, and obtain skills in specialized techniques such as trace analysis of archaeobiological finds.<br>Students proceed beyond routine lab methodology and learn how to adapt "standard" lab protocols to unique states of preservation with an extremely low number of degraded target molecules.<br>Students will prepare protocols according to the usual guidelines for authors of scientific journals, thereby learning the principles of scientific writing (structure of a paper, data presentation, data interpretation, conclusions, general scientific context of the topic). |

| **Practical research courses** | |
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| Instructor: | Teaching staff, Anthropology division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Current topics in Physical Anthropology (varying topics each term)** | |
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| Instructor: | Prof. Dr. Gisela Grupe, Dr. Marina Vohberger |
| Course content: | Seminar on changing current topics of physical anthropology, related to the MSc courses. The topics are different each term. To be held "en bloc" on one weekend. |
| Qualification Goals: | Students are proficient in presentation skills with modern media, are instructed about library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers.<br>Focus is on hypothesis building, context and theory-guided discussion.<br>Students sharpen communication, presentation, and posture skills gained through speaking in front of a group.<br>Students are exposed to current literature and gain insight into language and presentation formats required for peer-reviewed publication. |

# Cell and Developmental Biology

| **Lecture: Current topics in Cell and Developmental Biology I (*Zoology*)** | |
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| Instructors: | Prof. Dr. Barbara Conradt, Prof. Dr. Angelika Böttger, Prof. Dr. Dr. Walter Neupert, Dr. Stephane Rolland, PD Dr. Eric Lambie, Dr. Frank Schnorrer, Prof. Dr. Charles David |
| Course content: | "Current topics in Cell and Developmental Biology I" is a lecture |

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| | series that is team-taught by several instructors that cover basic background as well as research currently ongoing in their fields of expertise (post-transcriptional gene regulation/splicing, mitochondrial biogenesis and dynamics, dosage compensation, muscle development, genome analyses, apoptosis). The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | The students are proficient in the areas of post-transcriptional gene regulation/splicing, mitochondrial biogenesis and dynamics, dosage compensation, muscle development, genome analyses, and apoptosis and are able to depict basic principles and transfer knowledge in an exam situation.<br>Students obtain the fundamental knowledge required to participate in further specialized courses and to understand and critically evaluate primary literature in these areas of research.<br>Students are equipped with the basic knowledge prerequisite to scientific research in these topics. |
| **Lecture: Current topics in Cell and Developmental Biology II (*Zoology*)** | |
| Instructors: | Prof. Dr. Barbara Conradt, Dr. Tamara Mikeladze-Dvali, Prof. Dr. Michael Schleicher, Dr. Annette Müller-Taubenberger, Dr. Zeynep Ökten, Dr. Anne-Kathrin Classen, Dr. Ilona Kadow, Müller, Prof. Dr. Andreas Ladurner |
| Course content: | Current topics in "Cell and Developmental Biology II" is a lecture series that is team-taught by several instructors that cover basic background as well as research currently ongoing in their fields of expertise (centrioles, cytoskeleton, cell polarity, tissue homeostasis, miRNAs, nervous system development, epigenetic gene regulation, regulation of apoptosis). The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | The students are proficient in the areas of centrioles, cytoskeleton, cell polarity, tissue homeostasis, miRNAs, nervous system development, epigenetic gene regulation, and regulation of apoptosis and are able to depict basic principles and transfer knowledge in an exam situation.<br>Students obtain the fundamental knowledge required to participate in further specialized courses and to understand and critically evaluate primary literature in these areas of research.<br>Students are equipped with the basic knowledge prerequisite to scientific research in these topics. |
| **Lecture: Mechanisms of animal development (*Zoology*)** | |
| Instructors: | PD Dr. Eric Lambie, Dr. Anne-Kathrin Classen, Dr. Tamara Mikeladze-Dvali, Prof. Dr. Barbara Conradt |

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| Course content: | This course covers fundamental mechanisms of animal development, as determined using the model invertebrates, *Drosophila melanogaster* and *Caenorhabditis elegans*. Basic principles are discussed, as are the experimental methodologies that have led to key discoveries. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | The students are proficient in the basic developmental biology (embryology and fate maps) of *Drosophila* and *C. elegans*.<br>Students are familiar with the genetic, molecular, and experimental methods used to elucidate principles of development.<br>Students are able to interpret novel data sets, formulate hypotheses, and suggest experimental approaches that could be used to test these hypotheses.<br>Students are able to integrate knowledge from lecture with information obtained through online data searches. |
| **Lecture: Molecular Virology, Part I (**Human Biology, Genetics, Microbiology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| | *See Human Biology for course description and qualification goals. |
| **Lecture: Molecular Virology, Part II (**Human Biology, Genetics, Microbiology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| | *See Human Biology for course description and qualification goals. |
| **Lecture: Introduction to electron microscopy (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Gerhard Wanner |
| | *See Plant Sciences for course description and qualification goals. |
| **Lecture: Modern methods in Plant Sciences (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Dario Leister, Prof. Dr. Peter Geigenberger, PD Dr. Cordelia Bolle, Dr. Iris Finkemeier, Prof. Dr. Jörg Nickelsen, PD Dr. Tatjana Kleine, Dr. Anja Schneider, Dr. Mathias Pribil |
| | *See Plant Sciences for course description and qualification goals. |
| **Lecture: Membranes: physical and biological aspects (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Ute Vothknecht |
| | *See Plant Sciences for course description and qualification goals. |

| **Lecture: Biochemistry 3 (**Plant Sciences*)** | |
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| Instructors: | PD Dr. Bettina Bölter, PD Dr. Katrin Philippar, Prof. Dr. Jörg Nickelsen |
| | *See Plant Sciences for course description and qualification goals. |
| **Lecture: Biochemistry and Cell Biology of plants (**Plant Sciences*)** | |
| Instructors: | Prof. Dr. Jürgen Soll, Prof. Dr. Ute Vothknecht, Prof. Dr. Gerhard Wanner |
| | *See Plant Sciences for course description and qualification goals. |
| **Lecture: Epigenetics (**Human Biology*)** | |
| Instructor: | Prof. Dr. Heinrich Leonhardt, Dr. Anne-Kathrin Classen |
| | *See Human Biology for course description and qualification goals. |

| **Practical course: *C. elegans* as an experimental model (*Zoology*)** | |
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| Instructors: | Prof. Dr. Barbara Conradt, PD Dr. Eric Lambie, Dr. Nadin Memar, Dr. Stephane Rolland |
| Course content: | Participants in "*C. elegans* as an experimental model" obtain basic knowledge of *C. elegans* biology and are introduced to procedures such as *C. elegans* handling, microscopy (stereo-, DIC- and fluorescence), gene discovery through mutant screening, various phenotypic analyses and genetic analyses (genetic crosses, classical and SNP mapping etc). During the course, each student will also obtain an unknown mutant, which the student needs to analyze phenotypically and molecularly to identify the gene that is affected in the particular mutant. Emphasis is placed on hands-on practice with the techniques mentioned above and interpretation of the data obtained. The lab entails 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | Students can apply theoretical and practical knowledge to approach biological questions in independent work. Students obtain skills for future lab work with *C. elegans* and other model organisms, in particular in preparation for their master's thesis.<br><br>Students are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments, conscientious documentation of lab procedures, and obtain skills in specialized techniques such as *C. elegans* handling, microscopy (stereo-, DIC- and fluorescence), gene discovery through mutant screening, various phenotypic analyses and genetic analyses (genetic crosses, classical and SNP mapping etc). |

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| | Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions.<br><br>In working in small lab groups (2 students), social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations, written lab reports), as well as organizational skills (efficient planning, documentation) are refined.<br><br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Developmental biology of hydra (*Zoology*)** | |
| Instructor: | Prof. Dr. Angelika Böttger, Prof. Dr. Charles David |
| Course content: | Participants are introduced to hydra as a model organism for studying the evolution of developmental mechanisms. Students get hands-on experience in analysing the cell cycle and differentiation kinetics of different cell types in hydra. They conduct transplantation and regeneration experiments to reveal fundamental principles of tissue self-organisation and pattern formation and the role of specific molecular signaling pathways in regulating developmental processes. The course includes introductory lectures and students´ talks to convey basic general knowledge about the major topics and techniques to the group. The lab entails 6 SWS, and requires a detailed written lab report |
| Qualification Goals: | Students obtain skills for future lab work, in particular in preparation for their master's thesis. These include skills in preparing of biological specimens, fluorescent dye and antibody staining, transplantation and use of standard visualization techniques with phase contrast and fluorescence light microscopy.<br><br>Students can apply theoretical and practical knowledge to approach biological questions in independent work. They learn to recognise cell types and subcellular structures, follow the fate of labelled cells and transplanted tissues and draw conclusions about cell and tissue homeostasis and mechanisms of pattern formation in a simple animal.<br><br>Students are trained in good general lab practice, including standard safety procedures, precise handling of chemicals and optical instruments, conscientious documentation of lab procedures, critical evaluation and interpretation of data as a basis for careful and relevant conclusions.<br><br>In working in small lab groups of three students, social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations of theoretical background and results, written lab reports), as well as organizational skills (efficient |

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| | planning, documentation) are refined. |
| **Practical course: Biogenesis of organelles (**Plant Sciences*)** | |
| Instructor: | PD Dr. Katrin Philippar |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Protein purification (**Plant Sciences*)** | |
| Instructors: | Prof. Dr. Jürgen Soll, Prof. Dr. Jörg Nickelsen, PD Dr. Bettina Bölter, Dr. Alexandra-Viola Bohne |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Structural and analytical investigations of plant chromosomes with scanning electron microscopy (**Plant Sciences*)** | |
| Instructor: | Dr. Elizabeth Schroeder-Reiter |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Protein transport *(*Plant Sciences)*** | |
| Instructor: | Prof. Dr. Jürgen Soll, PD Dr. Bettina Bölter |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Molecular biology and biochemistry of phototrophic microorganisms (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Jörg Nickelsen, Dr. Alexandra-Viola Bohne |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Signal transduction in plants *(*Plant Sciences)*** | |
| Instructor: | Prof. Dr. Ute Vothknecht |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Plant Molecular Cell Biology: Non-coding, regulatory RNAs in the moss *Physcomitrella patens* (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Wolfgang Frank, Dr. M. Asif Arif |
| | *See Plant Sciences for course description and qualification goals. |
| **Practical course: Plant Sciences III (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Dario Leister, Dr. Anja Schneider, PD Dr. Cordelia Bolle, Dr. Mathias Pribil, PD Dr. Tatjana Kleine, Dr. Iris Finkemeier |

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| | *See Plant Sciences for course description and qualification goals. |
| **Practical field course: Biology and ecology of the Wadden Sea (tidal flat) (AWI, List, Sylt) (*_Zoology_)** | |
| Instructor: | PD Dr. Martin Heß, Prof. Dr. Angelika Böttger |
| | *See Zoology for course description and qualification goals. |
| **Practical research courses** | |
| Instructor: | Teaching staff, Cell and Developmental Biology division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Apoptosis** | |
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| Instructor: | Prof. Dr. Barbara Conradt |
| Course content: | Research papers related to apoptosis are assigned to each participant. Using recommended literature and resources, and with consultation with the instructor, students independently study the research paper. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the paper, according to excellent scientific practice, to the entire group. |
| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources. They can also assess, discuss and present a topic in the area of apoptosis thoroughly and understandably to scientific peers.<br><br>Students are exposed to primary literature in the apoptosis field and learn about different experimental approaches that led to new insight into the field. They also gain insight into language and presentation formats required for peer-reviewed publication. |

| **Seminar: *C. elegans* research** | |
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| Instructors: | Prof. Dr. Barbara Conradt, PD Dr. Eric Lambie |
| Course content: | Students attend eight presentations on ongoing *C. elegans* research (90 min each) and then pick a topic related to the research presented. Using recommended literature and resources, and with consultation with the instructor, students independently study the topic and prepare a written research proposal according to excellent scientific practice on this topic. The seminar entails 2 SWS. |
| Qualification Goals: | Students are proficient in certain areas of research using *C. elegans* as a model and are introduced to different experimental approaches, state-of-the art methodology and primary literature. They learn to assess and discuss research and primary literature. They also gain insight into language and presentation formats required for peer-reviewed publication. |
| **Seminar: Single cell analyses** | |
| Instructor: | Prof. Dr. Barbara Conradt |
| Course content: | Topics on single cell analyses are assigned to each participant. Using recommended literature and resources, and with consultation with the instructor, students independently study the topic. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. |
| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources. They can also assess, discuss and present a topic in the area of single cell analyses thoroughly and understandably to scientific peers.<br>Students are exposed to primary literature on single cell analyses and learn about different experimental approaches that led to new insight into the field. They also gain insight into language and presentation formats required for peer-reviewed publication. |
| **Seminar: Mitochondria and degenerative diseases (*Zoology*)** | |
| Instructor: | Dr. Stephane Rolland, Prof. Dr. Charles David |
| Course content: | Research papers related to mitochondria and degenerative diseases are assigned to each participant. Using recommended literature and resources, and with consultation with the instructor, students independently study the research paper. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the paper, according to excellent scientific practice, to the entire group. |

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| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources. They can also assess, discuss and present a topic in the area of mitochondria and degenerative diseases thoroughly and understandably to scientific peers.<br><br>Students are exposed to primary literature in the field of mitochondria and degenerative diseases and learn about different experimental approaches that led to new insight into the field. They also gain insight into language and presentation formats required for peer-reviewed publication. |
| **Seminar: Signaling during embryonic development (*Zoology*)** | |
| Instructor: | Dr. Nadin Memar |
| Course content: | Topics related to signaling pathways involved in embryonic development are assigned to each participant. Using recommended literature (reviews, prior and recent papers) students research their topic independently if needed with the help of the seminar supervisor. The seminar entails 2 SWS, and requires an approx. 20 min. oral presentation of their topic, plus 10 min. discussion, according to excellent scientific practice, to the entire group. |
| Qualification Goals: | Students acquire their own scientific topic by using library and internet resources and are able to abstract the main points in front of a group. By this, students gain insight into the English language.<br><br>Students are exposed to recent literature and current problems in developmental biology, which they have to examine critically.<br><br>The final presentation in front of a group and the discussion will help the students to sharpen their skills in communication and presentation. |
| **Seminar: Stem cells** | |
| Instructor: | Prof. Dr. Angelika Böttger |
| Course content: | Topics related to different aspects of stem cell biology are assigned to each student. These include embryonic stem cells, experimental approaches to cell fate manipulation, adult stem cells and their niches and others. Using recommended literature and resources, and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic to the entire group with subsequent general discussion. |
| Qualification Goals: | Students are proficient in presentation skills using PowerPoint, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to a group and critically evaluate the presented literature. They will be exposed to |

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| | elder literature describing the beginnings of research on embryonic stem cells and literature about recent advances in the field, and acquire knowledge about current events in stem cell research. This enables them to participate in more general discussions of this topic. |
| **Seminar: Animal regeneration** | |
| Instructor: | Prof. Dr. Angelika Böttger |
| Course content: | Topics related to animal regeneration are assigned to each student. These cover regeneration in invertebrates including cnidarians (hydra), planarians, echinoderms and in vertebrates, e.g. amphibians and mammals. The main emphasis is on molecular mechanisms involved in these regeneration processes. Using recommended literature and resources, and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 25 minutes oral presentation of the topic to the entire group with subsequent general discussion. |
| Qualification Goals: | Students are introduced to current advances in our understanding of molecular mechanisms in animal regeneration and can discuss this in a broad context. Participants are introduced to library and internet resources and are encouraged to independently research them to cover their chosen topic. They learn to critically evaluate historical and current experimental data and introduce the state of the art of their theme to the group. They are proficient in presentation skills using mainly PowerPoint and can engage in a broader discussion within the group. |
| **Seminar: Animal sex determination** | |
| Instructor: | PD Dr. Eric Lambie |
| Course content: | Students choose from among a list of potential topics, typically focusing on the mechanism of sex determination in a particular group (e.g., amphibians) or species (e.g., *C. elegans*) of animals. In consultation with the instructor, students select specific papers from the primary literature that have led to significant advances in our understanding of how sex is determined. The seminar entails 2 SWS, and each student is responsible for an oral presentation of approximately 25 minutes. Students are also expected to participate in discussion in the form of dialog between the audience and the presenter. |
| Qualification Goals: | Students are exposed to current literature, and gain insight into language and presentation formats required for peer-reviewed publication.<br>Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and |

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| | present a topic thoroughly and understandably to scientific peers.<br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group. |
| **Seminar: Noncoding RNAs** | |
| Instructor: | PD Dr. Eric Lambie |
| Course content: | Students choose from among a list of potential topics, typically focusing on a particular class of noncoding RNAs (e.g, miRNAs) or context (ncRNAs that regulate dosage compensation). In consultation with the instructor, students select specific papers from the primary literature that have led to significant advances in our understanding of how ncRNAs function. The seminar entails 2 SWS, and each student is responsible for an oral presentation of approximately 25 minutes. Students are also expected to participate in discussion in the form of dialog between the audience and the presenter. |
| Qualification Goals: | Students are exposed to current literature, and gain insight into language and presentation formats required for peer-reviewed publication.<br>Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers.<br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group. |
| **Seminar: Optogenetics** | |
| Instructor: | PD Dr. Eric Lambie |
| Course content: | Students choose from among a list of potential topics, typically focusing on a particular methodology (e.g., light-gated ion channels) or application (e.g., optical regulation of behavior) in the field of optogenetics. In consultation with the instructor, students select specific papers from the primary literature that have led to significant advances in our understanding of how light can be used to manipulate the functions of macromolecules within living cells. The seminar entails 2 SWS, and each student is responsible for an oral presentation of approximately 25 minutes. Students are also expected to participate in discussion in the form of dialog between the audience and the presenter. |
| Qualification Goals: | Students are exposed to current literature, and gain insight into language and presentation formats required for peer-reviewed publication.<br>Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers. |

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| | Students sharpen communication, presentation and posture skills gained through speaking in front of a group. |
| **Seminar: Signaling in development and diseases** | |
| Instructor: | Dr. Tamara Mikeladze-Dvali |
| Course content: | The seminar will cover one specific signaling pathway (e.g. Hedgehog, BMP, Wnt, Hippo) and its role in development and disease. Each year a different signaling pathway will be chosen for discussion. Using recommended literature and resources students will independently research the topic. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. Students should actively participate during the presentations of peer students by asking questions and discussing the presented topic. |
| Qualification Goals: | Students should obtain a basic knowledge about the specific topic of the seminar and be exposed to most current state-of-the-art research in this field. Students should acquire an understanding of the logic of a research process (Why were specific experiments conducted? How were experiments designed? What were the conclusions based on the obtained data?), learn how to critically read, understand and present a research paper and how to engage in a scientific discussion. |
| **Seminar: Centrioles and cilia** | |
| Instructor: | Dr. Tamara Mikeladze-Dvali |
| Course content: | The seminar will cover the topic of centrioles and cilia and their role during different cellular processes like mitosis, asymmetric cell division, signaling. Each year the most current research publications on this topic will be included in the seminar. Using recommended literature and resources students will independently research the topic. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. Students should actively participate during the presentations of peer students by asking questions and discussing the presented topic. |
| Qualification Goals: | Students should obtain a basic knowledge about the structure and function of centrioles and cilia and be exposed to most current state-of-the-art research in this field. Students should acquire an understanding of the logic of a research process (Why were specific experiments conducted? How were experiments designed? What were the conclusions based on the obtained data?), learn how to critically read, understand and present a research paper and how to engage in a scientific discussion. |

| **Seminar: Immortal germline (*Zoology*)** | |
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| Instructor: | Dr. Tamara Mikeladze-Dvali |
| Course content: | The seminar will cover the topic germ cell specification, migration and formation of a stem cell niche during the development of invertebrate and vertebrate model organisms. Each year the most current research publications on this topic will be included in the seminar. Using recommended literature and resources students will independently research the topic. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. Students should actively participate during the presentations of peer students by asking questions and discussing the presented topic. |
| Qualification Goals: | Students should obtain a basic knowledge about the specification and formation of germ cells and the germline and be exposed to most current, state-of-the-art research in this field. Students should acquire an understanding of the logic of a research process (Why were specific experiments conducted? How were experiments designed? What were the conclusions based on the obtained data?), learn how to critically read, understand and present a research paper and how to engage in a scientific discussion. |
| **Seminar: Molecular and ecological aspects of the biotechnological usage of microalgae and cyanobacteria (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Jörg Nickelsen, Prof. Dr. Herwig Stibor |
| | *See Plant Sciences for course description and qualification goals. |
| **Seminar: Protein Purification (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Jürgen Soll, Prof. Dr. Jörg Nickelsen, PD Dr. Bettina Bölter, Dr. Alexandra Viola Bohne |
| | *See Plant Sciences for course description and qualification goals. |
| **Seminar: Endosymbiosis (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Jürgen Soll, PD Dr. Bettina Bölter |
| | *See Plant Sciences for course description and qualification goals. |
| **Seminar: Ultrastructure of chromosomes (**Plant Sciences*)** | |
| Instructor: | Dr. Elizabeth Schroeder-Reiter |
| | *See Plant Sciences for course description and qualification goals. |

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| **Seminar: Molecular Cell Biology and Signaling (**Plant Sciences*)** | |
| Instructors: | Prof. Dr. Wolfgang Frank, Prof. Dr. Ute Vothknecht |
| | *See Plant Sciences for course description and qualification goals. |
| **Seminar: Current methods in electron microscopy/Aktuelle Methoden der Elektronenmikroskopie (**Plant Sciences*)** | |
| Instructors: | Prof. Dr. Gerhard Wanner, Dr. Elizabeth Schroeder-Reiter |
| | *See Plant Sciences for course description and qualification goals. |
| **Seminar: Design of experiments in Plant Science (**Plant Sciences*)** | |
| Instructor: | Prof. Dr. Dario Leister, PD Dr. Cordelia Bolle, Dr. Anja Schneider, Dr. Mathias Pribil, Dr. Iris Finkemeier, PD Dr. Tatjana Kleine |
| | *See Plant Sciences for course description and qualification goals. |
| **Seminar: Biology and ecology of the Wadden Sea (tidal flat) (AWI, List, Sylt) (**Zoology*)** | |
| Instructor: | PD Dr. Martin Heß, Prof. Dr. Angelika Böttger |
| | Seminar accompanies practical field course Wadden Sea.<br>*See Zoology for course description and qualification goals. |

