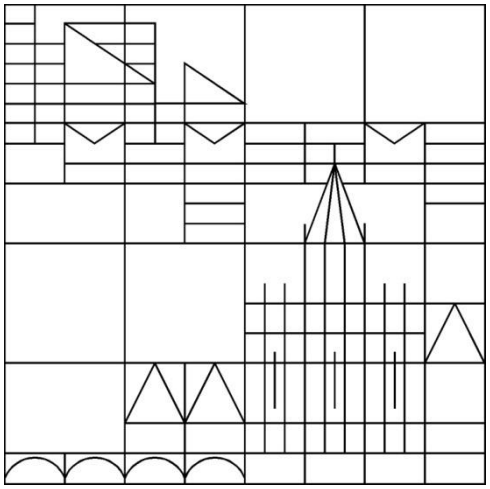
University of Konstanz
Faculty of Sciences
Department of Biology



Module manual

M. Sc. Biological Sciences

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Contact Person:

Anastasiia Hahn
Department of Biology
Tel.: 07531 88-2968
Email: anastasiia.hahn@uni-konstanz.de

INHALT

Qualification aims of the M.Sc. “BIOLOGICAL SCIENCES”

General

The course of studies “M.Sc. Biological Sciences” imparts professional qualification in the areas of organismic as well as molecular biology.

The Masters-course provides a natural extension to the studies that builds upon the foundations laid as part of the bachelors-coursework. The theoretical, experimental and analytical abilities that the students acquired in their bachelor’s studies are to be extended upon and expanded to impart a specialization in one of the specified research foci of the Department of Biology (it should be stated that these research foci are not to be regarded as separate from one-another, but rather as intermeshing parts of the overall research pursued in the department). Aim of the masters-level course is to prepare the students for an academic or non-academic career pursuing basic science (i.e. Doctoral research/ Ph.D.), the pursuit of applied research in a biotechnology or industrial setting as well as the ability to work for service providers (e.g. “consulting firms” or 'environmental agencies”) requiring a solid expertise in biological topics and the general natural sciences. For each student, the course of studies is individually adapted so as to best match their specific interests while also taking into account advice provided by the lecturers of the Department of Biology. In addition to extending their subject-specific theoretical and experimental knowledge, the students are also expected to expand and refine their abilities in other areas, such as developing additional competences in methods, communication or socially relevant topics. To this effect, the Department of Biology and other departments of the University of Konstanz offer a variety of optional modules the student can select from.

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td colspan="3"><u>Module Title:</u>
Preference Module</td></tr>
<tr><td>Credits</td><td>8</td><td>Duration</td><td>1 Semester
4 SWS</td><td>Part of module of the total rating</td><td colspan="2">20 %</td></tr>
<tr><td colspan="4">Module grade</td><td colspan="3">In case of a compulsory course the module mark is composed of the arithmetic average of two selected courses within this module unit.
In case of an optional course the module is not graded.</td></tr>
<tr><td colspan="4">Module units</td><td colspan="3">a. Disease Biology I
b. Disease Biology II
c. Pharmacology and Toxicology II
d. Biochemistry III
e. Methods in Biology
f. Evolutionary Organismal Biology
g. Concepts in Ecology</td></tr>
<tr><td colspan="4">Qualification aims</td><td colspan="3">After successful completion of two of courses offered as alternatives within this module the students will have acquired the following capabilities:
- To give an account of the specific basics and important concepts of the fields chosen and to explain the current state-of-the art of science by using examples
- To explain the relevant methodology and to give a critical evaluation thereof
- To identify, collect, evaluate and correctly interpret scientific information relevant for a certain field, and to develop their own process of learning
- To come up with further research questions in the field, based on current concepts and research data, and to select appropriate methodology
- To find out where their own scientific interest lies and to critically evaluate it; assess if the knowledge and skills they have acquired in the field is going to contribute to their own qualification they aspire to.</td></tr>
<tr><td colspan="4">Educational objectives</td><td colspan="3">a-d. The objective is to give the students insight, at an advanced level, into major topics in the field of Biomedicine, as a basis for the full understanding of the current literature and for their own future experimental work in the field of Biomedicine.</td></tr>
</table>

	e. Get to know your possibilities: An overview on methods, techniques, and facilities available to you for your future (Master) research work at University of Konstanz. f. A wide overview of research in ecology and evolution at the University of Konstanz. g. The aim of the lecture is to introduce the students to basic conceptual approaches in ecology. Theoretical and modeling issues are presented at the integrative levels of behavioral, population and community ecology.
Module unit	**a. Disease Biology I**
Coordinator	Prof. Dr. Ivano Amelio, Prof. Dr. Alexander Bürkle
Teaching content	The topics covered deal with the pathology, pathogenesis, clinical picture, therapy and prevention of specific human diseases or disease groups; animal and in vitro models of human disease; and specific microbial pathogens, at the organismal, tissue, cellular and molecular level. Infectious Diseases (INF)/Specific Organs (ORG)/Cancer (CAN) • Introduction / Model systems in Disease Biology • INF I: Viral infections • INF II: Fungal infections • INF III: Bacterial infections • INF IV: Protozoan infections • INF V: Inflammation / sepsis • ORG I: Autoimmune diseases and their therapy • ORG II: Pathogenesis of renal disease • ORG III: Chronic obstructive pulmonary disease • CAN I: Molecular pathogenesis of cancer: human colon cancer as an example • CAN II: Mitosis-Aneuploidy-Cancer: how mitotic checkpoints control chromosome segregation • CAN III: Oncogenes and transgenic models • CAN IV: Molecular Targets of current cancer chemotherapy • Epidemiological studies and clinical trials
Forms of teaching/Amount of SWS	Lecture/2 SWS

Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation
Credits for this unit	4
Examination and unit completion	Written exam (2 h; questions in English, answers in English or German)
Prerequisites	Bachelor degree in Biological Sciences, Life Science or similar study courses
Language	English
Time slot and frequency of the module	Winter term
Module unit	**b. Disease Biology II**
Coordinator	Prof. Dr. Bürkle
Teaching content	The topics covered deal with the pathology, pathogenesis, clinical picture, therapy and prevention of specific human diseases or disease groups; animal and in vitro models of human disease; and specific microbial pathogens, at the organismal, tissue, cellular and molecular level. Metabolic and cardiovascular disorders (MCD) / Modern approaches to therapy (MAT) / Nervous system disorders (NSD) MCD-1: Adiposity / neuroendocrinology / diabetes MCD-2: Hereditary diseases and disorders of imprinting MCD-3: Cardiac dysrhythmias MCD-4: Atherosclerosis and ischemic disease MCD-5: Inflammatory bowel disease MCD-6: Gout and rheumatoid arthritis MAT-1: Gene therapy MAT-2: Transplantation medicine MAT-3: Regenerative medicine NSD-1: Dementias NSD-2: Addiction NSD-3: Channelopathies NSD-4: Schizophrenia
Forms of teaching/Amount of SWS	Lecture/2 SWS
Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation

Credits for this unit	4
Examination and unit completion	Written exam (2 h; questions in English, answers in English or German)
Prerequisites	Bachelor degree in Biological Sciences, Life Science or similar study courses
Language	English
Time slot and frequency of the module	Summer term
Module unit	**c. Pharmacology and Toxicology II**
Coordinator	Prof. Dr. Alexander Bürkle
Teaching content	The topics covered deal with current methodology in the field, including in vitro Toxicology, major molecular mechanisms involved in the cellular and organismal response to xenobiotics, in-depth discussion of major classes of natural or man-made hazardous substances, the pharmacology of selected disease groups and the interface between Toxicology and legislation (Regulatory Toxicology). The following specific topics are included: • Basics of Toxicology / molecular targets of toxic substances/assessment of toxic effects • Pharmacology of hematopoiesis and blood coagulation • In vitro Toxicology • Cell death, necrosis, apoptosis • Neurotoxicology • Toxicokinetics and xenobiotic metabolism • Toxic industrial compounds • Chemical carcinogenesis • Toxic gasses and dusts • Pharmacogenomics and toxicogenomics • Nanotoxicology • Toxins from animals or plants / chemical warfare agents • Regulatory Toxicology • Pharmacology of water and electrolyte disturbances
Forms of teaching/Amount of SWS	Lecture/2 SWS
Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation

