Kiel University
Christian-Albrechts-Universität zu Kiel

Faculty of Mathematics and Natural Sciences

Module Catalogue

for Molecular Biology and Evolution

Master, 1-subject

Version 2015

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Module Name	Module Code
Evolution of Organisms and Molecules	biol600
Module Coordinator	
Prof. Dr. Eva Holtgrewe-Stukenbrock Prof. Dr. Hinrich Schulenburg	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	2 semester
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260,5 hours
Contact Time	84 h
Independent Study	84 + 52,5 = 136,5
Teaching Language	English

Recommended Requirements			
Basic knowledge of evolutionary biology			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Evolution of organisms and molecules	Compulsory	2
Seminar	Evolution of organisms and molecules	Compulsory	2
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and seminar			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination 1: Evolution of Organisms and Molecules	Written Examination	Graded	Compulsory	50
Written Examination 2: Evolution of Organisms and Molecules	Written Examination	Graded	Compulsory	50

Short Summary

Evolution is key to our understanding of biology, because the characteristics of an organism or any biological process is a consequence of its evolutionary past. Full appreciation of biological complexity and molecular dynamic mechanisms require detailed knowledge of evolution. This course provides an in-depth overview of evolution, the underlying mechanisms, the current concepts and also current research activities.

Course Content

Detailed introduction into evolutionary biology, its past history and current research activities, including an overview of important concepts and mathematical models. Topics covered include population genetics, sexual selection, behavioral ecology, molecular evolution, phylogeny, host-parasite coevolution, altruism, selfish genes, genome evolution. Critical reading, seminar presentation, and discussion of current articles on the topic. Creative development of new ideas.

Learning Outcome

The students acquire an in-depth understanding of evolutionary concepts, underlying mathematical models, and current research activities. The students are able to use their knowledge to develop new concepts. The students possess competences in the critical evaluation of current primary research articles. The students are able to present and explain complex scientific concepts and results, and discuss these with others.

Reading List

M. Ridley: Evolution

N. Barton et al.: Evolution

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Module Name	Module Code
Molecular Biology of Dynamic Processes	biol601
Module Coordinator	
Prof. Dr. Tal Dagan Prof. Dr. Frank Kempken	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	2 semester
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260,5
Contact Time	84 h
Independent Study	84 + 52,5 = 136,5 h
Teaching Language	English

Recommended Requirements			
Bachelor in Biology or related subject			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Molecular biology of dynamic change	Compulsory	2
Seminar	Advanced Molecular Biology Research	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in the lecture and seminar. Passing a poster presentation each semester.			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination 1: Molecular Biology of Dynamic Processes	Written Examination	Graded	Compulsory	50
Written Examination 2: Molecular Biology of Dynamic Processes	Written Examination	Graded	Compulsory	50

Short Summary
This module will present a comprehensive view of advanced topics in molecular biology, important model systems and techniques. The teaching of molecular biology topics will be done within the framework of established model organisms.
Course Content
The module will review the biology of molecules such DNA, RNA, and proteins and their functional dynamics in prokaryotic and eukaryotic systems. This includes DNA mutation, repair and recombination, Epigenetics, RNA regulation, Gene expression and protein function. Additional topics in cell biology will comprise organelles biology, signal transduction, cell cycle and developmental genetics.
Learning Outcome
The students will acquire an in-depth understanding of cell biology and the underlying molecular biology. In addition, the students will perform a literature research project where they will be encouraged to use their knowledge to develop new synthesis. The students will be able to present and explain complex biological systems and techniques as well as discuss these with others.
Reading List

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Name	Code
Optional Section: Evolution of Organisms and Molecules	biol602
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	15
Evaluation	Graded

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Module Name	Module Code
Evolution of UV-B Resistance	biol221
Module Coordinator	
Prof. Dr. Wolfgang Bilger	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	2 weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	134,5 hours
Contact Time	42 h
Independent Study	31,5 + 21 = 52,5
Teaching Language	English

Recommended Requirements			
Basic knowledge of plant stress physiology, especially high light stress			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Evolution of UV-B resistance	Compulsory	1
Practical exercise	Evolution of UV-B resistance	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Evolution of UV-B resistance	Protocol	Graded	Compulsory	70
Seminar Coursework: Evolution of UV-B resistance	Seminar Course-work	Graded	Compulsory	30

Short Summary
An important precondition for the move of plants from the sea to the land during evolution was the possession of UV-B protecting pigments. In the course the various strategies for UV protection in terrestrial and aquatic cyanobacteria, algae and vascular plants will be compared and analyzed.
Course Content
Strategies for UV-B protection, different biochemical pathways for the formation of UV absorbing pigments and their potential evolutionary development. Techniques for the in vivo investigation of damage and photoprotection, analyses of pigment content. Critical reading and discussion of current research publications and their presentation. Design of experiments.
Learning Outcome
The students understand the physiology of damage by UV radiation, the protection strategies against it and their evolution. The students know to develop hypotheses and to design an experiment. They are able to employ techniques for damage evaluation, UV-B radiation measurement and pigment analysis. They are able to critically discuss current concepts. They are able to evaluate and to present research results and know to write a report.
Reading List
Original publications, CS Cockell, AR Blaustein (2001) Ecosystems, Evolution , and Ultraviolet Radiation. Springer, New York

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Environmental Management, (Version 2017)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Evolution, Ecology and Genetics	biol227
Module Coordinator	
Prof. Dr. Hinrich Schulenburg	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	136 hours
Contact Time	42 h
Independent Study	31,5 + 21 = 52,5
Teaching Language	English

Recommended Requirements			
Basic knowledge of concepts in evolutionary biology			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Evolution, Ecology and Genetics	Compulsory	1
Practical exercise	Evolution, Ecology and Genetics	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Evolution, Ecology and Genetics	Protocol	Graded	Compulsory	50
Seminar Coursework: Evolution, Ecology and Genetics	Seminar Course-work	Graded	Compulsory	50
Further Information on the Examination(s)				
Ausweis bei Anmeldung im Prüfungsamt.				

Short Summary
The course focuses on the recent novel insights in biology and biomedicine, which have been obtained through the interdisciplinary approach of connecting evolutionary concepts with ecological processes and genetic mechanisms. Each year, the course will address a novel topic of particular current interest, for example the rapid evolution of antibiotic resistance in pathogens or the evolution of complexity in animal immune systems.
Course Content
Introduction into the current concepts in Evolutionary Ecology and Genetics, their discussion, and their further development. Critical reading and discussion of current articles on the topic. Creative development of new ideas. Introduction into experimental analysis of theoretical concepts. Presentation of research concepts and results and their critical discussion within the group.
Learning Outcome
The students acquire in-depth understanding of current concepts in evolutionary ecology and genetics. The students possess competence in the experimental analysis of these topics. The students are able to use creativity combined with their knowledge to develop new concepts. The students possess competences in the critical evaluation of current primary research articles. The students are able to present and explain complex scientific concepts and results, and discuss these with others.
Reading List
Current research papers, as provided at beginning of course General introduction into evolutionary biology, such as: Evolution by Ridley; Evolution by Barton et al.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Environmental Management, (Version 2017)	Optional	-
Master, 1-subject, Environmental Management, (Version 2013)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 1-subject, Sustainability, Society and the Environment, (Version 2013)	Optional	-
Master, 1-subject with Minor Subject, Prehistoric and Historic Archeology, (Version 2007)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	-

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Module Name	Module Code
Inference of Positive Selection	biol243
Module Coordinator	
Prof. Dr. Eva Holtgrewe-Stukenbrock	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	135 hours
Contact Time	63h
Independent Study	31,5 + 10,5 = 42
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Inference of positive selection	Compulsory	2
Internship	Inference of positive selection	Compulsory	4
Further Information on the Courses			
12 places			
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Inference of Positive Selection	Seminar Course-work	Graded	Compulsory	50
Written Report: Inference of Positive Selec-tion	Written Report	Graded	Compulsory	50

Short Summary
Positive selection occurs when a new or previously rare mutation confers a fitness advantage to individuals carrying it. Positive selection is essential in the adaptation of organisms to new ecological niches, environmental changes or during the divergence of new species. Different methods allow us to detect signatures of positive selection in sequence data, but using different statistical approaches. In this course we will discuss concept of sequence evolution, and we will see and use different methods for detection of positive selection in nucleotide as well as amino acid sequence data.
Course Content
The course will introduce the population genetics theory of positive selection. Central questions addressed in this course are: What is positive selection, and what is the impact of positive selection on speciation and adaptation to new environments. How can positive selection be detected in DNA/protein sequences? The course will introduce models of codon sequence evolution that can be used to infer positive selection. The students will read and discuss original key articles: Mc Donald and Kreitman (1991), Nei and Gojobori (1986), Yang and Nielsen (1998). Methods presented will be used by the students with real data analysis. Standard software will be presented such as DNASP and PAML. Participants will learn how to prepare a data set of molecular sequences, with emphasis on the alignment improvement. We will also emphasize the underlying statistical concepts of the methods introduced.
Learning Outcome
The course enables students to understand the theory of positive selection and to learn methods and tools for analyses of DNA/protein sequences. Students use and learn state of the art software in the field by analyse real datasets (practical part).
Reading List
Computational Molecular Evolution Ziheng Yang, October 2006, Oxford University Press CHAPTER 8 Neutral and Adaptive Protein Evolution Kosiol, Carolin, and Maria Anisimova. "Selection on the protein-coding genome." Evolutionary Genomics. Humana Press, 2012. 113-140.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Population Genomics	biol244
Module Coordinator	
Prof. Dr. Eva Holtgrewe-Stukenbrock	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	135 hours
Contact Time	63 h
Independent Study	42 + 21 = 63
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Population genomics	Compulsory	2
Internship	Population genomics	Compulsory	4
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Population Genomics	Seminar Course-work	Graded	Compulsory	100

Short Summary
Advances in next generation sequencing techniques allow the analyses of genomic data from multiple individuals of the same species. “Population genomics” is the field wherein patterns of genetic variation across full genomes of many individuals is analysed. By assessing the distribution of variable sites in coding and non-coding parts of the genome, we can learn about the effects of natural selection, recombination, genetic drift and effective population size on genome evolution. The course will give an introduction into key concepts in the field of population genomics and introduce methods for analyses of population genomic data.
Course Content
The module will present the concepts of population genomics and relate these to “traditional” population genetics. The concepts presented and discussed in the course will be explained with examples from primary literature including population genomics studies of Primates, Insects, Plants, and Fungi. The common features as well as the particularities of these examples will be emphasized. Computer exercises will be conducted with real data. Analyses of population genomic datasets will include SNP calling, analyses of SNP data, inference of natural selection and comparisons of within species structural genome variation.
Learning Outcome
Students understand and discuss concepts in population genomic analyses, including variation of population genetics parameters along the genome (effective population size, recombination rate, mutation rate, GC content etc). The students will be introduced to genome browsers and learn to use these. Analyses of real population genomic data will provide the students with insight into genome analyses, including software and data formats. The attendants will learn how to read, process and analyze of comparative genomic data such as multiple genome alignments and variant calls (SNPs).
Reading List
Michael Lynch: The origins of genome architecture Sinauer associates Chapter 4: Why Population Size Matters Chapter 6: The Nucleotide Composition Landscape Chapter 8: Genomic Expansion by Gene Duplication

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Molecular Evolution of Biotic Interactions	biol247
Module Coordinator	
Prof. Dr. Dietrich Ober	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	134,5 hours
Contact Time	10,5h + 31,5h = 42h
Independent Study	31,5h + 21h = 52,5h
Teaching Language	German / English

Further Information on the Teaching Language			
German as teaching language is possible if all participants have German as native language.			
Recommended Requirements			
Basic knowledge of experimental work and of methods of molecular biology.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Molecular Evolution of Biotic Interactions	Compulsory	1
Practical exercise	Molecular Evolution of Biotic Interactions	Compulsory	3
Further Information on the Courses			
Special seminar including practical part, small project within the research group			
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar/lecture and practical.			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination: Molecular Evolution of Biotic Interactions	Written Examination	Graded	Compulsory	60
Seminar Coursework: Molecular Evolution of Biotic Interactions	Seminar Coursework	Graded	Compulsory	40
Further Information on the Examination(s)				
Exams within the duration of the course.				

