MSc 'Animal Biology and Biomedical Sciences'

3 rd Term
2023/2024

You have to choose 2 modules!

1st Main topic

Evolution, animal biodiversity and behaviour

Name of module	**Evolutionary and developmental genetics**	**3101**
No. of semester	3	
Lecturer	Bernd Schierwater, NN	
Kind of course/SWS	Practical course (10 SWS), seminar (1 SWS)	
Achievements in studies	Regular attendance, written report	
Exam performance	Examined oral presentation (colloquium), 100%	
ECTS-CP	15	
Study targets: Acquisition of advanced skills in evolutionary and developmental genetics. Scientific formulation of hypotheses, tests, and interpretations. Advanced scientific presentation of research data.		
Course contents: lab work: Advanced – non-trivial - molecular genetic studies on regulatory genes in insects or basal marine invertebrates with special emphasis on gene knock down studies. Unpublished cutting-edge research on the origin of wings in insects and the origin of the head in animals will be the themes. seminar: Original and recent research articles will be discussed in detail.		
Admissions requirements/recommended previous knowledge: Knowledge of modules: Evolutionary Genetics and Developmental Genetics.		
Basic literature: Werner A Müller: Developmental Biology. Springer. Manyuan Lang (ed.): Origin and Evolution of New Gene Functions. Kluwer Academic.		
Didactic aids: Computer animations, state-of-the-art equipment, live animal observations		
Exam requirements: Data analysis and preparation of a scientific paper (4 pages) in English.		
Time and effort involved in studying (in hours)**:** 450 Presence during studies 150 h Self-study 300 h Participants: max 3		

Name of module	**Biodiversity, population ecology and species conservation**	**3102**
No. of semester	3	
Lecturer	Heike Hadrys	
Kind of course/SWS	Practical course (10 SWS), seminar (1 SWS)	
Achievements in studies	Regular attendance, written report	
Exam performance	Examined oral presentation (colloquium), 100%	
ECTS-CP	15	

Study targets: Acquisition of advanced skills in applying molecular methods to biodiversity studies. Advanced scientific presentation of research data. This course is THE introduction to real life scientific research in ecology and evolution.

Course contents:

lab work:

Molecular methods have become a *conditio sine qua non* in modern biodiversity, population ecology, and conservation research. Using selected animal groups and ongoing research projects students will take part in real time scientific research. They will be faced with recent and future research questions and methods for biodiversity assessment, conservation genetics, and evolutionary biology. State-of-the-art techniques may range from microsatellite isolation to gene knock downs and field work. Application of advanced bioinformatic tools and learning how create a scientific presentation put a crown to the work.

seminar:

Original and recent research articles will be looked at in detail. The recent theoretical concepts will be discussed for each topic. Principles of writing a scientific paper.

Admissions requirements/recommended previous knowledge:

Knowledge of modules: Molecular Systematics and Conservation Genetics, Molecular Ecology.

Basic literature:

Frankham, R., Ballou, J. D. & Briscoe, D. A. *Introduction to Conservation Genetics* (Cambridge Univ. Press, Cambridge, United Kingdom, 2003).

Rob DeSalle R. & Amato, G. The Expansion of Conservation genetics, Nature Genetics, Volume5, 2004 pp.702-712 (*www.nature.com/reviews/genetics*).

Didactic aids:

state-of-the-art technologies and hardware

Exam requirements:

Data analysis and preparation of a scientific talk (15 min) or paper (4 pages) in English.

Time and effort involved in studying (in hours)**:** 450

Presence during studies	150 h
Self-study	300 h
Participants:	max 3

Name of module	Sensory Biology and Psychoacoustics	3104
No. of semester	3	
Lecturer	Sabine Schmidt	
Kind of course/SWS	Practical research course (10 SWS), seminar (2 SWS)	
Achievements in studies	Performance of an own research project in the field of Sensory Biology or Psychoacoustics, including a presentation of literature background (journal club) and results (seminar)	
Exam performance	Experimental work (50%), “mini” thesis (25%), oral defence (25%)	
ECTS-CP	15	

Study targets:

- design of a scientific study and development of testable hypotheses,
- data collection for and analysis of an independent research project
- presentation and defence of a research project and its results
- scientific report following international publication standards

Course contents:

- active participation in the Zoological Seminar (Recent topics in Sensory Biology and Psychoacoustics)
- acquisition of advanced skills and knowledge in the research field of Sensory Biology and Psychoacoustics
- acquisition of state of the art techniques in this research field (e.g. sound synthesis and analysis tools, video analysis, field data acquisition)
- overview of research activities of AG Schmidt

Admissions requirements/recommended previous knowledge:
Successful participation in module Neuro-and Sensory Biology and /or 2nd term modules of branch Evolution/Biodiversity/Behaviour with a focus on behaviour.
Depending on specific topic, FELASA-course may be required.