# Genetics

| **Lecture: Methods in Molecular Genetics** | |
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| Instructor: | Prof. Dr. Michael Boshart |
| Contents: | The lecture will teach the most relevant methods used in Molecular Genetics and Molecular Biology to analyse biomolecules like DNA, RNA, proteins and metabolites. As state-of-the-art life sciences have a largely overlapping methods portfolio, this will include methods used in cell biology, biochemistry and analytical biochemistry. In contrast to practical courses that teach and practice the protocols, the lecture will focus on the principles of the methods that are mostly based on the ground of chemistry and physical chemistry. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam for the credit of 2 ECTS. |
| Qualification goals: | The lecture will prepare students to understand in depth and critically evaluate the suitability of methods used in practical courses of all molecular sub-disciplines of biology and in a variety of research applications they are involved in during lab rotations, BSc theses or Master theses. |
| **Lecture: Introduction to Evolutionary Genomics** | |
| Instructor: | Prof. Dr. John Parsch |
| Contents: | Students will be taught in genome analysis, in particular in genome sequencing and assembly, genome annotation, forward and reverse genetics, transcriptomics, interactomics and proteomics. |
| Qualification goals: | Students are introduced to evolutionary genomics, with examples from prokaryotes and eukaryotes and will receive an overview of the main methods used in the field. |
| **Lecture: Advanced Evolutionary Genomics** | |
| Instructor: | Prof. Dr. John Parsch |

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| Contents: | Students will be taught in evolutionary genomics, in particular in comparative genomics, evolution of genome size, repetitive DNA, gene and genome duplication, isochors, GC content, codon bias and evolution of gene expression. |
| Qualification goals: | Students gain further knowledge of issues in evolutionary genomics. They are able to study more advanced issues in the field. |
| **Lecture: Population Genetics** | |
| Instructor: | Prof. Dr. Wolfgang Stephan, Dr. Stephan Hutter |
| Contents: | Students will be taught in population genetics, in particular they learn about divergence data and substitution models, polymorphism data and population models, coalescent theory, structured populations, recombination and linkage, selection and neutrality tests. |
| Qualification goals: | Students learn principles of molecular population genetics. |
| **Lecture: Genetics in pharmaceutical and industrial practice (Fundamentals in finding active substances) (*Microbiology*)** | |
| Instructor: | PD Dr. Günter Müller |
| Contents: | The lecture presents the fundamentals of the modern drug discovery process as established at small biotech and large pharmaceutical companies, with emphasis on biopharmaceuticals and biochemical, genetic, cell biological and pharmacological methods. These topics will be elucidated and accompanied by examples derived from important disease areas, such as metabolic diseases and cancer. |
| Qualification goals: | The scope of this lecture is geared primarily toward advanced bachelor and master students interested in applied Genetics. The overall aim of the lecture is to give a first impression about the complexity of modern drug finding and development and the professional opportunities for molecular and cellular biologists. |
| **Lecture: Molecular Virology, Part I (*Cell Biology, *Human Biology, Microbiology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| | *See Human Biology for course description and qualification goals. |
| **Lecture: Molecular Virology, Part II (*Cell Biology, *Human Biology, Microbiology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |

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| | *See Human Biology for course description and qualification goals. |

| **Practical course: Signaling protein function in vitro and in vivo** | |
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| Instructor: | Prof. Dr. Michael Boshart |
| Contents: | The course will introduce students to a set of methods to analyse the function of signaling proteins, e. g. protein kinases. The in vitro part includes protein expression in *E. coli* or *L. tarentolae*, purification with and without epitope tag, kinase enzyme assays, ligand binding assays (beads, thermophoresis) and structural modeling of binding sites. The in vivo part introduces reverse genetic tools like KO lines, RNAi lines reporter assays and protein phosphorylation analysis to study the function of the proteins in the cellular context. Credit of 6 ECTS points requires continuous participation, a written course report following the style of a short scientific paper (introduction, methods, results with figures and legends, discussion, references) and oral presentation of one original research paper including background that will be discussed in the seminar part of the course. |
| Qualification goals: | The students can independently practice the methods applied in the course and understand the theoretical background of methods, the research questions and the experimental design. They gain first hands-on experience with real lab experiments that address new questions with no prior knowledge of the result. The participants also train critical evaluation and interpretation of their own experiments as well as of published data. They will be prepared for lab rotations, BSc theses or Master theses in the research area covered by the course. |
| **Practical course: Methods to study protein-protein interactions** | |
| Instructor: | Dr. Thomas Ott |
| Contents: | Participants are introduced to different techniques to study protein-protein interactions in vitro and in vivo. The interaction between two published proteins will be assessed using yeast-2-hybrid and yeast-split-ubiquitin systems, fluorescence lifetime imaging microscopy (FLIM), bi-molecular fluorescence complementation (BiFC), thermophoresis and co-immunoprecipitation. Emphasis is placed on the choice of the appropriate experimental systems and conducting valid controls to ensure robustness of the obtained scientific data. Beside the practical work, seven lectures on the theoretical basis of these methods will be given to the participating students during the course.<br>The entire course accounts for 6 ECTS points upon successfully |

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| | fulfilling the course requirements which include full participation, a written report following the style of a scientific paper and an oral presentation of one original research paper in frame of the course seminar. |
| Qualification goals: | Students obtain skills for future lab work, in particular in preparation for their master's thesis if done on a subject in molecular biology and/or protein biochemistry. As a large variety of methods to study protein-protein interactions are applied in many labs, this course provides a basis to use such technologies for all students. The participants also practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions. Latter is done on their own as well as published data. |
| **Practical course: Protein posttranslational modifications** | |
| Instructor: | Dr. Meritxell Antolin-Llovera, Prof. Dr. Martin Parniske |
| Contents: | Protein biosynthesis often involves posttranslational modifications. The modified structure determines the fate, the turnover, the folding, the activity or interactions of the protein. Participants in the course will be faced with biochemical methods to decipher some of the many posttranslational modifications that exist in nature. The students will gain insight into broad methods commonly used to resolve particular proteins such as protein extraction from plant tissues, SDS-PAGE, immunoprecipitation and Western blot. Enzymatic reactions will aid to determine some of the posttranslational modifications that will be under study. Mutations in the primary structure of the protein can cause aberrant posttranslational modifications, which lead to a non-functional or less functional function. We will check by biochemical methods the distinct behavior of the mutant protein in comparison to the wild-type one. The participants will analyse how the distinct modifications affect the behavior of the protein in vivo with the aim of epifluorescence or confocal microscope. For that, the participants will be introduced to transient expression of fluorescent-tagged proteins in *Nicotiana benthamiana* and subsequent microscope techniques in order to follow their localisation. In addition, we will study the consequences of protein incorrect modifications in vivo. Thus, wild-type phenotypes will be compared with mutant phenotypes. Novel questions will be addressed through this course so the students will be able to provide conclusions or hypothesis so far unknown. Once the students have acquired the suitable knowledge, they will be faced to design and conduct their "own" experiment to answer a particular question. A combination of lectures and seminars covering the theoretical background will complement the experimental work.<br><br>The entire course accounts for 6 ECTS points upon successfully fulfilling the course requirements which include full participation, a written report following the style of a scientific paper and an oral |

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| | presentation of one original research paper in frame of the course seminar. |
| Qualification goals: | Students obtain skills for biochemistry and cell biology, which will be important for a master's thesis in the context of molecular biology. Certainly, the biochemistry and cell biology techniques used will be valuable for their future careers. The participants will learn how to confront a particular goal and the evaluation of their own results. They will also gain insight into an analytical comprehension of scientific relevant published articles. |
| **Practical course: Molecular plant-microbe interactions** | |
| Instructor: | Dr. Caroline Gutjahr, Prof. Dr. Martin Parniske |
| Contents: | Participants are introduced to forward genetic techniques aimed at finding genes involved in a chosen biological process. Methods taught will include segregation analysis, map based cloning, the use of natural variation and next generation sequencing. The course will focus on plant genetics of the most-studied root symbioses arbuscular mycorrhiza and root nodule symbiosis. Participants will learn to stain and microscopically recognize symbiotic structures and symbiotic mutant phenotypes. Practical work will address novel questions of current research topics such that students will be confronted with a "real research situation". Besides practical work, the course will be flanked by lectures and seminars covering the theoretical background of the techniques applied and of plant genetics of root symbioses.<br><br>The entire course accounts for 6 ECTS points upon successfully fulfilling the course requirements which include full participation, a written report following the style of a scientific paper and an oral presentation of one original research paper in frame of the course seminar. |
| Qualification goals: | Students obtain skills for future lab work, in particular in preparation for their master's thesis if done on a subject in molecular biology. The course provides a strong knowledge basis for classic and modern forward genetic approaches that are used in many academic labs and companies as a powerful approach to find genes. The participants also practice critical evaluation and interpretation of their own as well as published data as a basis for careful and scientifically relevant conclusions. |
| **Practical course: Analyzing quantitative genetic data** | |
| Instructor: | Dr. Axel Strauß |
| Contents: | Participants will get a step-by-step introduction to data summary and statistical analysis of different kind of data usually collected during lab work. Additionally, a special focus is on data visualisation and experimental design. Software used is the statistical programming language R, a few very basic topics are |

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| | handled with Excel as well. It is a "computer course" with 6 ECTS, conducted during a three-week block in both winter and summer term. No prior knowledge on statistics and R is required. |
| Qualification goals: | The participants will experience the importance of a proper experimental design and data collection. They will get an idea of what to think about before starting experiments.<br><br>The participants will learn how to summarise, visualise, and statistically analyse collected data. Additionally, they will learn how to justify their choice - often, the methods used in practice are just wrong and discussions with colleagues and reviewers can be solved with strong arguments.<br><br>The participants learn how to handle R, a very powerful programming language that is increasingly used, not only for statistics but covering many different topics, such as phylogenetics, analysis of high throughput sequencing data... (the latter examples not covered in the course). |
| **Practical course: Bioinformatics** | |
| Instructor: | Prof. Dr. Martin Parniske, Dr. Axel Strauß, Andreas Binder, Dr. Meritxell Antolin Llovera, Dr. Gloria Torres |
| Contents: | Participants are introduced to a range of software tools used in daily practice not only in genetics. In one- and two-day courses, the following topics are covered: protein structure analysis (software: deep view), DNA sequence analysis and cloning support (software: CLC), phylogenetic analysis (RAxML, MAFFT, ...) as the more "lab based parts" and literature management (software: EndNote, Mendeley) and vector graphics (software: Adobe Illustrator) as tools of general importance. It is a "computer course" with 6 ECTS, conducted during a three-week block in both winter and summer term. |
| Qualification goals: | The participants will gain both qualifications regarding the analyses/handling of the topics mentioned above and general experience in the use of very different scientific software tools. Students will also experience the different philosophies behind software tools (e.g., commercial vs. free; computer vs. online based ...) and that there are often professional alternatives if a specific program is not available (e.g., due to high costs). |
| **Practical course: Population Genetics** | |
| Instructor: | Prof. Wolfgang Stephan, Dr. Stephan Hutter |
| Contents: | Students have to answer questions and work on problems either on paper or at the computer. This requires the use of software for analysing sequence data and modelling software. The results are presented and discussed in the tutorial. |

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| Qualification goals: | Students learn the necessary tools to interpret data and apply their knowledge in exercises. |
| **Practical course: Introduction to confocal laser scanning microscopy (CLSM)** | |
| Instructor: | PD Dr. Arthur Schüßler |
| Contents: | The course covers the theory and practice (approximately 50% each) of fluorescence microscopy and confocal laser scanning microscopy (CLSM), with a detailed theoretical introduction and practical work on a state-of-the-art CLSM. |
| Qualification goals: | The seminar accounts for 1 ECTS point and provides the students with a detailed understanding of the principles of confocal laser scanning microscopy (CLSM) and about which methods to apply for a given approach. After the course, they are able to operate the CLSM independently. |
| **Practical course: DNA Repair (****Human Biology***)** | |
| Instructor: | PD Dr. Anna Friedl, Dr. Simone Mörtl |
| | *See Human Biology for course description and qualification goals. |
| **Practical research courses** | |
| Instructor: | Teaching staff, Genetics division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

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| **Seminar: Molecular genetics of signal transduction and metabolism in *Trypanosoma*** | |
| Instructor: | Prof. Dr. Michael Boshart |

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| Contents: | The seminar is devoted to the research projects of the Boshart laboratory and includes progress reports of all group members. The format is variable with longer overview progress reports as well as short presentations and round table discussions. Most emphasis is given to critical evaluation of the work, trouble shooting of methodological issues and conceptual planning of additional experiments.<br><br>This seminar is an internal seminar for members of the Boshart lab. It is obligatory for all students enrolled in lab rotations, BSc theses or Master theses in the lab in the respective period and integral part of the respective course requirements. |
| Qualification goals: | Students will learn to present their own experimental work and expose it to critical evaluation, comments and suggestions. The seminar will give students the opportunity to follow expert discussions on their and related projects among the participating research group members, and they will be encouraged to participate actively in these discussions. ECTS for this seminar are included in the ECTS credited for lab rotations, BSc theses or Master theses. |
| **Seminar: Journal club "Current papers on genetics, cell biology and biochemistry of protozoan pathogens"** | |
| Instructor: | Prof. Dr. Michael Boshart |
| Contents: | In this journal club seminar current publications related to molecular research on protozoans are presented and discussed with a focus on the role of signaling and metabolism for pathogenicity mechanisms. The model organisms include *Trypanosoma*, *Leishmania*, *Plasmodium* and *Toxoplasma* that cause important tropical diseases. Relevant publications on signaling mechanisms and metabolic regulation in yeast and mammalian cells are included where comparison is informative. Methods papers relevant to the subject are discussed as well. Presentation of papers includes a short introduction that usually requires additional reading of at least one short review article on the subject. The seminar will give students the opportunity to follow expert discussions on the presented publications among the participating research group members, and they will be encouraged to participate actively in these discussions. Participants in the weekly 1 SWS seminar that will give a minimum of 2 paper presentations will be credited with 1 ECTS.<br><br>The seminar is strongly recommended for all students enrolled in lab rotations, BSc theses or Master theses in the Boshart research group. |
| Qualification goals: | The students will get used to read, understand and present research literature. They will learn to read critically, find the weak and unconvincing points and distinguish between good and bad papers, high impact work and more specialised reports. They will |

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| | learn to approach published research critically and phrase their arguments. |
| **Seminar: Genetik und Gesellschaft / Genetics and Society** | |
| Instructor: | Dozenten der Genetik |
| Contents: | In diesem Seminar setzen sich die teilnehmenden Studierenden kritisch mit neuen Ansätzen im Bereich der modernen Biotechnologie und Genetik auseinander und lernen, in welchem Maße sich die Entwicklung neuer Technologien auf gesellschaftlich relevante Bereiche auswirkt. Dabei werden im Wintersemester vor allem aktuelle Entwicklungen in der Humangenetik und molekularen Medizin (z.B. genomweite Assoziationsstudien, Gentherapie, Pränataldiagnostik, forensische Diagnostik, etc.) und im Sommersemester andere Bereiche der Biotechnologie (z.B. grüne Gentechnik, transgene Insekten und Nutztiere, Biokraftstoffe und synthetische Biologie) diskutiert. Die Studierenden müssen in einem Vortrag neben der fachlichen Darstellung der technischen Ansätze zusätzlich auch eine Zusammenfassung der gesellschaftlichen Diskussion und des rechtlichen Rahmens erbringen. Im Rahmen dieses interdisziplinären Seminars geben zusätzlich Expertinnen und Experten aus anderen Fachrichtungen Einblicke in Bereiche wie Recht, Ethik und Sozialwissenschaften.<br>Kurssprache ist Deutsch. |
| Qualification goals: | Nach erfolgreicher Teilnahme sind die Studierenden in der Lage, einen Diskurs zu gesellschaftlichen Relevanzen biotechnologischer Innovationen mit einem Fach- und Laienpublikum zu führen. Sie haben die technischen Grundlagen der modernen Gentechnik verstanden und können diese in einem ethischen Kontext bewerten und analysieren. Dies qualifiziert sie zu einer strukturierten und interdisziplinären Beurteilung und erlaubt zukünftig einen verantwortungsbewussten Umgang mit gentechnischen Methoden sowie eine fachkompetente Auseinandersetzung und Beratung eines Laienpublikums. |
| **Seminar: Genetics training seminar** | |
| Instructor: | Teaching staff, Genetics division |
| Contents: | This seminar gives detailed insights into new as well as established methods used in the field of genetics and molecular biology. Besides providing fundamental information on the different technologies the seminar also offers a valuable platform to introduce expertise that is present on the campus and the Munich area to students and staff of the Biocenter of the LMU. Contents are supplemented by a number of external guest speakers who present novel updates on cutting-edge technologies. |
| Qualification goals: | The seminar accounts for 1 ECTS point and provides a fundamental basis for technologies used in molecular biology and genetics. At |

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| | the end of each semester, students visiting the seminar gained detailed, theoretical knowledge on the presented methods. They have learned to critically analyse technologies and to evaluate data obtained in such experiments. Furthermore all speakers provide valuable tips and tricks for hands-on work at the lab. |
| **Seminar: Molecular interaction between plants and microorganisms** | |
| Instructor: | Teaching staff, Genetics division |
| Contents: | This seminar gives detailed insights into current research results and current experimental approaches and strategies used in the field of genetics and molecular biology. This seminar provides detailed information on ongoing research projects through presentations by the students. The results are discussed and evaluated to develop research directions and approaches. |
| Qualification goals: | The seminar accounts for 1 ECTS point and provides insights into recent research results and technologies used in molecular biology and genetics. At the end of each semester, students visiting the seminar gained detailed, theoretical knowledge on the presented projects and methods. They have learned to critically analyse research data and to evaluate the experimental settings. Furthermore all speakers provide valuable tips and tricks for hands-on work at the lab. |
| **Seminar: Journal club "Current research in Genetics"** | |
| Instructor: | Prof. Dr. Martin Parniske, Dr. Andreas Brachmann, Dr. Thomas Ott |
| Contents: | This seminar analyses the recent literature and thus provides insights into current research results and new methods used in the field of genetics and molecular biology. Recent publications are introduced through presentations by the students and the experimental approaches and results are discussed. |
| Qualification goals: | The seminar accounts for 1 ECTS point and provides insights into recent research results and technologies used in molecular biology and genetics. At the end of each semester, students attending the seminar gained detailed, theoretical knowledge on the presented publications and methods. They have learned to critically analyse research data and to evaluate the experimental settings. |
| **Seminar: Plant genetics of symbiosis** | |
| Instructor: | Prof. Dr. Martin Parniske, Dr. Caroline Gutjahr |
| Contents: | This seminar gives detailed insights into the current research results and current experimental approaches and strategies used in the field of plant genetics of symbiosis. This seminar provides detailed information on ongoing research projects. The results of the past week are discussed in detail based on primary data and |

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| | entries in the students´ lab books. The results are discussed and evaluated to develop research directions and approaches. |
| Qualification goals: | The seminar accounts for 1 ECTS point and is directed at students performing lab rotations, or practical research projects for their bachelor's or master's thesis. The seminar provides insights into recent research results and technologies used in molecular biology and genetics. At the end of each semester, students visiting the seminar gained detailed knowledge on the presented projects and methods. They have learned to critically analyse research data and to evaluate the experimental settings. Furthermore all lab members provide valuable tips and tricks for hands-on work at the lab. The students will obtain important guidance how to use the lab book as important documentation of their research results. |
| **Seminar: Model organisms** | |
| Instructor: | Dr. Andreas Brachmann |
| Contents: | In this seminar the most important eukaryotic model organisms for genetic research are presented with a special focus on their respective features, advantages, and limitations. Every seminar day deals with a different model organism, which is introduced by a recent publication that is a good example for the specific topics investigated in this system. Thereby a good overview on different areas of genetic research and especially relevant methods used in molecular genetics is provided. Each student prepares an oral presentation on one model organism using recommended literature and resources, with regular consultation with the instructor. Considerable focus is laid on presentation and discussion. Three separate seminar days cover the topics "How to read a scientific article", "How to make a good presentation", and "Scientific publishing".<br><br>The seminar accounts for 3 ECTS points. Besides full attendance the workload for each participant includes preparation of the oral presentation, reading and careful preparation of the weekly original research paper, and active participation in the seminar discussion. |
| Qualification goals: | Students know the most important model organisms for genetic research and their special features. They are exposed to current literature, gain insight into language and presentation formats required for peer-reviewed publication, and are able to discuss the scientific topic with their peers. Students are proficient in assessing and preparing a topic employing library and internet resources, can present this topic thoroughly and understandably, and are competent in communication and feedback. |
| **Seminar: Classic papers in Genetics** | |
| Instructor: | Dr. Andreas Brachmann |

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| Contents: | The seminar covers the first roughly 100 years of genetic research, 'from Mendel to Monod', an important part of biological sciences' history. Major discoveries, as well as the respective scientific personalities and the scientific knowledge at the time of the discovery are introduced. In the seminar central genetic knowledge is revised. Every seminar day deals with one or two milestone publications, the topics of which are introduced by an oral student presentation, prepared using recommended literature and resources, with regular consultation with the instructor. Considerable focus is laid on presentation and discussion. Two introductory seminar days cover the topics "How to read a scientific article" and "How to make a good presentation".<br><br>The seminar accounts for 3 ECTS points. Besides full attendance the workload for each participant includes preparation of the oral presentation, reading and careful preparation of the weekly original research paper, and active participation in the seminar discussion. |
| Qualification goals: | Students know the most important milestone publications in genetics research. They are exposed to various types of literature, gain insight into different language and presentation formats, and are able to discuss the scientific topic with their peers. Students are proficient in assessing and preparing a topic employing library and internet resources, can present this topic thoroughly and understandably, and are competent in communication and feedback. |
| **Seminar: Intellectual property and patent law 1** | |
| Instructor: | Dr. Andreas Brachmann, Dr. Andreas Koch, Dr. Gerhard Weinzierl |
| Contents: | The seminar provides a general overview on intellectual property (IP) and patent law, with the specific focus on life sciences. The legal framework (with an emphasis on European patent law), as well as the practical way from invention to patent to litigation is presented. Several well-known industry experts provide as guest speakers their inside view into the industry's need for IP protection and give insight into job opportunities in the field of IP rights. An excursion to the European Patent Office provides the opportunity to meet patent examiners and/or judges.<br><br>The seminar accounts for 3 ECTS points. Besides attendance the workload for each participant includes preparation of the provided material, active participation, and successful completion of the written final exam. |
| Qualification goals: | Students are equipped with the basic knowledge prerequisite to understand the value of IP and the ways for protection. They know the different types of IP rights, ways to obtain them, and possibilities for attack and defence. Specifically, students are able to judge as to when an invention could be patentable. They understand what "patent claims" are and can formulate these. The |