Short Summary
Studies of the evolution of organismic interactions require a good understanding of the basics of gene evolution. The course will provide an introduction into models of gene evolution and into methods used to study organismic interactions on the molecular level.
Course Content
Basics of molecular evolution with a special focus on the evolution of genes by gene duplication. Introduction to actual methods of molecular biology and biochemistry for evolutionary and functional analyses of proteins, natural compound analysis. Practical wok on a project in this field of science.
Learning Outcome
The students have a good overview about the basics of molecular evolution and have developed an understanding of the mechanisms of adaptation and specialization resulting in biodiversity. They have knowledge about various experimental and computational research methods and competence in experimental design and hypothesis-driven research. The students are able to present and discuss own results in front of a molecular evolutionary background.
Reading List
Specific literature (including original research articles) will be provided during the introductory seminar or during the course.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Functional Morphology of Invertebrata	biol251
Module Coordinator	
Prof. Dr. Stanislav Gorb	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	136 hours
Contact Time	42 h
Independent Study	52,5 +31,5 = 84 h
Teaching Language	German / English

Recommended Requirements			
Basic knowledge of statistics and experimental design			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Functional Morphology of Invertebrates	Compulsory	1
Seminar	Functional Morphology of Invertebrates	Compulsory	1
Practical exercise	Functional Morphology of Invertebrates	Compulsory	2
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Oral Examination: Functional Morphology of Invertebrata	Oral Examination	Graded	Compulsory	60
Seminar Coursework: Functional Morphology of Invertebrata	Seminar Coursework	Graded	Compulsory	40
Protocol: Functional Morphology of Invertebrata	Protocol	Not graded	Compulsory	-

Short Summary

The understanding of relationships between structure and function is crucial in organismic biology. It is especially important in the science of evolution.The course provides an introduction into the basics of functional morphology of invertebrates on a series of examples from different representatives of Arthropoda. Some basics of biomechanics will be also discussed.

Course Content

Comparative morphological studies of different functional systems of invertebrates, ultrastructure, evolutionary and phylogenetic aspects of relationships between structure and function, biomechanics, methods of preparation, various types of microscopy, basics of experimental design

Learning Outcome

The students acquire an understanding of the evolution of different systems of organs, adaptations to the environment, diversity of functional solutions, and in the physical principles behind biological structure. The students possess competence in experimental design, data presentation, and various microscopy techniques. The students will be able to recognize and explain functional principles behind morphological characters. They will obtain the ability to explore structure-function relationship using classical well-established and modern methods. Finally, they will refine their ability to make good scientific presentations.

Reading List

Kästner: Lehrbuch der speziellen Zoologie

Ruppert/Barnes: Invertebrate Zoology. 6th edition

Storch, V. Welsch. U. Lehrbuch der speziellen Zoologie

Storch, V. Welsch. U. Kükenthal Zoologisches Praktikum

S. M. Manton. 1977: The Arthropoda. Clarendon Press Oxford

W. H. Freeman & B. Bracegirdle. 1985. An atlas of invertebrate structure. Heinemann educational books

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	-

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Module Name	Module Code
Biomechanics and Biomimetics/Bionik	biol252
Module Coordinator	
Prof. Dr. Stanislav Gorb	
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks, all day laboratory course
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	157,5 hours
Contact Time	42 h
Independent Study	63 h
Teaching Language	German / English

Recommended Requirements			
Basic knowledge of statistics and experimental design			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Biomechanics and Biomimetics/Bionik	Compulsory	1
Seminar	Seminar Biomechanics and Biomimetics/Bionik	Compulsory	1
Practical exercise	Exercise: Biomechanics and Biomimetics/Bionik	Compulsory	2

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Oral Examination: Biomechanics and Bio-mimetics/Bionik	Oral Examination	Graded	Compulsory	60
Seminar Coursework: Biomechanics and Biomimetics/Bionik	Seminar Course-work	Graded	Compulsory	40
Protocol: Biomechanics and Biomime-tics/Bionik	Protocol	Not graded	Compulsory	-

Short Summary
The understanding of functional significance of mechanically-relevant surface structures is very important in organismic biology. It is especially important in the science of evolution, but may provide an important basic for biomimetics/Bionik, which is the implementation of biological functional principles into technical applications.The course provides an introduction into the basics of functional morphology of surfaces of animals and plants on a series of striking successful examples from biomimetics/Bionik.
Course Content
Basics of surface biomechanics of different functional systems of animals and plants, ultrastructure, evolutionary and phylogenetic aspects of relationships between structure and function, methods of preparation, various types of microscopy, basics of biomechanical experimental design, abstraction as a method of biomimetics/Bionik
Learning Outcome
The students acquire an understanding of the mechanical significance of different biological surfaces, adaptations to the environment, diversity of functional solutions, and physical principles behind biological structure. The students will obtain strong skills in the ability of potential implication of biological results for technical applications. They will learn state of the art of biomimetic/Bionik inventions of last years. In the course of the seminar, each student will prepare an integrative presentation of one of the topics of biomimetics/Bionik that will improve their ability to make good scientific presentations.
Reading List
W. Nachtigall, Biomechanik. Grundlagen - Beispiele - Übungen S. Vogel, Comparative Biomechanics: Life's Physical World S.A. Wainwright, Mechanical Design in Organisms K. Kendall, Molecular Adhesion and its Applications W. Nachtigall, Bionik. Grundlagen und Beispiele für Ingenieure und Naturwissenschaftler

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Materials Science and Engineering, (Version 2014)	Optional	-
Master, 1-subject, Materials Science and Engineering, (Version 2010)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Evolutionary Genetics	biol253
Module Coordinator	
Diethard Tautz	
Organizer	
Max-Planck-Institut für Evolutionsbiologie	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	134 hours
Contact Time	42 h
Independent Study	52,5 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of molecular biology and laboratory work			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Methods in Evolutionary Genetics	Compulsory	1
Practical exercise	Methods in Evolutionary Genetics	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Evolutionary Genetics	Presentation	Graded	Compulsory	50
Protocol: Evolutionary Genetics	Protocol	Graded	Compulsory	50

Short Summary
Understanding the nature and distribution of polymorphisms is a fundamental prerequisite for understanding the process of evolution. The course deals with methods and statistical procedures for detecting and evaluating molecular polymorphisms in populations at the DNA level.
Course Content
Polymorphism types in molecular evolutionary analysis of populations (SNPs, micro-satellites, mitochondrial haplotypes), methods for detecting polymorphisms (sequencing and length measurements), high throughput methods (next generation sequencing), experiments in population genetics (DNA extraction, PCR and sequencing), scoring of polymorphisms, statistical analysis (analysis of population differentiation, detection of natural selection)
Learning Outcome
The students acquire an understanding of basic concepts of evolutionary genetic analyses, train basic experimental methods, learn how to design an experiment in population genetic analysis, low how to apply statistical methods and algorithms in population genetic analysis. The students will read primary research papers on selected statistical methods and present their results in the context of a scientific question.
Reading List
Herron and Freeman, Evolutionary Analysis

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

Module Name	Module Code
Evolutionary Game Theory	biol620
Module Coordinator	
Arne Traulsen	
Organizer	
Max-Planck-Institut für Evolutionsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	135 hours
Contact Time	42 h
Independent Study	31,5 + 31,5 = 63 h
Teaching Language	English

Recommended Requirements			
Basic knowledge of applied mathematics (e.g. derivatives, basic probability)			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Evolutionary game theory	Compulsory	1
Exercise	Evolutionary game theory	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in exercises.			
Further Requirements for Awarding ECTS Credits			
Written exercises, 50% of the total points in the exercises have to be obtained during the course. In addition, every student has to present one solved exercise in the exercise sessions.			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Oral Examination: Evolutionary Game Theory	Oral Examination	Graded	Compulsory	100

Short Summary
The course gives an introduction to evolutionary game theory as an intuitive modelling approach. The course is focused on analytical approaches and thus requires a basic familiarity with applied mathematics. Solving exercises is an essential part of the course and will allow students to use these tools to address questions.
Course Content
Basics of classical game theory, deterministic and stochastic evolutionary game dynamics, the evolution of cooperation, structured populations, repeated games, applications in genetics, ecology and social dynamics
Learning Outcome
The students can explain and apply the basic concepts of game theory. They can construct evolutionary models based on game theoretic interactions. They can analyse simple models based on evolutionary games formally.
Reading List
Nowak, Evolutionary Dynamics – Exploring the equations of life (Harvard University Press, 2006) Broom & Rychtá#, Game-Theoretical Models in Biology (Chapman & Hall, 2013)

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Man as a Factor of Evolution - Case Studies in Vertebrates	biol621
Module Coordinator	
Prof. Dr. Günther Hartl	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	140 hours
Contact Time	42 hours
Independent Study	63 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of population genetic laboratory techniques and statistical evaluation of results			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Man as a Factor of Evolution - Cases and Research Methods	Compulsory	1
Seminar	Conservation Genetics in Vertebrates	Compulsory	1
Exercise	Statistical Tools in Conservation Genetics	Compulsory	2
Prerequisits for Admission to the Examination(s)			
Active participation in lecture, seminar, and course			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Presentation: Man as a Factor of Evolution - Case Studies in Vertebrates	Presentation	Graded	Compulsory	30
Protocol: Man as a Factor of Evolution - Case Studies in Vertebrates	Protocol	Graded	Compulsory	70

Short Summary

Vertebrate populations dwelling in the cultivated landscape are subjected to a number of anthropogenic influences, such as landscape fragmentation, translocations, (re-) introductions, keeping in enclosures, and trophy hunting. These influences often have a profound effect on demographic parameters, resulting in increased genetic drift, altered selection, genetic depletion (inbreeding depression) or incompatibilities within gene pools (outbreeding depression).

Course Content

Based on case studies in vertebrates, the students are introduced into specific problems associated with anthropogenic influences on population size and structure. Molecular techniques commonly used in population genetics are reviewed as to their resolution power in monitoring anthropogenic effects on gene pools. Statistics used for defining a population, assessing genetic diversity within and among populations and methods of estimating genetic changes over time and their potential causes are examined and applied to available molecular data sets. The students will also examine original papers and provide talks on published case studies. Pros and cons of various approaches will be discussed.

Learning Outcome

The students will acquire knowledge on the proper selection of both molecular and statistical tools best suited for the detection of various anthropogenic influences on vertebrate populations in the cultivated landscape (lecture). They will gain experience in the handling of molecular datasets and in the specific application of statistical program packages (course). They will acquire competence in the comparative interpretation of population genetic indices and in the evaluation of their findings as well as of published results on the topic (course, seminar).

Reading List

Allendorf, F. W. & Luikert, G. (2007): Conservation and the Genetics of Populations. Blackwell, Malden, MA.
Frankham, R.; Ballou, J. D. & Briscoe, D. A. (2007): Introduction to Conservation Genetics. Cambridge Univ. Press, NY.
Original scientific papers as distributed during the seminar

Additional Information

Maximum number of participants: 8
The module is open only to students of “Molecular Biology and Evolution”

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Name	Code
Optional Section: Molecular Biology of Dynamic Processes	biol603
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Module Name	Module Code
Environmental Stress Adaptation in Plants	biol214
Module Coordinator	
Prof. Dr. Margareta Sauter	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	134 hours
Contact Time	42h
Independent Study	31,5 + 21 = 52,5
Teaching Language	English

Recommended Requirements			
Basic knowledge of plant biology.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Environmental stress adaptation in plants	Compulsory	1
Practical exercise	Environmental stress adaptation in plants	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Environmental Stress Adaptation in Plants	Seminar Course-work	Graded	Compulsory	30
Written Examination: Environmental Stress Adaptation in Plants	Written Examina-tion	Graded	Compulsory	70

Short Summary
Plants possess the ability to adapt to their environment. Plant growth and development is driven by genetic programs which are however highly variable to compensate for the sessile life style of plants. This course focusses on the stress hormone ethylene that helps plants to adapt for instance to flooding conditions. The student learns about the genes that drive ethylene synthesis and signaling, and about environmental stresses that induce ethylene signaling. This course teaches experimental approaches to study adaptative responses to environmental sress.
Course Content
Introduction into plant stress physiology and into plant stress hormones. Use of mutants to decipher the ethylene signaling pathway, of protein-based methods, and of analytical methods to study ethylene synthesis and function. Setup of laboratory experiments. Comparison of genetic approaches and protein analysis. Presentation of research findings. Study, presentation, and discussion of primary research literature.
Learning Outcome
The students will acquire knowledge on the plant stress hormone ethylene. They will know ethylene-mediated stress responses including flooding adaptation. They will have knowledge on the application of appropriate research methods and the value of experimental results. They will be able to summarize and evaluate their data and the methods used in a general context. The seminar will introduce students to the current literature on the topic and to the presentation of primary literature.
Reading List
Taiz, Zeiger ‘Plant Physiology’ Chapters 22 and 26, Spektrum Verlag Primary literature supplied during the course.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, AgriGenomics, (Version 2017)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester

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Module Name	Module Code
Molecular Microbiology: Metagenomic and Biotechnology	biol216
Module Coordinator	
Prof. Dr. Ruth Anne Schmitz-Streit	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	120,8 hours
Contact Time	42 hours
Independent Study	78,8 hours
Teaching Language	German / English

Entry Requirements as Stated in the Examination Regulations
BSc Biology
Recommended Requirements
Knowledge of molecular biology and microbiology, practical experience of experimental work in the laboratory

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Molecular microbiology	Compulsory	1
Practical exercise	Molecular microbiology	Compulsory	2
Seminar	Bacterial metabolism physiology and molecular bio-technology	Compulsory	1

Further Information on the Courses
Max. 10 participants (both masters)
Prerequisits for Admission to the Examination(s)
Active participation in both seminar and practical; submission of a protocol
Further Requirements for Awarding ECTS Credits
None

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Microbiology: Metage-nomic and Biotechnology	Protocol	Not graded	Compulsory	-
Written Examination: Molecular Microbio-logy: Metagenomic and Biotechnology	Written Examina-tion	Graded	Compulsory	100

Short Summary
Microorganisms are ubiquitous distributed and possess various physiological benefits and properties. Today roughly only 0.5 % of all microorganisms are described and cultivated, which is due to by the high amount of species uncultivable under laboratory conditions. In this module we compare modern molecular gene-tic tools as well as bioinformatics analysis of the generated data and classical microbiological methods to determine the biodiversity of different habitats
Course Content
Introduction of molecular microbiology methods to characterise the microbial diversity of different habitats and biotechnological utilisation of the respective genetic potential using a metagenomic approach. Exem-plarily selected habitats are analysed using (i) modern molecular genetic tools like phylogenetic 16 S rDNA analyses, FISH anlyzes, and PCR amplification to detect and analysis marker genes (key genes of certain metabolisms) to determine the microbial diversity or (ii) classical microbiological methods for enrichment of cultivatable microorganisms and (iii) the whole genetic information for potential biotechnological applications will be studied. One or two biotechnological processes will be performed (production of beer and of biotech-nological interesting enzymes). Furthermore students will be guided to good scientifical practice and critical review of their results.
Learning Outcome
The students will acquire practical knowledge on various microbial cultivations and molecular and genetic tools and bioinformatic analysis of 16S rDNA data sets. They will be able to present and discuss their data in a protocol. In the seminar they learn to present current literature in a short talk.

Reading List
Lecture: Schlegel/Fuchs Allgemeine Mikrobiologie (Thieme Verlag, 8. Auflage), Munk Mikrobiologie (Spektrum Verlag), Brock Mikrobiologie (Spektrum Verlag), Molecular Genetics of Bacteria (ASM Press), Angewandte Mikrobiologie (Springer Verlag) 'Molecular Genetics of bacteria' L. Snyder, J E. Peters, T M. Henkin, W.Champness, 4th edition 2013, ASM Press Practical/Seminar: Script and Primary research literature, as distributed during the course

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester

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Module Name	Module Code
Molecular Genetics and Cell Biology of Plants and Fungi	biol218
Module Coordinator	
Prof. Dr. Frank Kempken	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	135 hours
Contact Time	42 hours
Independent Study	63 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge in molecular genetics and cellular biology			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Molecular Genetics and Cellular Biology of Plants and Fungi	Compulsory	1
Practical exercise	Molecular Genetics and Cellular Biology of Plants and Fungi	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in practical; participation in lecture is recommended			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination: Molecular Genetics and Cell Biology of Plants and Fungi	Written Examination	Graded	Compulsory	75
Protocol: Molecular Genetics and Cell Biology of Plants and Fungi	Protocol	Graded	Compulsory	25

Short Summary
The course focuses on principles and recent achievements in molecular genetics and cellular biology. Important theoretical background, methodology and applications are addressed in the lecture and the practical part. The major focus is on fungal and plant model systems. Experiments in the practical part include aspects of bioinformatics.
Course Content
Introduction into the current concepts in molecular geneticas and cellular biology of plants and fungi. Important principles and new achievements are presented and discussed. The practical will help students to understand the rational of experimental strategies and the specifics of plant and fungal experimental systems.
Learning Outcome
Students are aquainted with the most important methods in cellular biology and molecular genetics, have a good theoretical background and and can use this knowledge to address scientific problems. Students are able to write protocols in a scientific writing stile. Students will be critical towards their own results and are able to use scientific literature to discuss their own work.
Reading List
textbooks on molecular genetics and cell biology as well as primary literature;

Use	Compulsory / Optional	Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	1.-2. Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester

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Module Name	Module Code
Molecular Fundamentals of Ethology and Neurobiology	biol222
Module Coordinator	
Prof. Dr. Thomas Roeder	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	134,5 hours
Contact Time	10,5h + 31,5h = 42h
Independent Study	31,5h + 21h = 52,5h
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Neurobiology	Compulsory	1
Practical exercise	Behaviour and neurobiology	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Neurobiology	Seminar Course-work	Graded	Compulsory	50
Protocol: Behavior and Neurobiology	Protocol	Graded	Compulsory	50

Short Summary
Introduction to basic concepts and methods in behavioural sciences and neurobiology. The course provides an overview of the structure of the nervous system and the mechanisms underlying simple behaviours. Moreover, it provides information about basic experimental strategies that are used in behavioural sciences and neurobiology.
Course Content
Formulation of research questions and hypotheses in the field of behavioural sciences and neurobiology (e.g., cellular substrate to execute complex behaviours, hormonal regulation of behaviours). Application of molecular, computational and microscopic methods to test hypotheses. Evaluation of primary research literature. Presentation of research findings.
Learning Outcome
The students will acquire practical knowledge on basic concepts in behavioral sciences and neurobiology. Moreover, they will have knowledge about various experimental and molecular genetic research methods, including their statistical analysis. They will be able to present their data. During the seminar, students will get to know the current literature on the topic.
Reading List
Neuroscience Online - http://neuroscience.uth.tmc.edu Primary research literature, as distributed during the course

Use	Compulsory / Optional	Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	-
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	-
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Evolution of RNA Regulatory Elements in Prokaryotes	biol231
Module Coordinator	
Prof. Dr. Ruth Anne Schmitz-Streit	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	135 hours
Contact Time	42 h
Independent Study	31,5 + 31,5 = 63 h
Teaching Language	English

Entry Requirements as Stated in the Examination Regulations			
Successful participation in microbiology master course biol237 or proven experience in molecular work			
Recommended Requirements			
Basic knowledge of cell biology, molecular microbiology and genetics; practical experience in experimental work in the laboratory.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Evolution of RNA regulatory elements	Compulsory	1
Practical exercise	Computational and experimental research of RNA regulatory elements in prokaryotes	Compulsory	3
Further Information on the Courses			
Max. 10 participants			
Prerequisits for Admission to the Examination(s)			
Active participation in the lectures and exercises and the submission of a written protocol			
Further Requirements for Awarding ECTS Credits			
Written protocol			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination: Evolution of RNA Regulatory Elements in Prokaryotes	Written Examination	Graded	Compulsory	100

Short Summary

RNA elements play an important role in post-transcriptional and post-translational regulation. The module provides an overview on the evolution of RNA-based regulation as well as the diversity and structure of regulatory RNAs in the prokaryotic domain. The practical part will e.g. focus on the microbial immune system against invasive foreign DNA and will include computational approaches to identify regulatory RNAs and experimental methods to validate those in the laboratory.

Course Content

The module will begin with an introduction into the evolution of RNA-based regulation and non-coding RNA elements in the prokaryotic domain (sRNAs, microRNAs, riboswitches). Further topics include phage-resistance mechanisms with a focus on the CRISPR/Cas system and the respective computational and molecular tools for studying that system. The computational part will include prediction, annotation and phylogenetics of RNA regulatory elements. The experimental exercise will include the following methods: (i) in vitro synthesis of RNA (repeat-spacer-repeat cassette), (ii) purification of an RNA endonuclease (e.g. Cas6), (iii) nuclease activity assays, casposon assays, and /or RNA-RNA interaction measurements by MST. The students will be further instructed in good scientific practice, critical handling of data and the presentation of scientific results.

Learning Outcome

The students will acquire practical and theoretical knowledge of regulatory RNA elements and their evolutionary history. They will gain experience in performing various molecular and biochemical approaches as well as skills in bioinformatic analysis of RNA sequences. Furthermore, the students will gain experience in presenting their data and results in a seminar form. Overall, the students expected to acquire the competence to perform a Master project.

Reading List

Westra ER, Swarts DC, Staals RHJ, Jore MM, Brouns SJJ, van der Oost J. 2012. The CRISPRs, They Are A-Changin': How Prokaryotes Generate Adaptive Immunity. Annu Rev Genet 46:311–339.
Ran FA, Hsu PD, Wright J, Agarwala V, Scott DA, Zhang F. 2013. Genome engineering using the CRISPR-Cas9 system. Nat Protoc 8:2281–2308.
Güell M, Yus E, Lluch-Senar M, Serrano L. 2011. Bacterial transcriptomics: what is beyond the RNA horizome? Nat Rev Microbiol 9:658–669.
Sesto N, Wurtzel O, Archambaud C, Sorek R, Cossart P. 2013. The excludon: a new concept in bacterial antisense RNA-mediated gene regulation. Nat Rev Microbiol 11:75–82.
Storz G, Vogel J, Wassarman KM 2011. Regulation by small RNAs in bacteria: expanding frontiers Mol Cell. 2011 Sep 16;43(6):880-91

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester

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Module Name	Module Code
Evolution and Development	biol233
Module Coordinator	
Prof. Dr. Dr. Thomas Bosch	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	134 hours
Contact Time	42 hours
Independent Study	31,5 + 21 = 52,5 hours
Teaching Language	German / English

Recommended Requirements			
Elementary Zoology, Developmental Biology, and Molecular Biology			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Practical exercise	Evolution and Development	Compulsory	3
Seminar	Evolution and Development	Compulsory	1
Further Information on the Courses			
Block course in the free period			
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination: Evolution and Development	Written Examination	Graded	Compulsory	100

Short Summary
The module will allow students to explore and present one research topic in molecular developmental biology based on primary English literature. They will learn to use the appropriate methodology and their application potential to eventually resolve a given subject/topic.
Course Content
With the help of cell biology and molecular biology methods students are investigating developmental biology related question in early branching metazoan Hydra (Cnidaria).
Learning Outcome
Students will: acquire social competencies while working in groups; learn to present talks with PowerPoint or similar programs, train free speech, gain subject specific competence/knowledge in zoology, developmental biology, and in appropriate methodology, learn to approach certain research questions on the molecular, cellular and/or organismic level.
Reading List
Scripts provided during the class, recommended literature: Developmental Biology, 10th Edition, by Scott F. Gilbert, primary literature for seminar

Use	Compulsory / Optional	Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	-
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	-
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	-

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Module Name	Module Code
Evolution and Biology of Lateral Gene Transfer Mechanisms in Prokaryotes	biol254
Module Coordinator	
Prof. Dr. Tal Dagan	
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks, all day laboratory course
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 Stunden
Total Workload	130 Stunden
Contact Time	42 Stunden
Independent Study	58 Stunden
Teaching Language	English

Further Information on the Teaching Language
The lecture and all course material are in English.
Recommended Requirements
Basic knowledge of cell biology, molecular microbiology and genetics; practical experience in experimental work in the laboratory. Successful participation in experimental microbiology courses or proven experience in molecular work.