Basic Literature:
Project-specific literature research, using literature archives for Biology/Behaviour/Evolution/Ecology/Psychology/Neuroscience

Didactic aids:
Recording and analysis of behaviour via specialised hardware and software, PowerPoint presentations (seminar), video film sequences, group discussions, hand-outs

Exam requirements:
Set-up, design and performance of own scientific project, written thesis and oral presentation and defense

Time and effort involved in studying (in hours): 450

Presence during studies	200 h
Self-study	250 h
Participants: max	2

Name of module	**Behavioural ecology and conservation genetics, primate research**	**3105**
No. of semester	3	
Lecturers	Ute Radespiel	
Kind of course/SWS	seminar (2 SWS), research project (10 SWS)	
Study performance	Regular attendance, completion of a small research project, participation in zoological seminar with own presentation	
Exam performance	Seminar presentation (25%) written mini thesis (25%), active experimental research work (50%)	
ECTS-CP	15	

Study targets:
The students …

- … design a scientific study and know how to formulate hypotheses/predictions
- … become familiar with standard molecular techniques (PCR, genotyping, sequencing) depending on topic
- … become familiar with standard socioecological data collection methods (e.g., capture/ recapture, handling, census, direct observation) depending on topic
- … collect and analyse data for a small scientific project independently after initial introduction
- … know how to present recent scientific results (in English)
- … know how to write a scientific report following international publication standards

Course contents:

- Active participation in the Zoological Seminar (Recent topics in tropical ecology) (incl. one presentation)
- Acquisition of advanced scientific knowledge and skills in the research field of Behavioural Ecology or Conservation Genetics (field trip to Madagascar is possible after consultation with the lecturer)
- Depending of topic introduction to the use of molecular techniques in the field of behavioural ecology, conservation genetics and population genetics
- Introduction to the research activities in the working group Radespiel

Admissions requirements/recommended previous knowledge: Successful participation in modules of the branch Evolution/Biodiversity/Behaviour in the second semester
Depending on topic a FELASA course may be necessary

Basic Literature:
Begon/Harper/Townsend: Ökologie, Alcock: Animal Behavior, Kappeler: Verhaltensbiologie, Frankham/Ballou/Briscoe: Introduction to Conservation Genetics, Mittermeier et al.: Lemurs of Madagascar, Primack: Essentials of Conservation Biology

Didactic aids:
DNA-lab equipment, analytical software packages, handheld computers, Camcorder, Dictaphone, field equipment (radiotelemetry, lamps etc.), PowerPoint presentation of students (seminar), individual tutoring, group discussion

Exam requirements:
Active participation in a research project with oral presentation, composition of a scientific mini thesis

Time and effort involved in studying (in hours): 450

Presence during studies	200 h
Self-study	250 h
Participants: max.	3

Name of module	**Research weeks "Bioacoustics, Behavioural Ecology Population Genetics, Herpetology"**	**3106**
No. of semester	3	
Lecturers	Heike Pröhl, Ariel Rodriguez	
Kind of course/SWS	seminar (2 SWS), research course (10 SWS)	
Achievements in studies	Research project	
Exam performance	Practical lab and fieldwork (50%); final presentation (50%)	
ECTS-CP	15	

Study targets:

- Field and laboratory methods in the areas of bioacoustics, behavioural ecology, population genetics and herpetology
- Acquisition of advanced theoretical knowledge in the research fields behavioural and evolutionary ecology, conservation biology
- Improvement of written language in scientific reports (in English)

Course contents:

- Bioacoustic recording techniques, playback experiments, bioacoustics analyses
- Measuring of colour pattern, visual modelling
- Recording techniques in ethology, e.g. reproductive behaviour
- Observation of amphibian in the field
- Survey of population sizes and home ranges
- Lab methods for population genetics: PCR, electrophoresis, sequencing, genotyping
- Statistical assessment of bioacoustic, behavioural and genetic data
- Application of ecological and population genetic data for species conservation
- Introduction to the research activities in the working group of the lecturer