Credits for this unit	4
Examination and unit completion	Written exam (2 h; questions in English, answers in English or German)
Prerequisites	Bachelor degree in Biological Sciences, Life Science or similar study courses
Language	English
Time slot and frequency of the module	Winter term
Module unit	**d. Biochemistry III**
Coordinator	Prof. Dr. Bürkle
Teaching content	The topics covered deal with fundamental cellular mechanisms like nucleotide synthesis, oxidative stress, inflammation, cell death, cellular and organismal ageing, cell cycle regulation and post-translational modification.
Forms of teaching/Amount of SWS	Lecture/2 SWS
Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation
Credits for this unit	4
Examination and unit completion	Written exam (2 h; questions in English, answers in English or German)
Prerequisites	Bachelor degree in Biological Sciences, Life Science or similar study courses
Language	English
Time slot and frequency of the module	Summer term
Module unit	**e. Methods in Biology**
Coordinator	Prof. Dr. Schleheck, Dr. Marc Stift
Teaching content	A selection of seminars on current methods and techniques in use at the Department of Biology at University of Konstanz, presented by Postdocs of various groups and by members of the particular research facilities (Proteomics, Genomics, Microscopy units).
Forms of teaching/Amount of SWS	Lecture/2 SWS

Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation
Credits for this unit	4
Examination and unit completion	Exam
Prerequisites	n/a
Language	English
Time slot and frequency of the module	Winter term
Module unit	**f. Evolutionary Organismal Biology**
Coordinator	Prof. Dr. Christian Voolstra
Teaching content	"Evolutionary Organismal Biology" is a lecture series that gives a wide overview of research in ecology and evolution at the University of Konstanz. Each lecture presents a general theme of one active researcher, with particular focus on ecological and evolutionary context. The lecture series is integrative and includes a wide range of contributions, e.g., from physiologists, limnologists and developmental and behavioural biologists. It is specifically intended for MA students who chose "Ecology and Evolution" as emphasis area but it is also open to other interested persons.
Forms of teaching/Amount of SWS	Lecture/2 SWS
Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation
Credits for this unit	4
Examination and unit completion	written examination
Prerequisites	none
Language	English
Time slot and frequency of the module	summer term
Module unit	**g. Concepts in Ecology**
Coordinator	Prof. Dr. Becks, Prof. Dr. Peeters, PD Dr. Straile
Teaching content	optimal foraging, ecological stoichiometry versus essential biochemicals,

	chemical communication, life histories, population growth and demography, predator-prey models, intra- and interspecific facilitation, theory of food chains and food webs, spatial ecology, biological invasions, patterns and functional aspects of biodiversity
Forms of teaching/Amount of SWS	Lecture/2 SWS
Work load	30 h Attendance time 60 h Preparation and post-processing 30 h Exam preparation
Credits for this unit	4
Examination and unit completion	Written exam, 90 minutes.
Prerequisites	Basic class/lecture in ecology.
Language	English
Time slot and frequency of the module	Winter term

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title:</u>

Advanced Courses

Advanced Technologies for the Life Sciences</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>Advanced course of scientific lab work consisting of lecture, internship and single projects.</td></tr>
<tr><td colspan="4">Educational objectives</td><td>Lecture:
The hosting Core Facilities will give lectures covering technologies, methodologies and tools used within. Based on this broad knowledge the students will learn how to do interdisciplinary research and include diverse methodologies in their experimental design and data collection. A special focus is on the connection of different experimental approaches that allow to add new information to the growing set of data.

Seminar:
In a journal club the students will learn how to read and interpret present scientific publications. Furthermore, in a second methodology literature project they should get deeper insight in various techniques and methods used in the field of scientific research.

Internship:
In the practical part the students will prepare several relevant biological samples and will use the techniques and tools provided by the different Core Facilities to answer different scientific questions.

Bio Imaging Center (BIC): Using several relevant biological samples students will learn how to solve scientific questions using different light microscopy methods. Students will learn how to prepare the samples for microscopy, to image the samples and analyze the images. Typical measurements to assess microscope performance will be demonstrated.

Flow Cytometry Center (FlowKon): The course will provide a systematic theoretical and practical introduction to flow cytometry and fluorescence activated cell sorting. We will</td></tr>
</table>

	outline essential functional properties of fluorophores, explain basic rules of panel design and compensation. Students will learn how to prepare and analyze most frequent assays (apoptose, cell cycle, immunophenotyping) on our high-end analyzers. **Electron Microscopy Center (EMC):** On the basis of their own samples the students will learn how to handle, preparate and preserve different kinds of cells or tissue for ultrastructural analyses. They will have the opportunity to work at a scanning electron microscope or at a transmission electron microscope to visualize and analyze these structures in the nanometer scale. **Sequencing Analysis Core Facility (SeqAna):** The advent of next-generation sequencing (NGS) has transformed the life sciences. A human genome can now be sequenced in a matter of days for US$1,000, and whole genome sequencing is now accessible for non-model organisms. About 30% of the course will cover theoretical aspects of molecular biology and wet lab techniques (sequencing library generation and quality control) and the remaining 70% will cover bioinformatics analysis (curation, processing and analysis of sequencing data). Students will work with command line-based applications and generate bespoke scripts (R, Python, awk). No prior knowledge will be assumed but students should be prepared to undertake self-study to familiarise themselves with required informatics skills that will be used in the instructor-led exercises. **Colloquium:** The students will learn to summarize, present and discuss the results of their own scientific projects in poster form.
Module unit	**a. Lecture and Seminar**
Coordinator	Dr. Benjamin Hume, Dr. Michael Laumann, Dr. Martin Stöckl, Dr. Annette Sommershof
Teaching content	**Lecture:** The lecture will cover the methods and analytical techniques used in the hosting Core Facilities and the tools and devices which are available and in action: This will cover the underlying theoretical principles, but also the classical methods to the point of up-to-date analytical techniques. In the field of cellular biology, genetics, bioinformatics and

	biochemistry the basics will be recapitulated as far as necessary for the different scientific projects. **Seminar:** The journal club focuses on current publications which will be discussed in detail. The topics are in accordance to the scientific work of the core facilities. Each student presents in a short oral presentation one original paper to get trained in critically assessing scientific publications. The methodology literature project deepens the knowledge given in the lectures regarding different techniques and methods: In groups of two the students will learn to summarize new applications in the field and introduce these techniques to their fellows via a short poster presentation.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Journal club / seminar
Prerequisites	The course is open to all master students, experience in laboratory work is presumed.
Language	English
Time slot and frequency of the course	Winterterm, 1. half
Module unit	**b. Internship**
Coordinator	Dr. Benjamin Hume, Dr. Michael Laumann, Dr. Martin Stöckl, Dr. Annette Sommershof
Teaching content	**Internship:** The course is based on a series of small research projects and hands-on modules in the hosting Core Facilities. The students will work in groups of four and are supervised by the researchers of the Core Facilities. Every group gets assigned to a small research project consisting of different hands-on modules in which the students will learn how to use the wet labs, tools and devices in the different Core Facilities. The groups will rotate through the different Core Facilities. The available projects are centered around the various services of

	the Core Facilities and will be presented in the first week of the course. **Colloquium:** At the end of the course each group will give a poster presentation of the results obtained during the internship. While presenting each student will focus on one Core Facility associated part of their research project. *Each group compiles and documents their data to make them available for further use in the Core Facilities*.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium with poster presentation
Language	English
Time slot and frequency of the course	Winterterm, 1. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Applied Bioinformatics for Studying Health and Disease**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Learn how to quality control and analyse next generation sequencing (NGS) data for studying health and/or disease.
Module unit				a. Lecture and Seminar
Coordinator				Prof. Dr. Andreas Gruber
Teaching content				The lectures cover the fundamentals of next generation sequencing (NGS) data analysis. The participants will gather knowledge on high-throughput sequencing technologies and data science techniques / tools to analyse and interpret large-scale NGS datasets. They will also learn how to read, interpret and present scientific publications (literature seminar).
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				B.Sc. degree. Interest in high-throughput sequencing technologies as well as in bioinformatics approaches and tools.
Language				English