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| | seminar is the basis for the seminar "Intellectual property and patent law 2". |
| **Seminar: Intellectual property and patent law 2** | |
| Instructor: | Dr. Andreas Brachmann, Dr. Andreas Koch, Dr. Gerhard Weinzierl |
| Contents: | The seminar is based on the seminar "Intellectual property and patent law 1" and provides a practical approach to gain deeper insight into the patenting process. It is structured in several longer block events. Students prepare for an excursion to the European Patent Court where they participate in a current hearing. On separate seminar dates, they prepare a patent application or a patent opposition, dependent on whichever case the group decides to work on. Additional excursions to biotech companies and law firms provide the opportunity for direct contact with the working environment of the intellectual property (IP) field.<br><br>The seminar accounts for 3 ECTS points. Besides full attendance at all events the workload for each participant includes preparation of the provided material, active participation, and successful completion of the homework (formulation of a patent application or opposition). |
| Qualification goals: | Students are proficient in the field of IP and patent law. They know the proceedings leading to granting of patent rights as well as ways for attack and defence. Specifically, students are able to judge as to when an invention could be patentable, and can formulate patent claims. |
| **Seminar: Molecular biology and diversity of plant symbiotic fungi** | |
| Instructor: | PD Dr. Arthur Schüßler |
| Contents: | The seminar covers recent publications about molecular biology and functional diversity of plant-symbiotic fungi and their endobacteria, with a focus on arbuscular mycorrhizal fungi (AMF). In this context, also ecological and applied agricultural aspects are discussed, as well as the used statistical and molecular biological methods. |
| Qualification goals: | The seminar accounts for 1 ECTS point and provides a fundamental basis for techniques and theory applied and used in molecular diversity studies and DNA barcoding of plant-symbiotic fungi. At the end of each semester, students gained detailed, theoretical knowledge on the presented data, questions and methods. They have learned to critically analyse technologies and to evaluate data obtained in such experiments. Furthermore, they will obtain valuable tips and tricks for hands-on work at the lab. |

| **Seminar: DNA Repair (*_Human Biology_)** | |
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| Instructor: | PD Dr. Anna Friedl, Dr. Simone Mörtl |
| | *See Human Biology for course description and qualification goals. |

# Human Biology and BioImaging

| **Lecture: Epigenetics (*Cell Biology*)** | |
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| Instructor: | Prof. Dr. Heinrich Leonhardt, Dr. Anne-Kathrin Classen |
| Course content: | "Epigenetics" is a lecture series that is team-taught by several instructors that cover basic background information as well as currently ongoing research topics in the field of epigenetics, involving DNA methylation, histone modification, polycomb, non-coding RNA, epigenetic regulations and networks. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification goals: | The students are proficient in the areas of epigenetics, involving DNA methylation, histone modification, polycomb, non-coding RNA, epigenetic regulations and networks and are able to depict basic principles and transfer knowledge in an exam situation.<br>Students obtain the fundamental knowledge required to participate in further specialized courses and to understand and critically evaluate primary literature in these areas of research.<br>Students are equipped with the basic knowledge prerequisite to scientific research in these topics. |
| **Lecture: Methods in Molecular and Cell Biology** | |
| Instructor: | Prof. Dr. Heinrich Leonhardt, Dr. Anne-Kathrin Classen, Dr. Andreas Brachmann |
| Course content: | "Methods in Molecular and Cell Biology" is a lecture series that is team-taught by several instructors that cover classic as well as modern methods on molecular and cellular biology. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification goals: | The students are proficient in the areas of basic and modern methods, involving blotting techniques, Real Time PCR, EMSA, RACE, Next Generation Sequencing, Super Resolution Microscopy, gel filtration techniques, antibody formats, FACS and are able to depict basic principles and transfer knowledge.<br>Students obtain the fundamental knowledge required to participate in further specialized courses.<br>Students are equipped with the basic knowledge prerequisite to scientific research in these topics. |
| **Lecture: Human Biology – development and disease** | |
| Instructor: | Prof. Dr. Heinrich Leonhardt |
| Course content: | This lecture covers the introduction into mammalian |

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| | developmental processes as well as basic human diseases. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification goals: | The students are proficient in the basic mammalian developmental biology as well as basic human diseases. |
| **Lecture: Molecular Virology, Part I (*Cell Biology, Genetics, Microbiology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| Course content: | "Molecular Virology I" covers basic principles of virology with respect to virus taxonomy, replication and expression strategies, methodologies and focuses on specific virus families, particularly RNA viruses. The lecture is given weekly (2 SWS) during the winter semester. Credits require the passing of a final exam. |
| Qualification goals: | In conjunction with course 2, the students gain an overview of the major RNA virus families, their molecular features, replication strategies of viruses, major discoveries in cell biology made by the study of viruses, principles of molecular virology, and strategies for the development of antiviral inhibitors, among others.<br>This lecture series puts students in the position to appreciate the significance of virology on biology and provides important knowledge for independent research work in various areas, including molecular virology, human biology and cell biology. |
| **Lecture: Molecular Virology, Part II (*Cell Biology, Genetics, Microbiology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| Course content: | "Molecular Virology II" covers basic principles of virology with respect to virus-induced cell transformation, virus evolution, infection types, strategies, virus vectors, molecular diagnostics, vaccines, development of antivirals, and provides an introduction to major DNA virus families. The lecture is given weekly (2 SWS) during the summer semester. Credits require the passing of a final exam. |
| Qualification goals: | In conjunction with course 2, the students gain an overview of the major RNA virus families, their molecular features, replication strategies of viruses, major discoveries in cell biology made by the study of viruses, principles of molecular virology, and strategies for the development of antiviral inhibitors, among others.<br>This lecture series puts students in the position to appreciate the significance of virology on biology and provides important knowledge pertaining not only to molecular virology but also to human biology and cell biology which is useful for future independent research work. |

| **Practical course: Tumorepigenetics** | |
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| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach, Dr. Anne-Kathrin Classen |
| Course content: | Participants in "Tumorepigenetics" obtain basic knowledge of DNA methylation, histone modifications and polycomb. During the scope of the practical course participants are introduced to classic DNA methylation analysis techniques such as bisulfite modification and COBRA, as well as basic cell culture handling, RT PCR for expression profiles and fluorescence microscopy.<br><br>During the course, the students will treat 3 different human carcinoma cell lines with different epigenetic inhibitors, isolate genomic DNA and perform a COBRA for methylation analysis. In addition, they perform antibody staining for methylcytosine and different histone modifications for microscopic analysis.<br><br>A mandatory part of this course is an accompanying seminar, which entails the presentation of topics related to epigenetics and tumorigenesis to support the practical course. Each student will have to present one topic.<br><br>Emphasis is placed on hands-on practice with the techniques mentioned above and interpretation of the data obtained. The lab entails 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students can apply theoretical and practical knowledge to approach biological questions in independent work. Students obtain skills for future lab work in the field of epigenetics, in particular in preparation for their master's thesis.<br><br>Students are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments, conscientious documentation of lab procedures, and obtain skills in specialized techniques such as cell culture of mammalian cells, genomic DNA isolation, bisulfite treatment, COBRA, Real Time PCR, antibody staining of fixed cells and fluorescence microscopy.<br><br>Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions.<br><br>In working in small lab groups (2 students), social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations, written lab reports), as well as organizational skills (efficient planning, documentation) are refined.<br><br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for thesis writing and scientific publications. |

| **Practical course: Basic methods in Cell Biology** | |
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| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach |
| Course content: | Participants in "Basic methods in cell biology" obtain basic knowledge of standard molecular biology techniques. During the scope of the practical course participants are introduced to molecular cloning, involving PCR amplification, restriction digests, ligation, transformation in *E. coli*, DNA mini-prep, analytical digest, transfection in mammalian cells, Western blot and transfection in mammalian cells for fluorescence microscopy.<br><br>During the course, the students will establish a distinct cloning strategy and clone a construct in a mammalian expression vector to generate a GFP fusion protein. To obtain this construct they are trained in basic techniques such as PCR amplification, restriction digests, ligation, transformation in *E. coli*, DNA mini-prep, analytical digest, and transfection in mammalian cells. They will perform a Western blot and fluorescence microscopy to control the generated construct.<br><br>Part of the course is a seminar, which entails the presentation of topics related to basic and standard methods in molecular genetics to support the practical course. Each student will have to present one topic.<br><br>Emphasis is placed on hands-on practice with the techniques mentioned above and to introduce standard techniques. The lab entails 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students can apply theoretical and practical knowledge to approach biological questions in independent work. Students obtain skills for future lab work in the field of molecular and cellular biology in particular in preparation for future lab work and master's thesis.<br><br>Students are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments, conscientious documentation of lab procedures, and obtain skills in standard techniques such molecular cloning involving PCR amplification, restriction digests, ligation, transformation in *E. coli*, DNA mini-prep, analytical digest, transfection in mammalian cells and WB. Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions.<br><br>In working in small lab groups (2 students), social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations, written lab reports), as well as organizational skills (efficient planning, documentation) are refined.<br><br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, |

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| | documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for thesis writing and scientific publications. |
| **Practical course: Embryonic stem cells** | |
| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach |
| Course content: | Participants in "Embryonic stem cells" obtain detailed knowledge of culturing embryonic stem cells and recent methods in the field of epigenetics. During the scope of the practical course participants are introduced to culturing embryonic stem cells and differentiation techniques such as the embryoid body formation. Moreover, they are introduced to "rescue assays" with knock-out cell lines, which involves genomic DNA preparation, bisulfite treatment and pyrosequencing. In addition, participants are introduced to tissue embedding, sectioning, antibody staining and confocal microscopy.<br><br>During the course, the students will culture embryonic stem cells and perform a rescue assay. The rescue assay introduces students to transfection of ES cells, FACS sorting, genomic DNA isolation, bisulfite modification and pyrosequencing as a quantitative DNA methylation analysis. In addition, students will differentiate embryonic stem cells into embryoid body to visually follow differentiation processes by collecting samples, prepare them for cryosectioning followed by an antibody staining for pluripotency markers.<br><br>A mandatory part of this course is an accompanying seminar, which entails the presentation of topics related to embryonic stem cells and epigenetics to support the practical course. Each student will have to present one topic.<br><br>Emphasis is placed on hands-on practice with the techniques mentioned above and to specialized techniques. The lab entails 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students can apply theoretical and practical knowledge to approach biological questions in independent work. Students obtain skills for future lab work in the field of embryonic stem cells in particular in preparation for future lab work and master's thesis.<br><br>Students are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments, conscientious documentation of lab procedures, and obtain skills in specialized techniques such embryonic stem cell culture, differentiation techniques, modern DNA methylation analysis as well as confocal microscopy. Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions.<br><br>In working in small lab groups (2 students), social skills (teamwork, cooperation, fair play, work delegation, mutual respect), |

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| | communication skills (rapport with instructors and fellow students, presentations, written lab reports), as well as organizational skills (efficient planning, documentation) are refined.<br><br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for thesis writing and scientific publications. |
| **Practical course: Antibodies** | |
| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach |
| Course content: | Participants in "Antibodies" obtain detailed knowledge of generating different antibody formats (polyclonal; monoclonal; recombinant; nanobodies) and methods using these antibodies in a variety of different cell biological and biochemical assays. During the scope of the practical course participants are introduced to antigen and antibody purification, ELISA, Co-Immunoprecipitation and Western blotting. Moreover, they are introduced to immofluorescence staining of fixed cells, as well as *in vivo* tracking of antigens using fluorescent nanobodies by confocal microscopy.<br><br>During the course, the students will purify fluorescent proteins as potential new antigens via Ni-NTA columns as well as antibodies using protein G sepharose. Participants will perform an ELISA in a 96-well format to determine titer and subclass of polyclonal as well as monoclonal antibodies. In addition, students will analyse protein-protein interactions by Co-IP experiments of fluorescent fusion proteins, followed by Western blot analyses. Besides conventional antibody staining of fixed cells, participants will perform *in vivo* tracking of antigens via nanobodies using confocal microscopy.<br><br>A mandatory part of this course is an accompanying seminar, which entails the presentation of topics related to basic immunology, antibody formats and respective methods to support the practical course. Each student will have to present one topic.<br><br>Emphasis is placed on hands-on practice with the techniques mentioned above and to specialized techniques. The lab entails 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students can apply theoretical and practical knowledge to approach biological questions in independent work. Students obtain skills for future lab work in the field of basic immunological methods with the focus on antigens and antibodies in particular in preparation for future lab work and master's thesis.<br><br>Students are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments, conscientious documentation of lab procedures, and obtain skills in specialized techniques such antigen and antibody |

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| | purification, ELISA, CO-IP, Western blotting and as well as confocal microscopy. Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions.<br><br>In working in small lab groups (2 students), social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations, written lab reports), as well as organizational skills (efficient planning, documentation) are refined.<br><br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for thesis writing and scientific publications. |
| **Practical course: Bioimaging** | |
| Instructor: | Dr. Jürgen Neumann |
| Course content: | In-depth introduction to relevant methods for basic and advanced light-microscopy techniques.<br><br>Participants are introduced to classical microscopy techniques like widefield, phase contrast and dark-field. In parallel, participants get a brief introduction to cell culture and are preparing their own fluorescently labeled cell samples using direct- and immunolabeling techniques. Based on these samples several advanced microscopy techniques are used for image acquisition. Technological possibilities are evaluated based on the acquired and processed images.<br><br>Emphasis is placed on the relevance and hands-on practice with these microscopic techniques as well as the interpretation and presentation of data. Successful participation requires a detailed report according to excellent scientific practice. |
| Qualification goals: | Students are well trained in sample preparation and basic as well as advanced optical microscopy techniques. They obtain the fundamental knowledge required to understand the individual possibilities and limitations of these techniques. Obtained skills are a prerequisite for a successful selection and utilization of optical microscopes, e.g. during their master's thesis. |
| **Practical course: Modern Histology** | |
| Instructor: | Dr. Irina Solovei |
| Course content: | Participants are introduced to basic methods of histology, such as preparation of paraffin, resin, and frozen sections, cryosections immunostaining, microscopy, and image work.<br><br>Students get hands-on experience on tissues processing, embedding, sections preparation, staining sections with |

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| | conventional histological dyes, and immunostaining using fluorochrome conjugated antibodies. Important part of the practicum is working with modern widefield and confocal microscopes, as well as with image computer programs.<br><br>In the beginning of the course, each student gets a set of fixed mouse tissues which have to be stained with antibodies revealing tissue specific stem cells and tissue-specific cells and structures. After analysis of immunostaining and image acquisition, students describe obtained results and prepare relevant images.<br><br>The course includes introductory lectures about histological techniques and students´ talks about organization of tissue which they study during the practicum. The lab requires a detailed written report, is accompanied by a mandatory seminar, and entails a total of 6 SWS. |
| Qualification goals: | Students obtain practical knowledge in histological lab work, which includes preparation of standard histological slides, fluorescent immunostaining, advanced light microscopy, and computer image work.<br><br>Students learn to recognize tissues, cell types and tissue specific extracellular structures as well as learn techniques for revealing tissue specific stem cells.<br><br>All participants receive a good general lab practice, including standard safety procedures, handling of chemicals and optical instruments, following pre-existing protocols, critical interpretation of data as a basis for careful and relevant conclusions.<br><br>Students learn to work independently in the lab, train their communication skills (rapport with instructors, oral presentations of theoretical background), as well as organizational skills (efficient planning and documentation). The participants´ work on images and the final reports aims at preparing students for writing scientific publications. |
| **Practical course: Light microscopy, from bright field to multi-photon** | |
| Instructor: | PD Dr. Steffen Dietzel |
| Course content: | The students will learn the theory and practical application of light microscopic techniques, starting with the basics of “classic” techniques such as bright field Koehler Illumination, phase contrast, dark field, differential interference contrast (DIC) and fluorescence microscopy. We then move on to confocal laser scanning microscopy and multi-photon microscopy. Newer developments such as super resolution microscopy are also covered.<br><br>These techniques are applied to a variety of samples from fixed tissue sections to live cells and intravital microscopy.<br><br>Small groups of students will use image processing software to generate a presentation with the images and movies recorded. |

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| | Apart from giving said presentation, each student will have to pass an oral examination on one of the topics of the course.<br><br>This is a 10 day course, set up with accompanying lecture and seminar. The student has the opportunity to prepare and present a talk on one of the microscopic techniques in which case the course is counted as 6 SWS. Otherwise it is a 3 SWS course. The course will be in English, except all (!) participants should agree on German. |
| Qualification Goals: | With this broad overview the student will be capable to determine advantages and disadvantages of various light microscopic approaches for different experimental settings and thus to select and apply the best approach for a given question. |
| **Practical course: Genetics, Epigenetics and Genomics – Mechanisms of gene regulation in *Drosophila*** | |
| Instructors: | Dr. Anne-Kathrin Classen |
| Course content: | Participants are introduced to the model organism *Drosophila melanogaster* and learn how recent research on neuronal, muscle and epithelial tissues contributes to our current understanding of gene function during normal development and disease-related processes.<br><br>The course demonstrates how advanced genetic tools (enhancer or protein traps, promoter reporters, UAS/GAL4, FLP/FRT, RNAi etc.) are used to study gene regulation in contexts of flight muscle development, development of neuronal circuits for odor-perception, epithelial tissue regeneration and tumorous overgrowth.<br><br>During the course students are introduced to handling flies, identifying genotypes, setting up crosses, and dissecting various fly tissues. Confocal laser scanning microscopy and other cell-biological assays are employed as read-outs of experimental results. The students utilize genomic resources and bioinformatic tools to further interpret their findings.<br><br>The lab entails 3 SWS, requires a journal club discussion, an oral presentation of experimental results, and a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | Students obtain skills to work with *Drosophila* and are able to understand different genetic manipulations and distinguish different genetic reporter tools to study gene regulation in flies. Students apply theoretical and practical knowledge to approach a biological question in independent work.<br><br>Students learn how to use database resources such as Flybase, FlyLight or Modencode and how to properly process multi-channel immunofluorescence microscopy images using ImageJ and Photoshop software. |

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| | Students learn how to present a scientific paper, how to critically discuss its findings and how to evaluate its contribution in a larger scientific field. Students are trained to write a scientific abstract of their work and to document their experiments in form of a lab notebook page. The written report requires a well-founded introduction to the topic, documentation, interpretation and discussion of the results. Therefore students obtain skills for future lab work and skills that are aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Biological databases – making efficient use of information** | |
| Instructors: | Dr. Sebastian Bultmann, Dr. Jürgen Neumann, Prof. Dr. Heinrich Leonhardt |
| Course content: | Today's research is largely dependent on receiving and exchanging information with databases. Literature, sequence information and structural predictions are essential tools for modern scientists.<br>This course introduces the students to the available databases and web tools. The students will learn how to extract sequence information from databases such as NCBI and ENSEMBL and how to use available web tools for sequence alignments, phylogenic analysis as well as domain and structural predictions. In the second part of the practical course students will be introduced to the programming language Python aiming to teach a basic understanding of bioinformatics. The students will learn how to receive information from databases and process sequences in an automated fashion using Python scripts. |
| Qualification Goals: | Students have a basic understanding of computer work and internet resources. They can also assess, discuss and present a topic understandably to scientific peers.<br>Students are proficient in basic biological and biochemical systems. |
| **Practical course: DNA Repair (*Genetics*)** | |
| Instructor: | PD Dr. Anna Friedl, Dr. Simone Mörtl |
| Course content: | In the context of a general overview on cellular response mechanisms to DNA damage, participants are introduced to several current questions such as genetic and miRNA network controlling the DNA damage response mechanisms, or influence of specific inhibitors. Participants learn handling and cultivation of mammalian cells, treatment with inhibitors, knock-down by RNA interference, indirect immunolabeling of fixed cells, fluorescence light microscopy and image analysis by imageJ, protein isolation and Western blot-based protein analysis, RNA isolation and RT-PCR, FACS analysis of cell cycle distribution and apoptosis. Emphasis is placed on hands-on practice in small groups (max. 8 |

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| | participants), planning of experiments with appropriate controls, and interpretation of data. For presentation of results, the participants produce scientific posters. The lab entails 3 SWS. |
| Qualification goals: | The students are proficient in basic knowledge on DNA damage response mechanisms.<br>Students can apply theoretical and practical knowledge to approach biological questions in independent work.<br>Students can apply introduced methods in future lab work, in particular in preparation for their master's thesis.<br>Students learn excellent scientific method in data presentation, especially in preparation of posters. These skills are particularly aimed at preparing students for participation in scientific conferences.<br>Students are equipped for scientific research in this topic and can discuss this in a broad context. |
| **Practical research courses** | |
| Instructor: | Teaching staff, Human Biology and BioImaging division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Antibodies** | |
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| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach |
| Course content: | The seminar is a mandatory for participants in the "Antibodies" practical course, and requires the presentation of topics related to basic immunology, antibody formats and respective methods to support the practical course. Each student presents one topic.<br>The seminar completes a practical/seminar unit that entails a total of 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students research a topic using different research media, are introduced to current literature and applications of relevant topics, |

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| | and gain experience in formal presentation to a group of peers according to international scientific practice. |
| **Seminar: Embryonic stem cells** | |
| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach |
| Course content: | The seminar is a mandatory for participants in the "Embryonic stem cells" practical course, and requires the presentation of topics related embryonic stem cells and epigenetics to support the practical course. Each student presents one topic.<br>The seminar completes a practical/seminar unit that entails a total of 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students research a topic using different research media, are introduced to current literature and applications of relevant topics, and gain experience in formal presentation to a group of peers according to international scientific practice. |
| **Seminar: Tumorepigenetics** | |
| Instructor: | Dr. Daniela Meilinger, Dr. Andrea Rottach, Dr. Anne-Kathrin Classen |
| Course content: | The seminar is a mandatory for participants in the "Tumorepigenetics" practical course, and requires the presentation of topics related to epigenetics and tumorigenesis to support the practical course. Each student presents one topic.<br>The seminar completes a practical/seminar unit that entails a total of 6 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification goals: | Students research a topic using different research media, are introduced to current literature and applications of relevant topics, and gain experience in formal presentation to a group of peers according to international scientific practice. |
| **Seminar: Seminar Bioimaging** | |
| Instructor: | Dr. Jürgen Neumann |
| Course content: | Participants are presenting and discussing basic and advanced microscopy concepts and related issues. |
| Qualification goals: | Students obtain a basic insight into optical microscopy, possibilities and limitations, cell sample preparation, and image processing challenges. Students sharpen their presentation- and discussion skills gained through speaking in front of a group and sharing their knowledge. The content of this seminar is a necessary prerequisite for a successful participation in the practical course. |

| **Seminar: Light microscopy, from bright field to multi-photon** | |
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| Instructor: | PD Dr. Steffen Dietzel |
| Course content: | The students will learn the theory and practical application of light microscopic techniques, starting with the basics of "classic" techniques such as bright field Koehler Illumination, phase contrast, dark field, differential interference contrast (DIC) and fluorescence microscopy. We then move on to confocal laser scanning microscopy and multi-photon microscopy. Newer developments such as super resolution microscopy are also covered.<br>This seminar is a part of a 10 day course, set up with accompanying lecture and practical course. The student has the opportunity to prepare and present a talk on one of the microscopic techniques in which case the course is counted as 6 SWS. Otherwise it is a 3 SWS course. The course will be in English, except all (!) participants should agree on German. |
| Qualification Goals: | With this broad overview the student will be capable to determine advantages and disadvantages of various light microscopic approaches for different experimental settings and thus to select and apply the best approach for a given question. |
| **Seminar: Modern Histology** | |
| Instructor: | Dr. Irina Solovei |
| Course content: | The seminar accompanies the practical course "Modern Histology". Students receive topics pertaining to Histology, research the topic independently, and present their findings in the group. |
| Qualification goals: | Students are exposed to literature and different media for researching their topics as well as for training their communication, posture, and presentation skills. The seminar serves as a theoretical background to the practical course "Modern Histology". |
| **Seminar: DNA repair (*Genetics*)** | |
| Instructor: | PD Dr. Anna Friedl, Dr. Simone Mörtl |
| Course content: | Current topics related to DNA repair are assigned to each participant. Using suggested literature and resources, and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 30 minute oral presentation of the topic to the entire group and participation in discussion of and feedback to the presentations of the other group members. |