Admissions requirements/recommended previous knowledge:
Successful participation in modules of the branch Evolution/Biodiversity/Behaviour in the second semester

Basic Literature:
H.Heathole: Amphibian Biology, Social Behaviour; M.Ryan: Anuran Communication; J. Alcock: Animal Behavior; T.J.C. Beebee: Ecology and Conservation of Amphibians; A. Lowe et al.: Ecological Genetics, O. Berger-Tal & D. Saltz: Conservation Behaviour

Didactic aids:
Bioacoustic equipment; spectrometer + accessories; DNA-lab equipment; analytical software packages, handheld computers, equipment for behavioral experiments (test arenas, walkmans, cameras), powerpoint presentation of students (seminar), individual tutoring, group discussion

Exam requirements:
Written final report

Time and effort involved in studying (in hours): 450 h
Presence during studies: 200 h
Self-study: 250 h
Number of participants: 2

Name of module:	Research Weeks: Conservation of the biodiversity of domestic animal breeds	3107
No. of semester	3	
Lecturers	Ottmar Distl	
Kind of course/SWS	Practical research course (10 SWS), seminar (2 SWS)	
Achievements in studies	Regular attendance, completion of a small research project, participation in seminars with own presentation	
Exam performance	Practical lab work (50%), final presentation with written report (50%)	
ECTS-CP	15	

Study targets:

- Field and laboratory methods in the areas of biodiversity, breed conservation, monitoring of genetic diversity
- Acquisition of advanced theoretical knowledge in population and molecular genetics with special reference to conservation biology and genetics
- Improvement of written language in scientific reports (English)

Course contents:

- Monitoring tools and techniques in conservation programs
- Useful software and tools for conservation programs
- Methods to analyse genetic diversity using software on PC and high performance computers
- Lab methods for population genetics: preparation of DNA, RNA with quality control, qPCR, gel electrophoresis, Sanger and next-generation sequencing, development of PCR-RLFPs, *Taq*-man and KASP genotyping, beadchip genotyping
- Software pipelines for mapping and variant calling of whole genome sequencing data
- Statistical inferences and data evaluation of whole genome genotyping and sequence data
- Interpretation of results and their application in conservation of genetic diversity

Admissions requirements/recommended previous knowledge:
Successful participation in modules of the branch Evolution/Biodiversity/Behaviour in the second semester

Literature:
Frankham, Ballou, Briscoe: Introduction to Conservation Genetics.Cambridge Univ. Press, 2002.
Oldenbroek, Genebanks and the conservation of farm animal genetic resources, DLO Lelystad, 1999
Geldermann: Tier-Biotechnologie, UTB, 2005
Specific references useful for the project

Didactic aids:
Lab protocols, software packages, courses at the institute

Exam requirements:
Written final report, power-point presentation

Time and effort involved in studying (in hours): 450

Presence during studies:	200 h
Self-study:	250 h
Number of participants:	2

Name of Module	Tropical Wildlife Biology and Wildife Medicine	3108
No of semester	3	
Lecturers	Heike Hadrys, Heike Pröhl, Ute Radespiel, Sabine Schmidt, Ariel Rodriguez	
Kind of courses /SWS	Practical course (12SWS)	
Study performance	Accomplishment of a research project, oral defence and written research report	
Exam Performance	Experimental field and/or lab work, written research report and oral defence (100%)	
ECTS-CP	15	

Study targets (Learning outcome):
The student learns…

- to develop and perform an independent field research project in the area of tropical Wildlife Biology/tropical Wildlife Medicine applying modern field techniques under supervision of lecturers
- to organise the field project independently (following the respective laws, e.g. research permissions, trapping permissions, exportation/importation permissions, CITES)
- to work independently on a goal-oriented field research project under tropical field conditions
- to prepare a research report in publication format and to defend it orally

Course contents:

- Identification of species using field guides with species descriptions
- Measuring biodiversity and abundance and application of relevant statistics
- Classification of tropical habitats
- assess the health status of tropical animals
- Autecology, population and community ecology of tropical organisms
- Species and habitat conservation strategies, species and conservation genetics
- Behaviour, communication and cognition of tropical organisms