Time slot and frequency of the course	Winter term, 1. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Andreas Gruber
Teaching content	Every participant gets assigned a small research project to learn (i) how to search databases for reference genomes, gene annotations, and datasets, (ii) perform quality control of next generation sequencing (NGS) data, (iii) map NGS data, (iv) infer global gene expression, (v) identify differential expressed genes, (vi) investigate gene expression at systems scale, (vii) identify transcriptional regulators, (viii) relate analysis results to the current scientific knowledge / publications, (ix) design a research project, follow-up analyses and validation experiments, (x) document, write-up and present analyses and research results, using FAIR (findable, accessible, interoperable, reusable) data principles.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 1. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Behavioral Neurobiology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of a lecture, a seminar and an internship with individual projects.
Educational objectives				The lecture will cover basic principles of Behavioral Neurobiology with special emphasis on olfaction
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Bahl, Prof. Dr. Kleineidam, and others
Teaching content				The lecture covers both, contemporary techniques used in Neuroscience and an overview of classic topics in Behavioral Neurobiology. For further reading, we recommend the textbook: 'Behavioral Neurobiology' by Tom Carew. The lecture also includes a number of presentations by invited speakers, which gives the students the opportunity to learn more about different exciting research topics currently investigated. In addition, a paper seminar is held during one of the first weekends (usually the second weekend) where we discuss related publications at a retreat in the Alps. Here, the students present a publication, and the supervisors introduce their own field of research.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				EOB and SIS or comparable background required. In case you did not attend one of the before mentioned classes, please contact Chr. Kleineidam
Language				English
Time slot and frequency of the course				Summer term, 2. half

Module unit	**b. Internship**
Coordinator	Prof. Dr. Bahl, Prof. Dr. Kleineidam, and others
Teaching content	students in this course will join one of our current research projects; either as single individuals or in pairs of two. Our main interest is Olfaction in Insects, Learning and Memory, and the proximate mechanisms for Social Organization in ants, bees and *Drosophila* flies and larvae. In order to study how insects, acquire and process odor information, we use a variety of different physiological techniques such as Calcium Imaging of the first olfactory neuropil, the antennal lobe, and electrophysiological approaches such as Single Neuron Recordings and Electroantennography. The connectivity of the olfactory pathway and modulation of information processing, e.g. during learning is investigated with neuroanatomical techniques such as Immunohistochemistry and subsequent Confocal Microscopy. The neuroanatomy of the insect brain is reconstructed by a detailed visualization based on image stacks using advanced 3D-software (AMIRA). Experimental setups that analyse the naïve responses of insects towards odors or even learning and memory on a behavioral level are used to test, how the insect brain organizes a particular insect behavioral. We address our questions in different insect species ranging from the model organism Drosophila, mosquitoes, bees and various ant species.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Biochemical Pharmacology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				The participants of the course should learn about the various molecular, biochemical and cellular processes underlying cell death induction and regulation and their consequences for health and disease. Furthermore, they should get a deeper insight into molecular mechanisms of immune regulation and immunopathological disorders of the liver, intestine, and lung, and their pharmacological control. Students will also present and discuss a scientific publication in the field.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Brunner
Teaching content				Regulation of cell death (apoptosis, necrosis, autophagy), cell biology, immunology, immunopathology, signal transduction, steroid synthesis, general pharmacology, in vitro and in vivo models, method applications
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Colloquium
Prerequisites				Successful completion of basic modules
Language				English
Time slot and frequency of the course				Summer term, 1. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Brunner
Teaching content				In the practical lab work participants should get familiar with various methods and techniques while working on current projects and scientific questions in the lab under the supervision of lab members. They will learn to summarize their

	data in scientific protocols and present their projects in internal seminars
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Report
Language	English
Time slot and frequency of the course	Summer term, 1. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Biochemistry and Mass Spectrometry**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Introduction to mass spectrometry and proteomics to prepare students for a future career in academia or industry
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Stengel
Teaching content				1. Proteomics (History, Sample Preparation, Basic Concepts, Peptide Identification, Data Analysis, Quantification) 2. Methods in Structural Mass Spectrometry (Cross-Linking MS, Native MS, Ion Mobility, Integrated Modeling)
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				B.Sc. degree
Language				English
Time slot and frequency of the course				Summerterm, 2. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Stengel
Teaching content				The students will participate in current research projects and, dependig on the individual project, will be acquainted with various biochemical/cell and molecular biological methods (including cloning, protein expression and purification, enzyme assays, yeast and mammalian cell culture); in addition every project is designed to have a mass spectrometric part (including MS sample preparation, MS measurement and data analysis).
Forms of teaching/Amount of SWS				10

Work load	200 h Attendance time 100 h preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Bioinformatics and X-Ray Structure Analysis**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				The advanced course consists of a theoretical part with lecture and seminar and an internship with individual projects.
Educational objectives				Insight into theory and experimental work of macromolecular structure determination by X-ray crystallography. Understanding the impact of macromolecular structures at atomic resolution for modern molecular biology.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Mayans, Prof. Dr. Diederichs
Teaching content				Techniques for protein overexpression, purification, solubilization of membrane proteins, physicochemical analysis of protein solutions, macromolecular crystallization, oral reporting of scientific publications on from macromolecular structures at atomic resolution.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Seminar
Prerequisites				Interest in molecular genetics, biology, wet lab work, some basic mathematics, computer work.
Language				English
Time slot and frequency of the course				Winter term, 2. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Mayans, Prof. Dr. Diederichs
Teaching content				Techniques for protein overexpression, purification, solubilization of membrane proteins, physicochemical analysis of protein solutions, macromolecular crystallization, data collection, experimental phase determination, crystallographic computing, model building, structure refinement, oral reporting of scientific work done during the course and of scientific

	publications on from macromolecular structures at atomic resolution.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 2. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

Cell Biology - Cell Adhesion and Signal Transduction</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>The advanced course consists of a theoretical part with lecture and seminar and an internship with individual projects.</td></tr>
<tr><td colspan="4">Educational objectives</td><td>The students will be exposed to current conceptual and methodological approaches in cell biology with a particular emphasis on cell adhesion and signal transduction processes in animal cells. In the theoretical part a) of the module the students learn the current state of the art by focussed lectures. From this detailed theoretical background the students should be able to frame a hypothesis together with their supervisor. Furthermore, in part a) the students present and discuss original publications and seminal contributions to the field in the form of a seminar to understand how to deconstruct published information. Thereby, they will acquire the knowledge to analyse key experiments and to integrate such approaches in their own practical project. In the practical part b) the students experimentally address current research questions with state-of-the-art equipment in a one-to-one interaction with their supervisor. Based on their hypotheses, the students will learn to plan and conduct different experiments including proper experimental controls. They will learn to critically analyse the raw data, summarize results, and present their data to peers. Finally, they will have the opportunity to refine or reformulate their starting hypothesis. The students should understand that this iterative process is key to scientific discovery</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Dr. Hauck</td></tr>
<tr><td colspan="4">Teaching content</td><td>The lectures cover the following areas of cell biology : adhesion molecules: integrins, IgCAMs; focal adhesions, protein and lipid phosphorylation: kinases/ phosphatases, adapter proteins/ protein-protein-interaction domains/ SH3-domains/ SH2- domains / ITAMs/ITIMs, endocytosis –</td></tr>
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	autophagocytosis, lipid rafts, vesicle trafficking, dynamics of the actin cytoskeleton, regulation of cell migration, phagocytosis, innate immunity, cellular microbiology. Selected pathogenic bacteria will be presented (e.g. Neisseria, Haemophilus, Staphylococci) and medical aspects and their biology will be discussed. Furthermore, the second part of the lecture series addresses common experimental strategies, and the principles, application and pitfalls of the used methodology will be discussed. In particular we talk about: i) cell biological and genetic methods, e.g. cell culture, hybridoma cells, monoclonal antibodies, manipulation of cells – transfection, transduction, RNA-interference (RNAi), microRNAs, siRNA, shRNA, generation of viral particles, transgenic and knock-out mice, fluorescence labeling and –detection, flow cytometry, next-generation sequencing. ii) microscopy, electron microscopy and advanced light microscopy including confocal microscopy, TIRF, FRAP, FRET, FLIM iii) protein biochemistry, e.g. protein detection, epitope-tagging, affinity purification, Western Blotting, detection of protein-protein-interactions, protein-arrays, and identification of novel protein-protein-interactions The seminar focusses on current publications and breakthrough findings in the above mentioned areas, which will be discussed in detail. Each student presents one original paper.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Seminar
Prerequisites	The lectures Cell Biology I and II, Biochemistry II, and Immunology (BA Life Science or BA Biological sciences) or equivalents to these lectures must have been followed and passed. Attending the lecture Disease Biology I (especially the series on infectious diseases) is an asset. A specific introduction into laboratory safety is mandatory and will be given on the first day of the course

Language	English
Time slot and frequency of the course	Winter term, 2. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Hauck
Teaching content	Individual projects will be conducted alongside existing lines of investigation in the field of cell adhesion receptors and address the following topics: CEACAMs, Integrins & pathogenic microbes / Regulation of cell adhesion / Advanced Methodology in Microscopy Examples of recent projects: CEACAM3 initiated signalling in granulocytes / The adapter molecule Nck is involved in phagocytosis / CEACAM1 localization to membrane microdomains / The role of Pyk2 in complement-mediated phagocytosis / Role of Vinculin in the Internalization of Staphylococcus aureus / Influence of CD105 on subcelluar localization of zyxin / Role of Focal Adhesion Kinase (FAK) in cell migration
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 2. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Cellular Biochemistry**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Introduction to the biochemistry and (patho-)physiology of the ubiquitin-conjugation system to prepare students for a future career in academia or industry
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Scheffner
Teaching content				(1) Ubiquitin-conjugation system: history, current research concepts and activities, role in human disorders (2) Methods used in ubiquitin research including yeast genetics, mass spectrometry, unnatural amino acids (3) Cancer: "classical" and current concepts, DNA tumor viruses
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				B.Sc. degree
Language				English
Time slot and frequency of the course				Summer term, 2. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Scheffner
Teaching content				The students will participate in current research projects and, depending on the individual project, will be acquainted with various biochemical/cell and molecular biological methods including PCR mutagenesis and cloning, protein expression and purification, enyzme assays, yeast and mammalian cell culture, mass spectrometry, etc.

Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

Study program/Usability **Master Biological Sciences** **Master Life Science** **Credits** 15 **Duration** 6 weeks	**Module Title: Advanced Courses** **Chemical Ecology**
Module grade	The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units	Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives	The students should realise that most aspects in Chemical Ecology are mediated by chemical processes. In order to successfully address biological questions it is often crucial to appreciate their (bio)chemical basis. In interdisciplinary research it is necessary to be open minded and to include diverse methodologies in the experimental design. A broad knowledge in different techniques is communicated. The students should learn to design experiments, perform experiments independantly, to critically evaluate obtained experimental data and to present their results in a concise report.
Module unit	**a. Lecture and Seminar**
Coordinator	Prof. Dr. Spiteller
Teaching content	Chemical ecology, microbial chemical ecology, natural products chemisty and biochemistry, chemistry of microbial symbionts, microbiology, secondary metabolites: Presentation of own research topics and current topics in microbial chemical ecology. Presentation of analytical techniques such as chromatography, HPLC, gas chromatography, mass spectrometry, MS Imaging, and NMR). Discussion of microbiology and molecular biology techniques techniques (isolation, cultivation, bioassays, cloning techniques, analysis of gene clusters, phylogeny). General topics: experimental design, how to write a paper, how to give an oral presentation, bibliography. Short oral presentation of a research topic by each student.

Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Journal club / seminar
Prerequisites	Solid knowledge in organic chemistry, analytical chemistry, biochemistry, and microbiology/molecular biology. Attendance of the lectures Bioorganic Chemistry and the lecture Chemical Ecology as basis for the practical course is expected.
Language	English
Time slot and frequency of the course	Winter term, 2. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Spiteller
Teaching content	Interdisciplinary course: Depending on the interests of the students the focus of the experiments can be microbiology/molecular biology or biochemistry and analytical chemistry. Microbiology and molecular biology techniques: isolation, cultivation, phylogeny, bioassays, gene cluster analysis, mutagenesis, heterologous expression of enzymes. Chemistry: biosynthetic studies, feeding studies, isolation of bioactive compounds, structure elucidation (mass spectrometry, NMR), functional analysis of secondary metabolite gene clusters, enzymology. Ecology: Bioassays, function of natural products.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 2. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Collective Animal Behaviour**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Develop an understanding of collective animal behaviour, and how theoretical models and empirical studies together can provide new insights about complex systems
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Iain Couzin, Dr. Alex Jordan
Teaching content				The lectures for this course will cover theoretical models explaining collective animal behaviour and explain how these lead to predictions about the benefits individuals gain by forming groups. The lectures will focus on modelling studies, but also review the empirical literature that has tested the predictions that models have generated.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				none
Language				English
Time slot and frequency of the course				Winterterm, 1.half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Iain Couzin, Dr. Alex Jordan
Teaching content				Projects for small groups will be offered in the Couzin, Farine & Jordan labs. These will include opportunities to work with fish, invertebrates, and birds (both captive and wild). Projects can include tracking individuals using video, PIT tag, and QR code technologies, to answer questions about how individuals

	behave and how individual behaviours scale up to group-level outcomes. Projects on fish will require completing the animal care course, which must be done prior to the module.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winterterm, 1.half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Developmental Biology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				The advanced course consists of a theoretical part with lecture and seminar, and an internship with individual projects.
Educational objectives				The aim of this course is to familiarize students with fundamental principles of developmental biology, with an empasis on pattern formation mediated by signaling molecules. The course participants will learn to conduct independent research projects and to present scientific findings to a broad audience.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Patrick Müller
Teaching content				The course is centered around modern approaches to the central question in developmental biology: How is a ball of nearly equal cells transformed into a structured embryo? And how does cellular communication via signaling molecules mediate this self-organizing process? In lectures, we will introduce exciting new areas in developmental biology and ongoing research in our lab. In tutorials, we will discuss classical techniques as well as quantitative tools for image-based studies in developmental biology, from image processing and data analysis to computational modeling. To get trained in critically assessing scientific publications, each student will present one paper describing a major finding in developmental biology.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Active participation in the lectures and paper presentation
Prerequisites				Successful completion of basic modules (biochemistry, mathematics, physics)

Language	English
Time slot and frequency of the course	Summer term, 1. half
Module unit	**b. Internship**
Coordinator	Prof. Patrick Müller
Teaching content	The course participants will work on individual research projects to elucidate how signaling molecules control pattern formation in vertebrate embryos. The students will be trained and accompanied in their projects by experienced scientists. They can choose from a variety of experimental and theoretical techniques and combine them in new ways. Experimental techniques cover zebrafish and medaka embryology, molecular biology, and advanced imaging approaches such as light-sheet and high-throughput microscopy. Theoretical techniques range from basic and advanced image analysis to machine learning and numerical simulations of reaction-diffusion systems. The available projects, centered around ongoing research in our lab, will be presented on the first day of the course. The students will be mentored to present their research findings to an international audience and practice their skills by giving a presentation to the participants at the end of the course.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 1. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Dynamics of Aquatic Ecosystems**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				The students learn that the investigation of ecological processes and their interactions in aquatic systems requires an interdisciplinary approach. They will acquire basic knowledge about physical limnology and oceanography, abiotic-biotic interactions, ecological modelling and implications of climate change on aquatic systems. The course communicates theoretical concepts and field methods that enable the students to independently conduct a process oriented research project. The main focus is on the interaction between ecological and physical processes in aquatic systems. The students learn how to design and conduct field experiments for the investigation of ecological processes. They learn how to analyse their data, and to critically evaluate the results of their work with respect to existing knowledge. They learn to communicate scientific results in form of oral presentations and scientific manuscripts.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Peeters
Teaching content				Basic principles in physical limnology (exchange and transport processes, tracer techniques), relevance and release of methane, utilization of acoustic techniques in aquatic systems, plankton patchiness, waves and their ecological relevance, basic ocean dynamics, climate change, introduction to ecological modelling, case studies from specific lakes. The lectures not only present basic principles but will also show recent results from the current projects of the research group. We will have additional presentations from invited guests addressing specific research topics.

	Seminar: In the seminar the participants present selected articles relevant for their projects.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Journal club / seminar
Prerequisites	none
Language	English
Time slot and frequency of the course	Summer term, 2. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Peeters
Teaching content	Introduction to field techniques in lake research (water sampling, in-situ techniques from a boat on Lake Constance), water sample analyses (e.g. zooplankton, methane, toxins) and data analysis using MATLAB (hands-on tutorial). Conduction of a research project according to the current focus of the group (e.g. temporal and spatial distribution patterns of plankton or methane). Typically this include 2 weeks of field work at a specific site (e.g. Lake Ammer, Illmensee, Untersee, Obersee). Projects focussing on modelling may also be possible if desired. The students work in groups of two. They develop a work plan for their project, conduct the field work and analyse the data with the support of a project supervisor. All projects are integrated part of our current research. After three weeks intermediate results are presented by the research groups and discussed with the other participants and supervisors of the course to adjust the remaining research program based on the information gained so far. At the end of the course the project results will be presented by the research groups in a poster session. Each group compiles and documents their data to make them available for further use in our research group. After the course the students provide a summary of their project work in the format of a scientific manuscript consisting of an abstract, an introduction providing the motivation of the

	project, a methods section, a section on the main results and a discussion.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

Environmental Genomics</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>Advanced course of scientific lab work consisting of lecture, internship and single projects.</td></tr>
<tr><td colspan="4">Educational objectives</td><td>In this course you will
▪ gain a thorough current understanding and practical experience of the application and uses of environmental DNA in ecological research
▪ learn how to analyse eDNA data
▪ acquire skills in designing and conducting a research project
▪ gain an understanding of the scales and causes of ecosystem changes at different timescales (centennial, millenial) and acquire knowledge of fundamental paleoecological concepts and methods.
▪ expand your presentation skills</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Laura Epp</td></tr>
<tr><td colspan="4">Teaching content</td><td>Current advances in molecular genetic techniques offer the possibility to investigate present and past biodiversity using DNA extracted directly from environmental samples, such as water or sediments. This environmental DNA (eDNA) is shed into the environment by all organisms, both microbial and macrobial, and it can be used to identify species and sub-specific variation. We can thus analyse diversity patterns in space and through time, both at the level of species composition of biotic communities and within single species.