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| Qualification goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers. |
| **Seminar: Journal club "DNA damage response"** | |
| Instructor: | PD Dr. Anna Friedl, Dr. Simone Mörtl |
| Course content: | Participants select a relevant paper on current topics related to DNA damage response. After acceptance of the topic by the instructor, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 35 minute oral presentation of the topic to the entire group and participation in the weekly journal club over the whole semester. |
| Qualification goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers. |

# Interdisciplinary

| **Lecture: Principles of Behavioral Ecology (*Behavioral Ecology*)** | |
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| Instructor: | Prof. Dr. Niels Dingemanse, PD Dr. Volker Witte |
| Course content: | Students will be thoroughly introduced to behavioral ecology. They will learn in depth about the history of the field, the role of evolution in behavioral ecology, mechanisms of behavior, communication, predator-prey and parasite-host interactions, foraging and optimality, sexual selection, mating systems, parental care, life history theory, altruism and cooperation, and group living.<br>The lecture is given 3 times per week, 1.5 h each, and requires a final exam. |
| Qualification Goals: | Students acquire a firm knowledge about basic principles and different research fields in behavioral ecology. They obtain the fundamental knowledge required to participate in further specialized courses, such as "Experimental Behavioral Ecology" |
| **Lecture: Behavioral Ecology meets Quantitative Genetics (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse |
| Course content: | Students will be thoroughly introduced to state-of-the-art behavioral ecology paradigms that require tools from quantitative genetics. The lecture is accompanied by a practical course. Students learn about how the two fields differ and where they meet: empirical testing of adaptive hypotheses that require variance partitioning. The students are introduced to Bayesian statistical paradigms and mixed-effect modelling, and learn to graph and estimate a diverse array of within- and between-individual (co)variance components (e.g. between-individual (co)variances, additive genetic (co)variances) using a single empirical dataset used throughout the course. The students give daily presentations of their findings, in preparation of an overall presentation on the final day of the course, and discuss a paper each day.<br>The course takes place at the Max Planck Institute for Ornithology, three days per week (9h00-16h30) for a period of three weeks. |
| Qualification Goals: | Students learn to program in the statistical language R, visualize, interpret, and present outcomes of mixed-effect models. Social skills are refined by working in pairs of two, presentation skills are improved by daily presentations and feedback, and reading and interpretation of scientific literature through paper discussions. |
| **Lecture/Tutorial: Current topics in Behavioral Ecology (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse |

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| Course content: | Students are introduced to current hot topics in the field of behavioral ecology (one topic per day). On each day, students are given a lecture by an expert, and ask prepared questions, introduced to specifics of the experimental setup, and also discuss a paper on the subject. Each student writes an essay after each day.<br>The course takes place at the Max Planck Institute for Ornithology, nine days (9h00-16h30) spread over the summer. |
| Qualification Goals: | Students learn to read and discuss papers, to engage in scientific discussions, and learn about current topics in behavioral ecology. Students improve their scientific writing skills. |
| **Lecture/Tutorial: Statistical-computational methods in phylogenetics** | |
| Instructor: | Prof. Dr. Dirk Metzler |
| Course content: | Contents are computational methods for the reconstruction of phylogenetic trees as well as the underlying probabilistic evolution models and statistical principles, in particular Maximum-Likelihood and Bayesian methods. We discuss which phylogenetic problems can be solved efficiently and which problems are NP complete, such that only approximate solutions are available.<br>In the accompanying tutorial, students will use the knowledge gained in the corresponding lecture and apply this to actual data sets. They will learn to use current software, including Phylip, RAxML, MrBayes and BEAST. The Students perform simulation studies for various scenarios to assess whether and, if so, how the methods can be applied. Further exercises will help the students to improve their comprehension of the theoretical contents of the lecture. |
| Qualification Goals: | Students will be familiar with the theoretical (bioinformatical and statistical) fundamentals of phylogenetic tree reconstruction and with a range of methods for the reconstruction of phylogenetic trees and will be able to interpret and critically judge the results of such analyses. |
| **Lecture/Tutorial: Computational methods in Population Genetics** | |
| Instructor: | Prof. Dr. Dirk Metzler |
| Course content: | Contents are Maximum-Likelihood methods and Bayesian approaches for the estimation of population genetic parameters (e.g. population structure, growth and migration rates). In the lecture, the underlying models (e.g. coalescent and ancestral recombination graph), statistical principles, and computational strategies (e.g. importance sampling and MCMC) are discussed.<br>During the exercises, students will analyse the methods learned in the corresponding lectures. They will also try out various software |

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| | packages (e.g. Hudson's MS, LAMARC, GENETREE, IMa2) and explore by computer simulation studies under which circumstances they are appropriate. Further exercises will help the students to improve their comprehension of the lecture's content. |
| Qualification Goals: | The students will have the theoretical background in order to interpret and critically judge the results of population genetic analyses. In addition, students are able to infer evolutionary and ecological features, using various software packages, methods and models. |
| **Lecture/Tutorial: Advanced computational methods for analyzing population genetic data** | |
| Instructor: | Prof. Dr. Dirk Metzler |
| Course content: | In depth we treat state-of-the art data analysis methods for special problems in population genetics as for example novel variants of Approximate Bayesian Computation (ABC), Approximations of the Ancestral Recombination Graph, the Ancestral Selection Graph and/or novel methods for analyzing genome-wide sequence data. Contents are also the theoretical models and algorithms underlying these methods.<br><br>In the tutorial the students learn to use software to analyze data with the methods learned in the corresponding lecture. They test these methods with empirical and simulated data. Theoretical exercises will help the students to improve their understanding of the lecture's contents |
| Qualification Goals: | As basis for their scientific specialization, students achieve an in-depth understanding of special computational methods for analyzing population genetic data. This knowledge will enable them to acquire the comprehension of related methods from the current literature. In addition, the students will learn to perform data analyses with the methods learned in the lecture and to critically interpret the results of such analyses. |
| **Lecture/Tutorial: An introduction to R** | |
| Instructor: | Prof. Dr. Dirk Metzler, Dr. Noémi Becker |
| Course content: | R is a widely used, freely available software and programming language for analysing data. In the lecture students learn the necessary theoretical background for using R. They will become familiar with the basic data structures and control flows of the R programming language.<br><br>In the tutorial, the students become familiar with R, by first trying simple commands and then learning how to simulate data. Then they learn to perform basic data analyses and to write simple program scripts. |

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| Qualification Goals: | Students will have the theoretical background knowledge needed to use R practically, and will be able to perform basic data analyses with R. They are familiar with a selection of functions of R and will be able to write simple program scripts. |
| **Lecture/Tutorial: Advanced computational methods in phylogenetics** | |
| Instructor: | Prof. Dr. Dirk Metzler |
| Course content: | Contents are current data-analytical methods for special areas of phylogenetics as for example phylogeography, evolution of quantitative traits, reconciliation of gene trees and species trees, or phylogenetic alignment. The theoretical models and algorithms underlying the methods are also treated.<br>In the tutorial students learn to analyse data with software packages providing implementations of the methods discussed in the corresponding lecture. They evaluate the methods with empirical data and with simulated data. The students will solve theoretical exercises to improve their comprehension of the lecture's contents. |
| Qualification Goals: | As a basis for their scientific specialization, students achieve an in-depth comprehension of special phylogenetic methods. They will have the fundamental knowledge to acquire related methods from the literature. In addition, students learn to perform data analyses with the methods taught in the lecture and to interpret and critically judge the results of such analyses. |
| **Lecture/Tutorial: Multivariate statistics in Ecology and Quantitative Genetics** | |
| Instructor: | Prof. Dr. Dirk Metzler, Dr. Noémie Becker |
| Course content: | Contents of the lecture are statistical methods for analyzing complex data sets, e.g. in ecology or evolutionary genetics. Among the methods treated in the lecture are Generalized Linear Models (GLMs), (Generalized) Linear Mixed-Effects Models (GLMMs), redundancy analyses, QTL analyses and genome-wide association studies.<br>In the tutorial students apply the methods learned in the corresponding lecture to data with the R software. Further exercises help them to develop a better understanding of the lecture's contents. By means of computer experiments, students explore under which conditions the methods give reasonable results. |
| Qualification Goals: | Students learn to critically assess under which conditions and, if so, how these methods can be applied to data. They achieve the fundamental knowledge to later acquire related methods from the literature.<br>In addition, students learn to use the statistics software R to apply |

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| | the methods treated in the lecture to empirical data and to interpret the results. They learn how to assess whether a method is appropriate for a given dataset. |
| **Lecture: Comparative Anatomy and Evolution of the Vertebrates (Neurobiology)** | |
| Instructor: | PD Dr. Mario F Wullimann (with Prof. Dr. Benedikt Grothe, Prof. Dr. Mark Hübener, PD Dr. Lars Kunz, Prof. Dr. Oliver Behrend) |
| Course content: | Topics related to chemical perception, from receptor activation through signal transduction up to brain activity and behaviour, in vertebrates as well as invertebrates, are assigned to each participant. Using recommended literature and resources and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires in an approx. 30 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. |
| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers.<br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group.<br>Students are exposed to current literature in sensory physiology, and gain insight into language and presentation formats required for peer-reviewed publication. |

| **Practical course: An introduction to remote sensing and GIS** | |
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| Instructor: | Prof. Dr. Florian Siegert |
| Course content: | The aim of this course is to provide a first insight into the potential of satellite remote sensing and Geographical Information Systems (GIS) in the field of biology and environmental monitoring.<br>The first part of the course introduces to various methods of image processing such as image calibration and enhancement, geo-referencing, image to image registration, filtering and spectral analysis (using ERDAS IMAGINE). The students will learn about the spectral properties of different sensors and how to interpret the information in satellite images. They will explore how to extract relevant information by supervised and unsupervised classification approaches. The students will learn also the basic principles of object based image classification using eCognition. Next they will apply this knowledge to practical examples: they will analyse land cover change and deforestation by comparing time series of satellite images as well as the impacts of fire and storm. The second part will give an introduction into GIS (using ArcGIS) and its basic functions for spatial analysis and digital cartography. |

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| | This course corresponds to 3 ECTS points and requires homework and a report. |
| Qualification Goals: | Students learn to process, understand and interpret satellite images. They obtain skills to work with satellite images using three different software packages (ERDAS IMAGINE, ArcGIS, and eCognition). |
| **Practical course: Light microscopy, from bright field to multi-photon (*Human Biology)*** | |
| Instructor: | Dr. Steffen Dietzel |
| Course content: | The students will learn the theory and practical application of light microscopic techniques, starting with the basics of "classic" techniques such as bright field Koehler Illumination, phase contrast, dark field, differential interference contrast (DIC) and fluorescence microscopy. We then move on to confocal laser scanning microscopy and multi-photon microscopy. Newer developments such as super resolution microscopy are also covered.<br>These techniques are applied to a variety of samples from fixed tissue sections to live cells and intravital microscopy.<br>Small groups of students will use image processing software to generate a presentation with the images and movies recorded. Apart from giving said presentation, each student will have to pass an oral examination on one of the topics of the course.<br>This is a 10 day course, set up with accompanying lecture and seminar. The student has the opportunity to prepare and present a talk on one of the microscopic techniques in which case the course is counted as 6 SWS. Otherwise it is a 3 SWS course. The course will be in English, except all (!) participants should agree on German. |
| Qualification Goals: | With this broad overview the student will be capable to determine advantages and disadvantages of various light microscopic approaches for different experimental settings and thus to select and apply the best approach for a given question. |
| **Practical course: Experimental Behavioral Ecology (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse, PD Dr. Volker Witte |
| Course content: | Students study scientific methods used in behavioral ecological research. They plan, conduct and analyse a number of behavioral experiments. They are required to apply knowledge from the course "Principles of behavioral ecology" to understand and interpret the experiments belonging to different research fields within behavioral ecology, such as sexual selection, socio-biology or species interactions. |

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| | The lab entails 3 full days per week, and requires a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | Students learn to design and carry out behavioral experiments. In working in small lab groups, social skills are refined. They also learn about data analysis and interpretation of results, and they improve their scientific writing skills. |
| **Practical course: Behavioral Ecology meets Quantitative Genetics (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse |
| Course content: | Students will be thoroughly introduced to state-of-the-art behavioral ecology paradigms that require tools from quantitative genetics. The course is accompanied by a lecture. Students learn about how the two fields differ and where they meet: empirical testing of adaptive hypotheses that require variance partitioning. The students are introduced to Bayesian statistical paradigms and mixed-effect modelling, and learn to graph and estimate a diverse array of within- and between-individual (co)variance components (e.g. between-individual (co)variances, additive genetic (co)variances) using a single empirical dataset throughout the course. The students give daily presentations of their findings, in preparation of an overall presentation on the final day of the course, and discuss a paper each day.<br><br>The course takes place at the Max Planck Institute for Ornithology, three days per week (9h00-16h30) for a period of three weeks. |
| Qualification Goals: | Students learn to program in the statistical language R, visualize, interpret, and present outcomes of mixed-effect models. Social skills are refined by working in pairs of two, presentation skills are improved by daily presentations and feedback, and reading and interpretation of scientific literature through paper discussions. |
| **Practical course: Receptors and transporters in the rodent auditory brainstem explored by patch-clamping and immunohistochemistry (Neurobiology)** | |
| Instructor: | Dr. Conny Kopp-Scheinpflug, Dr. Susanne Radtke-Schuller, Dr. Lina Yassin |
| Course content: | The course provides 1) an introduction into receptors and transporters in the central nervous system, 2) basics in patch-clamping and 3) histological and immunocytochemical methods. The course consists of a three lectures and 2 week lab practical (6 hours/day) and requires regular attendance. |
| Qualification Goals: | Students will learn to prepare acute brain slices of the rodent brainstem and use voltage-clamp and current-clamp recordings to investigate receptors and transporters in the auditory brainstem. Namely, they will record excitatory and inhibitory synaptic currents from the auditory brainstem as well as determine the |

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| | influence of transporters such as KCC2 on the receptor currents. In addition, they will conduct immunohistological staining and colocalizations of receptors and transporters in the brainstem.<br><br>Students obtain the fundamental knowledge required to learn to apply similar methods in research projects and their Masters thesis. |

| **Seminar: Management of scientific information** | |
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| Instructor: | Prof. Dr. J. Matthias Starck, Dipl. Biol. Nikola Trapp (librarian) |
| Course content: | The class is organized as a 3 SWS lecture / seminar / discussion group (soft skills module). The seminar is given 3 days a week as a 4 week block, regular attendance is required.<br><br>The seminar covers all aspects of how scientific data are processed, from generating data during research, through publishing and archiving. The students will learn and understand the important steps that accompany scientific publishing.<br><br>The participants are also introduced to all up-to date search engines, web of science and other online resources for finding archived data.<br><br>Contents of the class are presented from the view of the researcher and paper author, editor, publisher, and librarian, so that diverging and sometimes conflicting views on principles of scientific publishing are understood. |
| Qualification Goals: | Understanding principles of scientific publishing, archiving and retrieving of scientific information. Know up-to-date tools to effectively find scientific literature. Understanding current tools of science evaluation (e.g. impact factor, h-factor etc.) |
| **Seminar: Tropical rain forests: ecology, conversion, conservation** | |
| Instructor: | Prof. Dr. Florian Siegert |
| Course content: | Students read, explain and present scientific publications on the basic ecology of tropical rain forest ecosystems, on processes which lead to degradation and deforestation, the role of tropical deforestation for climate change and on potentially successful strategies to protect the remaining forests. The literature consists mainly on recent articles published in renowned scientific journals but includes also some selected grey literature such as NGO reports and internet resources of official bodies such as UNFCCC and FSC.<br><br>This seminar corresponds to 3 ECTS points and requires homework and the preparation of a written hand out and an oral presentation. |

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| Qualification Goals: | The students prepare and give a PowerPoint presentation on a selected topic based on a scientific article and additional material (photographs, graphs, illustrations) from internet resources. They will respond to questions from the audience and lead the discussion. |
| **Seminar: Light microscopy, from bright field to multi-photon (*Human Biology*)** | |
| Instructor: | PD Dr. Steffen Dietzel |
| Course content: | The students will learn the theory and practical application of light microscopic techniques, starting with the basics of "classic" techniques such as bright field Koehler Illumination, phase contrast, dark field, differential interference contrast (DIC) and fluorescence microscopy. We then move on to confocal laser scanning microscopy and multi-photon microscopy. Newer developments such as super resolution microscopy are also covered.<br>This seminar is part of a 10 day course, set up with accompanying lecture and practical course. The student has the opportunity to prepare and present a talk on one of the microscopic techniques in which case the course is counted as 6 SWS. Otherwise it is a 3 SWS course. The course will be in English, except all (!) participants should agree on German. |
| Qualification Goals: | With this broad overview the student will be capable to determine advantages and disadvantages of various light microscopic approaches for different experimental settings and thus to select and apply the best approach for a given question. |
| **Seminar: Neurophysiology of olfaction and taste (Neurobiology)** | |
| Instructor: | PD Dr. Blanka Pophof |
| Course content: | Topics related to chemical perception, from receptor activation through signal transduction up to brain activity and behaviour, in vertebrates as well as invertebrates, are assigned to each participant. Using recommended literature and resources and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires in an approx. 30 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. |
| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers.<br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group.<br>Students are exposed to current literature in sensory physiology, and gain insight into language and presentation formats required |

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| | for peer-reviewed publication. |
| **Seminar: Neurobiology (Neurobiology)** | |
| Instructor: | Prof. Dr. Hans Straka |
| Course content: | In this seminar current topics of neurobiology are discussed. Topics include but are not limited to single cell physiology, molecular biology, neuroanatomy and systems neurobiology. Using recommended literature and resources, and with regular consultation with the instructor, students independently research a current topic. The seminar entails 2 SWS, and requires an approx. 30 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. |
| Qualification Goals: | The seminar will introduce students to current events in neurobiology, which will be discussed in a broad context. Students presentation skills with different media will be assessed and commented on. Students will be exposed to current literature which will give them an insight into language and presentation formats required for peer-reviewed publication. |
| **Seminar: Intellectual property and patent law 1 (****Genetics***)** | |
| Instructor: | Dr. Andreas Brachmann, Dr. Andreas Koch, Dr. Gerhard Weinzierl |
| | *See Genetics for course descriptions and qualification goals. |
| **Seminar: Intellectual property and patent law 2 (****Genetics***)** | |
| Instructor: | Dr. Andreas Brachmann, Dr. Andreas Koch, Dr. Gerhard Weinzierl |
| | *See Genetics for course descriptions and qualification goals. |

# Microbiology

| **Lecture: Molecular Microbiology I** | |
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| Instructors: | Prof. Dr. Kirsten Jung, Prof. Dr. Thorsten Mascher |
| Course content: | The lecture covers the basic principles of bacterial signal transduction, bacterial motility, (chemo)taxis, and bacterial stress responses. In addition, students learn the biochemistry of biopolymer degradation and carbon assimilation under aerobic and anaerobic conditions as well as iron assimilation, and nitrogen fixation. The third part of the lecture covers fundamental principles and models of bacterial (multicellular) differentiation, e.g. cell cycle and formation of endospores, mycelia and fruiting bodies. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | Students are proficient in the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation.<br><br>Students have fundamental as well as up-to-date knowledge. The latter is published as original articles and not yet found in text books.<br><br>Students are equipped with the basic knowledge as prerequisite to do scientific research in these topics.<br><br>Questions during the lecture foster creative thinking and the dialog with the students. |
| **Lecture: Molecular Microbiology II** | |
| Instructor: | Prof. Dr. Dirk Schüler, Prof. Dr. Thorsten Mascher |
| Course content: | The lecture focuses on basic principles and recent developments in microbial cell biology (Schüler) and synthetic microbiology (Mascher). Based on most recent literature, this covers novel advances that demonstrated that prokaryotic cells have a highly organized and dynamic subcellular architecture. The lecture introduces to the current knowledge of bacterial ultrastructure. It provides an overview over modern light, fluorescence, and electron microscopic techniques for studying prokaryotic cellular architecture. Among major topics are the structure and function of bacterial compartments, organelles, appendages, and cytoskeletal elements. Key cellular processes such as bacterial cell division and differentiation are highlighted.<br><br>The second part provides an overview over the latest developments in the rapidly evolving field of Synthetic Biology in microorganisms. The major topics include: i) biological design principles and the “engineering way” of genetic engineering, ii) |

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| | synthetic genes, genomes and organisms, iii) minimal cells and protocells, iv) orthogonal biological systems, v) design and construction of novel biosynthetic pathways, and vi) complex artificial genetic switches and circuits.<br>The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | Students are proficient in the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation. Students acquire fundamental as well as up-to-date knowledge. The latter is published as original articles and not yet found in text books.<br>Students are equipped with the basic knowledge as prerequisite to do scientific research in these topics.<br>An interactive lecture style fosters independent thinking and active participation. |
| **Lecture: Molecular Microbiology III** | |
| Instructor: | Prof. Dr. Kirsten Jung, Prof. Dr. Dirk Schüler |
| Course content: | The lecture focuses on a deep understanding of molecular environmental microbiology and bacterial physiological adaptation. It covers the basic principles of the molecular characterization of diverse microbial communities, the detection, enrichment and analysis of non-culturable bacteria, environmental and single-cell genomics as well as metagenomic, metaproteomic and metabolic analysis of environmental communities. The second part of the lecture covers the interconnectivity between quorum sensing molecules, secondary metabolites and metabolism as prerequisite for differentiation, biofilm formation and phenotypic individuality. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | The students are proficient in the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation.<br>Students have fundamental as well as up-to-date knowledge, since about 10 to 20 % of the lecture covers new results and modern methods.<br>Students are equipped with the basic and advanced knowledge as prerequisite to do scientific research in these topics.<br>Questions during the lecture foster creative thinking and the dialogue with the students. |
| **Lecture: Prokaryote-eukaryote-interactions** | |
| Instructor: | Prof. Dr. Anton Hartmann |