Admission requirements/recommended previous knowledge:
Successful completion of one or more of the following modules: “Behavioural Ecology of Tropical Vertebrates“ in the Hannover Bachelor program of Biology or equivalent, or “Tropical Wildlife Biology“, “Biodiversity and Species Conservation“, ”Molecular Systematics and Conservation Genetics“, “Current Methods in Virology“, “Current Methods in Parasitology”, or “Behavioural Ecology“ in the Master program. FELASA course is necessary

Basic Literature:
Bradbury/Vehrencanp: Principles of Animal Communication
Dudgeon: Tropical Stream Ecology
Engel: Signifikante Schule der schlichten Statistik
Huffmann/Chapman: Primate Parasite Ecology
Krebs: Ecological Methodology
Kricher: Tropical Ecology
Magurran: Measuring Biological Diversity
Martin/Bateson: Measuring Behaviour – an introductory guide
Primack: Essentials of Conservation Biology
Setchell/Curtis: Field & Lab methods in Primatology
Sutherland (Ed.): Ecological Census Techniques

Didactic Aids: Geographic information system, classification or field guides, modern trapping techniques (incl. mist nets, camera traps), GPS-based radiotracking techniques , modern bioacoustic and ethological techniques, equipment for environmental analyses, molecular genetic laboratory, laboratory of tropical medicine, bioacoustic and video graphic laboratories, software for statistical analyses.

Exam requirements: written research report and its defence

Time and effort involved in studying (in hours)**:** 450
Presence during studies 100 h
Self-study 350 h
Number of participants: unlimited (depending on possible semester abroad)

Name of module	The Tree of Life and Invertebrate Zoology	3109
No. of semester	3	
Lecturers	Bernd Schierwater, NN	
Kind of course/SWS	Practical course (9 SWS), seminar (1 SWS)	
Study performance	Regular attendance, written report	
Exam performance	Examined oral presentation (colloquium, 100%)	
ECTS-CP	15	

Study targets:
The course will take a modern and multidisciplinary approach to the study of Invertebrate Zoology, integrating classical anatomy, modern genomics and evo-devo. The course will cover all of the major invertebrate animal phyla (excluding protists) and use phylogenetic matrices to organize the anatomical and sequence information for each of the greater than 30 phyla we will focus on.

Course contents:
Project Description: Each student will be assigned at least five phyla for the duration of the course. The projects will involve compiling and curating character matrices using both anatomy and molecules for each of the five phyla assigned to them. As well, each student will compile a bibliography of relevant phylogenetic literature for each phyla assigned and complete the assignment with a written assessment of analysis of their compiled matrices with the literature. These written assessments should be no longer than 1500 words per phyla.

Learning Objectives:
1) The primary objective is to increase the student's knowledge of the diversity of invertebrates using the greater than 30 phyla of animal invertebrates as a guide
2) The student will become familiar with the phyla that are commonly encountered, and be able to understand the anatomical characters that are used to diagnose these phyla.
3) The student will utilize phylogenetic matrices comprised of both anatomical and molecular characters to understand the evidence available for the organization of invertebrates.
4) The student will gain an integrated understanding of invertebrate phylogeny and biology

Course Evaluation: Each student is required to complete an anonymous course evaluation at the end of the term. The course evaluation is a tool for faculty and administrators to improve the student learning experience.
The course will be an intense three weeks long minicourse. We have divided the course into three sections, corresponding to the three weeks the course will run. There will be two lectures and five labs per week. Each lecture will be three hours long and each lab will be half a day long. This uniqueness of the course will lie in its use of morphological and molecular characters to interpret the major groups of invertebrates on the planet. At the end of week two of the course, each student will choose a well defined monophyletic phylum or a well defined group of phyla and compile a phylogenetic matrix for the taxa in their chosen group. They will then rigidly analyze their matrices and extensively compare these to the published record on their chosen group. We hope that this exercise will lead to meaningful treatments of several invertebrate groups that will add to our knowledge of invertebrate zoology
Hadrys, DeSalle and Schierwater will share lectures and lab duties and both will attend all lectures and lab exercises. DeSalle will focus on the molecular evidence while Hadrys and Schierwater will focus on the morphological evidence for each group.