Techniques and theoretical concepts covered
▪ sampling and extraction of environmental DNA.
▪ specificities of working with ancient and degraded DNA.
▪ bioinformatic design of reactions to trace target organisms in water and sediments.
▪ wet-lab evaluation and application of these reactions: (quantitative) PCR and DNA-metabarcoding.</td></tr>
</table>

	▪ bioinformatic analyses of NGS sequencing data from environmental samples ▪ taxonomic assignments of DNA sequences using reference databases ▪ statistical analyses of eDNA data in (paleo)ecology In the **lecture course**, you will be introduced to the underlying theoretical principles of environmental DNA analyses and will learn analytical skills. In a **literature seminar** you will present and discuss papers highlighting current applications of environmental DNA in ecology and paleoecology.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Journal club / seminar
Prerequisites	B.Sc. degree
Language	English
Time slot and frequency of the course	Winterterm, 1. half
Module unit	**b. Internship**
Coordinator	Prof. Laura Epp
Teaching content	Current advances in molecular genetic techniques offer the possibility to investigate present and past biodiversity using DNA extracted directly from environmental samples, such as water or sediments. This environmental DNA (eDNA) is shed into the environment by all organisms, both microbial and macrobial, and it can be used to identify species and sub-specific variation. We can thus analyse diversity patterns in space and through time, both at the level of species composition of biotic communities and within single species. Techniques and theoretical concepts covered ▪ sampling and extraction of environmental DNA. ▪ specificities of working with ancient and degraded DNA. ▪ bioinformatic design of reactions to trace target organisms in water and sediments. ▪ wet-lab evaluation and application of these reactions: (quantitative) PCR and DNA-metabarcoding. ▪ bioinformatic analyses of NGS sequencing data from environmental samples

	▪ taxonomic assignments of DNA sequences using reference databases ▪ statistical analyses of eDNA data in (paleo)ecology The practical course is structured around small research projects related to ongoing work in our group, in which you will learn the **practical steps** of environmental DNA analyses, from sampling through wet-lab methods to bioinformatics. In accompanying **workshops**, you will learn analytical skills as well as scientific writing and project planning.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium with poster presentation and written report
Language	English
Time slot and frequency of the course	Winterterm, 1. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Global change ecology and plants**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				The major objectives are that by the end of this course, the students will know: • What is plant ecology, and why it is important. • What are big questions in plant ecology. • How to test hypotheses in plant ecology. • What are the major methods and approaches in plant ecology. • How to set-up, run and analyse experiments in plant ecology. • How to present results of plant ecological studies.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. van Kleunen
Teaching content				In the lectures, we teach the major theories in plant ecology. Some examples of topics are plant life-histories, dispersal and pollination, functional diversity and invasion ecology. In seminars, the students present and discuss recent publications.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				Requirement for the course are basic knowledge of ecology (the 3rd semester course “Ökologie”, the book “The Ecology of Plants” by Gurevitch, Scheiner and Fox, particularly Chapter 1 and Chapters 5-13) and basic knowledge of statistical methods.
Language				English
Time slot and frequency of the course				Summer term, 2. half

Module unit	**b. Internship**
Coordinator	Prof. Dr. van Kleunen
Teaching content	In addtion to the lectures and seminars, we teach practicals and workshop, and the students have to do a research project. In the practicals and workshops, we teach major skills and methods in plant ecology. In the research projects, the students will have to put the acquired skills and knowledge into practice. Collaborating in groups of 2-4 persons, students will obtain experience in all aspects of scientific research: from design and planning to analysis and presentation of results. The projects will be independent or directly linked to ongoing studies in our group, and are supervised by PhD students and postdocs.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Human and Environmental Toxicology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Interconnective thinking, holistic views of toxicological problems, evaluation of data, detailed understanding of experimental approaches, design and interpretation, extrapolation of datasets for toxicological risk assessment
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Dietrich
Teaching content				Toxicology of natural toxins (cyanobacteria and mycotoxins), intrinsic mechanisms of acute and chronic toxicity including carcinogenicity
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				As a minimum the BS course in Ecotoxicology, preferably the 2 advanced courses in Human and Environmental Toxicology by Prof. Dietrich, or similar Toxicology courses provided by Profs. Bürkle, Leist, Hartung and Brunner
Language				English
Time slot and frequency of the course				Winter term, 1. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Dietrich
Teaching content				Labwork on specific research topics associated or direct part of ongoing research projects in the area of renal toxicology or natural toxins
Forms of teaching/Amount of SWS				10

Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 1. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Immunology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Presentation of research publications in the field of immunology. Understanding of how and when immunological techiques are applied in research in immunology. Overview of latest concepts in immunobiology.
Module unit				**a. Lecture and Seminar**
Coordinator				PD Dr. Basler, PD Dr. Schmidtke
Teaching content				Antiviral response, T helper cell differentiation, lineage commitment, thymic T cell selection, antigen processing pathways, ubiquitin-proteasome system, T cell vaccination, tumor immunology.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				Lecture on Immunology in the fourth semester with written exam at Konstanz University or equivalent education at external universities.
Language				English
Time slot and frequency of the course				Winter term, 1. half
Module unit				**b. Internship**
Coordinator				PD Dr. Basler, PD Dr. Schmidtke
Teaching content				Practical application of research methods in immunology like intracellular cytokine staining, ELISA, ELISPOT, proliferation assay, flow cytometry, cell sorting, immunization of mice, virus plaque assays, tumor imaging.
Forms of teaching/Amount of SWS				10

Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 1. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Microbial Ecology and Limnic Microbiology**
Credits	15	**Duration**	6 weeks	
Module grade				The grading for the Life-Science-Students is based on the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lectures, seminars and single research projects.
Educational objectives				Understanding the activities of microbes, for example in the aquatic environment, and the physiology and biochemistry behind their cycling of matter and covering their growth requirements.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. David Schleheck
Teaching content				Cultivation of aerobic and anaerobic bacteria in the lab. Analytical-chemical, biochemical and molecular methods for Microbial Ecology lab work. Dissimilatory and assimilatory metabolism. Aerobic and anaerobic degradation of organic matter. Fermentations, sulfate reduction, methanogenesis, syntrophic associations, dehalorespiration. Roles of microbes in biogeochemical carbon, nitrogen, sulfur and phosphorus cycling. Limits of microbial transformation (e.g. pesticides, plastic). Starvation and survival. Microbial communities and microbial biofilms. Cell-cell interactions, chemical communication and signalling (quorum sensing). Cultivation-independent techniques of microbial community analysis. Microbial ecology of specific environments, e.g., lake water column and sediment, soil, intestinal systems of humans and animals, extreme environments.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / literature seminar
Prerequisites				At least one course in basic microbiology and basic experience in microbiological lab work are required. Basic

	knowledge in biochemistry is also required. Experience in molecular biology and analytical chemistry is helpful.
Language	English
Time slot and frequency of the course	Winter term, 2. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. David Schleheck
Teaching content	We study environmental bacteria (from water, soil, human gut) in our lab for their biodegradation capabilities and the underlying biochemical transformations, enzymes and genes. This includes growth of the strains in batch or continuous culture, quantifying biomass formation, substrate disapperance and product formation, and balancing of the metabolism. In the past, bacterial pathways for degradation of industrial chemicals and natural organo-sulfur compounds have been studied in aerobic as well as anaerobic strains, including the enzymes catalyzing these transformations. Our research involves also genome sequencing, proteomic and transcriptomic analysis, and production of enzymes by heterologous expression. Another research avenue aims at characterizing microbial communities right in their environment, by total DNA extraction and meta-genomic sequencing (Bodensee plankton and biofilms). Projects offered will be chosen based on the research currently being done in the lab. However, you are also strongly encouraged and highly welcome to propose your own research project; please discuss this with us in advance.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Project introduction colloquium, project results colloquium, written report (or poster)
Language	English
Time slot and frequency of the course	Winter term, 2. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Molecular Evolutionary Biology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				The advanced course consists of a theoretical part with lecture and seminar and an internship with individual projects.
Educational objectives				We study several fundamental issues in evolutionary and developmental biology, as well as comparative genomics and bioinformatics. The evolution of biodiversity, and specifically the developmental basis and molecular and genomic causes of morphological diversity between species are of interest to us. We would like to better understand the relationship between tempo and mode of evolution both in terms of morphological adaptation and speciation on one hand and genetic differentiation among species and speciation on the other. In trying to understand the origin and maintenance of biodiversity we mostly use molecular approaches, namely the study of mitochondrial and nuclear DNA variation (in protein coding genes and microsatellites), to ask how much genetic divergence accompanies morphological differentiation among populations and separates species.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Meyer
Teaching content				We will have daily lectures on topics including developmental-evolutionary biology as well as major themes in evolutionary biology. Other topics will cover some of the theory behind molecular phylogenetics, genomics and bioinformatics.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Seminar
Prerequisites				B.Sc. degree
Language				English