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| Course content: | The lecture presents basic principles of microbial ecology of organismic interactions and covers bacterial as well as fungal interactions with plants and animals/humans. Also bacterial-fungal interactions are covered. The quality of interactions deals with the whole spectrum from pathogenic, saprophytic to symbiotic interactions. Besides the presentations of examples of organismic interactions, basic mechanisms are taught including molecular signaling, specific gene expression and ecological niche occupation. Students get an insight into trans-kingdom interactions of organisms including common principles and basic mechanisms like quorum sensing signal production at the bacterial and QS-perception at the eukaryotic side. Also different types of mycorrhizal symbiosis as well as different symbiotic nitrogen fixation systems are presented. The lecture series (1 SWS) is included in the two week block course "Prokaryote-eukaryote-interactions" and requires regular attendance and a final exam. |
| Qualification Goals: | Students acquire detailed and over-arching understanding about the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation.<br>Students have fundamental as well as up-to-date knowledge. The latter is published as original articles and not yet found in text books.<br>Creative thinking and dialog between the students are encouraged. |
| **Lecture: Molecular Virology, Part I (*Cell Biology, Genetics, *Human Biology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| | *See Human Biology for course description and qualification goals. |
| **Lecture: Molecular Virology, Part II (*Cell Biology, Genetics, *Human Biology*)** | |
| Instructor: | Prof. Dr. Ruth Brack-Werner |
| | *See Human Biology for course description and qualification goals. |
| **Lecture: Genetics in pharmaceutical and industrial practice (Fundamentals in finding active substances) (**Genetics*)** | |
| Instructor: | PD Dr. Günter Müller |
| | *See Genetics for course description and qualification goals. |

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| **Practical course: Molecular Microbiology I** | |
| Instructor: | Prof. Dr. Heinrich Jung |

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| Course content: | The practical course contains experiments on the topics membrane biochemistry and transport, cell-cell communication by quorum sensing, and bacterial regulatory networks. The methods applied in the course involve, e.g., amino acid uptake measurements with radiolabeled substrates, atom absorption spectroscopy, qRT-PCR, reporter gene fusion analyses, fluorescence microscopy, and biofilm formation analyses. The course introduces to handling of complex data sets and the determination of kinetic parameters. In addition, the course addresses safety issues including handling of genetically altered organisms and radio safety. The practical course is given as a block within 2 weeks (3 SWS) and requires regular attendance and writing a protocol. |
| Qualification Goals: | Students are proficient in the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation.<br><br>Students have fundamental as well as up-to-date knowledge. Specifically, the students learn how do design and critical evaluate experiments in molecular microbiology.<br><br>Students are equipped with the advanced theoretical and experimental knowledge as prerequisite to do scientific research in the topics listed above.<br><br>Students are proficient in safety regulations regarding handling of genetically altered organisms and radio safety.<br><br>Discussions on the experimental design and on critical data evaluation during the course foster creative and critical thinking and the dialog with the students. |
| **Practical course: Molecular Microbiology II** | |
| Instructors: | PD Dr. Ralf Heermann, Dr. Frank Landgraf |
| Course content: | In this practical course, students are taught in biotechnological and protein chemical methods. Bacterial growth is analysed in dependence of different environmental conditions. Students learn to prepare and to handle a fermenter for setting constant conditions of a bacterial culture. Thereby, each team consisting of two students handles its own fermenter, so that this technique is individually trained. Furthermore, the proteome of the cells is analysed and compared in reflection to the different growth conditions. This downstream process also includes the application of further protein-biochemical standard techniques. The practical course is given as a block within 2 weeks (3 SWS) and requires regular attendance and writing a protocol. |
| Qualification Goals: | Students are proficient in the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation.<br><br>Students have fundamental as well as up-to-date knowledge. |

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| | Specifically, the students learn how do design and critical evaluate experiments in molecular microbiology.<br><br>Students are equipped with the advanced theoretical and experimental knowledge as prerequisite to do scientific research in the field of molecular microbiology.<br><br>Students are well trained in handling of a modern fermenter and downstream processing as important methods used by many biotechnological and pharmaceutical companies.<br><br>Discussions on the experimental design and on critical data evaluation during the course foster creative and critical thinking and the dialog with the students. |
| **Practical course: Molecular Microbiology III – Bacterial Cell Biology** | |
| Instructors: | Prof. Dr. Marc Bramkamp, Dr. Catriona Donovan, Dr. Karin Schubert |
| Course content: | Participants are introduced to the model organisms (*B. subtilis* or *C. glutamicum*). They will learn how to generate translational fusions, gene knock-outs and construction of conditional mutants. The participants will construct strains expressing fluorescent fusion proteins and learn how to visualize the bacteria with modern fluorescence widefield microscopy. In parallel, participants will learn current methods to purify proteins using the standard FPLC techniques, gel-electrophoresis and immune-detection. The lab entails 4 SWS, and requires a detailed lab report according to good scientific practice |
| Qualification Goals: | Students obtain essential skills for future lab work, in particular in preparation for their master's thesis. Emphasis is placed on hands-on experience in protein biochemistry, genetics and fluorescence microscopy with small specimens. |
| **Practical course: Microbial systems biology and signal transduction** | |
| Instructor: | Prof. Dr. Thorsten Mascher, PhD/Otago Susanne Gebhard |
| Course content: | The research course teaches independent laboratory work to address individual research topics in the field of microbial systems biology and signal transduction. Students are taught a range of experimental techniques in molecular biology, bacterial physiology and/or protein biochemistry. Emphasis is placed on good scientific practice in the documentation of results as well as data analysis, evaluation and critical discussion of results in the context of the available literature. Students also practice the presentation of their results in both informal and formal group meetings.<br><br>The course duration is 8 weeks and requires full-time work in the lab, plus a final scientific presentation (ca. 30 min) of the results to the research group. |

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| Qualification Goals: | The students can design and carry out experiments to address scientific questions.<br>The students become familiar with the theoretical background relevant to their research topic and can apply this information to the critical evaluation of their own results.<br>Students can transfer their theoretical knowledge to the design of their own experiments.<br>Students are able to clearly present their research to other scientists. |
| **Practical course: Prokaryote-eukaryote-interactions** | |
| Instructor: | Prof. Dr. Anton Hartmann |
| Course content: | The practical course contains experiments on the topics microbial identification and localization using molecular phylogenetic tools, molecular tagging with green-fluorescent protein, immunochemical methods (like enzyme-linked immunostaining assay) and advanced microscopic techniques (like confocal laser scanning microscopy). The course teaches not only to understand and perform in detail complex protocols to acquire qualitative data of organismic interactions but also how to obtain quantitative data of detection of specific small molecules relevant in the interaction. In addition, students are made familiar with important safety regulations and issues. The practical course (3 SWS) is included in the two week block course "Prokaryote-eukaryote-interactions" and requires regular attendance, writing a short protocol and a final exam. |
| Qualification Goals: | Students are proficient in the contents of the course, understand the basic principles of key methods in microbial ecology and transfer this knowledge in an exam situation.<br>Students have fundamental as well as up-to-date knowledge and are well trained in good biological lab practice and documentation. Specifically, the students learn how do design and critically evaluate experiments in molecular microbial ecology of organismic interactions.<br>Students are equipped with the advanced theoretical and experimental knowledge as prerequisite to apply methods according to the topics listed above.<br>Students having worked in small groups have improved social communication, as well as organizational skills.<br>Discussions on the experimental design and on critical data evaluation during the course foster creative and critical thinking and the dialog with the students. |

| **Practical field course: Microbiological excursion** | |
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| Instructor: | Prof. Dr. Dirk Schüler, Prof. Kirsten Jung, Prof. Dr. Thorsten Mascher, PD Dr. Ralf Heermann |
| Course content: | Students are introduced to various practical and applied aspects of microbiology. This will include scientifically guided field trips (3 SWS) to various biotech companies from the start-up to large enterprise level, extra-university research institutions, sewage treatment plants, and others. Participants will become familiar with several aspects of applied biotechnological research, the microbial production of food, pharmaceuticals and diagnostics, as well as microbial waste-water treatment technology. Students gain insights into the organizational structures and strategies of real-world, non-academic companies and research institutions and will get into contact with prospective employers. The course requires attendance of all excursions and the submission of an extended scientific report documenting the key information on each subject. |
| Qualification Goals: | Students become familiar with cutting-edge non-academic research and production using applied microbiology.<br>Students are able to extent and transfer their theoretical knowledge into real-world applications of various fields of microbiology. |
| **Practical research courses** | |
| Instructor: | Teaching staff, Microbiology division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Molecular Microbiology I** | |
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| Instructor: | Prof. Dr. Heinrich Jung |

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| Course content: | The seminar covers up-to-date topics on membrane biochemistry and transport, principles of bacterial signal transduction, bacterial motility, (chemo)taxis, bacterial communication, and bacteria-host interactions. Each student takes over a topic, and is requested to perform a literature search, e.g., via PubMed and to select minimum one review article as source of background information and overview on the selected topic and one related original article. Based on this search, each student has to prepare a presentation which introduces to the topic and depicts state-of-the-art problems. The presentation is followed by a discussion involving all seminar participants. Part of the seminar is a computer course that introduces to in silico analyses of structures of membrane proteins. The seminar is given weekly (2 SWS) and requires regular attendance and active participation in the seminar discussions including oral presentations on selected topics. |
| Qualification Goals: | Students are proficient in the contents of the course and are able to depict basic principles and transfer knowledge in an exam situation.<br><br>Students have fundamental as well as up-to-date knowledge. Specifically, the students are equipped with knowledge on literature search, evaluation, presentation and critical discussion of state-of-the-art problems in molecular microbiology.<br><br>Students are equipped with the advanced knowledge as prerequisite to do scientific research in these topics.<br><br>Seminar discussions foster creative thinking and the dialog with and interactions between the students. |
| **Seminar: Molecular Microbiology II** | |
| Instructors: | Prof. Dr. Kirsten Jung, PhD/Otago Susanne Gebhard, Dr. Frank Landgraf |
| Course content: | In the first part of the seminar the students will give presentations on techniques used in cell biology. By going into detail on techniques used in the analysis of cell structures, the students will learn to have a deeper understanding of the abilities of modern science, as well as its borders.<br><br>In the second part of the seminar the students are introduced to some fundamental principles and applications of synthetic microbiology. Current primary publications covering engineering of synthetic regulatory circuits and potential practical applications of the designed bacterial strains will be presented by the participants as oral presentations to the whole group. Preparation of these presentations will be supported by the students' independent research of the topic, assisted by the course instructor. A special emphasis is placed on standard methodologies in synthetic biology, levels of regulatory control, theory of transcriptional logic as well as safety aspects in genetic |

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| | engineering. |
| Qualification Goals: | Scientific publications will be presented to the group together with accessory information necessary for understanding. Students thereby practice to prepare sophisticated scientific work for a professional audience and to assess and interpret data critically as a basis for careful and relevant conclusions. The group will discuss the scientific work presented, as well as the lecture itself. In that way students improve their presentation and communication skills particularly in respect to thesis writing, scientific publications and defense.<br><br>The students will gain detailed insight into sophisticated techniques used in cell biology.<br><br>The students are exposed to a relatively new field in biology, i.e. synthetic biology, and gain an understanding of how principles of classical engineering can be applied to living systems. They enhance their skills in critical thinking and scientific argumentation from group discussions on experimental as well as ethical aspects of synthetic biology.<br><br>The seminar entails 2 SWS, and requires an approx. 25-minute oral presentation of the topic in front of the group. |
| **Seminar: Molecular Microbiology III** | |
| Instructor: | Dr. Frank Landgraf, Dr. Frank Müller |
| Course content: | The students are proficient in understanding and presenting research publications. They are familiar with techniques to search for and access scientific publications and accessory / supplementary information.<br><br>Students are equipped with the aptitude to critically read scientific publications and to recognize and discuss their weaknesses and strengths in a broader context.<br><br>The course aims further to extend and broaden basic textbook knowledge by appreciation and critical analysis of current literature. In addition, students learn how to approach scientific questions and to validate experimental results.<br><br>Students become proficient in presentation skills with different media, are introduced to library and online resources, can assess and present a topic thoroughly and understandably to scientific peers.<br><br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group. |
| Qualification Goals: | Students are exposed to recent high impact research publications in microbiology. After consultation with the instructor, students independently research the topic and gain insight into language and presentation formats required for peer-reviewed publication |

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| | and access to online resources.<br><br>Subsequently, the scientific publications will be presented to the group together with accessory information necessary for understanding. Students thereby practice to prepare sophisticated scientific work to a professional audience and to assess and interpret data critically as a basis for careful and relevant conclusions. The group will discuss the scientific work presented, as well as the lecture itself. In that way students improve their presentation and communication skills particularly in respect to thesis writing, scientific publications and defense.<br><br>The seminar entails 2 SWS, and requires an approx. 25-minute oral presentation of the topic in front of the group. |
| **Seminar: Molecular Microbiology III – Bacterial Cell Biology** | |
| Instructor: | Prof. Dr. Marc Bramkamp, Dr. Catriona Donovan, Dr. Karin Schubert |
| Course content: | Seminar: (Bacterial cell biology) Topics related to bacterial cell biology (e.g. organization of the bacterial cell in 4D) are assigned to each participant. Using recommended literature and resources, and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 20 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. Each talk will be discussed by the audience (10 min). Active participation in discussions is expected. |
| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers.<br><br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group.<br><br>Students are exposed to current literature, and gain insight into language and presentation formats required for peer-reviewed publication. |
| **Microbiology seminar series** | |
| Instructors: | Prof. Dr. Kirsten Jung, Prof. Dr. Dirk Schüler, Prof. Dr. Thorsten Mascher, Prof. Dr. Heinrich Jung |
| Course content: | The Microbiology seminar series covers modern aspects in molecular, cellular, and environmental microbiology. Seminars are given by out-standing scientists in their fields from Germany, other European countries, Asia or North America. The seminar is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | Students are competent with state-of-the-art research and are able to widen their basic knowledge and their knowledge in new |

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| | methods and techniques.<br>Students are experienced to apply their knowledge in an exam situation.<br>Students are able to transfer the knowledge to their own scientific research topics and interests.<br>Students are trained to discuss scientific issues. |
| **Research seminar: Structural and functional analysis of prokaryotic transmembrane receptors and transporters** | |
| Instructors: | Prof. Dr. Kirsten Jung, Prof. Dr. Heinrich Jung |
| Course content: | The research seminar teaches theoretical, practical and applied aspects of specific research topics in molecular and biochemical microbiology.<br>The seminar is given weekly (2 SWS), and requires regular attendance and one own scientific presentation (25 min). |
| Qualification Goals: | Students are competent with state-of-the-art research and are able to extend their theoretical knowledge and their knowledge in new methods and techniques.<br>Students are able to transfer basic knowledge to an own scientific research topic.<br>Students are trained to present and discuss scientific issues. |
| **Seminar: Prokaryote-eukaryote-interactions** | |
| Instructor: | Prof. Dr. Anton Hartmann |
| Course content: | The seminar covers up-to-date topics on trans-kingdom interactions of prokaryotes with eukaryotic hosts. The topics include symbiotic as well as pathogenic interactions and also deal with bacterial-fungal interactions. Biochemical mechanisms of interactions, like specific recognition and receptor interactions, small molecule signaling and signal transfer. Each student selects a specific topic and is requested to present a review article and original research literature, which he/she has selected within the topic. Based on this literature, each student has to prepare a presentation which contains a general introduction and overview part as well as an experimental results part followed by a discussion and summary. A discussion involving all seminar participants is obligatory. The seminar (1 SWS) is included in the two week block course "Prokaryote-eukaryote-interactions" and requires regular attendance and active participation including an oral presentation (20 min) on a selected topic. |
| Qualification Goals: | Students are familiar with in the contents of the course and are able to depict basic principles and transfer knowledge in widened connections. |

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| | Students have fundamental as well as up-to-date knowledge. Specifically, the students are equipped with knowledge on evaluation, presentation and critical discussion of state-of-the-art problems in molecular microbial ecology and organismic interactions.<br><br>Students are equipped with adequate presentations skills, including the use of a scientific library and internet resources.<br><br>Students have improved skills to speak in front of a group, improve and train their (English) language and communication abilities.<br><br>Seminar discussions foster creative thinking and the dialog with and interactions between the students. |
| **Seminar: Regulation and transduction of bacterial stress** | |
| Instructors: | Prof. Dr. Thorsten Mascher, PhD/Otago Susanne Gebhard |
| Course content: | The research seminar teaches state-of-the-art practical and theoretical aspects of signal transduction and gene regulation in response to environmental stress in Gram-positive bacteria. The core topics covered are centered on on-going research in the Mascher- and Gebhard-laboratories. A strong focus is placed on the discussion of laboratory experiments and interpretation of results in the context of available literature.<br><br>Regular attendance of the seminar is required. One presentation (c. 30 min) of their own work or a relevant publication is to be given by each participant |
| Qualification Goals: | Students are familiar with state-of-the-art international research on aspects of bacterial signal transduction<br><br>Students gain proficiency in the presentation of scientific results, primarily of their own practical work, but also of studies published by other groups.<br><br>Students practice the critical discussion of experimental results, both their own and those of others.<br><br>Students are able to independently gather information to extend their theoretical knowledge of a field, including methodologies, and to apply this knowledge to their own research project. |
| **Seminar: Structural and functional analysis of prokaryotic transmembrane receptors and transporters** | |
| Instructors: | Prof. Dr. Dirk Schüler, Dr. Frank Müller |
| Course content: | The research seminar teaches theoretical, practical and applied aspects of specific molecular genetics, genomics and cell biology of prokaryotic microorganisms.<br><br>The seminar is held weekly (2 SWS) and requires regular attendance and one own scientific presentation (25 min). |

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| Qualification Goals: | Students become familiar with cutting-edge research and are able to extend their theoretical knowledge and expertise in new methods and techniques.<br>Students are able to transfer basic knowledge to an own scientific research topic.<br>Students are trained to present and discuss scientific issues. |
| **Seminar: Current research in Microbiology/ Aktuelle Arbeiten der Mikrobiologie** | |
| Instructors: | Prof. Dr. Kirsten Jung, Prof. Dr. Dirk Schüler, Prof. Dr. Thorsten Mascher, Prof. Dr. Marc Bramkamp, Prof. Dr. Heinrich Jung, PD Dr. Ralf Heermann |
| Course content: | This seminar is a microbiology progress seminar. In this seminar, PhD and Master students present the current status of their research work, followed by a discussion. |
| Qualification Goals: | Students practice to prepare sophisticated scientific work for a professional audience and to assess and interpret data critically as a basis for careful and relevant conclusions. The group will discuss the scientific work presented. In that way students improve their presentation and communication skills, particularly in respect to thesis writing, scientific publications and defense.<br>Students sharpen communication, presentation and posture skills gained through speaking in front of a group. |

# Plant Sciences

| **Lecture: Biochemistry 3 (*Cell Biology*)** | |
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| Instructors: | PD Dr. Bettina Bölter, PD Dr. Katrin Philippar, Prof. Dr. Jörg Nickelsen |
| Course content: | The lecture is divided into three parts: one part deals with RNA structure and function, one part with chaperones, protein folding and diseases caused by protein misfolding, one section is about membrane transport proteins.<br>The lecture is given weekly (2 SWS) and a final exam is to be passed. |
| Qualification Goals: | Students are provided with general facts about the above named topics and confronted with actual research results. They will learn about the possibility of discrepancies in the results of different research groups. In the end, they will have an impression of how to tackle specific scientific questions experimentally. |
| **Lecture: Membranes: physical and biological aspects (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Ute Vothknecht |
| Course content: | Membranes are essential functional components of many cellular functions. The lecture gives a detailed overview over the molecular structure of biomembranes, including the basic physical and |

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| | biological principles of membrane proteins and lipids, their synthesis and transport within the cell. It furthermore explains the functional role of membranes in different cellular processes. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | At the end of the lecture the students have obtained fundamental knowledge about the molecular structure and composition of biomembranes in a cellular context. They are able to understand the functional (and not only structural) role that membranes play in many cellular processes. |
| **Lecture: Einführung in die Elektronenmikroskopie/ Introduction to electron microscopy (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Gerhard Wanner |
| Course content: | This lecture covers the basic physical principles of optical and electron microscopy as well as the detailed explanation of preparation processes and their theoretical background. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam.<br>The lecture is held in German (also offered in bachelor's program). |
| Qualification Goals: | The students are proficient in the basic principles of optical and electron microscopy and are able transfer knowledge in an exam situation.<br>Students obtain the fundamental knowledge required to participate in specialized practical courses and seminars on current research in Electron Microscopy, and are introduced to the advantages and limitations of current methods in order to potentially consider application of this method in their own research projects. |
| **Lecture: Biochemistry and Cell Biology of plants (*Cell Biology*)** | |
| Instructors: | Prof. Dr. Jürgen Soll, Prof. Dr. Ute Vothknecht, Prof. Dr. Gerhard Wanner |
| Course content: | The lecture covers advanced aspects of cellular structures and metabolic pathways specific for plant cells and tissues such as special forms of photosynthesis, plant respiration, evolution and function of plant organelles, protein transport and intercellular communication. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | At the end of the lecture the students have obtained fundamental knowledge about the particularity of the plant cell in structure and function. They are able to understand the specific function of plant specific organelles and metabolic processes for plant life. |

| **Lecture: Interactions of plants and environment** | |
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| Instructor: | Prof. Dr. Dario Leister, Prof. Dr. Wolfgang Frank, PD Dr. Cordelia Bolle, Dr. Iris Finkemeier, PD Dr. Tatjana Kleine, Prof. Dr. Peter Geigenberger, Dr. Mathias Pribil, Dr. Anja Schneider |
| Course content: | Plants as sessile organisms react on adverse environmental conditions by a diversity of physiological adaptations. This lecture covers the basics in the interaction of plants with the environment and the specific responses to different kinds of stimuli and stresses. Adaptation mechanisms will be reviewed in depth to be able to teach biochemical and molecular mechanisms in more detail and to reinforce recurring mechanisms. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | Students obtain the fundamental knowledge required to participate in further specialized courses and are able to depict basic principles. |
| **Lecture: Modern methods in Plant Sciences (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Dario Leister, Prof. Dr. Peter Geigenberger, PD Dr. Cordelia Bolle, Dr. Iris Finkemeier, Prof. Dr. Jörg Nickelsen, PD Dr. Tatjana Kleine, Dr. Anja Schneider, Dr. Mathias Pribil |
| Course content: | In this lecture the most important molecular, biochemical and genetic methods used in plant science are discussed in detail. It covers the basic principles as well as detailed explanation of different methods which can be used or have been used to address certain problems. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | Students obtain the fundamental knowledge required to participate in further specialized courses. These methods which are explained will be used in several practical courses which will reinforce this theoretical knowledge, but also allow the transfer to the practical work. |
| **Lecture: Current topics in Plant Sciences** | |
| Instructor: | Prof. Dr. Dario Leister, Prof. Dr. Wolfgang Frank, Prof. Dr. Peter Geigenberger, PD Dr. Cordelia Bolle, Dr. Iris Finkemeier, PD Dr. Jörg Meurer, PD Dr. Tatjana Kleine, Dr. Anja Schneider, Dr. Mathias Pribil, Dr. Edda von Roepenack-Lahaye |
| Course content: | This lecture series introduces the current research topics which are investigated within the groups of Plant Sciences. Topics cover photosynthesis, light signaling, signaling between plastid and nucleus or mitochondria and nucleus, regulation of metabolism, inheritance of organelles, "omics"-approaches, molecular mechanisms of stress adaptation, and the control of gene expression by non-coding RNAs. The lecture is given weekly (2 |