Admissions requirements/recommended previous knowledge:

Basic literature:
Invertebrate Zoology: A Functional Evolutionary Approach [Hardcover] Edward E. Ruppert, Richard S. Fox and Robert D. Barnes
 _Westheide, W. & R. Rieger (Hrsgg.): Spezielle Zoologie, Gustav Fischer Verlag
 _Schaefer, M.: BROHMER-Fauna von Deutschland, Quelle & Meyer Verlag

Didactic aids:
Microscopes, computers, software for phylogenetic analyses, examination of living animals

Exam requirements:
Basic knowledge about major invertebrate animal phyla (excluding protists) and phylogenetic methods.

Time and effort involved in studying (in hours)**:** 450

Presence during studies	250 h
Self-study	200 h
Participants:	max 3

Name of module	DNA-barcoding für state-of-the-art biologische und medizinische Anwendungen	3110
No of semester	3	
Lecturers	Heike Hadrys, Bernd Schierwater, Kai Kamm	
Kind of courses /SWS	Practical course (10 SWS), seminar (1 SWS)	
Study performance	Regular attendance, written report	
Exam Performance	Examined oral presentation (colloquium, 100%)	
ECTS-CP	15	

Study targets (Learning outcome):
(i) The development of a basic understanding of DNA bar coding and its modern applications in research.
(ii) Learning practical skills for state-of-the-art barcoding of any living being

Contents:
Practical part: One of the world's largest biological ventureis the so-called "DNA barcoding", which aims to provide a genetic barcode (identification code) for all living beings on earth. DNA barcoding provides completely new and fundamental possibilities for species and nature conservation, for measuring bio diversities and also aids in many medical applications (e.g. pathogen identification).
Dragonflies are excellent examples to demonstrate the principles and biological importance of DNA barcoding. Odonates are outstanding model organisms for species and environmental protection, as they occur in all types of fresh waters and are qualitative indicators of the most diverse habitats.
Bacteria are excellent examples to demonstrate medical applications for DNA barcoding. For example pathogen identification by means of barcoding has been revealing new strains of critical relevance for human health issues.
The practical part teaches the techniques of modern DNA barcoding, from the isolation and sequencing of specific mitochondrial target genes, to the computer-aided identification of character-based barcodes, using both dragonflies and bacteria as model systems.
Seminar: The theoretical basics of DNA barcoding are developed using case studies of current scientific work. The diverse biological and medical applications are critically discussed.

Admission requirements/recommended previous knowledge:
Successful participation in and knowledge of at least one course of the modules Artenschutzgenetik, Mol. Arbeitsmethoden und Entwicklungsgenetik.

Basic Literature:
Rach et al., (2008): Character-based DNA barcoding allows discrimination of genera, species and populations in Odonata.
CORBET: Dragonflies – Behavior and Ecology of Odonata.

Didactic Aids
Computer-based DNA-analysis, CAOS-Interface

Exam requirements Data analysis and a scientific oral report in English language

Time and effort involved in studying (in hours): 450

Presence during studies	150 h
Self-study	300 h
Participants:	max 3

Name of module	**Cell, developmental and gravitational biology of Placozoa, a model organism in cancer research**	**3111**
No of semester	3	
Lecturers	Bernd Schierwater, Jens Hauslage, NN	
Kind of courses /SWS	Practical course (10 SWS), seminar (1 SWS)	
Study performance	Regular attendance, written report	
Exam Performance	Examined oral presentation (colloquium, 100%)	
ECTS-CP	15	

Study targets (Learning outcome):
Recognition of model systems; Introduction to cell biology, gravitational biology and cancer research in a model system.

Contents:
Practicum: We will introduce the most simple organized metazoan animal, *Trichoplax adhaerens,* as a new model system for cell cycle, apoptosis, gravitational biology and cancer research. Key regulatory genes, like the cell cycle control gene, p53, will be isolated and subjected to expression studies in *Trichoplax adhaerens*.
We will gain first insights into a complex gene regulatory network that controls cell proliferation and apoptosis in humans by studying the most simple network present in *Trichoplax*, a basal animal, that uses uncontrolled cell proliferation for reproduction but does not know cancer.
In addition the basic principles of gravity perception in organisms, methods to simulate microgravity and microgravity platforms will be introduced with lectures and experiments.

Admission requirements/recommended previous knowledge:
Successful participation in at least two courses using molecular genetic techniques.