Module Courses

Course Type	Course Name	Compul-sory/Optional	SWS
Lecture	Evolution and Biology of Lateral Gene Transfer Mechanisms in Prokaryotes	Compulsory	2
Practical exercise	Evolution and Biology of Lateral Gene Transfer Mechanisms in Prokaryotes	Compulsory	2

Examination(s)

Examination Name	Type of Examination	Evaluation	Compulsory / Optional	Weighting
Protocol: Evolution and Biology of Lateral Gene Transfer Mechanisms in Prokaryotes	Protocol	Graded	Compulsory	100

Short Summary
Prokaryotes possess the unique ability to acquire DNA from the environment, or their neighbors, and incorporate it into their genome in a process called lateral gene transfer (LGT). Accumulating evidence shows that LGT plays a major role in prokaryote genome evolution, affecting virtually all genes, with only few genes that are resistant to it. Lateral gene transfer is crucial to our understanding of microbial evolution; furthermore, as a source of natural variation it facilitates the emergence of novel infectious diseases through the spread of virulence mechanisms. The known mechanisms for LGT include transformation, conjugation (via plasmids), transduction (via phages), and gene transfer agents. In this module we will focus mainly on plasmids, which are genetic elements that promote transfer of DNA within genomes or between bacterial cells. Many plasmids, however, share a history of co-evolution with their host, while others appear as promiscuous elements with a broad host-range. The practical part of the module will focus on host-plasmid associations and the evolutionary consequences that different plasmid-lifestyles impart on microbial populations under different environmental conditions.
Course Content
The module comprises an introduction to the diversity of lateral gene transfer mechanisms found in prokaryotes, including plasmids, phages and transposons. A particular focus of the module is on plasmid-host interactions. The experimental lab work will include the learning of the following methods: (i) in vitro construction of DNA substrates for targeted mutations in plasmids and bacterial genomes using Gibson assembly as a modern technique in molecular biology, (ii) investigation of plasmid-loss frequencies and conjugative transfer frequencies under different environmental conditions, and (iii) the determination of the biological costs conferred by plasmids on their bacterial host species.
Learning Outcome
The students are expected to acquire practical and theoretical knowledge on evolution and biology of lateral gene transfer and mobile genetic elements in bacteria. They will gain experience in molecular techniques and working with DNA sequences. The students will learn to conceive and design experiments with bacteria and to critically inspect and analyze the data obtained. Furthermore, the students will gain experience in presenting their data and results in a protocol and contextualize their results to the existing scientific literature.
Reading List
Primary research literature, as distributed during the course.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester

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Module Name	Module Code
Developmental Biology of Marine Invertebrates	biol235
Module Coordinator	
Prof. Dr. Dr. Thomas Bosch	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	five days
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	94,5 hours
Contact Time	42 hours
Independent Study	31,5 + 21 = 52,5 hours
Teaching Language	German / English

Recommended Requirements			
Elementary Zoology, Developmental Biology, and Molecular Biology			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Practical exercise	Developmental Biology of Marine Invertebrates	Compulsory	3
Seminar	Developmental Biology of Marine Invertebrates	Compulsory	1
Further Information on the Courses			
Takes place in the marine station of the Alfred-Wegener Institute (AWI) at Helgoland			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Developmental Biology of Marine Invertebrates	Seminar Coursework	Graded	Compulsory	100

Short Summary
The module will allow students to explore and present one research topic in molecular developmental biology based on primary English literature. They will learn to use the appropriate methodology and their application potential to eventually resolve a given subject/topic.
Course Content
With the help of cell biology and molecular biology methods students are investigating sexual reproduction and developmental biology mechanisms in marine invertebrates around Helgoland island.
Learning Outcome
Students will: acquire social competencies while working in groups; learn to present talks with PowerPoint or similar programs, train free speech, gain subject specific competence/knowledge in zoology, developmental biology, and in appropriate methodology, learn to approach certain research questions on the molecular, cellular and/or organismic level
Reading List
Scripts provided during the class, recommended literature: Developmental Biology, 10th Edition, by Scott F. Gilbert, primary literature for seminar
Additional Information
An der biologischen Anstalt Helgoland.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	1.-2. Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	1.-2. Semester

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Module Name	Module Code
Molecular Microbiology: (Transposon)mutagenesis Approaches and Biotechnology	biol237
Module Coordinator	
Prof. Dr. Ruth Anne Schmitz-Streit	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26
Total Workload	135 hours
Contact Time	42 h
Independent Study	31,5 + 31,5 = 63 h
Teaching Language	German / English

Recommended Requirements
Depend knowledge of molecular biology methods and practical experience of experimental work in the laboratory (e.g. microbiology tools), master module biol216

Module Courses			
Course Type	**Course Name**	**Compulsory/Optional**	**SWS**
Lecture	Molecular biotechnology	Compulsory	1
Practical exercise	Molecular biotechnology	Compulsory	2
Seminar	Selected examples from molecular biotechnology	Compulsory	1
Further Information on the Courses			
Max. 10 participants (BOTH Masters!)			
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical; submitted protocol			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Microbiology: (Transposon)mutagenesis Approaches and Biotechnology	Protocol	Not graded	Compulsory	-
Written Examination: Molecular Microbiology: (Transposon)mutagenesis Approaches and Biotechnology	Written Examination	Graded	Compulsory	100

Short Summary

Transposons are genetic elements (insertion elements), which are able to change their localization in the genome by a process called transposition; this property can be used for genetic analyses especially functional description of genes. In practical two different transposon types will be used for generation of Raoutella. terrigena mutants, (general mutation). Mutants, which show a nitrogen phenoptype (defect in N-metabolism), will be characterized by determine the insertion localization of the transposon by rescue cloning and sequencing.

Course Content

Introduction into (i) transposons, (ii) key questions in molecular biotechnology and the respective experimental realization, as well as (iii) possibly occurring problems (e.g. during heterologous enzyme production due to insolubility) and potential approaches to address these problems. Selected examples for gene expression will be worked out. The respective gene products will be further purified and analysed by modern tools. Further, selected general and specific mutational approaches will be performed self-contained (e.g. transposon mutagenesis, site specific mutagenesis); and the respective mutants will be further characterized with modern techniques (e.g. by quantitative RT-PCR analysis). Furthermore the students will be instructed for good scientific practice, critical handling and presenting of scientific results.

Learning Outcome

The students understand and know the application of molecular biological methods and tools in biotechnology by means of prokaryotic model systems. Selected examples will be worked out by acting independently. The students will acquire competence to critically analyze and present scientific original publications as well as their own scientific results based on accompanying seminars.

Reading List

Lecture: Schlegel/Fuchs Allgemeine Mikrobiologie (Thieme Verlag, 8. Auflage),
Munk Mikrobiologie (Spektrum Verlag), Brock Mikrobiologie (Spektrum Verlag), Molecular Genetics of Bacteria (ASM Press), Angewandte Mikrobiologie (Springer Verlag),
'Molecular Genetics of bacteria' L. Snyder, J E. Peters, T M. Henkin, W.Champness, 4th edition 2013, ASM Press
Practical/Seminar: Script and Primary research literature, as distributed during the course

Use	Compulsory / Optional	Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	1.-2. Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester

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Module Name	Module Code
Simple Animal Models for Human Disease	biol256
Module Coordinator	
Prof. Dr. Thomas Roeder	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	94,5 hours
Contact Time	42 hours
Independent Study	31,5 + 21 = 52,5 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Drosophila and C. elegans as model organisms	Compulsory	1
Practical exercise	Working with Drosophila and C. elegans	Compulsory	3
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Simple Animal Models for Human Disease	Seminar Course-work	Graded	Compulsory	50
Protocol: Simple Animal Models for Human Disease	Protocol	Graded	Compulsory	50

Short Summary
Introduction to simple model organisms. The course provides an overview of types of genetic interventions in simple, invertebrate organisms and provides examples of using transgenic animals in biomedical research. Moreover, it provides information about basic experimental strategies that are used to model human diseases in simple, genetically amenable organisms.
Course Content
Formulation of research questions and hypotheses in the field of biomedical research (e.g., models that mimic human diseases, molecular alterations that are associated with specific diseases etc.). Application of molecular, computational and microscopic methods to test hypotheses. Evaluation of primary research literature. Presentation of research findings.
Learning Outcome
The students will acquire practical knowledge on basic concepts in the field of genetic intervention to produce tailored organisms. Moreover, they will have knowledge about various experimental and molecular genetic research methods, including their statistical analysis. They will be able to present their data. During the seminar, students will get to know the current literature on the topic.
Reading List
Neuroscience Online - http://neuroscience.uth.tmc.edu Primary research literature, as distributed during the course

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	1.-2. Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester

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Module Name	Module Code
Scientific Presentation and Management	biol604
Module Coordinator	
Dr. Katja Dierking Michael Habig	
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	two semester
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	261,5 hours
Contact Time	84 h
Independent Study	105+52,5 = 157,5
Teaching Language	English

Recommended Requirements			
Basic knowledge of Office programs such as Powerpoint or something similar			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Scientific presentation and management	Compulsory	2
Exercise	Scientific presentation and management	Compulsory	2
Prerequisits for Admission to the Examination(s)			
Active participation in entire seminar			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Presentation: Scientific Presentation and Management I	Presentation	Graded	Compulsory	50
Presentation: Scientific Presentation and Management II	Presentation	Graded	Compulsory	50

Short Summary
The presentation of research results, scientific concepts and research plans represents an essential part of life as a scientist. This module provides practical training in different presentation types, including seminar talks, posters, or written reports, essays, articles, or research applications.
Course Content
Introduction into different presentation types such as seminar talks, posters, written reports, essays, scientific articles, and research applications. Practical training in these different presentation types and also in the design of scientific graphs, presentation slides, and posters. Introduction into scientific writing.
Learning Outcome
The students acquire comprehensive skills in scientific presentation, including the different presentation forms. The students possess competences in the design of scientific graphs and slides. The students are able to express themselves in written form and explain complex scientific concepts and results to others.
Reading List
Literature provided during the course.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Name	Code
Optional Section: Biological Data Analysis	biol605
Organizer	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	

ECTS Credits	5
Evaluation	Graded

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Module Name	Module Code
Biostatistics	biol226
Module Coordinator	
Prof. Dr. Hinrich Schulenburg	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 hours
Total Workload	136 hours
Contact Time	63 hours
Independent Study	31,5 + 31,5 = 63 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of statistics and experimental design			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Biostatistics	Compulsory	2
Internship	Biostatistics	Compulsory	4
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Examination: Biostatistics	Written Examina-tion	Graded	Compulsory	100

Short Summary
Any work in science relies on the application of statistical tests in order to evaluate the significance of the obtained data. The course provides an in-depth introduction into the basics of statistics with a particular focus on biological data.
Course Content
Basic background information on scientific research approaches, including understanding of falsification principle, precise formulation of hypothesis, and development of experimental design. Application of various statistical approaches, including explorative statistics, t tests, analysis of variance, correlation, regression analysis, etc. Usage of R package.
Learning Outcome
The students acquire an understanding of the basic concepts of statistical analysis. The students possess competence in experimental design, hypothesis-driven research, data types, data exploration, data presentation in figures and table, and common statistical tests. The students are able to apply statistical methods and test procedures on real biological data. The students possess competences in the critical evaluation of statistical results. The students are able to use the program R for statistical analysis.
Reading List
Peter Dalgaard: Introductory Statistics with R. Calvin Dytham: Choosing and Using Statistics: A Biologist's Guide. Steve McKillup: Statistics explained. An introductory guide for life scientists.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2016)	Optional	1.-2. Semester
Master, 1-subject, Biochemistry and Molecular Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2015)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2011)	Optional	1.-2. Semester
Master, 1-subject, Biology, (Version 2007)	Optional	1.-2. Semester
Master, 1-subject, Materials Science and Engineering, (Version 2014)	Optional	1.-2. Semester
Master, 1-subject, Materials Science and Engineering, (Version 2010)	Optional	1.-2. Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	1.-2. Semester
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	1.-2. Semester

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Module Name	Module Code
Computational and Comparative Genomics	biol258
Module Coordinator	
Prof. Dr. Tal Dagan	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	5
Evaluation	Graded
Duration	two weeks
Frequency	Only takes place during summer semesters
Workload per ECTS Credit	26 hours
Total Workload	126 hours
Contact Time	63 hours
Independent Study	42 + 21 = 63 Stunden
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Lecture	Computational and Comparative Genomics	Compulsory	2
Internship	Computational and Comparative Genomics	Compulsory	4
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Assignments: Computational and Comparative Genomics	Assignment	Not graded	Compulsory	-
Written Examination: Computational and Comparative Genomics	Written Examination	Graded	Compulsory	100

Short Summary
The module is aimed at teaching basic methods for the analysis of genomic data. This includes an overview of the theory and practice of computational methods for the identification and characterization of genetic elements from DNA sequence data. The course focuses on approaches for extracting the maximum amount of information from protein and DNA sequence similarity through sequence database searches, statistical analysis, and multiple sequence alignment.
Course Content
Genomic data mining, sequence comparison, phylogenetic trees, protein domain prediction, genome sequencing and assembly, genome annotation, identification of genomic structural variants, Transcriptomics.
Learning Outcome
The students will gain basic knowledge in the analysis of genomic and transcriptomic data. This includes data mining of biological databases, phylogenetics, microbial genome assembly and annotation, microbial biodiversity analysis, eukaryotic chromosome assembly and annotation, analysis of genomic structural variants, analysis and annotation of transcriptomes and analysis of metagenomics data. The students will be introduced to the commonly used computer software for the analysis and research of genomics and transcriptomics.
Reading List
Praktikumsskript, Manuals, Videos