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| | SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | Students get first-hand insights into the major research topics of the Plant Sciences section. They gain knowledge on current fundamental questions in plant molecular biology and physiology and different experimental approaches in plant model species. This introduction to on-going studies will help to obtain the fundamental knowledge required to participate in further specialized courses and to make decisions on the research topics and different laboratories for their final master's thesis. |
| **Lecture: Plant-based natural products - biochemistry and utilization** | |
| Instructor: | PD Dr. Paula Braun, Prof. Dr. Hugo Scheer, PD Dr. Cordelia Bolle |
| Course content: | This lecture covers several groups of secondary metabolites and their biosynthesis, regulation and function. Also the utilization of these metabolites in industry, medicine or nutrition is being explored. The focus is on tetrapyrrols, fatty acids, phenylpropanoids and terpenoids. The lecture is given weekly (2 SWS) and requires regular attendance and a final exam. |
| Qualification Goals: | The students are encouraged to consider physical, chemical, and biochemical molecular aspects of metabolites to inspire knowledge transfer between these different fields. Furthermore, students start to understand how basic science can be applied in industry. |
| **Lecture: Pflanzen in der natürlichen Umgebung, Strahlung, Wasser, Klima(-wandel)/ Plants in their natural environment, radiation, water, climate** | |
| Instructor: | Prof. Dr. Hugo Scheer, Dr. Alexander Pazur |
| Course content: | The main part of this course is a lecture, which imparts the connection of ecosystems and their abiotic environment, using the example of vegetation areas and chosen representative plant families and species. It focuses on the interaction between climatic and geophysical factors: light (and other radiations), heat energy, water availability, state of soils and waters. After a short sketch of basic meteorology, methods and models in palaeoclimatic and modern climate research (e.g. proxies, isotope dating, GCMs, ocean-, ice- and vegetation-models, climate scenarios) and discussed consequences for the species change are explained. Further, the role of photosynthesis in this geo-biological context is shown up.<br><br>Course language: German (also offered for bachelor's and teaching degree students)<br><br>In the integrated seminar part, an approx. 20 minute oral presentation (in German or English), deepening a topic of the lecture, and regular attendance are obligatory for any participant in order to obtain the 3 ECTS points for this 2 SWS weekly course. |

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| Qualification Goals: | The course offers a broad pallet of themes of modern environmental sciences for further professional orientation. Students obtain the fundamental knowledge required for a future work in the fields of environment, climate or species protection, ecology and hydrology, and, furthermore, for agricultural or forest science. Teaching degree students get suggestions for an attractive environmental education in their lessons. Also this course was approved for students of the common "Bioinformatics"-study by LMU and TUM. |

| **Practical course: Biogenesis of organelles (*Cell Biology*)** | |
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| Instructor: | PD Dr. Katrin Philippar |
| Course content: | Analyses on biogenesis of organelles e.g. de-etiolation of plastids, from etioplast to chloroplast. Experiments involve advanced studies on transcript, protein and pigment levels, including quantitative real-time RT-PCR and immunoblotting. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice as well as presentation of results and discussion with respect to original literature in a seminar. |
| Qualification Goals: | Students obtain skills for future lab work, in particular in preparation for their master's thesis.<br>Students are well trained in lab practice, including standard procedures of molecular biology and biochemistry, and obtain skills in specialized techniques such as quantitative real-time RT PCR.<br>Students practice critical evaluation and interpretation of data as well as of original publications as a basis for careful and relevant conclusions.<br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Protein purification (*Cell Biology*)** | |
| Instructors: | Prof. Dr. Jürgen Soll, Prof. Dr. Jörg Nickelsen, PD Dr. Bettina Bölter, Dr. Alexandra-Viola Bohne |
| Course content: | The course covers all basic state-of-the-art techniques in protein purification, i.e. ion exchange chromatography, gel filtration as well as purification of tagged proteins. The students are introduced to a FPLC system which they learn to operate in a single-handed manner during the course. Proteins are extracted from different |

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| | sources such as *E. coli* and plant material. Moreover, basic biochemical techniques including SDS-PAGE, enzyme measurements, and immunodetection of proteins are performed. Students are further challenged to apply their theoretical knowledge by developing a purification method for a specific protein on their own. A theoretical survey of the applied methods is provided and the participants each present a short seminar on a selected topic. The course entails 3 SWS and requires a detailed lab report as well as a comprehensive oral summary at the end of the course. |
| Qualification Goals: | Due to the intensive hands-on training the students will acquire technical skills in fundamental biochemical techniques. Especially the training with a FPLC system will allow them to understand and perform methods, which are widely applied in pharmaceutical and biotechnological research today. They will be able to apply their theoretical knowledge self dependently in a practical experiment. In addition they will learn to interpret their data and discuss it with their colleagues. |
| **Practical course: Structural and analytical investigations of plant chromosomes with scanning electron microscopy (*Cell Biology*)** | |
| Instructor: | Dr. Elizabeth Schroeder-Reiter |
| Course content: | Participants are introduced to step-by-step procedures for isolation of plant chromosomes, standard visualization techniques with phase contrast and fluorescence light microscopy, indirect immunolabeling techniques, and analytical techniques and visualization with high resolution scanning electron microscopy. Emphasis is placed on the relevance of and hands-on practice with these microscopic techniques, as well as interpretation and presentation of data. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice.<br><br>Recommended lecture: Einführung in die Elektronenmikroskopie. Course is limited to 6 participants. Course language is determined by participants: English or German. |
| Qualification Goals: | Acquisition and understanding of specific methods (and their theoretical background) for chromosome isolation and preparation for different microscopic techniques, in particular immunolabeling for correlative fluorescence light microscopy and scanning electron microscopy. Students are able to apply appropriate microscopic techniques depending on required resolution in future research.<br><br>Students are familiar with acquisition, image editing and layout software for data presentation. Through close feed-back and evaluation with the instructor, practice in written data presentation according to good standard scientific practice, including well-founded introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for thesis writing and scientific publications. |

| **Practical course: Protein transport *(Cell Biology)*** | |
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| Instructor: | Prof. Dr. Jürgen Soll, PD Dr. Bettina Bölter |
| Course content: | Students learn how to isolate intact organelles such as chloroplasts and mitochondria from plants and how to set up an in vitro import assay. They are taught how to properly handle in vitro translation systems and thereby how to work with radioactively labelled amino acids. Further, they will perform overexpression of heterologous proteins in bacteria and subsequently purify them via IMAC. During the course they can apply all the basic methods acquired during their studies such as SDS PAGE, Western blotting etc. |
| Qualification Goals: | Students will be trained in good general lab practice and taught the principles of safely handling radioactivity. They will learn and apply methods which are used in daily lab work. At the end of the course they should be able to plan and exert an experiment as well as scientifically present their data in oral and written form. |
| **Practical course: Molecular biology and biochemistry of phototrophic microorganisms (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Jörg Nickelsen, Dr. Alexandra-Viola Bohne |
| Course content: | The course imparts knowledge about the principles of plastidic gene expression. Students will work with the unicellular green alga *Chlamydomonas reinhardtii* and analyze different strains with regard to their gene expression at the level of transcription as well as translation. Applied methods comprise reporter gene expression analysis, nuclear transformation of *C. reinhardtii,* and testing of growth under photoautotrophic conditions. Emphasis will lie on molecular methods, like the isolation and detection of DNAs (Southern blot), RNAs (Northern blot) as well as proteins (Western blot), respectively. Based on the performed phenotypical and molecular analyses of different strains the students will be able to draw conclusions on the identity of the investigated mutants. The lab entails 3 SWS (3 ECTS points), and requires a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | After participation in this course, students will know how to combine different methods to address a specific scientific question. They will be able to summarize, present, and discuss the outcome. Furthermore, they can distinguish different regulatory levels of gene expression and integrate the obtained results in an overall context. Methodically, they have deepened skills in Southern, Northern and Western analysis and will have gained insights into basic working practice with unicellular green algae. |

| **Practical course: Rasterelektronenmikroskopische Untersuchungen an lebendem Pflanzenmaterial / SEM investigations on fresh plant material *(Systematic Botany and Mycology)*** | |
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| Instructor: | Prof. Dr. Gerhard Wanner, Dr. Eva Facher |
| Course content: | Participants are introduced to techniques and hands-on applications in variable pressure Electron Microscopy. Using these techniques students are able to make detailed observations of fresh botanical material using standard LM visualization techniques as well as special EM procedures. Students are encouraged to actively participate in specimen selection and course planning. Emphasis is placed on interpretation and presentation of image data.<br>Prerequisite lecture: Einführung in die Elektronenmikroskopie. Course takes place in the Systematic Botany and Mycology Institute, Menzinger Str. 67, is limited to 6 participants, and is held in German (also offered in bachelor's program). |
| Qualification Goals: | Students obtain skills for future work, in particular documentation for their master's thesis. They gain experience in precise handling of instruments and conscientious documentation of results. In working in small groups, social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication (rapport with instructors, presentations, written lab reports), as well as organization (efficient planning, documentation) are refined. |
| **Practical course: Signal transduction in plants *(Cell Biology)*** | |
| Instructor: | Prof. Dr. Ute Vothknecht |
| Course content: | Students are introduced to different experimental approaches to analyse calcium-dependent regulation of protein-protein interaction and protein function. The students have to set up their own experimental plan, which is discussed with and approved by the instructor. The course (3 SWS) further entails the presentation of experimental results to the whole group in form of an oral presentation that also covers the basic principles of the methodological approaches utilized in the experiments. |
| Qualification Goals: | Students obtain useful skills for future experimental work. They acquire new, advanced experimental techniques and learn how different experimental approaches can be applied to the solution of specific scientific problems. The course further teaches valuable organization skills with regard to experimental planning and interpretation of results in a wider scientific context. |
| **Practical course: Plant Molecular Cell Biology: Non-coding, regulatory RNAs in the moss *Physcomitrella patens* (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Wolfgang Frank, Dr. M. Asif Arif |

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| Course content: | Participants are introduced to step-by-step procedures for the isolation of plant DNA and RNA, cDNA preparation, real time PCR detection and quantification of small RNAs and mRNAs, and analysis of cleavage products of small RNA target genes via Rapid Amplification of cDNA Ends (RACE) PCRs. Specific small RNA biogenesis pathways will be analysed at the molecular level in *Physcomitrella patens* mutant lines that are affected in essential proteins of the small RNA processing machinery (e.g. DICER-LIKE knockout mutants).<br><br>The lab entails 3 SWS arranged in a two-week course and requires a detailed lab report according to excellent scientific practice.<br><br>Accompanying lecture: An introduction to the plant model species *Physcomitrella patens* will be given with an emphasis on the biogenesis of different classes of small, non-coding RNAs. The biological function of different small RNAs with respect to their crucial role in the development of *Physcomitrella patens* will be discussed. Regular attendance to the accompanying lecture is required. |
| Qualification Goals: | Students are trained in general lab practice, including standard safety procedures, handling of chemicals and instruments, and documentation of lab procedures. Students obtain the fundamental knowledge and hands-on practice on basic molecular biological methods required for future master's thesis research in the field of Plant Molecular Biology. Students will work in small groups, so they will get awareness about the team-work, cooperation and mutual respect which are desired characteristics for succeeding in any field.<br><br>Students obtain a basic knowledge to write a scientific research report which is the basis for writing a scientific publication. |
| **Practical course: Plant Sciences III (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Dario Leister, Dr. Anja Schneider, PD Dr. Cordelia Bolle, Dr. Mathias Pribil, PD Dr. Tatjana Kleine, Dr. Iris Finkemeier |
| Course content: | The aim of this course is to teach relevant methods within the background of fundamental principles in plant science. We compare *Arabidopsis mutants* with defects in the photosynthesis on the physiological (state transition measurements) and biochemical level. Participants are introduced to advanced biochemical techniques such as the isolation of protein complexes (photosystems) and to analyze them with Blue Native Gel analysis, 2D gel electrophoresis, and Western analysis. Furthermore expression patterns in the nucleus and the plastids are compared (Northern blot and RT PCR, non-radioactive labeling of probes). The emphasis lies on hands-on practice as the students are preparing every step of the experiment themselves, from making solutions to discussing the results. Furthermore, they are trained to compare different methods and to understand the biological and |

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| | biochemical background of the methods used. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice. In a closing event all results are presented and the experiments are discussed in detail. |
| Qualification Goals: | Students obtain necessary skills for future lab work, in particular in preparation for their master's thesis. The methods are taught in reference to the biological questions asked. Therefore, a transfer of theoretical knowledge to practical applications can be made. In working in small lab groups, social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations, written lab reports), as well as organizational skills (efficient planning, documentation) are refined.<br><br>Students learn excellent scientific methods in written data presentation, including well-founded introduction to the topic, documentation (including how to use figures to present data), interpretation and discussion of the results. These skills are particularly aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Molecular biology and biochemistry of phototrophic microorganisms** | |
| Instructors: | Prof. Dr. Jörg Nickelsen, Dr. Alexandra-Viola Bohne |
| Course content: | The course imparts knowledge about the principles of plastidic gene expression. Students will work with the unicellular green alga *Chlamydomonas reinhardtii* and analyze different strains with regard to their gene expression at the level of transcription as well as translation. Applied methods comprise reporter gene expression analysis, nuclear transformation of *C. reinhardtii* and testing of growth under photoautotrophic conditions. Emphasis will lie on molecular methods, like the isolation and detection of DNAs (Southern blot), RNAs (Northern blot) as well as proteins (Western blot), respectively. Based on the performed phenotypical and molecular analyses of different strains the students will be able to draw conclusions on the identity of the investigated mutants. The lab entails 3 SWS (3 ECTS points), and requires a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | After participation in this course, students will know how to combine different methods to address a specific scientific question. They will be able to summarize, present, and discuss the outcome. Furthermore, they can distinguish different regulatory levels of gene expression and integrate the obtained results in an overall context. Methodically, they have deepened skills in Southern, Northern and Western analysis and will have gained insights into basic working practice with unicellular green algae. |

| **Practical research courses** | |
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| Instructor: | Teaching staff, Plant Sciences division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Current methods in electron microscopy/Aktuelle Methoden der Elektronenmikroskopie (*Cell Biology*)** | |
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| Instructors: | Prof. Dr. Gerhard Wanner, Dr. Elizabeth Schroeder-Reiter |
| Course content: | Topics pertaining to different Electron Microscopic techniques are assigned to participants. Using recommended literature and resources, and with regular consultation with the instructors, students independently research the topic. Students are encouraged to critically approach their topic and to clearly present advantages and limitations of various EM techniques and their applications. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to good scientific practice, to the entire group.<br>Prerequisite lecture: Einführung in die Elektronenmikroskopie. Course language is determined by participants: English or German. |
| Qualification Goals: | Students gain a general overview of different EM techniques, and are able to discuss them in a broad context. They gain experience with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to peers. Students gain proficiency in communication, presentation and posture skills gained through speaking in front of a group. |
| **Seminar: Elektronenmikroskopie an unpräparierten biologischen Objekten/ EM with unprepared biological specimens** | |
| Instructors: | Prof. Dr. Gerhard Wanner, Dr. Eva Facher |

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| Course content: | Topics ranging from general technical information to current applications in variable pressure electron microscopic work are presented and discussed, using recommended literature and resources. Students independently research the topic, accompanied by regular consultation with the instructor.<br>The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to good scientific practice, to all participants.<br>Recommended lecture: Einführung in die Elektronenmikroskopie.<br>Course is held in German (also offered in bachelor's program). |
| Qualification Goals: | Students gain insight into theory and application of variable pressure EM, and are able to apply this knowledge in further research. They are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to peers. In addition, students gain proficiency in communication, presentation and posture skills gained through speaking in front of a group. |
| **Seminar: Ultrastructure of chromosomes (*Cell Biology*)** | |
| Instructor: | Dr. Elizabeth Schroeder-Reiter |
| Course content: | Topics related to chromosome structure are assigned to each participant. Using recommended literature and resources, and with regular consultation with the instructor, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 25 minute oral presentation of the topic, according to good scientific practice, to the entire group.<br>Recommended lecture: Einführung in die Elektronenmikroskopie.<br>Course language is determined by participants: English or German. |
| Qualification Goals: | Students gain insight into the field of chromosome research, with aspects of Botany and Cell Biology and an emphasis on understanding different visualization techniques for chromosomes. Students are introduced to historically relevant original texts as well as current topics and approaches in chromosome research.<br>Students gain experience with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers. Students gain proficiency in communication, presentation and posture skills gained through speaking in front of a group. |
| **Seminar: Molecular Cell Biology and Signaling (*Cell Biology*)** | |
| Instructors: | Prof. Dr. Wolfgang Frank, Prof. Dr. Ute Vothknecht |
| Course content: | The seminar covers topics closely related to the scientific focus of the AG Frank and AG Vothknecht with an emphasis on intracellular |

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| | signaling and regulation. Students are assigned specific topics and are given some basic literature (made available to the whole group) based on which they independently research and prepare a 30 min presentation on their topic. Further consultation is provided by instructors assigned to each topic. The scientific content of the presentations are discussed with participation of the whole group. Seminars are given weekly (2 SWS) by different participants. |
| Qualification Goals: | Students are introduced to plant specific aspects of intracellular signaling and regulation. They are exposed to present-day English-language literature in this field and can advance their skills in presenting a topic comprehensively to a group and discussing a scientific topic in the English language. |
| **Seminar: Transgenic plants: Facts and fiction** | |
| Instructors: | PD Dr. Bettina Bölter, PD Dr. Katrin Philippar, Prof. Dr. Ute Vothknecht |
| Course content: | This seminar introduces students to the basics of plant gene technology as a foundation for informed discussions and decision making. It covers the historical development, major methodologies and applications as well as the legal situation in different countries. Case studies will be presented by the students and discussed with the whole group. Speakers from outside the University representing both users and opponents of the technique will complement the student presentations. |
| Qualification Goals: | Plant gene technology has been implemented into agriculture in many forms but its usefulness and risks are controversially discussed in society. The course will give students detailed and balanced information about this technology to enable them to form their own opinion about its acceptability in different areas and applications. |
| **Seminar: Design of experiments in Plant Science (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Dario Leister, PD Dr. Cordelia Bolle, Dr. Anja Schneider, Dr. Mathias Pribil, Dr. Iris Finkemeier, PD Dr. Tatjana Kleine |
| Course content: | Research projects related to current questions in plant science are assigned to each participant. The aim is that the students research the topics independently by finding appropriate literature and resource. Then the students' task is to apply learned techniques to this topic and to propose how to address these scientific questions. Students consult regularly with the instructor. The seminar entails 2 SWS, and requires an approx. 15 minute oral presentation of the proposed research plan to the entire group. In addition a written proposal also has to be submitted. |
| Qualification Goals: | Students need to apply (theoretically) acquired knowledge about techniques and methods to the scientific questions posed. This |

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| | allows a transfer of knowledge and application of techniques learned in different lectures and practical courses. Furthermore, the students are introduced to library and internet resources, and can sharpen presentation skills gained through speaking in front of a group. To learn how to plan experiments is fundamental for a further scientific career. |
| **Seminar: Molecular biology and genetic engineering** | |
| Instructor: | Prof. Dr. Dario Leister, PD Dr. Cordelia Bolle, PD Dr. Tatjana Kleine, Dr. Mathias Pribil, Dr. Anja Schneider, PD Dr. Jörg Meurer |
| Course content: | Topics related to current projects in the laboratory are assigned to each participant. Using recommended literature and resources, students independently research the topic. The seminar entails 2 SWS, and requires an approx. 20 minute oral presentation of the topic, according to excellent scientific practice, to the entire group. Vivid discussion of the topics is encouraged. |
| Qualification Goals: | Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers. Furthermore, they gain inside in current scientific projects from the PhD students who present some of their project and can discuss this in a broad context. |
| **Seminar: Current topics in plant metabolism** | |
| Instructor: | Prof. Dr. Peter Geigenberger, Dr. Iris Finkemeier |
| Course content: | This seminar comprises weekly presentations by students and different members from the Finkemeier and Geigenberger labs on on-going research projects alternating with journal club presentations. The seminar topics focus mainly on current research on plant metabolism, including metabolic signaling, post-translational modifications, redox regulation, and gene expression regulation in plants. Seminar topics are assigned to each participant at the start of the course. Each participant has to prepare a 20 minutes oral presentation on a selected manuscript/ research topic which is discussed with the whole group in the following. The seminar entails 2 SWS. |
| Qualification Goals: | Students will be exposed to the latest research on plant metabolism and will be trained on critical discussions of research papers and scientific hypothesis as well as experimental design. Students can advance on their presentation skills and on discussing scientific results in the English language. |
| **Seminar: Molecular and ecological aspects of the biotechnological usage of microalgae and cyanobacteria (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Jörg Nickelsen, Prof. Dr. Herwig Stibor |