Basic Literature:
1) Schierwater B (2005) My favorite animal, *Trichoplax adhaerens*. BioEssays **27**: 1294-1302.
2) Andrew H. Wyllie (2010) “Where, O Death, Is Thy Sting?” A Brief Review of Apoptosis Biology. Mol Neurobiol **42**: 4–9.
3) Vermeulen,K, Van Bockstaele D & Berneman Z (2003) The cell cycle: a review of regulation, deregulation and therapeutic targets in cancer. Cell Prolif., **36**, 131–149.
4) Morey-Holton, E. R. (2003). The impact of gravity on life. In *Evolution on Planet Earth.* Academic Press. 143-159.
5) Mayorova, T. D., Smith, C. L., Hammar, K., Winters, C. A., Pivovarova, N. B., Aronova, M. A., ... & Reese, T. S. (2018). Cells containing aragonite crystals mediate responses to gravity in Trichoplax adhaerens (Placozoa), an animal lacking neurons and synapses. *PloS one*, *13*(1), e0190905.

Didactic Aids
Computer algorithms, state-of-the-art technologies and hardware.

Exam requirements
Scientific presentation.

Time and effort involved in studying (in hours): 450
Presence during studies 150 h
Self-study 300 h
Participants: max 3

Name of module	Current wildlife research	3112
No. of semester	3	
Lecturers	Ursula Siebert, Oliver Keuling, Friederike Gethöffer, Ulrich Voigt et al. Kristina Lehnert Sobotta, Maria Morell Ybarz (contact: Oliver Keuling)	
Kind of course/SWS	Practical field course (10 SWS), seminar (2 SWS)	
Study performance	Treatment of a research subject, active seminar participation	
Exam performance	Written report (80%), examined oral presentation (colloquium) (20%)	
ECTS-CP	15	

Study targets: Mediation of research-related special knowledge in behavioural and population-ecology within game biology or marine mammal research at the example of a small independent research project within a running project of wildlife biology and wildlife veterinary medicine:
Definition of a scientific question on the background of recent knowledge, choice of method, planning, development and realisation of investigation, evaluation (statistics with "R") and interpretation of results, conclusions and discussion in relation to the question, documentation as written report and final presentation in the seminar of the ITAW

Course contents:

- Acquisition of specific and detailed knowledge and methodical abilities in wildlife research within a running project
- Introduction to statistical analyses with "R"
- Active participation in the seminar on wildlife research (incl. own talk)
- Insights into the current research activities of other projects of the working group
- Insights into wildlife management

e.g. radio telemetry, census methods, reproduction, analysis of optical and acoustic observation data, PowerPoint, specific software and literature, web recherché

Admissions requirements:
Preliminary briefing, knowledge of native German fauna
Recommended previous knowledge (not essential):
knowledge of hunting practice and participation in former lectures on wildlife biology (e.g. practical module methods of wildlife research (BSc) or lecture "Wildbiologie" (Veterinarians and MSc)

Basic literature:
Köhler et al.: Biostatistik; Borchers et al.: Estimating animal abundance; Silvy: The Wildlife Techniques Manual; Schoolbook for hunters to get basic knowledge of native game species (e.g. Krebs, Blase, Schultz, Seibt…)
Advanced literature will be part of the module, all literature available in the ITAW

Didactic aids: radio telemetry, methods for population estimation, analysis of video- and foto-traps, advanced literature, internet inquiry, PowerPoint, several advanced software

Exam requirements: Examined report, examined oral presentation

Time and effort involved in studying (in hours)**:** 450

Presence during studies	250 h
Self-study	200 h
Participants: max	6

Name of module	Applied farm animal ethology	3113
No. of semester	3	
Lecturers	Michaela Fels, Birgit Spindler	
Kind of course/SWS	Practical field course (10 SWS), seminar (1 SWS)	
Study performance	Working on a research topic in farm animal ethology, active participation in a seminar	
Exam performance	Written project report, oral presentation (50 %, respectively)	
ECTS-CP	15	

Study targets: Provision of specific knowledge about behavior analysis in farm animals with the aim of assessing animal welfare in farming systems and their optimization. Independently perform behavioral studies, data analysis and interpretation of results as well as final presentation in a research report and in a seminar.