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	-

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Module Name	Module Code
Introductory Research Module	biol606
Module Coordinator	
Organizer	
Zoologisches Institut und Museum	
Botanisches Institut und Botanischer Garten	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	1 semester
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26
Total Workload	249,5 h
Contact Time	105 h
Independent Study	94,5 h
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Introductory Research Module	Compulsory	1
Project	Introductory Research Module	Compulsory	9
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and independent work			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Introductory Research Module	Protocol	Graded	Compulsory	80
Seminar Coursework: Introductory Research Module	Seminar Coursework	Graded	Compulsory	20

Short Summary
The ability to perform a research project represents a central competence for Master students. During this module, the students will be introduced into the application of up-to-date research methods to address a specific scientific question of current interest.
Course Content
Introduction into application of several research methods to address a focused research topic. Organization of research work across several weeks. Evaluation of research results using basic statistics. Introduction into writing a scientific report and presentation of the research findings with the help of a seminar talk.
Learning Outcome
The students acquire competence in performance of a focused research project, application of complementary research methods and approaches to address the research project, and organization of the work within a restricted time frame. The students will also acquire experience in writing a scientific report and presenting complex data within a seminar talk.
Reading List
Primary research literature, as distributed during the course.
Additional Information
The modules biol 606 and biol 607 cannot be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

↑

Module Name	Module Code
Advanced Research Module	biol607
Module Coordinator	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Institut für Allgemeine Mikrobiologie	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	one semester
Frequency	Only takes place during winter semesters
Workload per ECTS Credit	26 h
Total Workload	249,5 h
Contact Time	105 h
Independent Study	94,5 h
Teaching Language	English

Recommended Requirements			
Completion of the Introductory Research Module			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Advanced Research Module	Compulsory	1
Project	Advanced Research Module	Compulsory	9
Further Information on the Courses			
The modules biol 606 and biol 607 cannot be done in the same research group			
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and independent work			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Advanced Research Module	Protocol	Graded	Compulsory	80
Seminar Coursework: Advanced Research Module	Seminar Course-work	Graded	Compulsory	20

Short Summary
Master students require in-depth competence in performing research projects. Based upon completion of the module "Introductory Research Module", this advanced module will allow the students to improve their ability to address a specific research question using current methods and techniques.
Course Content
Advanced application of current research methods to address a focused research topic. Organization of research work across several weeks. Evaluation of research results using statistics, graphical tools and current literature. Practise of writing a scientific report and presentation of the research findings with the help of a seminar talk.
Learning Outcome
The students acquire in-depth competence in performance of a focused research project, application of complementary research methods and techniques to address a research question, and organization of the work within a restricted time frame. The students will acquire advanced experience in writing a scientific report, data analysis, and presenting complex data within a seminar talk.
Reading List
Primary research literature, as distributed during the course.

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

↑

Module Name	Module Code
Development of a Scientific Project	biol608
Module Coordinator	
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	one semester
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	136 hours
Contact Time	42 h
Independent Study	105 + 84 = 189 h
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Seminar	Development of a scientific Project	Compulsory	2
Internship	Development of a scientific Project	Compulsory	2
Project	Development of a scientific Project	Compulsory	7
Further Information on the Courses			
Seminar and exercise takes places in the working group in which the master thesis will be done			
Prerequisits for Admission to the Examination(s)			
Active participation in both lecture and seminar			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Written Report: Development of a Scientific Project	Written Report	Graded	Compulsory	80
Colloquium: Development of a Scientific Project	Kolloquium	Graded	Compulsory	20

Short Summary
A Master in Science implies that the students are able to develop a scientific project on their own. Therefore, this module will teach the students the necessary skill set required for identifying a relevant research question and setting up a project that addresses this question.
Course Content
Introduction into the elements of a good scientific project. Identification of relevant and interesting research questions. Planning and performance of a research project, including experimental design. Introduction into the necessary repertoire of research methods and approaches. Introduction into data analysis, summary and presentation, and also data discussion in form of a written report.
Learning Outcome
The students acquire competence in the creative and knowledge-based identification of interesting research topics, the development of a scientific project, and the planning of all necessary experiments and study approaches. The students will additionally increase the methodological skill set and learn how to present and evaluate their results in written form.
Reading List
Primary research literature, as distributed during the course.

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

↑

Name	Code
Optional Section: Introductory Research Module	biol606
Organizer	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	

ECTS Credits	10
Evaluation	Graded

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

↑

Module Name	Module Code
Molecular Genetics of Plants and Fungi	biol260
Module Coordinator	
Prof. Dr. Frank Kempken	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Recommended Requirements			
Advanced understanding of genetics			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Molecular Genetics of Plants and Fungi	Compulsory	8
Further Information on the Courses			
Practical laboratory course including a seminar			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Genetics of Plants and Fungi	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecular Genetics of Plants and Fungi	Seminar Course-work	Graded	Compulsory	20

Short Summary
Individual molecular genetic project using fungal or plant model systems

Course Content
The research objective will be discussed individually for each participant; research projects are part of the research activities in the laboratory and include molecular genetic projects using fungal or plant model systems
Learning Outcome
Students can handle limited research areas; they are able to write scientific reports and to discuss data in the context of published work. They are able to present and defend their research in a colloquium.
Reading List
Scientific reports, original literature in the context of the specific project
Additional Information
Registration with module advisor (not OLAT!) at the beginning of each semester; time schedule upon request.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, AgriGenomics, (Version 2017)	Optional	3.
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Comparative Immunology and Molecular Parasitology	biol262
Module Coordinator	
Prof. Dr. Matthias Leippe	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work, statistical analysis, and concepts in evolutionary biology.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Comparative immunobiology of invertebrates and molecular parasitology	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Comparative Immunology and Molecular Parasitology	Protocol	Graded	Compulsory	80
Seminar Coursework: Comparative Immunology and Molecular Parasitology	Seminar Coursework	Graded	Compulsory	20

Short Summary
The research work involves current topics of comparative immunobiology or molecular parasitology. We are studying the evolution of the immune systems by comparing well-established model systems such as the free-living amoeboid protozoon Dictyostelium discoideum and the nematode Caenorhabditis elegans, and, in addition, marine invertebrates. We analyze the biological function of immune effector proteins such as antimicrobial peptides, pore-forming proteins and lysozymes from various animal taxa, including their activity spectrum, mode of action and structure-function relationships. The other side of host-pathogen interactions may also be a potential study object by investigating molecularly pathogenicity mechanisms of eukaryotic parasites and medically important human pathogens such as free-living and enteric amoebic parasites.
Course Content
Molecular biological, protein chemical and cell biological investigations on invertebrates. In particular the studies will concern molecular defense mechanisms of these animals against bacteria, fungi, and parasites. Moreover, molecular mechanisms of protozoan parasites such as amoebae can be analysed which are involved in the interaction with cells of the host.
Learning Outcome
The students will have knowledge about various experimental and molecular biology research methods, The students are able to experimentally work on a selected project quite independently in a laboratory and can analyze the data, and report the results. They are able to write an accurate protocol including original data. They will be able to present their topic and their data in a seminar talk. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Molecular Genetic Studies on Plant Development	biol265
Module Coordinator	
Prof. Dr. Margareta Sauter	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut - Entwicklungsphysiologie der Pflanzen	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Molecular Genetic Studies on Plant Development	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Plant Physiology and Developmental Biology	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecular Plant Physiology and Developmental Biology	Seminar Coursework	Graded	Compulsory	20

Short Summary
Plant development is regulated by endogenous and environmental signals. Many developmental programs in plants are controlled by phytohormones. This course provides insight into specific aspects of plant development such as root or flower development and teaches experimental approaches to decipher regulation of plant development.

Course Content
Introduction into hypothesis-driven experimental research and in experiment planning. Use of physiological, molecular, genetic, and cell biological methods to study plant development. Setup of laboratory experiments, their statistical analysis, and critical evaluation. Presentation of research findings. Study, presentation and discussion of primary research literature.
Learning Outcome
The students will acquire practical knowledge on regulation of plant developmental processes. They will have knowledge about various basic and advanced experimental methods, and evaluation of experimental results. They will be able to summarize their data in a protocol. The seminar will introduce students to the current literature on the topic and to the presentation of primary literature. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, AgriGenomics, (Version 2017)	Optional	3.
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Current Research in Ecophysiology	biol266
Module Coordinator	
Prof. Dr. Wolfgang Bilger	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 Stunden
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Aktuelle ökophysiologische Forschung	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Current Research in Ecophysio-logy	Protocol	Graded	Compulsory	80
Seminar Coursework: Current Research in Ecophysiology	Seminar Course-work	Graded	Compulsory	20

Course Content
Akklimatisationsmechanismen höherer Pflanzen; photoprotektive Mechanismen; Regulation von Stomata
Learning Outcome
Die Studierenden beherrschen selbstständiges wissenschaftliches Arbeiten in einem aktuellen ökophysiologischen Thema; das Anlegen eines Laborbuches; intensive Beschäftigung mit englischsprachiger Fachliteratur. Sie sind auf die Anfertigung einer Masterarbeit vorbereitet.

Reading List
Originalliteratur, Laborprotokolle
Additional Information
Die beiden Forschungspraktika dürfen nicht in derselben Arbeitsgruppe durchgeführt werden.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Molecularbiology of Microorganisms	biol268
Module Coordinator	
Prof. Dr. Ruth Anne Schmitz-Streit	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks (all day laboratory course)
Frequency	Takes place every semester
Workload per ECTS Credit	26 Stunden
Total Workload	260 hours
Teaching Language	German / English

Recommended Requirements			
Advanced knowledge of cell biology, molecular microbiology and genetics; practical experience in experimental work in the laboratory obligatory, minimum two Master of Science modules (preferably in Microbiology, Genetics)			
Module Courses			
Course Type	**Course Name**	**Compulsory/Optional**	**SWS**
Research project	Molecularbiology of Microorganisms	Compulsory	8
Further Requirements for Awarding ECTS Credits			
submission of a written protocol			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecularbiology of Microorganisms	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecularbiology of Microorganisms	Seminar Coursework	Graded	Compulsory	20

Short Summary
Signal processing and the corresponding reaction of Prokaryotes: • Environmental changes / stress / viruses enable microorganisms to adapt to these changes by adjusting their regulatory network. This module offers an insight into a specific regulation process and imparts learning of the corresponding methods to analyze single molecular mechanisms of regulation.
Course Content
Molecular genetically and biochemical approaches for the analysis of regulatory networks and regulatory processes in microorganisms in response to stress; such as molecular analysis of signal transduction and signal processing, virus defence systems (e.g. CRISPR), biofilms, host#microbe interactions and regulation through small proteins or non#coding RNAs. For this purpose, analyses of protein interactions, RNA interactions or transcriptional analyses are performed using modern technologies.
Learning Outcome
Research and teaching skills in the respective specializations.
Reading List
Methodical protocols and specialized English literature Text books: Schlegel/Fuchs “Allgemeine Mikrobiologie” (Thieme, 10th edition, ISBN: 3132418854) Snyder/Peters/Henkin/Champness “Molecular Genetics of Bacteria” (ASM Press, 4th edition, ISBN: 1555816274)Lengeler/Drews/Schlegel “Biology of the Prokaryotes” (Blackwell Science Ltd, ISBN-10: 0632053577)

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Comparative Developmental and Immunobiology	biol271
Module Coordinator	
Prof. Dr. Dr. Thomas Bosch	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut - Zell- und Entwicklungsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Comparative Developmental and Immunobiology	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Comparative Developmental and Immunobiology	Protocol	Graded	Compulsory	80
Seminar Coursework: Comparative Developmental and Immunobiology	Seminar Coursework	Graded	Compulsory	20

Course Content
The research is focused on developmental biology and/or immunology related question in early branching animals using molecular biology, biochemical and cell biology methods.
Learning Outcome
Students will develop and work on a clearly defined small research topic mostly by themselves. In the seminar the cutting edge research will be discussed and processed. Thereby students will require the basic understanding in how to work on and write a successful master thesis.

Reading List
Lab protocols and English primary literature

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Evolutionary Biology, Population Genetics and Systematics	biol272
Module Coordinator	
Prof. Dr. Günther Hartl	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Entry Requirements as Stated in the Examination Regulations			
Bachelor of Science, Biologie und mindestens zwei Module des Master of Science			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Evolutionsbiologie, Populationsgenetik & Systematik	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Evolutionary Biology, Population Genetics and Systematics	Protocol	Graded	Compulsory	80
Seminar Coursework: Evolutionary Biology, Population Genetics and Systematics	Seminar Course-work	Graded	Compulsory	20

Short Summary
Vertebrate populations dwelling in the cultivated landscape are subjected to a number of anthropogenic influences, such as landscape fragmentation, translocations, (re-) introductions, keeping in enclosures, and trophy hunting. These influences often have a profound effect on demographic parameters, resulting in increased genetic drift, altered selection, genetic depletion (inbreeding depression) or incompatibilities within gene pools (outbreeding depression).