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| Course content: | Participants get insights into current work in the field of molecular biology, biotechnology and ecology of cyanobacteria, algae, and cell organelles. They present results of a recommended publication in a 20 minute oral presentation according to excellent scientific practice, to the entire group. After each talk, the subject is discussed in the whole group and the presenter is supposed to answer questions. The seminar entails 2 SWS (3 ECTS points). |
| Qualification Goals: | Students are introduced to current literature and learn how to independently research a topic. They improve their presentation skills and learn how to present scientific data. In addition, the discussion of the topics with other participants trains a critical review of illustrated data which is the basis for good scientific practice. |
| **Seminar: Protein Purification (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Jürgen Soll, Prof. Dr. Jörg Nickelsen, PD Dr. Bettina Bölter, Dr. Alexandra Viola Bohne |
| Course content: | This Seminar is to be attended in combination with the practical course 'protein purification'. A theoretical survey is provided covering the methods applied in the practical course in detail. Theoretical background on protein classes and application possibilities for protein chromatography are major issues. Moreover the participants each present a seminar on either an original work or a review publication related to protein purification topics. The issues are discussed with all students. The seminar entails 3 SWS. |
| Qualification Goals: | The theoretical background will broaden the students' knowledge in respect of protein biochemistry. It will help them to understand application possibilities for the techniques in research and industry. By preparing and presenting a talk in English they will deal intensively with one subject and they will learn to summarize and present data in a concise manner to others. |
| **Seminar: Endosymbiosis (*Cell Biology*)** | |
| Instructor: | Prof. Dr. Jürgen Soll, PD Dr. Bettina Bölter |
| Course content: | Participants are provided with recent publications concerning organellar biogenesis and development, which they are required to present as an oral presentation within the seminar. The topics include mitochondria and chloroplasts as true endosymbiotic organelles, but also peroxisomes and ER to broaden the field. The seminar entails 2 SWS. |
| Qualification Goals: | Students are confronted with literature reporting state of the art research, which they need to understand and convert into a presentable form for their peers. They are encouraged to apply critical evaluation of the published experiments and deductions |

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| | and to discuss this with the supervisor and the other participants. They have the possibility to train their presentation skills in English. |

# Systematic Botany and Mycology

| **Lecture: Reproduktionsbiologie höherer Pflanzen/ Reproductive biology of higher plants** | |
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| Instructor: | Prof. Dr. Susanne Renner |
| Course content: | The evolution of flowers and flowering plants is the result of mutualistic plant-animal interactions. The lecture covers all aspects of the function of flowers, integrating findings and approaches from ecology, plant physiology, and animal behavior. Topics to be discussed are (1) current hypotheses about the benefits of sexual reproduction, (2) the origins of insect pollination, (3) the production and ecological role of flower color, scent, and nectar, (4) deceptive pollination systems, (5) pollen-stigma interactions and incompatibility systems, (6) flowering plant mating systems (incl. selfing and apomixis), and (7) the main pollination syndromes.<br>The lecture entails 1 SWS and is held in German (also offered in bachelor's and teaching program). |
| **Lecture: Using molecular clocks** | |
| Instructor: | Prof. Dr. Susanne Renner |
| Course content: | Lectures in this block course will present the theory behind molecular clock dating and will show how clocks are being used in different disciplines, ranging from historical biogeography to the dating of virus outbreaks.<br>The lecture is accompanied by a tandem practical course. |
| Qualification Goals: | Knowledge about molecular clocks, also as a basis for tandem practical work. |
| **Lecture: Palynology (pollen and spores)** | |
| Instructor: | Prof. Dr. Günther Heubl |
| Course content: | The lecture covers the use of standard terminology for the description of pollen and spores, pollen identification and classification, development of pollen grains, pollen ultrastructure, pollen chemistry and the application of pollen characters in systematic and phylogenetic studies. Further aspects are problems of allergenic pollen, the interpretation of pollen diagrams based on stratigraphic analyses, monitoring of pollen in honey, analysis of pollen in excrements of herbivores, and the use of pollen for |

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| | forensic purposes. |
| Qualification Goals: | The lecture is intended to provide a thorough grounding in the theory, methodology and application of palynology. Students will acquire knowledge on the range of pollen and spore diversity in living and fossil plants and understand the theory and methodology of palynology.<br>The lecture is mandatory for the practical course |
| **Lecture: Morphology, evolution and diversity of seed plants** | |
| Instructor: | PD Dr. Marc Gottschling |
| Course content: | The lecture covers the morphological and biogeographical diversity of seed plants based on (also molecular) phylogenetic analyses published in the past years. First part: introduction to phylogenetics; phylogenetic relationships within spermatophytes, with a focus on gymnosperms, magnoliids, and monocots; second part: phylogenetic relationships within eudicots (ranunculids, caryophyllids, rosids, asterids). Preferably, the lecture is given weekly (2 SWS) and requires regular attendance and a final exam. Please visit the central enrolment meeting of Syst Bot Mycol at the beginning of each term. |
| Qualification Goals: | The students will gain professional knowledge in spermatophyte morphology, diversity, and evolution. This competence is the basis for any further application of organisms using contemporary in vitro methods and for the accompanying practical course and seminar. |
| **Lecture: Introduction to dispersal biology of seed plants and microscopic techniques** | |
| Instructor: | Dr. Eva Facher, PD Dr. Marc Gottschling |
| Course content: | The lecture covers the basic principles of dispersal biology in plants as well as optical microscopy. The lecture is given as block (1 SWS) and requires regular attendance and a final exam. Please visit the central enrolment meeting of Syst Bot Mycol at the beginning of each term. |
| Qualification Goals: | The students are proficient in the contents of dispersal biology in plants as well as basic light microscopy techniques. Students obtain the fundamental knowledge required to participate in further specialized courses. |
| **Lecture: Morphology and diversity of eukaryotic algae and microscopic techniques** | |
| Instructor: | Dr. Eva Facher, PD Dr. Marc Gottschling |

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| Course content: | The lecture covers the morphological and molecular diversity of eukaryotic algae (e.g., red algae, green algae, brown algae, dinophytes) based on phylogenetic analyses published in the past years. The lecture is given as block (1 SWS) and requires regular attendance and a final exam. Please visit the central enrolment meeting of Syst Bot Mycol at the beginning of each term. |
| Qualification Goals: | The students are proficient in eukaryotic phycology as well as basic electron microscopy techniques. Students obtain the fundamental knowledge required to participate in further specialized courses and are equipped with the basic knowledge prerequisite to scientific research in this topic. |
| **Lecture: Flora and vegetation of the Alps** | |
| Instructor: | Prof. Dr. Günther Heubl |
| Course content: | The lecture covers the geology of the Alps, structure and development of the soils, elucidates general components of the climate, ecological zonation with its characteristic vegetation, the origin and genesis of the Alpine flora, plant distribution patterns, floristic composition and alpine plant associations, adaptations and interactions between plants and their environment, highlights the significance of agriculture, industry and tourisms, and discusses consequences of the climate change.<br>The lecture is the basis for a one week field excursion to the Central European Alps. |
| Qualification Goals: | At the end of the course, the students will have gained knowledge on alpine ecological principles and plant systematics, expertise in how to deduce local abiotic and biotic conditions from morphological characteristics of individual plants or vegetation structure, insight into the large variation in biodiversity among habitats, and an understanding of how plants cope with extreme environments.<br>The field trip (see practical field course) to the Central European Alps introduces students to Alpine biodiversity. |

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| **Practical course: Using molecular clocks** | |
| Instructor: | Prof. Dr. Susanne Renner |
| Course content: | This course is combined with a mandatory lecture “Using molecular clocks”.<br>This block course entails practice in molecular clock dating and shows how clocks are being used in different disciplines, ranging from historical biogeography to the dating of virus outbreaks. Students will analyze real data sets (including their own data if |

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| | appropriate), using available computer software (e.g., Sanderson's r8s and Rambaut et al.'s BEAST). |
| Qualification Goals: | Understanding of and being able to use molecular clocks. |
| **Practical course: Blüten und Bestäuber/ Angiosperm reproductive ecology - an introduction to theory and methods.** | |
| Instructors: | Prof. Susanne Renner, Dr. Eva Facher |
| Course content: | The evolution of flowers and flowering plants is the result of mutualistic plant-animal interactions. This course explores all aspects of the function of flowers, integrating findings and approaches from ecology, plant physiology, and animal behavior. Topics to be discussed are (1) current hypotheses about the benefits of sexual reproduction, (2) the origins of insect pollination, (3) the production and ecological role of flower color, scent, and nectar, (4) deceptive pollination systems, (5) pollen-stigma interactions and incompatibility systems, (6) flowering plant mating systems (incl. selfing and apomixis), and (7) the main pollination syndromes.<br><br>The course is held in German (also offered for bachelor's and teaching degree students).<br><br>The course takes place in the Systematic Botany and Mycology Institute, Menzinger Str. 67.<br><br>Mandatory lecture: Reproduction biology of higher plants. One week, 3 ECTS. |
| Qualification Goals: | The course consists lectures, class discussions (based on original literature) and a mini research project that employs some of the techniques learned in the course (usually this is carried out over one weekend). There is a course manual, covering each day's material with full literature references. The manual also is the basis for two written tests that are graded and discussed the following day.<br><br>For their oral presentations and mini research project, students will work in teams of two or three, the benefits being improved skills in team work, speaking in front of a group, literature searching, and scientific writing (with reciprocal correction by team members). |
| **Practical course: Morphology, evolution and diversity of seed plants** | |
| Instructor: | PD Dr. Marc Gottschling |
| Course content: | The practical course is an exercise about seed plant diversity following the lecture and based on physical specimens (fresh material from the Botanical Garden Munich as well as pickled material). Students will prepare a report in form of detailed drawings and short descriptions of the specimens. The practical course entails 6 SWS. |

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| Qualification Goals: | Preparing drawings trains the ability for accurate biological observation, and students will practice critical evaluation and interpretation of data in the discussions as a basis for careful and relevant conclusions in phylogenetic reconstructions. In working in small groups, communication skills (rapport with instructors and fellow students, presentations, written reports) as well as organizational skills (efficient planning, documentation) are refined. |
| **Practical course: Introduction to dispersal biology of seed plants and microscopic techniques** | |
| Instructor: | Dr. Eva Facher, PD Dr. Marc Gottschling |
| Course content: | In the practical course, participants are introduced to step-by-step procedures for anatomical studies, including detailed observation, embedding and sectioning of specimens as well as standard visualization techniques using light microscopy. Emphasis is placed on the relevance and hands-on practice with these microscopic techniques, and interpretation and presentation of data. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | The students are proficient in the contents of dispersal biology in plants as well as basic light microscopy techniques. Students obtain skills for future lab work, in particular in preparation for their master's thesis. They are well trained in good general lab practice, including standard safety procedures, precise handling of chemicals and instruments and conscientious documentation of lab procedures. In working in small lab groups, social skills (teamwork, cooperation, fair play, work delegation, mutual respect), communication skills (rapport with instructors and fellow students, presentations, written lab reports) as well as organizational skills (efficient planning, documentation) are refined. |
| **Practical course: Morphology and diversity of eukaryotic algae and microscopic techniques** | |
| Instructor: | Dr. Eva Facher, PD Dr. Marc Gottschling |
| Course content: | The lecture covers the morphological and molecular diversity of eukaryotic algae (e.g., red algae, green algae, brown algae, dinophytes) based on phylogenetic analyses published in the past years. The lecture is given as block (1 SWS) and requires regular attendance and a final exam. Please visit the central enrolment meeting of Syst Bot Mycol at the beginning of each term. |
| Qualification Goals: | The students are proficient in eukaryotic phycology as well as basic electron microscopy techniques. Students obtain the fundamental knowledge required to participate in further specialized courses and are equipped with the basic knowledge prerequisite to |

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| | scientific research in this topic. |
| **Practical course: Palynology (pollen and spores)** | |
| Instructor: | Prof. Dr. Günther Heubl |
| Course content: | The course covers aspects of pollination, pollen and spore morphology in living and fossil plants, pollen development, structure and function, morphology and classification, pollen chemistry and basic pollen terminology. There is special training in the application of determination keys and the use of pollen data bases and software for the evaluation of pollen data. Additionally the relevance of pollen characters in other fields is emphasized: 1. Reconstruction of vegetation history (fossil pollen deposits). 2. Analysis of pollen in traded honey. 3. Importance of airborne pollen in allergology, monitoring of seasonal production and hay fever. 4. Human use of plants in the past. 5. The study of pollen and spores in criminal investigations (forensic palynology). 6. Analysis of pollen in excrements of herbivores (diet diversity of animals). |
| Qualification Goals: | The course is intended to provide a thorough grounding in the theory and methodology of palynology, in particular pollen morphology, pollen ultrastructure and pollen identification. Lab exercises will involve methods of chemical pollen preparation and microscopic identification (acetolysis, critical point drying, LO-analysis, light and scanning electron microscopy). |
| **Practical course: Übung zur Kenntnis ausgewählter Nutz- und Giftpflanzen, Systematik, Morphologie, Biologie, Geschichte, Verwendung/ Useful plants: systematics, morphology, biology, history and practical applications** | |
| Instructor: | PD Dr. Ehrentraud Bayer |
| Course content: | Participants are introduced to a great variety of useful plants and a comprehensive selection of standard and current literature.<br><br>Emphasis is placed on comparative morphological and anatomical studies concerning the whole organism. Students practice critical evaluation and interpretation of data as a basis for careful and relevant conclusions. Conclusions should include especially systematic classification and morphological determination of the used parts.<br><br>Participation in accompanying seminar is mandatory: Kenntnis ausgewählter Nutz- und Giftpflanzen, Systematik, Biologie, Geschichte, Verwendung, Morphologie der genutzten Teile.<br><br>The course entails 3 SWS.<br><br>Lecture is held in German (also offered for bachelor's and teaching degree students). |
| Qualification Goals: | At the end of the course the students should have a well-founded |

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| | introduction to the topic, an extensive overview of the wide range of useful plants. Students gain a general overview of systematic useful plants.<br>Students improve their skills in observation, scientific drawing and general knowledge in systematic botany.<br>Working in a group, they learn documentation, interpretation and discussion of the observations. |
| **Practical field course: Übung zur Kenntnis der alpinen Flora und Vegetation der Zentralalpen/ The flora and vegetation of the Central European Alps.** | |
| Instructors: | Prof. Dr. Susanne Renner, Dr. Eva Facher |
| Course content: | Field course involving collecting, identifying and preserving plants.<br>Knowledge about Alpine biota and the adaptation of plants to Alpine and montane conditions.<br>Course is held in German (also offered for bachelor's and teaching degree students).<br>Prerequisite lecture: Alpine flora and vegetation. One week, 3 ECTS. |
| Qualification Goals: | Knowledge about ecological and physiological adaptations to an important habitat type: interpretation of growth forms, ecology, environmental factors, and anthropogenic influences.<br>Students work in teams, with each team having to give an oral presentation about observations in the field (incorporating literature that is provided by the instructors).<br>Teamwork, cooperation and communication with the other teams are essential. |
| **Practical field course: Flora and vegetation of the Canary Islands** | |
| Instructor: | Prof. Dr. Günther Heubl |
| Course content: | The field trip to the Canary Islands (Tenerife) is a unique opportunity for students to be confronted with totally unfamiliar plant families, vegetation types, and ecological conditions. A wide range of habitats, from the arid coastal zone (succulent communities), through montane pinewoods, heath scrub vegetation, relict laurel forest to alpine semi-deserts are explored. The excursion involves collecting, determination (using identification keys) and herbarisation of plants. Field work also includes application of methods in phytosociology (e.g. Braun-Blanquet) and data collection of environmental factors (humidity, temperature, elevation, wind, light) in different vegetation types. Problems in nature conservation are discussed.<br>During a half-day trip to the Botanical Garden of Orotava many ornamental and economic plants from tropical and subtropical |

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| | regions are demonstrated.<br>Previous attendance of seminar is prerequisite. |
| Qualification Goals: | The students acquire a deepened knowledge in species diversity and identification methods. They will be expected to learn about the living conditions of plants in the interaction with their environment. Different vegetation types are explored, presenting a unique opportunity to become acquainted with local biodiversity. |
| **Practical field courses: Eintagesexkursionen zur Kenntnis der alpinen Flora und Vegetation der Zentralalpen/ One-day excursions: Knowledge of flora and vegetation of the Central European Alps** | |
| Instructor: | Dr. Philomena Bodensteiner, Dr. Eva Facher, Prof. Dr. Günther Heubl |
| Course content: | One-day field trips to different regions in the Bavarian or Austrian parts of the Central European alps involving the observation and identification of plants.<br>Students are introduced to Alpine plant diversity and have the chance to gain and broaden their knowledge about major native plant families and their Alpine representatives, about Alpine biota, and the adaptation of plants to montane and Alpine conditions (growth and vegetation types). They also can practice the identification of plants in the field with and without the use of common determination literature.<br>The excursions are held in German (also offered for bachelor's and teaching degree students). |
| Qualification Goals: | Students have knowledge about plant systematics, ecological and physiological adaptations to an important habitat type and are able to recognize and interpret specialized growth forms, adaptations to habitat specific environmental factors, and anthropogenic influences. They have basic skills for inferring local abiotic and biotic conditions from the species composition, vegetation type and morphological characteristics of individual plants.<br>The students work in teams that have to compile a list of observed and identified plant species during the field trips with accompanying information such as altitude, life style specifics and taxonomic classification. That for, teamwork and communication among students is essential.<br>The one-day excursions offer a good opportunity to prepare for longer field trips and practical field courses in Alpine regions. |
| **Practical research courses** | |
| Instructor: | Teaching staff, Systematic Botany and Mycology division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according |

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| | to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |
| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Morphology, evolution and diversity of seed plants** | |
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| Instructor: | PD Dr. Marc Gottschling |
| Course content: | The seminar covers current topics related to seed plants evolution. Students will prepare an oral (PowerPoint) presentation (30 min) based on own literature search. Afterwards, we the talk will be discussed with regards to content (30 min) and methodological approach (30 min). The seminar entails 2 SWS. |
| Qualification Goals: | The students will gain professional knowledge in spermatophyte morphology, diversity, and evolution. This competence is the basis for any further application of organisms using contemporary in vitro methods.<br>Students are proficient in presentation skills with different media, are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to scientific peers. Students sharpen communication and presentation skills gained through speaking in front of a group. Students are introduced to current events in systematic biology and can discuss this in a broad context. |
| **Seminar: Flora and vegetation of the Macaronesian Islands** | |
| Instructor: | Prof. Dr. Günther Heubl |
| Course content: | The seminar covers the orography, landscape and geological formations (volcanism) of the Canary Islands and Madeira and structure and development of the volcanic soils, elucidates general components of the climate, ecological zonation with its characteristic vegetation (lower xerophytic coastal belt, laurel and pine forests, heath scrub, alpine semi deserts), the origin and genesis of the flora, importance of endemism and distribution patterns, floristic composition and plant associations, adaptations to the environment, the significance of agriculture and tourisms, |

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| | and consequences of the climate change.<br>The seminar is basic for a one-week field excursion to the Canary Islands. |
| Qualification Goals: | The students acquire knowledge on plant systematics, expertise in how to deduce local abiotic and biotic conditions from morphological characteristics of individual plants or vegetation structure. They achieve insight into the large variation in biodiversity among habitats and an understanding of how plants cope with extreme environments. |
| **Seminar: Kenntnis ausgewählter Nutz- und Giftpflanzen, Systematik, Biologie, Geschichte, Verwendung, Morphologie der genutzten Teile/ Useful plants: systematics, biology, history, morphology and practical applications** | |
| Instructor: | PD Dr. Ehrentraud Bayer |
| Course content: | Topics related to useful plants (including poisonous plants) are assigned to each participant.<br>Using recommended literature and resources, and with consultation with the instructor, students independently research the topic.<br>The seminar entails 1 SWS, and requires an approx. 25 min oral presentation of the topic, according to excellent scientific practice, to the entire group.<br>Course is held in German (also offered for bachelor's and teaching degree students). |
| Qualification Goals: | Students gain a general overview of many aspects of the use of plants (e.g. technical, medical, nutritional use), also taking in consideration ethnobotanical, historical and systematic aspects.<br>Students are introduced to library and internet resources, can assess and present a topic thoroughly and understandably to peers. In addition, students gain proficiency in communication, presentation and posture skills gained through speaking in front of a group. |

# Zoology

| **Lecture: Microscopic anatomy and histology of vertebrates** | |
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| Instructor: | Prof. Dr. J. Matthias Starck |
| Course content: | The lecture covers all aspects of light microscopic histology of vertebrate cells and tissues. A focus is on correct diagnosis of normal, healthy tissues. Technical aspects of light and electron microscopy are covered and explained so that students learn to read microscopic images correctly.<br>The class is organized as a 2 SWS lecture accompanied by a 3 SWS practical. Lecture and practical are highly integrated. Lecture and practical are given as a 4 week block, regular attendance and a final exam is required. |
| Qualification Goals: | General goals for the course are to communicate fundamental knowledge about cells, tissues and microscopic anatomy of organ systems.<br>Knowledge acquired in the class will enable the students to transfer theoretical knowledge to practical applications, in particular recognize and analyze structures of animals on a microscopic level. |

| **Lecture: Deuterostomia** | |
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| Instructor: | Prof. Dr. J. Matthias Starck |
| Course content: | The lecture covers all aspects of functional morphology, microscopic anatomy, and phylogeny of the deuterostomes. Goal of the lecture is that the students understand the body plan of the deuterostomes and how it changed during course of evolution. The lecture also covers important aspects of the ecological and economic importance of the animals in that clade.<br><br>The class is part of a series of morphology and phylogeny classes which all communicate fundamental knowledge about major clades of the animals. Together, all these classes present a concise but complete overview of all animal clades (“Lower Invertebrates”, Arthropoda, Mollusca, Deuterostomia, Vertebrates).<br><br>The class is organized as a 2 SWS lecture accompanied by a 3 SWS practical. Lecture and practical are highly integrated. Lecture and practical are given as a 4 week block, regular attendance and a final exam is required |
| Qualification Goals: | General goal for the course is to communicate fundamental knowledge about deuterostome biology (anatomy, microscopic anatomy, ecology, and basic physiology).<br><br>Knowledge acquired in the class will enable the students to transfer theoretical knowledge to practical applications, in particular recognize and analyse structures of deuterostomes. |
| **Lecture: Arthropoda** | |
| Instructor: | Prof. Dr. J. Matthias Starck, Prof. Dr. Roland Melzer, PD Dr. Renate Matzke-Karasz |
| Course content: | The lecture covers all aspects of functional morphology, microscopic anatomy and phylogeny of the arthropods. Goal of the lecture is that the students understand the body plan of the arthropods and how it changed during course of evolution. The lecture also covers important aspects of the ecological and economic importance of the animals in that clade.<br><br>The class is part of a series of morphology and phylogeny classes which all communicate fundamental knowledge about major clades of the animals. Together, all these classes present a concise but complete overview of all animal clades (“Lower Invertebrates”, Arthropoda, Mollusca, Deuterostomia, Vertebrates).<br><br>The class is organized as a 2 SWS lecture accompanied by a 3 SWS practical. Lecture and practical are highly integrated. Lecture and practical are given as a 4 week block, regular attendance and a final exam is required. |
| Qualification Goals: | General goal for the course is to communicate fundamental |