Time slot and frequency of the course	Summer term, 1. Half
Module unit	Compulsory/Optional course
Module unit	**b. Internship**
Coordinator	Prof. Dr. Meyer
Teaching content	In order to address the central issues in organismal evolutionary biology we are conducting multidisciplinary, integrative research that ranges from population genetics, molecular evolution, and molecular phylogenetics, to comparative genomics and bioinformatics and also includes work on the connections between developmental and evolutionary biology. Our model organisms include the zebrafish and also the evolutionary highly diverse cichlid fishes.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Time slot and frequency of the course	Summer term, 1. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Molecular Genetics: Cell cycle regulation – from mechanisms to disease**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				This course enables students to understand the molecular mechanism underlying mitotic and meiotic divisions in higher eukaryotes. At the end of the course, the students will understand how cell cycle progression is regulated by posttranslational modifications of key cell cycle regulators and how mitotic kinesins facilitate the equal distribution of the genome in mitosis.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Th. Mayer
Teaching content				Molecular insights into the regulatory mechanisms controlling cell cycle progression in mitosis and meiosis. A particular focus will be on the function and regulation of ubiquitin ligases during the cell cycle. In addition, the molecular mechanisms enabling motor proteins to move along microtubules and the regulation of this process in mitosis will be explained in detail.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				Knowledge of the basic concepts of mitotic and meiotic cell cycle regulation in higher eukaryotes. Insights into the function and regulation of mitotic motor proteins. Knowledge of the respective chapters in the textbook " Cell Cycle" by David Morgan is regarded as prerequisite.
Language				English

Time slot and frequency of the course	Winter term, 1. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Th. Mayer
Teaching content	Experimental insights into the regulatory mechanisms underlying mitotic and meiotic cell cycle progression. Experimental insights into the function and regulation of motor proteins. The Xenopus egg extract and human tissue culture cells are used as model systems. Biochemical, cell biological approaches are combined with high resolution live-cell microscopy. In addition, small molecules are applied to modulate protein function on a fast time scale.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 1. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

Molecular Microbiology and Cell Biology: Chaperone functions in health and disease</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>Advanced course of scientific lab work consisting of lecture, internship and single projects.</td></tr>
<tr><td colspan="4">Educational objectives</td><td>Conducting research projects independently, presenting data in seminars</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Dr. Deuerling</td></tr>
<tr><td colspan="4">Teaching content</td><td>a) Theoretical part:
Protein folding, function and mechanisms of molecular chaperones, protein folding defects, molecular basis of neurodegenerative diseases and aging, E. coli, yeast and C. elegans as genetic model systems; biochemical methods for the analysis of protein-protein interactions: crosslinking techniques and fluorescence spectroscopy; detailed structural and functional insights into ribosomes and translation regulation.
b) Practical part
The practical part of this advanced course orients itself at our current research projects. Our major goal is to enhance our understanding of protein synthesis and folding in health and disease.
We work on
- principles of molecular chaperones
- cotranslational folding pathways of nascent polypeptides
- protein processing and quality control mechanisms in the cell
- functions of ribosome-associated chaperones in aging and diseases related to protein misfolding
c) Model organisms and range of methods
We use three different model organisms: the bacterium Escherichia coli, the yeast Saccharomyces cerevisiae and the nematode C. elegans. We combine demanding genetic analyses of chaperone and ribosome mutants in vivo with</td></tr>
</table>

	protein analysis in vitro. This includes RNAi experiments in C. elegans, knockout mutations in E. coli and yeast and fluorescence microscopy analysis with all three model systems. State-of-the-art kinetic and mechanistic investigations of translation and chaperone-assisted protein folding in vitro are performed using translation systems, ribosome profiling, qPCR, fluorescence spectroscopy and crosslinking techniques.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Journal club / seminar
Prerequisites	a) Compact course Molecular Microbiology b) Elementary knowledge in microbiology, biochemistry and molecular biology including all the techniques like protein purification methods, PCR, cloning, etc.
Language	English
Time slot and frequency of the course	Summer term, 2. half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Deuerling
Teaching content	Same as above, part b)
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Molecular Toxicology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				The advanced course consists of a theoretical part with lecture and seminar and an internship with individual projects.
Educational objectives				Basic & advanced knowledge in Molecular Toxicology Presentation of a scientific poster, literature seminar
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Bürkle
Teaching content				Molecular Toxicology, Genotoxicology, Mechanisms of Aging & Carcinogenesis
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Poster Production and presentation
Prerequisites				Successful participation in modules like "Humanbiologie" and "Pharmakologie & Toxikologie" during Bachelor-Studies
Language				English
Time slot and frequency of the course				Winter term, 2. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Bürkle
Teaching content				Design, planning and running of experiments, data evaluation, interpretation & presentation
Forms of teaching/Amount of SWS				10
Work load				200 h Attendance time 100 h Preparation and post-processing
Credits for this unit				10
Examination and unit completion				Colloquium and written report
Language				English
Time slot and frequency of the course				Winter term, 2. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Novel in vitro methods in pharmacology & toxicology**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Knowledge on in vitro methods for toxicity testing Knowledge on novel approaches in toxicology Knowledge on mechanisms governing neurodegeneration and neurodevelopment
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Leist
Teaching content				Ethical aspects of animal experimentation, overview of non-animal approaches for toxicity testing, cytotoxicity assays, neurotoxicology, basics of pharmacology and toxicology, pluripotent stem cells and stem cell neuronal differentiation, epigenetic mechanisms in differentiation and toxicity, Parkinson's disease, neural crest function and toxicity, cell migration assays, test method development and validation, transcriptome analysis by PCR and microarray, data mining and statistics of genome-wide expression data, biostatistics.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				Good background in biochemistry (e.g. biochemistry II lecture), cell biology, pharmacology (e.g. pharmacology and toxicology I lecture) and physiology;
Language				English
Time slot and frequency of the course				Winterterm, 2. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Leist

Teaching content	Laboratory techniques related to stem cell and neuronal cell cultures, their exposure to toxicants and analysis of transcript, functional, metabolic, epigenetic and other changes. Data mining, statistical evaluation and presentation. Critical evaluation of literature.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winterterm, 2. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Organismal Biology: Going Wild**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Field ecological methods, such as animal marking and behavioural observations. Movement ecology and animal behavior. Design and conducting of field experiments in animal ecology including statistical analysis of the results and scientific communication and presentation.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Wikelski, PD Dr. Dechmann, Dr. Aplin
Teaching content				Animal ecology, movement ecology, ethology, behavioural ecology, statistics and programming.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Colloquium
Prerequisites				The participants should be willing to spend long hours in the field, including night work. Readings in ecology and organismal biology are suggested.
Language				English
Time slot and frequency of the course				Winter term, 2. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Wikelski, PD Dr. Dechmann
Teaching content				Combination of field work and lectures with problem based learning on organismal biology and animal ecology. Statistics and visualization in the R programming language.
Forms of teaching/Amount of SWS				10

Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Report
Language	English
Time slot and frequency of the course	Winter term, 2. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