Course Content
The students will work on a small and well defined problem in the course of ongoing scientific projects on conservation genetics carried out in our working group. They will perform all laboratory steps involved in microsatellite and mtDNA sequence analyses, respectively. Following the evaluation of the primary data the students will carry out all the statistical procedures relevant for the respective research target. A thorough interpretation of the results in the light of the relevant literature will lead to a complete presentation of the student project in a seminar talk and a protocol with particular emphasis on a well founded discussion.
Learning Outcome
The students will acquire knowledge on the planning of a small research project and on the proper application of selected molecular and statistical tools. They will gain experience in the interpretation of primary data and statistical results within the scope of their project. They will acquire competence in the evaluation and discussion of their findings in the light of published data as well as in their presentation.
Reading List
Allendorf, F. W. & Luikert, G. (2007): Conservation and the Genetics of Populations. Blackwell, Malden, MA. Frankham, R.; Ballou, J. D. & Briscoe, D. A. (2007): Introduction to Conservation Genetics. Cambridge Univ. Press, NY. Original scientific papers as distributed during the course
Additional Information
Die beiden Forschungspraktika dürfen nicht in derselben Arbeitsgruppe durchgeführt werden.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Chemical Ecology and Molecular Evolution	biol276
Module Coordinator	
Prof. Dr. Dietrich Ober	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Chemical Ecology and Molecular Evolution	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Chemical Ecology and Molecular Evolution	Protocol	Graded	Compulsory	80
Seminar Coursework: Chemical Ecology and Molecular Evolution	Seminar Course-work	Graded	Compulsory	20

Short Summary

Natural compounds are involved as small molecules in various interactions of the plant with its biotic environment including attraction of animals for pollination or fruit dispersal as well as defense against herbivores. In the focus of this module are studies on the evolution of specific pathways that allow the plants to produce natural compounds as part of their ecology. Methods range from techniques of molecular biology and biochemistry to natural compound analytics and bioinformatics.

Course Content
The projects offered within this module link analysis of sequence data and statistical prediction with functional analyses on the biochemical and analytical level. Genome and transcriptome data support the studies on the evolution of a group of natural compounds, i.e. of pyrrolizidine alkaloids, that are involved in several, often highly specific interaction between plants, insects, microbes and vertebrates.
Learning Outcome
The students are able to develop own projects in the field of chemical ecology and molecular evolution. They know how to get acquainted with an own research project and how to develop this by implementing a wide array of methods. The students are able to communicate the research strategy and the scientific background of their own project.
Reading List
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Molecular Physiology	biol278
Module Coordinator	
Prof. Dr. Thomas Roeder	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work (molecular biology) and statistical analysis.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Molecular Physiology	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Physiology	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecular Physiology	Presentation	Graded	Compulsory	20

Short Summary
The fruit fly Drosophila melanogaster serves as a highly versatile model in biomedical research. It is amenable to complex genetic interventions. The aim of this module is to use tailored fly models for different human lifestyle diseases including asthma, COPD, crohn’s disease, diabetes and Parkinson’s disease.

Course Content
Introduction into the formulation of precise research questions and hypotheses on neurobiology and immunology (e.g., mechanisms underlying hormonal control of complex behaviours, the interaction between environment and genotype regarding the development of disease phenotypes). Application of molecular and microscopic methods to characterize these interactions; performance of small laboratory experiments; statistical analysis of obtained data. Evaluation of primary research literature. Presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on using model organisms (Drosophila melanogaster) for studying human diseases. They will have knowledge about various experimental and molecular genetic research methods, including their statistical analysis. They will be able to present their data with the help of either talk or poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
Die beiden Forschungspraktika dürfen nicht in derselben Arbeitsgruppe durchgeführt werden.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Ecological Genetics and Genomics	biol280
Module Coordinator	
Prof. Dr. Hinrich Schulenburg	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work, statistical analysis, and genome analysis			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Ecological Genetics and Genomics	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Ecological Genetics and Genomics	Protocol	Graded	Compulsory	80
Seminar Coursework: Ecological Genetics and Genomics	Seminar Coursework	Graded	Compulsory	20

Short Summary
Ecological factors have a key influence on the evolution of genetic mechanisms and the structure and organization of the genome, as they provide the context in which an organism evolves and adapts. The course provides an overview of the current topics in this interdisciplinary field and an introduction into the relevant research methods.
Course Content
Introduction into the formulation of precise research questions and hypotheses on ecological genetics and genomics (e.g., influence of ecological factors on population genetics and genome architecture, importance of available genetic mechanisms on evolution in populations). Application of molecular genetic methods (e.g., SNP genotyping, microarray analysis, etc) and their statistical analysis (e.g., various population genetic methods). Performance of simple experiments to study this topic and statistical analysis of results. Evaluation of primary research literature. Presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on genetical and genomic topics in ecological research. They will have knowledge about various molecular genetic research methods, including their statistical analysis. They will be able to present their data with the help of either talk or poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Methods of Biomechanics and Biomimetics	biol281
Module Coordinator	
Prof. Dr. Stanislav Gorb	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Methods of Biomechanics and Biomimetics	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Methods of Biomechanics and Biomimetics	Protocol	Graded	Compulsory	80
Seminar Coursework: Methods of Biomechanics and Biomimetics	Seminar Coursework	Graded	Compulsory	20

Short Summary
This modulus deals with the methods of biomechanics and biomimetics. A series of modern methods of microscopy (scanning and transmission electron microscopy (SEM and TEM), confocal laser scanning microscopy (CLSM, white-light interferometry (WLI), atomic force microcopy (AFM), micro computer tomography (µCT), etc.) and experimental biology (high-speed video recordings, force measurements, material characterization using tensile test and nanoindentation, etc.) will be offered. Every year the most actual topics and questions in the research area of functional morphology and biomechanics will be treated.

Course Content
Microscopy techniques, as well as experimental methods of biomechanics, force measurements using centrifuge force tester, atomic force microscope on various biological objects; studies on biological surfaces using various microscopy methods; analysis of fast motion of animals and plants using high speed camera.
Learning Outcome
Students can (to large extent independently) work on a limited research topics from the area of biomechanics and biomimetics using one particular technique or a combination of several techniques. In the seminar, they can present and discuss literature data on their topic and the original data obtained in the course of this module. The module gives to the students an opportunity to receive a competence on topics of functional morphology, biomechanics and biomimetics and also skills for the further preparation of their master thesis. Additionally, their own presentation at the group seminar will deepen the competence and confidence in presenting own data.
Reading List
Original literature in the context of the specific project
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Evolutionary and Genomic Microbiology	biol283
Module Coordinator	
Prof. Dr. Tal Dagan	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements
Basic knowledge of methods in molecular microbiology, or alternatively, basic knowledge of programming and biostatistics/genome analysis.

Module Courses

Course Type	Course Name	Compul-sory/Optional	SWS
Research project	Evolutionary and genomic microbiology	Compulsory	8

Prerequisits for Admission to the Examination(s)
Active participation in both seminar and practical

Examination(s)

Examination Name	Type of Examination	Evaluation	Compulsory / Optional	Weighting
Seminar Coursework: Evolutionary and Genomic Microbiology	Seminar Course-work	Graded	Compulsory	20
Protocol: Evolutionary and Genomic Micro-biology	Protocol	Graded	Compulsory	80

Short Summary
Unlike eukaryotes, bacterial evolution comprises both vertical and horizontal components. Recombination at the species level plays a role in selective sweeps through the population, while inter-species lateral gene transfer has important implications to microbial adaptation and evolutionary transitions. The advance in high throughput sequencing methods has enabled to study the impact the horizontal component on microbial genome evolution at an unprecedented resolution. Research in field of evolutionary microbiology covers a broad range of topics including the biology of DNA transfer mechanisms, the ecology of mobile genetic elements, experimental evolution of rapid adaptation, and phylogenetics of reticulation events.
Course Content
The course will comprise a personal research project on the topic of microbial evolution. This includes an introduction into the different stages of the scientific work, starting with the formulation of a research hypothesis and experiment design, through experimental work and data analysis, to the presentation of the research results and conclusions. The course will include an experimental part in the laboratory where basic methods in molecular microbiology will be practiced, as well as a computational part where the students will analyze genomic data using the common phylogenetics tools.
Learning Outcome
The students will acquire practical knowledge in genomic research and evolutionary reconstruction. Furthermore, they will gain experience in the different stages of the scientific work in the filed of evolutionary microbiology, and competence for a Master thesis.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Evolutionary Genomics of Pathogens	biol285
Module Coordinator	
Prof. Dr. Eva Holtgrewe-Stukenbrock	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut - Genom-Evolution und Umwelt	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Insight into evolutionary biology and basic knowledge of experimental work, statistical analysis, and genome analysis			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Evolutionary Genomics of Pathogens	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**

Short Summary
Analyses of genome data in a comparative framework (either between species or at the population level, between individuals) provide information into past and present evolutionary changes of species or populations. With evolutionary genomics, patterns of genetic variation across full genomes of many individuals are analysed. Fungal pathogens are ideal models for studies of genome evolution. They have relative small genomes that can be easily sequenced and analysed. By assessing the distribution of variable sites in coding and non-coding parts of the genome, we can learn about the effects of natural selection, recombination, genetic drift, effective population size and repetitive elements on the evolution of genomes of pathogens used as model in this course. We will address patterns of genome evolution in the context of pathogen biology and life cycle.
Course Content
Introduction into the formulation of precise research questions and hypotheses on evolutionary genomics (e.g. the influence of natural selection, sexual versus asexual propagation, and demography on genome evolution). Application of computational methods to generate and analyse multiple genome alignments e.g. genome aligners, SNP callers and tools to analyses SNP distributions in coding and non-coding sequences. Performance of simple analyses to study the given topic and statistical analysis of results. Evaluation of primary research literature. Presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on genetical and genomic topics in ecological research. They will have knowledge about various molecular genetic research methods, including their statistical analysis. They will be able to present their data with the help of either talk or poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Mouse Evolutionary Genomics	biol640
Module Coordinator	
Diethard Tautz	
Organizer	
Sektion Biologie Allgemein	
Max-Planck-Institut für Evolutionsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements
knowledge of molecular biology and laboratory work, knowledge of concepts of evolutionary genetics

Module Courses

Course Type	Course Name	Compul-sory/Optional	SWS
Research project	Mouse Evolutionary Genomics	Compulsory	8

Examination(s)

Examination Name	Type of Examination	Evaluation	Compulsory / Optional	Weighting
Seminar Coursework: Mouse Evolutionary Genomics	Seminar Course-work	Graded	Compulsory	20
Protocol: Mouse Evolutionary Genomics	Protocol	Graded	Compulsory	80

Short Summary

Genomic approaches allow deep insights into many evolutionary processes in natural populations. The focus will be on natural populations of the house mouse and the generation and evaluation of genomic data-sets.