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| | knowledge about arthropod biology (anatomy, microscopic anatomy, ecology, and basic physiology).<br>Knowledge acquired in the class will enable the students to transfer theoretical knowledge to practical applications, in particular recognize and analyse structures of arthropods. |
| **Lecture: Zoomorphology: Introduction to malacology** | |
| Instructor: | Prof. Dr. Gerhard Haszprunar |
| Course content: | Diversity, systematics, and phylogeny of Molluscs and methods to investigate them |
| Qualification Goals: | The students are proficient in the theoretical contents of the course and have an overview of diversity and methodology in malacology. Students are equipped with the basic knowledge prerequisite to scientific research in this topic. |
| **Lecture: Zoomorphology: Lower invertebrates ("worms")** | |
| Instructor: | Prof. Dr. Gerhard Haszprunar |
| Course content: | Diversity, systematics, and phylogeny of the covered groups. |
| Qualification Goals: | Diversity, systematics, and phylogeny of the covered groups. |
| **Lecture: Introduction to Marine Biology (in German language)** | |
| Instructor: | PD Dr. Martin Heß, Prof. Dr. Roland Melzer, Prof. Dr. Alexander Steinbrecht, Prof. Dr. Klaus Schönitzer, PD Dr. Michael Schrödl |
| Course content: | The lecture covers many aspects of marine biology: history and methods of marine research, oceanography, climatology, pressure and salinity, osmoregulation, breathing physiology, locomotion in the sea, marine mammals, strictly marine animal groups, habitats: pelagial, littoral, deep sea, coral reefs, tidal flats, mangroves, Antarctic, artificial marine systems. |
| Qualification Goals: | Getting a first impression of the complex subject matter (see above mentioned topics), marine biodiversity, importance of the sea and marine life for the entire biosphere, diversity of scientific questions in marine biology, and of negative human impacts. Motivation for further literature studies and participation in marine practical courses. |
| **Lecture: Principles of Behavioral Ecology (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse, PD Dr. Volker Witte |
| Course content: | Students will be thoroughly introduced to behavioral ecology. They will learn in depth about the history of the field, the role of |

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| | evolution in behavioral ecology, mechanisms of behavior, communication, predator-prey and parasite-host interactions, foraging and optimality, sexual selection, mating systems, parental care, life history theory, altruism and cooperation, and group living.<br>The lecture is given 3 times per week, 1.5 h each, and requires a final exam. |
| Qualification Goals: | Students acquire a firm knowledge about basic principles and different research fields in behavioral ecology. They obtain the fundamental knowledge required to participate in further specialized courses, such as "Experimental Behavioral Ecology". |
| **Lecture: Behavioral Ecology meets Quantitative Genetics (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse |
| Course content: | Students will be thoroughly introduced to state-of-the-art behavioral ecology paradigms that require tools from quantitative genetics. The lecture is accompanied by a practical course. Students learn about how the two fields differ and where they meet: empirical testing of adaptive hypotheses that require variance partitioning. The students are introduced to Bayesian statistical paradigms and mixed-effect modelling, and learn to graph and estimate a diverse array of within- and between-individual (co)variance components (e.g. between-individual (co)variances, additive genetic (co)variances) using a single empirical dataset used throughout the course. The students give daily presentations of their findings, in preparation of an overall presentation on the final day of the course, and discuss a paper each day.<br>The course takes place at the Max Planck Institute for Ornithology, three days per week (9h00-16h30) for a period of three weeks. |
| Qualification Goals: | Students learn to program in the statistical language R, visualize, interpret, and present outcomes of mixed-effect models. Social skills are refined by working in pairs of two, presentation skills are improved by daily presentations and feedback, and reading and interpretation of scientific literature through paper discussions. |
| **Lecture/Tutorial: Current topics in Behavioral Ecology (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse |
| Course content: | Students are introduced to current hot topics in the field of behavioral ecology (one topic per day). On each day, students are given a lecture by an expert, and ask prepared questions, introduced to specifics of the experimental setup, and also discuss a paper on the subject. Each student writes an essay after each day.<br>The course takes place at the Max Planck Institute for Ornithology, |

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| | nine days (9h00-16h30) spread over the summer. |
| Qualification Goals: | Students learn to read and discuss papers, engage in scientific discussions, and learn about current topics in behavioral ecology. Students improve their scientific writing skills. |
| **Lecture: Bildgebende Verfahren in den Biowissenschaften/ BioImaging** | |
| Instructor: | PD Dr. Martin Heß |
| Course content: | The character of analogue and digital images, overview on macroscopic and microscopic imaging methods in bio-medical science, technique and applications of widefield microscopy (from basics to structured illumination), laser scanning microscopy (CLSM, 2PM and various special techniques), scanning and transmission electron microscopy, FIB-BFSEM, tomography (CT, MRT), selected methods of digital imaging (e.g. image parameter optimization, deconvolution, 3D-reconstruction, spectral unmixing, spatial frequency filtering).<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification Goals: | Getting an overview and deepened insight into the field of (mostly microscopic) imaging and the variety of applications, getting a feeling for the explanatory power of 2D to nD measurements, their visualization and possible manipulations, developing own ideas for own projects, reading and summarizing an advanced paper about a selected bioimaging technique/application. |
| **Lecture: Architektur von Sehsystemen/ Architecture and evolution of visual systems** | |
| Instructor: | PD Dr. Martin Heß |
| Course content: | Light-matter-interaction in biology, molecular/cellular/anatomic evolution of visual organs, overview on visual systems and their performance features in the animal kingdom, evolution of lense eyes (different types), evolution of compound eyes (different types), colour- and polarization contrast vision, shape/movement detection, stereoscopic vision, higher visual centers (insects, cephalopods, vertebrates), OKN and VOR, visual illusions.<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification Goals: | Getting an overview and deepened insight into the architecture, evolution and adaptation of visual systems in the animal kingdom. Reclassifying the human visual senses (and its performance) as one of many solutions in the animal kingdom. |

| **Lecture: Current topics in Cell and Developmental Biology I (**Cell Biology*)** | |
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| Instructors: | Prof. Dr. Barbara Conradt, Prof. Dr. Angelika Böttger, Prof. Dr. Dr. Walter Neupert, Dr. Stephane Rolland, PD Dr. Eric Lambie, Dr. Frank Schnorrer, Prof. Dr. Charles David |
| | *See Cell Biology for course descriptions and qualification goals. |
| **Lecture: Current topics in Cell and Developmental Biology II (**Cell Biology*)** | |
| Instructors: | Prof. Dr. Barbara Conradt, Dr. Tamara Mikeladze-Dvali, Prof. Dr. Michael Schleicher, Dr. Annette Müller-Taubenberger, Dr. Zeynep Ökten, Dr. Anne-Kathrin Classen, Dr. Ilona Kadow, Dr. Jürg Müller, Prof. Dr. Andreas Ladurner |
| | *See Cell Biology for course descriptions and qualification goals. |
| **Lecture: Mechanisms of animal development (**Cell Biology*)** | |
| Instructors: | PD Dr. Eric Lambie, Dr. Anne-Kathrin Classen, Dr. Tamara Mikeladze-Dvali, Prof. Dr. Barbara Conradt |
| | *See Cell Biology for course descriptions and qualification goals. |

| **Practical course: Microscopic anatomy and histology of vertebrates** | |
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| Instructor: | Prof. Dr. J. Matthias Starck |
| Course content: | During the practical course the participants are introduced to standard microscopy techniques with bright field, phase contrast and fluorescence light microscopy. The material studied is histological slides that embrace all cell and tissues types that occur in vertebrates. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice.<br>At the end of the class the students should be able to diagnose tissues and cells as well as recognize organ structure by their microscopic anatomy. The class communicates fundamental knowledge of how tissues and organs are built. |
| Qualification Goals: | General goals for the course are to communicate fundamental knowledge about cells, tissues, and microscopic anatomy of organ systems.<br>Knowledge acquired in the class will enable the students to transfer theoretical knowledge to practical applications, in particular recognize and analyse structures of animals on a microscopic level.<br>With this, the students obtain skills for future lab work, in particular in preparation for their master's thesis or PhD work. |

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| | Students learn scientific presentation in written data presentation, including introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Deuterostomia** | |
| Instructor: | Prof. Dr. J. Matthias Starck |
| Course content: | During the practical course the participants study preserved material, learn dissection techniques and analyse histological slides of all major clades of deuterostomes. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice.<br>The class is part of a series of morphology and phylogeny classes which all communicate fundamental knowledge about major clades of the animals. Together, all these classes present a concise but complete overview of all animal clades ("Lower Invertebrates", Arthropoda, Mollusca, Deuterostomia, Vertebrates).<br>This course is a 3 SWS practical, accompanied by a 2 SWS lecture. Lecture and practical are highly integrated. Lecture and practical are given as a 4 week block, regular attendance and a final exam are required. |
| Qualification Goals: | General goal for the course is to communicate fundamental knowledge about deuterostome biology (anatomy, microscopic anatomy, ecology, and basic physiology).<br>Knowledge acquired in the class will enable the students to transfer theoretical knowledge to practical applications, in particular recognize and analyse structures of deuterostomes.<br>With this, the students obtain skills for future lab work, in particular in preparation for their master's thesis or PhD work.<br>Students learn scientific presentation in written data presentation, including introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Arthropoda** | |
| Instructor: | Prof. Dr. J. Matthias Starck, Prof. Dr. Roland Melzer, PD Dr. Renate Matzke-Karasz |
| Course content: | During the practical course the participants study preserved material, learn dissection techniques and analyse histological slides of all major clades of arthropods. The lab entails 3 SWS, and requires a detailed lab report according to excellent scientific practice.<br>The class is part of a series of morphology and phylogeny classes which all communicate fundamental knowledge about major clades |

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| | of the animals. Together, all these classes present a concise but complete overview of all animal clades ("Lower Invertebrates", Arthropoda, Mollusca, Deuterostomia, Vertebrates).<br><br>This course is a 3 SWS practical, accompanied by a 2 SWS lecture. Lecture and practical are highly integrated. Lecture and practical are given as a 4 week block, regular attendance and a final exam are required. |
| Qualification Goals: | General goal for the course is to communicate fundamental knowledge about arthropod biology (anatomy, microscopic anatomy, ecology, and basic physiology).<br><br>Knowledge acquired in the class will enable the students to transfer theoretical knowledge to practical applications, in particular recognize and analyse structures of arthropods.<br><br>With this, the students obtain skills for future lab work, in particular in preparation for their master's thesis or PhD work.<br><br>Students learn scientific presentation in written data presentation, including introduction to the topic, documentation, interpretation and discussion of the results. These skills are particularly aimed at preparing students for theses writing and scientific publications. |
| **Practical course: Zoomorphology: Introduction to malacology** | |
| Instructor: | Prof. Dr. Gerhard Haszprunar, PD Dr. Alexander Nützel, PD Dr. Michael Schrödl, Dr. Katharina Jörger |
| Course content: | Dissections and drawings of histological sections, also introduction into collection policy, 3D-reconstruction, SEM-technique, molecular taxonomy, and e-libraries |
| Qualification Goals: | Students are able to do dissections of molluscs and to infer histological details out of sections. Students are introduced to current events in malacology. |
| **Practical course: Zoomorphology: Lower invertebrates ("worms")** | |
| Instructor: | PD Dr. Martin Heß, Dr. Timea Neusser, PD Dr. Dirk Erpenbeck, Dr. Oliver Voigt |
| Course content: | Dissections and drawings of histological sections. |
| Qualification Goals: | Students will become able to do dissections, drawings of histological sections and of living material. Students will gain an imagination of the eidonomy, 3D-anatomy, histology and some fine-structural aspects of the treated animal groups. |
| **Practical course: Phylogenetic analysis of morphological and molecular characters** | |
| Instructor: | Prof. Dr. Gerhard Haszprunar, PD Dr. Dirk Erpenbeck, Dr. Oliver |

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| | Voigt |
| Course content: | Students learn how to code morphological characters for the construction of phylogenies. They learn to use the main algorithms and software packages for the construction of phylogenetic trees and to use them in systematic classification. |
| Qualification Goals: | Students gain practical experience and knowledge of the use of algorithms and software for the construction of phylogenetic trees and systematic classification. |
| **Practical course: Experimental Behavioral Ecology (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse, PD Dr. Volker Witte |
| Course content: | Students study scientific methods used in behavioral ecological research. They plan, conduct, and analyse a number of behavioral experiments. They are required to apply knowledge from the course "Principles of behavioral ecology" to understand and interpret the experiments belonging to different research fields within behavioral ecology, such as sexual selection, socio-biology or species interactions.<br>The lab entails 3 full days per week, and requires a detailed lab report according to excellent scientific practice. |
| Qualification Goals: | Students learn to design and carry out behavioral experiments. In working in small lab groups, social skills are refined. They also learn about data analysis and interpretation of results, and they improve their scientific writing skills. |
| **Practical course: Behavioral Ecology meets Quantitative Genetics (*Behavioral Ecology*)** | |
| Instructor: | Prof. Dr. Niels Dingemanse |
| Course content: | Students will be thoroughly introduced to state-of-the-art behavioral ecology paradigms that require tools from quantitative genetics. The course is accompanied by a lecture. Students learn about how the two fields differ and where they meet: empirical testing of adaptive hypotheses that require variance partitioning. The students are introduced to Bayesian statistical paradigms and mixed-effect modelling, and learn to graph and estimate a diverse array of within- and between-individual (co)variance components (e.g. between-individual (co)variances, additive genetic (co)variances) using a single empirical dataset throughout the course. The students give daily presentations of their findings, in preparation of an overall presentation on the final day of the course, and discuss a paper each day.<br>The course takes place at the Max Planck Institute for Ornithology, three days per week (9h00-16h30) for a period of three weeks. |

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| Qualification Goals: | Students learn to program in the statistical language R, visualize, interpret, and present outcomes of mixed-effect models. Social skills are refined by working in pairs of two, presentation skills are improved by daily presentations and feedback, and reading and interpretation of scientific literature through paper discussions. |
| **Practical course: Sammeln, Präparieren und Bestimmen von Insekten/ Collecting, dissecting and categorizing of insects** | |
| Instructor: | Prof. Dr. Klaus Schönitzer |
| Contents: | Im Rahmen der Veranstaltung werden verschiedene Biotope besammelt. Im Mittelpunkt stehen Waldbiotope des bayerischen Waldes in unterschiedlichen Höhenstufen: Mischwald, Auwald, hoch gelegener Bergmischwald. Die Studenten werden in den gängigen entomologischen Sammeltechniken eingewiesen und angeleitet die gefangenen Insekten zu präparieren und zu etikettieren. Anschließend werden die Insekten soweit als möglich bestimmt. Dazu ist ein entsprechender Raum (ehemaliges Schulzimmer, als Kursraum eingerichtet) vorhanden. Da die verschiedenen Studenten verschiedene Insekten sammeln und bestimmen erhalten sie einen Überblick über die entsprechende Fauna. Jeder Student muss ein Referat halten, die von ihm bestimmten Insekten den anderen Studenten vorstellen und ein Protokoll abliefern.<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification goals: | Die Studierenden lernen die einheimische Fauna kennen, lernen wie man eine wissenschaftliche Sammlung anlegt und wie man in der Praxis Tiere bestimmt. Die Studierenden sollen dazu angeregt werden, im Freiland aktiv zoologisch zu arbeiten und ihre Formenkenntnis zu erweitern. |
| **Practical course: Developmental biology of hydra (****Cell Biology***)** | |
| Instructor: | Prof. Dr. Angelika Böttger, Prof. Dr. Charles David |
| | *See Cell Biology for course description and qualification goals. |
| **Practical course: *C. elegans* as an experimental model (****Cell Biology***)** | |
| Instructor: | Prof. Dr. Barbara Conradt, PD Dr. Eric Lambie, Dr. Nadin Memar, Dr. Stephane Rolland |
| | *See Cell Biology for course description and qualification goals. |
| **Practical field course: Diversity and ecology of marine fauna and flora** | |
| Instructor: | Prof. Dr. Gerhard Haszprunar, PD Dr. Martin Heß |

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| Course content: | Knowledge on major marine habitats, their ecological parameters, stress factors and biodiversity. Practice of collection techniques, professional determination of organisms and permanent conservation techniques for research. Students learn various collection techniques (e.g., snorkeling, dredging, extraction from interstitial habitats), professional determination (including special preparation techniques) and permanent conservation for various research methods (including EM or molecular research).<br>The course is accompanied by a mandatory seminar. |
| Qualification Goals: | Professional collection, conservation, and databased documentation. |
| **Practical field course: Meeresbiologisches Geländepraktikum/ Diversity and ecology of Mediterranean marine fauna and flora** | |
| Instructor: | Prof. Dr. Roland Melzer |
| Course content: | Knowledge on Mediterranean biodiversity, major marine habitats and their ecological parameters. Practice of observation, sampling (snorkelling, dredging, plankton sampling etc), professional determination of organisms, permanent conservation techniques for research. Field experiments, e.g. on ecological parameters, symbiosis and habitat preferences with special reference to teaching degree students.<br>The field course contains a mandatory seminar.<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification Goals: | Practical course: Professional collection, observation, conservation, and documentation.<br>Seminar: Presenting an overview of a marine group if organisms and/or habitats. |
| **Practical field course: Biology and ecology of the Wadden Sea (tidal flat) (AWI, List, Sylt) (also *Cell Biology*)** | |
| Instructor: | PD Dr. Martin Heß, Prof. Dr. Angelika Böttger |
| Course content: | Participants are introduced to the ecosystem Wadden Sea at the Northern coast of Germany and get acquainted with basic principles of analysing terrestrial and marine habitats and with the major plant and animal species colonising the Wadden sea. The course focuses on morphological, physiological and behavioral adaptations, predator-prey relationships, and the role of xenobionts. Students get hands-on experience in sampling and determination of species living in this ecosystem (e.g. cnidarians, polychaetes, arthropods, echinodermates a.o.), obtain practical experience in collecting plankton and meiofauna and observe larval stages of a number of animals as well as embryonic development of |

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| | sea urchins. Relevant methods for preparing specimens from field work for light and fluorescence microscopy and analysing smaller cellular or tissue structures are conveyed. The lab entails 6 SWS and requires a written lab report and an oral presentation summarising individual lab experiences and providing theoretical background about specific questions, which have been encountered during the course. |
| Qualification Goals: | Students are able to connect field work with closer analysis of specific biological questions in the lab. They can move and collect in the field, handle living organisms and observe them under laboratory conditions. They are well trained in using microscopes and field glasses routinely and are proficient in photo documentation and using determination literature. Students are able to cooperate on specific projects in small groups including designing and conducting experiments in the lab, conscientious documentation of day-to-day field observations and lab procedures. Soft skills around the scientific work (daily routine considering program, group and tides, cooking etc.) are refined. |
| **Practical field course: Hochalpen/ Alpine biology** | |
| Instructor: | PD Dr. Martin Heß |
| Course content: | Ecosystem alps and parallels with other mountains/tundra: geology/glaciology/meteorology, geomorphology, vertical and horizontal zonation of habitats (esp. botany), abiotic parameters/stress factors and organismic interactions (esp. zoology), variety of organisms (zoology + botany) and their morphological, physiological and behavioral adaptations, life observation (e.g. capricorns, golden eagle and other alpine birds, marmot) and species determination with literature.<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification Goals: | Becoming acquainted with the above mentioned topics, hiking on alpine trails/photo documentation: first-hand impressions of the landscapes, habitats and their organisms, routinely using field glasses and determination literature. |
| **Practical research courses** | |
| Instructor: | Teaching staff, Zoology division |
| Contents: | Practical research courses are independent projects arranged between teaching staff members and individual students according to current research topics. Research labs last for the equivalent of 8 full-time working weeks in the lab and subsequent preparation of a written lab report (entails 12 ECTS). They are intended as specialized courses, requiring advanced skills and excellent lab conduct. |

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| Qualification goals: | Students are required to work independently under close supervision of the instructor. Students learn specialized techniques and gain experience in research design, performance, data interpretation and written presentation according to international scientific standards. Research courses are central to the research-oriented curriculum of the Master of Science Biology program, and as comprehensive preparatory courses for the master's thesis. |

| **Seminar: Hochalpen/ Alpine Biology** | |
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| Instructor: | PD Dr. Martin Heß |
| Course content: | Establishing the theoretical background for the complex subject matter (mandatory seminar for participants in practical field course), partly @LMU Munich, partly @alpine huts.<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification Goals: | Learn to present (oral + PowerPoint) a subject and discuss it in the group. |
| **Seminar: Wattenmeer/ Biology and ecology of the Wadden Sea (*Cell Biology*)** | |
| Instructor: | PD Dr. Martin Heß, Prof. Dr. Angelika Böttger |
| Course content: | Topics related to geomorphology, ecology, and flora and fauna colonising the special ecosystem Wadden Sea at the Northern coast of Germany are assigned to each student. Students independently research their topic using library and internet resources and present a ca. 25 min talk to the group providing an overview of their topic. The seminar entails 2 SWS and is exclusively available and mandatory for participants in the practical course "Biology and Ecology of the Wadden Sea".<br>Course is in German (offered to bachelor's and teaching degree students). |
| Qualification Goals: | Students are proficient in researching text books, current literature and internet resources to present their topic comprehensively and understandably to the group and provide basic knowledge about individual aspects of the laboratory course. Students sharpen presentation skills through speaking in front of a group and discuss current problems of environmental biology in the context of the special ecosystem Wadden Sea. |
| **Seminar: Diversity and ecology of marine fauna and flora** | |
| Instructor: | Prof. Dr. Gerhard Haszprunar, PD Dr. Martin Heß |

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| Course content: | Mandatory seminar for participants in practical field course "Diversity and ecology of marine fauna and flora". |
| Qualification Goals: | Presenting an overview of a marine habitat. |
| **Seminar: Immortal germline (****Cell Biology***)** | |
| Instructor: | Dr. Tamara Mikeladze-Dvali |
| | *See Cell Biology for course description and qualification goals. |
| **Seminar: Signaling during embryonic development (****Cell Biology***)** | |
| Instructor: | Dr. Nadin Memar |
| | *See Cell Biology for course description and qualification goals. |
| **Seminar: Mitochondria and degenerative diseases (****Cell Biology***)** | |
| Instructor: | Dr. Stephane Rolland, Prof. Dr. Charles David |
| | *See Cell Biology for course description and qualification goals. |