Course contents:

- Acquiring specific and in-depth knowledge and methodological skills in behavior analysis in farm animals in standard housing systems
- Assessment of animal welfare in the investigated housing systems for farm animals
- Active participation in the institution's internal seminar with oral presentation
- Deepened insight into the research activities of the ethology working group of ITTN

Admissions requirements/recommended previous knowledge:
Basic knowledge of farm animal ethology, especially in pigs and first experience in behavioral analysis and knowledge of current methods of applied ethology

Basic literature:
Martin/Bateson: Measuring Behaviour – an introductory guide
Hoy: Nutztierethologie

Didactic aids: Experimental instructions on the research project, literature, video technique

Exam requirements:
Research report, scientific presentation

Time and effort involved in studying 450

Presence during studies	200 h
Self-study	250 h
Participants: max	3

Name of module	**Biocommunication in mammals**	**3115**
No. of semester	3. Semester	
Lecturers	Marina Scheumann	
Kind of course/SWS	Research project (10 SWS), Seminar (2 SWS)	
Achievements in studies	Processing of a research project and presentation of the results	
Exam performance	Experimental work (50%), Mini-Thesis (25%), Oral presentation (25%)	
ECTS-CP	15	

Study targets:

- Scientific working by performing an own research project
- Writing a scientific report according international publication standards
- Presentation and Defence of the research project and its results
- Acquisition of state of the art knowledge in behavioural research with focus on bio- and psychoacoustic topics in mammals

Course contents:

- Performance of a research project includes:
  - development of testable hypotheses and predictions
  - planning and performing behavioural experiments or observations
  - acquisition of different video and audio recording techniques
  - application of specialized video- and audio analysis software
  - statistical analyses with SPSS and R
  - literature research
- scientific report according to international publication standards
- Active participation in the Zoological Seminar including the defence of the own research project
- Insights into the research activities of the Institute of Zoology

Admissions requirements/recommended previous knowledge:

Research training in the field of behavioral biology e.g., Module Module „Cognitive Ethology and Bioacoustics“ or „Active Sensory Systems - Echo- and Electro location“ or bachelor thesis with focus on behavioral or acoustical research question

Didactic aids:

- Behavioural experiments, Playback techniques in mammals
- Video graphic equipment (Camcorder, closed-circuit television) and specialized software for video analysis (Interact, Observer, Boris)
- Bioacoustics equipment (microphone for infa- audible and ultrasound) and specialized software for audio analysis (Bat sound, SIGNAL, Song Scope, Praat, Audacity)
- Tablets with specialized software for collecting behavioral data online
- Statistical software (SPSS, Statistica und R)
- Project-specific literature and literature search via different online data bases
- Individual Tutoring

Basic literature:

Hopp, Owren, Evans: Animal acoustic communication: sound analysis and research methods
Fitch: The evolution of language
Field: Discovering statistics with SPSS / Discovering statistics with R
Project-specific literature

Exam requirements:

Processing of an own research project, writing a mini-thesis, oral presentation

Time and effort involved in studying (in hours):

Presence during studies	200 h
Self-study	250 h
Participants: max	3

2nd Main topic

Cellular, development and systems neurobiology

Name des Moduls	**Current Topics in cellular Neurophysiology**	**3201**
No. of semester	3	
Lecturers	Felix Felmy	
Kind of course/SWS	Practical course 11 SWS + Seminar 1 SWS	
Achievements in studies	Planning, performing, and documenting experiments and discussing acquired data.	
Exam performance	60% experimental work, 20% protocol, 20 % presentation	
ECTS-CP	15	

Aims:

Planning and performing experiments in a research project.

Analyzing experimental data.

Discussion and interpretation of the acquired data within the theoretical framework.

Written and oral presentations of the results.

Contents:

Introduction into the biophysics and physiology of neurons in defined circuit.
Introduction into in vitro physiology techniques: Acute brain slices, patch-clamp recordings, single cell labeling and cell imaging.

The practical course is limited to one student. Successful participation of the FELASA course is strongly recommended.

Eingangsvoraussetzungen/Empfohlene Vorkenntnisse:

Successful participation of the lecture series: „Zell-, Entwicklungs- und Neurobiologie“

Basic literature:
Kandel, Schwarz, Jessel: Principles of Neural Science (Part II & III)
Bear, Conners, Paradiso: Neuroscience, exploring the brain (Part I)

Didactic aids:
Original literature, Computer programs

Exam requirements:
Participation and independently conducted experiments, documentation and presentation and discussion of results.