Course Content
Introduction into the design of genomics based experiments, including genome sequencing RNA sequencing approaches. The scientific context of the project will be within the framework of an on going research question in the department. The work includes the generation of primary data and application of genome analysis software to evaluate the results. Protocol and presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on genome-based analysis in a population context. This includes experimental design and cost calculations, performance of the experiment and introduction to software packages for data analysis and visualization. They will be able to present their data with the help of either a talk or a poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Evolutionary Modelling	biol641
Module Coordinator	
Arne Traulsen	
Organizer	
Sektion Biologie Allgemein	
Max-Planck-Institut für Evolutionsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of applied mathematics (e.g. derivatives, basic probability)			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Evolutionary Modelling	Compulsory	8
Further Requirements for Awarding ECTS Credits			
Successful presentation of the research project, comprehensive written report about the project.			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Evolutionary Modelling	Seminar Coursework	Graded	Compulsory	20
Protocol: Evolutionary Modelling	Protocol	Graded	Compulsory	80

Short Summary
Mathematical modelling becomes more and more popular in biology. In this project, each student will choose a previously published theoretical paper and repeat the modelling excercise in detail. Both projects that allow a mathematical analysis or simulation based models are possible. Alternatively, the students can develop their own model, if they bring the necessary biological background and are prepared to take a theoretical approach to that particular problem.
Course Content
Re-evaluation or development of a mathematical model, supplemented by evaluation of the primary scientific literature. Analysis of the model based on mathematical and computational approaches.
Learning Outcome
The students can develop meaningful models that are complex enough to capture critical aspects of biological reality, but simple enough to allow for a detailed analysis of the model. The students can analyse the model based on mathematical and / or computational approaches.
Reading List
Nowak, Evolutionary Dynamics – Exploring the equations of life (Harvard University Press, 2006) Broom & Rychtá#, Game-Theoretical Models in Biology (Chapman & Hall, 2013)

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Name	Code
Optional Section: Advanced Research Module	biol607
Organizer	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	

ECTS Credits	10
Evaluation	Graded

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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Module Name	Module Code
Molecular Genetics of Plants and Fungi	biol260
Module Coordinator	
Prof. Dr. Frank Kempken	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Recommended Requirements			
Advanced understanding of genetics			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Molecular Genetics of Plants and Fungi	Compulsory	8
Further Information on the Courses			
Practical laboratory course including a seminar			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Genetics of Plants and Fungi	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecular Genetics of Plants and Fungi	Seminar Course-work	Graded	Compulsory	20

Short Summary
Individual molecular genetic project using fungal or plant model systems

Course Content
The research objective will be discussed individually for each participant; research projects are part of the research activities in the laboratory and include molecular genetic projects using fungal or plant model systems
Learning Outcome
Students can handle limited research areas; they are able to write scientific reports and to discuss data in the context of published work. They are able to present and defend their research in a colloquium.
Reading List
Scientific reports, original literature in the context of the specific project
Additional Information
Registration with module advisor (not OLAT!) at the beginning of each semester; time schedule upon request.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, AgriGenomics, (Version 2017)	Optional	3.
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Comparative Immunology and Molecular Parasitology	biol262
Module Coordinator	
Prof. Dr. Matthias Leippe	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work, statistical analysis, and concepts in evolutionary biology.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Comparative immunobiology of invertebrates and molecular parasitology	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Comparative Immunology and Molecular Parasitology	Protocol	Graded	Compulsory	80
Seminar Coursework: Comparative Immunology and Molecular Parasitology	Seminar Coursework	Graded	Compulsory	20

Short Summary
The research work involves current topics of comparative immunobiology or molecular parasitology. We are studying the evolution of the immune systems by comparing well-established model systems such as the free-living amoeboid protozoon Dictyostelium discoideum and the nematode Caenorhabditis elegans, and, in addition, marine invertebrates. We analyze the biological function of immune effector proteins such as antimicrobial peptides, pore-forming proteins and lysozymes from various animal taxa, including their activity spectrum, mode of action and structure-function relationships. The other side of host-pathogen interactions may also be a potential study object by investigating molecularly pathogenicity mechanisms of eukaryotic parasites and medically important human pathogens such as free-living and enteric amoebic parasites.
Course Content
Molecular biological, protein chemical and cell biological investigations on invertebrates. In particular the studies will concern molecular defense mechanisms of these animals against bacteria, fungi, and parasites. Moreover, molecular mechanisms of protozoan parasites such as amoebae can be analysed which are involved in the interaction with cells of the host.
Learning Outcome
The students will have knowledge about various experimental and molecular biology research methods, The students are able to experimentally work on a selected project quite independently in a laboratory and can analyze the data, and report the results. They are able to write an accurate protocol including original data. They will be able to present their topic and their data in a seminar talk. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Molecular Genetic Studies on Plant Development	biol265
Module Coordinator	
Prof. Dr. Margareta Sauter	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut - Entwicklungsphysiologie der Pflanzen	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Molecular Genetic Studies on Plant Development	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Plant Physiology and Developmental Biology	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecular Plant Physiology and Developmental Biology	Seminar Coursework	Graded	Compulsory	20

Short Summary
Plant development is regulated by endogenous and environmental signals. Many developmental programs in plants are controlled by phytohormones. This course provides insight into specific aspects of plant development such as root or flower development and teaches experimental approaches to decipher regulation of plant development.

Course Content
Introduction into hypothesis-driven experimental research and in experiment planning. Use of physiological, molecular, genetic, and cell biological methods to study plant development. Setup of laboratory experiments, their statistical analysis, and critical evaluation. Presentation of research findings. Study, presentation and discussion of primary research literature.
Learning Outcome
The students will acquire practical knowledge on regulation of plant developmental processes. They will have knowledge about various basic and advanced experimental methods, and evaluation of experimental results. They will be able to summarize their data in a protocol. The seminar will introduce students to the current literature on the topic and to the presentation of primary literature. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, AgriGenomics, (Version 2017)	Optional	3.
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Current Research in Ecophysiology	biol266
Module Coordinator	
Prof. Dr. Wolfgang Bilger	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 Stunden
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Aktuelle ökophysiologische Forschung	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Current Research in Ecophysio-logy	Protocol	Graded	Compulsory	80
Seminar Coursework: Current Research in Ecophysiology	Seminar Course-work	Graded	Compulsory	20

Course Content
Akklimatisationsmechanismen höherer Pflanzen; photoprotektive Mechanismen; Regulation von Stomata
Learning Outcome
Die Studierenden beherrschen selbstständiges wissenschaftliches Arbeiten in einem aktuellen ökophysiologischen Thema; das Anlegen eines Laborbuches; intensive Beschäftigung mit englischsprachiger Fachliteratur. Sie sind auf die Anfertigung einer Masterarbeit vorbereitet.

Reading List
Originalliteratur, Laborprotokolle
Additional Information
Die beiden Forschungspraktika dürfen nicht in derselben Arbeitsgruppe durchgeführt werden.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Molecularbiology of Microorganisms	biol268
Module Coordinator	
Prof. Dr. Ruth Anne Schmitz-Streit	
Organizer	
Sektion Biologie Allgemein	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks (all day laboratory course)
Frequency	Takes place every semester
Workload per ECTS Credit	26 Stunden
Total Workload	260 hours
Teaching Language	German / English

Recommended Requirements			
Advanced knowledge of cell biology, molecular microbiology and genetics; practical experience in experimental work in the laboratory obligatory, minimum two Master of Science modules (preferably in Microbiology, Genetics)			
Module Courses			
Course Type	**Course Name**	**Compulsory/Optional**	**SWS**
Research project	Molecularbiology of Microorganisms	Compulsory	8
Further Requirements for Awarding ECTS Credits			
submission of a written protocol			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecularbiology of Microorganisms	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecularbiology of Microorganisms	Seminar Coursework	Graded	Compulsory	20

Short Summary
Signal processing and the corresponding reaction of Prokaryotes: • Environmental changes / stress / viruses enable microorganisms to adapt to these changes by adjusting their regulatory network. This module offers an insight into a specific regulation process and imparts learning of the corresponding methods to analyze single molecular mechanisms of regulation.
Course Content
Molecular genetically and biochemical approaches for the analysis of regulatory networks and regulatory processes in microorganisms in response to stress; such as molecular analysis of signal transduction and signal processing, virus defence systems (e.g. CRISPR), biofilms, host#microbe interactions and regulation through small proteins or non#coding RNAs. For this purpose, analyses of protein interactions, RNA interactions or transcriptional analyses are performed using modern technologies.
Learning Outcome
Research and teaching skills in the respective specializations.
Reading List
Methodical protocols and specialized English literature Text books: Schlegel/Fuchs “Allgemeine Mikrobiologie” (Thieme, 10th edition, ISBN: 3132418854) Snyder/Peters/Henkin/Champness “Molecular Genetics of Bacteria” (ASM Press, 4th edition, ISBN: 1555816274)Lengeler/Drews/Schlegel “Biology of the Prokaryotes” (Blackwell Science Ltd, ISBN-10: 0632053577)

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Comparative Developmental and Immunobiology	biol271
Module Coordinator	
Prof. Dr. Dr. Thomas Bosch	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut - Zell- und Entwicklungsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Comparative Developmental and Immunobiology	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Comparative Developmental and Immunobiology	Protocol	Graded	Compulsory	80
Seminar Coursework: Comparative Developmental and Immunobiology	Seminar Coursework	Graded	Compulsory	20

Course Content
The research is focused on developmental biology and/or immunology related question in early branching animals using molecular biology, biochemical and cell biology methods.
Learning Outcome
Students will develop and work on a clearly defined small research topic mostly by themselves. In the seminar the cutting edge research will be discussed and processed. Thereby students will require the basic understanding in how to work on and write a successful master thesis.

Reading List
Lab protocols and English primary literature

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

↑

Module Name	Module Code
Evolutionary Biology, Population Genetics and Systematics	biol272
Module Coordinator	
Prof. Dr. Günther Hartl	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Entry Requirements as Stated in the Examination Regulations			
Bachelor of Science, Biologie und mindestens zwei Module des Master of Science			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Evolutionsbiologie, Populationsgenetik & Systematik	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Evolutionary Biology, Population Genetics and Systematics	Protocol	Graded	Compulsory	80
Seminar Coursework: Evolutionary Biology, Population Genetics and Systematics	Seminar Course-work	Graded	Compulsory	20

Short Summary
Vertebrate populations dwelling in the cultivated landscape are subjected to a number of anthropogenic influences, such as landscape fragmentation, translocations, (re-) introductions, keeping in enclosures, and trophy hunting. These influences often have a profound effect on demographic parameters, resulting in increased genetic drift, altered selection, genetic depletion (inbreeding depression) or incompatibilities within gene pools (outbreeding depression).

Course Content
The students will work on a small and well defined problem in the course of ongoing scientific projects on conservation genetics carried out in our working group. They will perform all laboratory steps involved in microsatellite and mtDNA sequence analyses, respectively. Following the evaluation of the primary data the students will carry out all the statistical procedures relevant for the respective research target. A thorough interpretation of the results in the light of the relevant literature will lead to a complete presentation of the student project in a seminar talk and a protocol with particular emphasis on a well founded discussion.
Learning Outcome
The students will acquire knowledge on the planning of a small research project and on the proper application of selected molecular and statistical tools. They will gain experience in the interpretation of primary data and statistical results within the scope of their project. They will acquire competence in the evaluation and discussion of their findings in the light of published data as well as in their presentation.
Reading List
Allendorf, F. W. & Luikert, G. (2007): Conservation and the Genetics of Populations. Blackwell, Malden, MA. Frankham, R.; Ballou, J. D. & Briscoe, D. A. (2007): Introduction to Conservation Genetics. Cambridge Univ. Press, NY. Original scientific papers as distributed during the course
Additional Information
Die beiden Forschungspraktika dürfen nicht in derselben Arbeitsgruppe durchgeführt werden.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Chemical Ecology and Molecular Evolution	biol276
Module Coordinator	
Prof. Dr. Dietrich Ober	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Chemical Ecology and Molecular Evolution	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Chemical Ecology and Molecular Evolution	Protocol	Graded	Compulsory	80
Seminar Coursework: Chemical Ecology and Molecular Evolution	Seminar Course-work	Graded	Compulsory	20

Short Summary

Natural compounds are involved as small molecules in various interactions of the plant with its biotic environment including attraction of animals for pollination or fruit dispersal as well as defense against herbivores. In the focus of this module are studies on the evolution of specific pathways that allow the plants to produce natural compounds as part of their ecology. Methods range from techniques of molecular biology and biochemistry to natural compound analytics and bioinformatics.

Course Content
The projects offered within this module link analysis of sequence data and statistical prediction with functional analyses on the biochemical and analytical level. Genome and transcriptome data support the studies on the evolution of a group of natural compounds, i.e. of pyrrolizidine alkaloids, that are involved in several, often highly specific interaction between plants, insects, microbes and vertebrates.
Learning Outcome
The students are able to develop own projects in the field of chemical ecology and molecular evolution. They know how to get acquainted with an own research project and how to develop this by implementing a wide array of methods. The students are able to communicate the research strategy and the scientific background of their own project.
Reading List
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Molecular Physiology	biol278
Module Coordinator	
Prof. Dr. Thomas Roeder	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work (molecular biology) and statistical analysis.			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Molecular Physiology	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Molecular Physiology	Protocol	Graded	Compulsory	80
Seminar Coursework: Molecular Physiology	Presentation	Graded	Compulsory	20

Short Summary
The fruit fly Drosophila melanogaster serves as a highly versatile model in biomedical research. It is amenable to complex genetic interventions. The aim of this module is to use tailored fly models for different human lifestyle diseases including asthma, COPD, crohn’s disease, diabetes and Parkinson’s disease.