Physiology and Biochemistry of Plants</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>The advanced course consists of a theoretical part with lecture and seminar and an internship with individual projects.</td></tr>
<tr><td colspan="4">Educational objectives
  </td><td>Lecture: The students will learn to understand the molecular and genetic basis of selected topics in physiology and biochemistry of plants and algae. A special focus is on experimental approaches that allow to gain new information about functional aspects of plant and algae metabolism and its regulation by internal and external factors.
Seminar: The students will learn how to read and interpret scientific literature and how to present hypotheses or experimental data to a broader audience.
Internship: In close contact with the active researchers in the lab the students will learn how to perceive a scientific problem and how to develop an experimental approach to test a hypothesis or how to extract knowledge from unbiased data aquisition. They will have the opportunity to learn and apply up to date methods in plant and cyanobacteria research. The students will also learn how to summarise and discuss their project work in written form.
Colloquium: The students will learn to present their scientific project and the results obtained during the internship. They will also learn how to perceive and analyse a scientific presentation.</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. E. Isono</td></tr>
<tr><td colspan="4">Teaching content</td><td>Lecture:
Based on the current research projects in the Isono and Kroth labs, the lecture will present recent results in the field of physiology and biochemistry of plants and algae.
The topics currently include adaptation of plants to environmental stress, especially high light stress and drought/salinity as well as the regulation of cellular functions</td></tr>
</table>

	by proteases. On the algae side, the focus is on compartimentation of metabolism and protein transport in diatoms and other algae with complex plastids. Recent advances in algae genomics are also presented. Seminar: Topics will be chosen by the students in accordance with the topics of their internships.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Seminar
Prerequisites	The course is open to all master students. Experience in laboratory work is presumed. Good basic knowledge of botany and plant physiology are expected along with a genuine interest in the special challenges that autotrophic organsims have to face in the environment.
Language	English
Time slot and frequency of the course	Summer term, 1. half
Module unit	**b. Internship**
Coordinator	Prof. E. Isono
Teaching content 	Internship: The students will participate in current research projects of the plant physiology and biochemistry lab. 1 or 2 students will be supervised by a PhD student or advanced researcher. The actual content depends on the topics available and the methodolocical focus of the supervisors. Colloquium: Each student will give an oral presentation of the results obtained during the internship. Special focus is on the comprehensivness and professionality of the presentation.
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10

Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 1. half

Study program/Usability Master Biological Sciences Master Life Science				**Module Title: Advanced Courses** **Physiology, Ecology and Molecular Biology of Algae**
Credits	15	**Duration**	6 weeks	
Module grade				The module mark is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				Design and performance of scientific experiments Development of approaches to solve scientific questions Drawing conclusions from obtained results Presentation of results in front of an audience Scientific writing
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Kroth
Teaching content				Molecular biology, biochemistry and physiology of algae Regulation of photosynthesis Algal Biology Algal Genomics
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				Experience in laboratory work
Language				English
Time slot and frequency of the course				Summer term, 1. half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Kroth
Teaching content				Molecular biology, biochemistry and physiology of algae. Each students will work on a a project during th course and present his/her results in a final seminar
Forms of teaching/Amount of SWS				10

Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 1. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

Quantitative tools for behavioral ecologists</td></tr>
<tr><td>Credits</td><td>15 + 3</td><td>Duration</td><td>6 + 2 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>Advanced course in scientific fieldwork and data analysis consisting of lecture, internship and individual and/or group projects;
must be taken in conjunction with “Field Research in Behavioral Ecology”</td></tr>
<tr><td colspan="4">Educational objectives</td><td>This course aims to help students develop scientific reasoning, quantitative and analytical proficiency, and research design and hands-on data collection skills, all in the context of real field-based research.</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Margaret Crofoot; Dr. Alex Jordan; Dr. Ariana Strandburg-Peshkin, Dr. Urs Kalbitzer</td></tr>
<tr><td colspan="4">Teaching content</td><td>The course will be based around a series of hands-on modules in which students learn quantitative and programming skills by interacting with real biological data as well the basic concepts of behavioral ecology. Students will learn how to design studies to ask specific biological questions and how to wrangle, visualize, and interpret the resulting data to answer those questions. In conjunction with short lectures on important concepts in programming, data analysis and behavioral ecology, they will get to “play” with a variety of existing datasets from recent and current studies in behavioral ecology.</td></tr>
<tr><td colspan="4">Forms of teaching / Amount of SWS</td><td>5</td></tr>
<tr><td colspan="4">Work load</td><td>60 h Attendance time
90 h Preparation and post-processing</td></tr>
<tr><td colspan="4">Credits for this unit</td><td>5 (+ 3 for Field research)</td></tr>
<tr><td colspan="4">Examination and unit completion</td><td>Journal club / seminar</td></tr>
<tr><td colspan="4">Prerequisites</td><td>Participation in the course “Field Research in Behavioral Ecology” co-requisite</td></tr>
<tr><td colspan="4">Language</td><td>English</td></tr>
<tr><td colspan="4">Time slot and frequency of the course</td><td>Summer term, 1. half</td></tr>
<tr><td colspan="4">Module unit</td><td>b. Internship</td></tr>
</table>

Coordinator	Prof. Margaret Crofoot; Dr. Alex Jordan; Dr. Ariana Strandburg-Peshkin, Dr. Urs Kalbitzer
Teaching content	The practical part of the advanced course is combined with the 2 week course "*Field Research in Behavioral Ecology"* coordinated by Dr. Alex Jordan. Students will apply their skills by designing their own research projects to be carried out in the field in groups of 2-3 students per project. The students will spend two weeks at an international field station and perform their own studies of animals in the wild, while also participating in lectures on biology and diversity of local fauna and relevant theory. Studies can be experimental or observational and may include emerging technologies and methods in field biology including, for example, bio-telemetry, environmental remote sensing, camera-trapping, and photogrammetry. After the field trip, students will participate in lectures and workshops on data analysis, computational ethology, interpretation, manuscript preparation, and science communication. In the final week, students will participate in a mini-conference presenting posters and/or scientific seminars on the results of their experiments.
Forms of teaching / Amount of SWS	10 (+ 4, "*Field Research in Behavioral Ecology*")
Work load	200 (+ 100) h Attendance time 100 (+ 50) h Preparation and post-processing
Credits for this unit	10 (+ 4, "*Field Research in Behavioral Ecology*")
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 1. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

Systems Toxicology</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>Advanced course of scientific lab work consisting of lecture, internship and single projects.</td></tr>
<tr><td colspan="4">Educational objectives</td><td>Knowledge of Systems Toxicology, with direct experience in independently conducting small projects and developing oral and poster presentation skills.</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Dr. Ivano Amelio</td></tr>
<tr><td colspan="4">Teaching content</td><td>The theoretical part will provide a comprehensive overview of the research priorities and methodologies of the Systems Toxicology, with in-depth focuses in specific areas as examples of GxE in the toxic response. This part will include background lectures, followed by specific scientific seminars on relevant research topics and completed by a set of journal clubs on recent literature in the field.</td></tr>
<tr><td colspan="4">Forms of teaching / Amount of SWS</td><td>5</td></tr>
<tr><td colspan="4">Work load</td><td>60 h Attendance time
90 h Preparation and post-processing</td></tr>
<tr><td colspan="4">Credits for this unit</td><td>5</td></tr>
<tr><td colspan="4">Examination and unit completion</td><td>Journal club / seminar</td></tr>
<tr><td colspan="4">Prerequisites</td><td>Good background in biochemistry (e.g. biochemistry II lecture), cell biology, pharmacology (e.g. pharmacology and toxicology I lecture), physiology and human biology</td></tr>
<tr><td colspan="4">Language</td><td>English</td></tr>
<tr><td colspan="4">Time slot and frequency of the course</td><td>Summer term, 2. half</td></tr>
<tr><td colspan="4">Module unit</td><td>b. Internship</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Dr. Ivano Amelio</td></tr>
<tr><td colspan="4">Teaching content</td><td>The students involved in the practical components will be integrated in the research activity of the group under the guidance of a tutor. The students will be assigned a specific experimental task (i.e. small project) that will represent part of a larger research project conducted in the laboratory. The student will be coached and trained for the experimental procedures, and the analysis and interpretation of the data with</td></tr>
</table>

	the goal of preparing her/him to future research activities in the area. Current research projects in the Chair for Systems Toxicology: - Molecular mechanisms for maintenance of genome integrity - Identification of novel genomic loci for hypersusceptibility to genotoxicants (Fbox proteins). - Context-dependent cell death decisions in response to cytotoxic drugs - Role of p53 variants in tumorigenesis - Epigenetic regulations of stress response by BAP-1
Forms of teaching / Amount of SWS	10
Work load	200 h Attendance time 100 h Preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summer term, 2. half