Course Content
Introduction into the formulation of precise research questions and hypotheses on neurobiology and immunology (e.g., mechanisms underlying hormonal control of complex behaviours, the interaction between environment and genotype regarding the development of disease phenotypes). Application of molecular and microscopic methods to characterize these interactions; performance of small laboratory experiments; statistical analysis of obtained data. Evaluation of primary research literature. Presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on using model organisms (Drosophila melanogaster) for studying human diseases. They will have knowledge about various experimental and molecular genetic research methods, including their statistical analysis. They will be able to present their data with the help of either talk or poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
Die beiden Forschungspraktika dürfen nicht in derselben Arbeitsgruppe durchgeführt werden.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Ecological Genetics and Genomics	biol280
Module Coordinator	
Prof. Dr. Hinrich Schulenburg	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of experimental work, statistical analysis, and genome analysis			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Ecological Genetics and Genomics	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Ecological Genetics and Genomics	Protocol	Graded	Compulsory	80
Seminar Coursework: Ecological Genetics and Genomics	Seminar Coursework	Graded	Compulsory	20

Short Summary
Ecological factors have a key influence on the evolution of genetic mechanisms and the structure and organization of the genome, as they provide the context in which an organism evolves and adapts. The course provides an overview of the current topics in this interdisciplinary field and an introduction into the relevant research methods.
Course Content
Introduction into the formulation of precise research questions and hypotheses on ecological genetics and genomics (e.g., influence of ecological factors on population genetics and genome architecture, importance of available genetic mechanisms on evolution in populations). Application of molecular genetic methods (e.g., SNP genotyping, microarray analysis, etc) and their statistical analysis (e.g., various population genetic methods). Performance of simple experiments to study this topic and statistical analysis of results. Evaluation of primary research literature. Presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on genetical and genomic topics in ecological research. They will have knowledge about various molecular genetic research methods, including their statistical analysis. They will be able to present their data with the help of either talk or poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2011)	Optional	3.
Master, 2-subject, Studies in Secondary Education (Profil Lehramt an Gymnasien), Biology, (Version 2007)	Optional	3.

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Module Name	Module Code
Methods of Biomechanics and Biomimetics	biol281
Module Coordinator	
Prof. Dr. Stanislav Gorb	
Organizer	
Sektion Biologie Allgemein	
Zoologisches Institut und Museum	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	German / English

Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Methods of Biomechanics and Biomimetics	Compulsory	8

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Protocol: Methods of Biomechanics and Biomimetics	Protocol	Graded	Compulsory	80
Seminar Coursework: Methods of Biomechanics and Biomimetics	Seminar Coursework	Graded	Compulsory	20

Short Summary
This modulus deals with the methods of biomechanics and biomimetics. A series of modern methods of microscopy (scanning and transmission electron microscopy (SEM and TEM), confocal laser scanning microscopy (CLSM, white-light interferometry (WLI), atomic force microcopy (AFM), micro computer tomography (µCT), etc.) and experimental biology (high-speed video recordings, force measurements, material characterization using tensile test and nanoindentation, etc.) will be offered. Every year the most actual topics and questions in the research area of functional morphology and biomechanics will be treated.

Course Content
Microscopy techniques, as well as experimental methods of biomechanics, force measurements using centrifuge force tester, atomic force microscope on various biological objects; studies on biological surfaces using various microscopy methods; analysis of fast motion of animals and plants using high speed camera.
Learning Outcome
Students can (to large extent independently) work on a limited research topics from the area of biomechanics and biomimetics using one particular technique or a combination of several techniques. In the seminar, they can present and discuss literature data on their topic and the original data obtained in the course of this module. The module gives to the students an opportunity to receive a competence on topics of functional morphology, biomechanics and biomimetics and also skills for the further preparation of their master thesis. Additionally, their own presentation at the group seminar will deepen the competence and confidence in presenting own data.
Reading List
Original literature in the context of the specific project
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Evolutionary and Genomic Microbiology	biol283
Module Coordinator	
Prof. Dr. Tal Dagan	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut und Botanischer Garten	
Institut für Allgemeine Mikrobiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements
Basic knowledge of methods in molecular microbiology, or alternatively, basic knowledge of programming and biostatistics/genome analysis.

Module Courses

Course Type	Course Name	Compul-sory/Optional	SWS
Research project	Evolutionary and genomic microbiology	Compulsory	8

Prerequisits for Admission to the Examination(s)
Active participation in both seminar and practical

Examination(s)

Examination Name	Type of Examination	Evaluation	Compulsory / Optional	Weighting
Seminar Coursework: Evolutionary and Genomic Microbiology	Seminar Course-work	Graded	Compulsory	20
Protocol: Evolutionary and Genomic Micro-biology	Protocol	Graded	Compulsory	80

Short Summary
Unlike eukaryotes, bacterial evolution comprises both vertical and horizontal components. Recombination at the species level plays a role in selective sweeps through the population, while inter-species lateral gene transfer has important implications to microbial adaptation and evolutionary transitions. The advance in high throughput sequencing methods has enabled to study the impact the horizontal component on microbial genome evolution at an unprecedented resolution. Research in field of evolutionary microbiology covers a broad range of topics including the biology of DNA transfer mechanisms, the ecology of mobile genetic elements, experimental evolution of rapid adaptation, and phylogenetics of reticulation events.
Course Content
The course will comprise a personal research project on the topic of microbial evolution. This includes an introduction into the different stages of the scientific work, starting with the formulation of a research hypothesis and experiment design, through experimental work and data analysis, to the presentation of the research results and conclusions. The course will include an experimental part in the laboratory where basic methods in molecular microbiology will be practiced, as well as a computational part where the students will analyze genomic data using the common phylogenetics tools.
Learning Outcome
The students will acquire practical knowledge in genomic research and evolutionary reconstruction. Furthermore, they will gain experience in the different stages of the scientific work in the filed of evolutionary microbiology, and competence for a Master thesis.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	Compulsory / Optional	Semester
Master, 1-subject, Biology, (Version 2015)	Optional	3.
Master, 1-subject, Biology, (Version 2011)	Optional	3.
Master, 1-subject, Biology, (Version 2007)	Optional	3.
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	3.

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Module Name	Module Code
Evolutionary Genomics of Pathogens	biol285
Module Coordinator	
Prof. Dr. Eva Holtgrewe-Stukenbrock	
Organizer	
Sektion Biologie Allgemein	
Botanisches Institut - Genom-Evolution und Umwelt	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Insight into evolutionary biology and basic knowledge of experimental work, statistical analysis, and genome analysis			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Evolutionary Genomics of Pathogens	Compulsory	8
Prerequisits for Admission to the Examination(s)			
Active participation in both seminar and practical			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**

Short Summary
Analyses of genome data in a comparative framework (either between species or at the population level, between individuals) provide information into past and present evolutionary changes of species or populations. With evolutionary genomics, patterns of genetic variation across full genomes of many individuals are analysed. Fungal pathogens are ideal models for studies of genome evolution. They have relative small genomes that can be easily sequenced and analysed. By assessing the distribution of variable sites in coding and non-coding parts of the genome, we can learn about the effects of natural selection, recombination, genetic drift, effective population size and repetitive elements on the evolution of genomes of pathogens used as model in this course. We will address patterns of genome evolution in the context of pathogen biology and life cycle.
Course Content
Introduction into the formulation of precise research questions and hypotheses on evolutionary genomics (e.g. the influence of natural selection, sexual versus asexual propagation, and demography on genome evolution). Application of computational methods to generate and analyse multiple genome alignments e.g. genome aligners, SNP callers and tools to analyses SNP distributions in coding and non-coding sequences. Performance of simple analyses to study the given topic and statistical analysis of results. Evaluation of primary research literature. Presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on genetical and genomic topics in ecological research. They will have knowledge about various molecular genetic research methods, including their statistical analysis. They will be able to present their data with the help of either talk or poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course
Additional Information
The two research projects must not be done in the same research group.

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Biology, (Version 2015)	Optional	-
Master, 1-subject, Biology, (Version 2011)	Optional	-
Master, 1-subject, Biology, (Version 2007)	Optional	-
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Mouse Evolutionary Genomics	biol640
Module Coordinator	
Diethard Tautz	
Organizer	
Sektion Biologie Allgemein	
Max-Planck-Institut für Evolutionsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements
knowledge of molecular biology and laboratory work, knowledge of concepts of evolutionary genetics

Module Courses

Course Type	Course Name	Compul-sory/Optional	SWS
Research project	Mouse Evolutionary Genomics	Compulsory	8

Examination(s)

Examination Name	Type of Examination	Evaluation	Compulsory / Optional	Weighting
Seminar Coursework: Mouse Evolutionary Genomics	Seminar Course-work	Graded	Compulsory	20
Protocol: Mouse Evolutionary Genomics	Protocol	Graded	Compulsory	80

Short Summary

Genomic approaches allow deep insights into many evolutionary processes in natural populations. The focus will be on natural populations of the house mouse and the generation and evaluation of genomic data-sets.

Course Content
Introduction into the design of genomics based experiments, including genome sequencing RNA sequencing approaches. The scientific context of the project will be within the framework of an on going research question in the department. The work includes the generation of primary data and application of genome analysis software to evaluate the results. Protocol and presentation of research findings (Talk or Poster).
Learning Outcome
The students will acquire practical knowledge on genome-based analysis in a population context. This includes experimental design and cost calculations, performance of the experiment and introduction to software packages for data analysis and visualization. They will be able to present their data with the help of either a talk or a poster. During the seminar, students will get to know the current literature on the topic. The students will acquire the competence to perform a Master project.
Reading List
Primary research literature, as distributed during the course

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Evolutionary Modelling	biol641
Module Coordinator	
Arne Traulsen	
Organizer	
Sektion Biologie Allgemein	
Max-Planck-Institut für Evolutionsbiologie	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	10
Evaluation	Graded
Duration	six weeks, all day laboratory course
Frequency	Takes place every semester
Workload per ECTS Credit	26 hours
Total Workload	260 hours
Teaching Language	English

Recommended Requirements			
Basic knowledge of applied mathematics (e.g. derivatives, basic probability)			
Module Courses			
Course Type	**Course Name**	**Compul-sory/Optional**	**SWS**
Research project	Evolutionary Modelling	Compulsory	8
Further Requirements for Awarding ECTS Credits			
Successful presentation of the research project, comprehensive written report about the project.			

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Seminar Coursework: Evolutionary Modelling	Seminar Coursework	Graded	Compulsory	20
Protocol: Evolutionary Modelling	Protocol	Graded	Compulsory	80

Short Summary
Mathematical modelling becomes more and more popular in biology. In this project, each student will choose a previously published theoretical paper and repeat the modelling excercise in detail. Both projects that allow a mathematical analysis or simulation based models are possible. Alternatively, the students can develop their own model, if they bring the necessary biological background and are prepared to take a theoretical approach to that particular problem.
Course Content
Re-evaluation or development of a mathematical model, supplemented by evaluation of the primary scientific literature. Analysis of the model based on mathematical and computational approaches.
Learning Outcome
The students can develop meaningful models that are complex enough to capture critical aspects of biological reality, but simple enough to allow for a detailed analysis of the model. The students can analyse the model based on mathematical and / or computational approaches.
Reading List
Nowak, Evolutionary Dynamics – Exploring the equations of life (Harvard University Press, 2006) Broom & Rychtá#, Game-Theoretical Models in Biology (Chapman & Hall, 2013)

Use	**Compulsory / Optional**	**Semester**
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Optional	-

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Module Name	Module Code
Master's Thesis	biol609
Module Coordinator	
Organizer	
Sektion Biologie Allgemein	
Faculty	
Faculty of Mathematics and Natural Sciences	
Examination Office	
Examination Office of the Department of Biology	

ECTS Credits	30
Evaluation	Graded
Duration	6 months
Frequency	Takes place every semester
Total Workload	900 hours
Teaching Language	English

Entry Requirements as Stated in the Examination Regulations
Admission to the Master thesis is gained by earning at least *80 credit points* in module examinations for compulsory and optional modules.

Examination(s)				
Examination Name	**Type of Examination**	**Evaluation**	**Compulsory / Optional**	**Weighting**
Masterarbeit	Written Examination	Graded	Compulsory	80
Presentation Master's Thesis	Presentation	Graded	Compulsory	20

Course Content
Independent handling of scientific research in a limited area under supervision of a scientist
Learning Outcome
Students will need here to demonstrate their ability to conduct scientific research in an independent manner, apply their theoretical knowledge to a practical or conceptual scientific question and be able to communicate their results in a lucid manner.
Reading List

Use	Compulsory / Optional	Semester
Master, 1-subject, Molecular Biology and Evolution, (Version 2015)	Compulsory	-

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