Study program/Usability **Master Biological Sciences** **Master Life Science**				**Module Title: Advanced Courses** **Theoretical and Experimental Ecology and Evolution**
Credits	15			
Module grade				The module mark for Life-Science-Students is composed of the individual examination results within this module.
Module units				Advanced course of scientific lab work consisting of lecture, internship and single projects.
Educational objectives				The participants of the course will learn about the novel research field of eco-evolutionary dynamics, ecological and evolutionary theory of species interactions and community ecology.
Module unit				**a. Lecture and Seminar**
Coordinator				Prof. Dr. Becks
Teaching content				The participants will learn to identify research questions and design their own experiments and analyses of mathematical models to answer research questions. They will learn a large range of methods used in ecology and evolution.
Forms of teaching/Amount of SWS				5
Work load				60 h Attendance time 90 h Preparation and post-processing
Credits for this unit				5
Examination and unit completion				Journal club / seminar
Prerequisites				Interest in ecology and evolutionary biology.
Language				English
Time slot and frequency of the course				Summerterm, 1. Half
Module unit				**b. Internship**
Coordinator				Prof. Dr. Becks
Teaching content				The participants will learn to identify research questions and design their own experiments and analyses of mathematical model to answer research questions. They will learn a large range of methods used in ecology and evolution.
Forms of teaching/Amount of SWS				10

Work load	200 h Attendance time 100 h preparation and post-processing
Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Summerterm, 1. half

<table>
<tr><td colspan="4">Study program/Usability

Master Biological Sciences
Master Life Science</td><td rowspan="2"><u>Module Title: Advanced Courses</u>

The role of microbes in stress response and resilience of aquatic metaorganisms</td></tr>
<tr><td>Credits</td><td>15</td><td>Duration</td><td>6 weeks</td></tr>
<tr><td colspan="4">Module grade</td><td>The module mark for Life-Science-Students is composed of the individual examination results within this module.</td></tr>
<tr><td colspan="4">Module units</td><td>The advanced course consists of a theoretic/background part with lectures and seminars and an internship with individual projects.</td></tr>
<tr><td colspan="4">Educational objectives</td><td>The students will be exposed to current conceptual and methodological approaches in metaorganism research. All plant and animal organisms alike associate with microbes that contribute to their ecology, well-being, and even adaptation. In the course, we will cover how to study microbial diversity and function with a particular emphasis on coral metaorganisms and aquatic model system metaorganisms. In the theoretical part of the module, the students learn about the current state of the field by lectures. Based on this background, they are encouraged to develop a hypothesis together with their supervisor. Furthermore, in this part of the course the students present and discuss original publications in the form of a seminar to understand how to deconstruct published information.

In a second practical part, the students address experimentally or bioinformatically current research questions in a one-to-one interaction with their supervisor. Based on the framed hypotheses, the students will learn to plan and conduct experiments including the design of proper experimental controls. The students will learn to generate and analyze raw data, summarize results, and present their data to peers. Finally, the students will have the opportunity to refine or reformulate their starting hypothesis. The students should understand that this iterative process is key to scientific discovery.</td></tr>
<tr><td colspan="4">Module unit</td><td>a. Lecture and Seminar</td></tr>
<tr><td colspan="4">Coordinator</td><td>Prof. Dr. Voolstra</td></tr>
</table>

Teaching content	The lectures cover the following areas of microbial ecology/metaorganism genomics: holobionts and metaorganisms; signaling between microbes and animal/plant hosts; cnidarian-dinoflagellate symbiosis; coral reefs; coral bleaching; stress resilience; stress tolerance; aquatic ecosystems; emerging model systems; functional microbial ecology; climate change. We will also cover experimental strategies, experimental design types, limitations of methodologies, next-generation sequencing, metagenomics, metatranscriptomics, marker gene sequencing, gene expression profiling, introduction to metabolomics.
Forms of teaching/Amount of SWS	5
Work load	60 h Attendance time 90 h Preparation and post-processing
Credits for this unit	5
Examination and unit completion	Seminar
Prerequisites	Knowledge on Molecular Biology, Genomics, Microbiology, Ecology are an asset.
Language	English
Time slot and frequency of the course	Winter term, 2. Half
Module unit	**b. Internship**
Coordinator	Prof. Dr. Voolstra
Teaching content	Individual projects will be conducted alongside existing lines of research concerning the role of microbes in stress response and resilience of aquatic metaorganisms that address the following topics: microbes and thermal tolerance, microbes and stress resilience, role of specific bacteria to coral health, role of specific bacteria in the model system Aiptasia, probiotics to increase metaorganism resilience, metaorganism composition across environmental gradients, effect of climate change on metaorganism composition and function
Forms of teaching/Amount of SWS	10
Work load	200 h Attendance time 100 h preparation and post-processing

Credits for this unit	10
Examination and unit completion	Colloquium and written report
Language	English
Time slot and frequency of the course	Winter term, 2. half

MODULE TITLE:

Optional Courses

The list of compulsory/optional courses may vary from semester to semester; some of them are offers only in one year periods. The actual list is available at the ZEuS:

https://zeus.uni-konstanz.de/hioserver/pages/cm/exa/coursecatalog/showCourseCatalog.xhtml?_flowId=showCourseCatalog-flow&_flowExecutionKey=e6s1

Study program/Usability Master Biological Sciences				**Internship: Practical work Experience**
Credits	15	**Duration**	2 month	
Module grade				The module is ungraded.
Module units				The module consists of an internship mainly at non-university research institutions.
Educational objectives				The students will be exposed to conditions and concepts of practical research within the context of industrial research. The students will get experience as a training on the job.
Coordinator				Professors of the Department of Biology
Teaching content				• An internship at the respective research institutions and writing of an experience report. • A lectures offered as part of an advanced module (worth 5 credits) A university teacher or Privatdozent shall supervise the student during the intern-ship. Academic staff may also be appointed as supervisors if they have long-standing successful teaching experience, and, upon recommendation of the Faculty Board, have been authorized to conduct examinations by the Rectorate as per § 52 para. 1 sentence 5 LHG.
Forms of teaching/Amount of SWS				Internship + Lecture/15 SWS
Work load				400 h Attendance time 50 h Preparation and post-processing (report)
Credits for this unit				15
Examination and unit completion				Experience report: Students have complete their internship by submitting a qualified final report to their supervisor.
Prerequisites				All private or public institutions in Germany or abroad are suitable for the internship if the student can experience practical work in the field of biological sciences there. Practical work experience (internship) shall be at least two months in length.
Language				depends on the respective research institution
Time slot and frequency of the course				1.-5. Semester (winter and summer semester)

Study program/Usability Master Biological Sciences				**Master preparation course**
Credits	12	**Duration**	3 month	
Module grade				The module is ungraded.
Module units				The module consists of an internship in the working group in which the master's thesis will be completed.
Educational objectives				Specific preparation (in theory and practice) for the following work on the master's thesis.
Coordinator				Supervisor of the following master´s thesis
Teaching content				Students become acquainted with the foundations of the intended topic area of their master's thesis. In particular, they will acquire special methodological knowledge and learn how to use the relevant expert literature.
Forms of teaching/Amount of SWS				Internship + Literature work/15 SWS
Work load				360 h
Credits for this unit				12
Examination and unit completion				Progress report (oral or written)
Prerequisites				Students must have successfully completed all course-related performance assessments (according to the Study and Examination Regulations).
Language				English
Time slot and frequency of the course				3. semester

Study program/Usability Master Biological Sciences Master Life Science				**Module TITLE** **Masters project**	
Credits	30	**Duration**	6 Month	**Part of module of total rating**	33 %
Module grade	The grade of the Masters project is calculated as the average of the grades provided by the two referees.				
Coordinator	Lecturers of the Department of Biology				
Educational objectives	The students are expected to pursue a scientific project in the area of biology, within a given time frame, in an independent manner, and to document their achievements in form of a written thesis.				
Teaching content	Aim is to impart the ability to independently establish a work-plan suited to complete the proposed masters-project within the prescribed time-frame, independently acquire knowledge corresponding to the current state of the scientific literature, gaining expertise in the methods and approaches required to perform the experimental work, independently examine, analyze, rate and discuss the achieved results, and collate all of the above in form of a written masters-thesis.				
Forms of teaching/ Amount of SWS	full-day tutoring in how to work scientifically as part of a team				
Work load	900 hours				
Examination and unit completion	Preparation of the written masters thesis				
Prerequisites	Successful completion of all exams specified in the rules and regulations governing the “Masters Biological Sciences” or “Masters Life Science” course of studies Immatriculation at the University of Konstanz				
Language	German, English				
Time slot and frequency of the course	Winter- and Summer-semester				
Recommended Term	4. Semester				
Compulsory/ Optional course	Compulsory course				