Time and effort involved in studying (in hours): 450

1. Presence during studies	250 h
2. Self-study	200 h
Participants:	1 person

Name of module	Auditory Neuroethology and Neurobiology	3202
No. of semester	3	
Lecturer	Karl-Heinz Esser	
Kind of course/SWS	practical course (9 SWS), seminar (2 SWS), journal club (1 SWS)	
Achievements in studies	regular attendance, seminar presentation	
Exam performance	Examined oral presentation (50%), written final report (50%)	
ECTS-CP	15	

Study targets:
to learn how to design a scientific study and how to formulate hypotheses
to develop the competence to analyse complex problems
to learn to collect and to analyse data for a small research project
to be able to present, discuss and defend recent scientific results (in English)
to learn how to write a scientific report following international publication standards

Course contents: Practical course:
selected experiments from the following areas:

- acoustic communication/ echolocation
- sound processing in the CNS (auditory midbrain, auditory cortex)
- sensory-motor/ audio-motor integration

- and application of a selection of the following methods/ techniques:
  - computer-based signal processing (e.g. animal vocalisations)
- characterisation of signals in the frequency and time domain (oscillograms, power spectra, sonagrams),
  - behavioural analysis, conditioning of animals
  - electrophysiology (production of electrodes, surgical (incl. stereotactic) techniques, anaesthesia)
  - single-unit recording
  - generation of tuning curves
  - 2-D and 3-D reconstruction of neural representations of selected sound parameters
  - cortical micro-stimulation
  - intra-cerebral application of neuroactive substances and tracers/ neurohistology

Seminar: oral presentation (defence) of own data from the practical course

Admissions requirements/recommended previous knowledge:
Successful participation in the modules (lectures) “Biodiversity, Behaviour and Evolution” and “Cell, Developmental and Neurobiology”; module “Active sensory systems – echo- and electro location” recommended

Basic Literature:
Hauser, M.D. & Konishi, M. (1999) The Design of Animal Communication. MIT Press, Cambridge, Massachusetts.
Fay, R.R. & Popper, A.N. (1992-2005) Springer Handbook of Auditory Research. 27 volumes. Springer, New York.

Didactic aids:
internet/ data bases, PowerPoint presentation of students, animated graphics, video film sequences, group discussions, hand-outs

Exam requirements: PowerPoint seminar presentation, written final report

Time and effort involved in studying (in hours): 450

Presence during studies:	200 h
Self-study	250h
No. of Participants min.:	1
No of Participants max.:	3

Name of module	Molecular signals in development and plasticityof simple brains	3204
No. of semester	3	
Lecturers	Michael Stern	
Kind of course/SWS	practical course 11 SWS, seminar 1SWS	
Achievements in studies	regular attendance, seminar presentation	
Exam performance	Report of project work (66%) oral presentation of data (33%)	
ECTS-CP	15	

Study targets:
Exploration of experimental strategies for manipulating the development of the nervous system

Course contents:

Students will carry out their own research project within the framework of the current research in the Cell Biology workgroup on embryonic or post embryonic development and plasticity of the nervous system (please have a look at our website for information). Some examples for topics: Migration and axonal pathfinding in PNS development, in vitro assays for developmental neurotoxicity, regeneration in the invertebrate CNS, chemical neuroarchitecture of nervous systems as phylogenetic markers, neuro-immune interactions. Discussion of experimental design, experimental results and original publications in seminars.

Admissions requirements/recommended previous knowledge:
Module 2203 and/or 2210

Basic Literature:
Developmental Biology, Scott Gilbert, Sinauer Associates Inc.
Kandel, Schwarz & Jessel, Principles of Neural Science 4th Edition, McGraw-Hill Publishers
Alberts et al. Molecular Biology of the Cell, 4th Edition, Garland Science

Didactic aids:
Reading assignment of published original research, use of data bases from the web, use of statistical packages

Exam requirements:
Good knowledge of modern research strategies in neurodevelopmental biology

Time and effort involved in studying (in hours): 450

Presence during studies	250 h
Self-study	200 h
Participants:	max. 4 persons

Name of module	Epilepsy research	3205
No. of semester	3	
Lecturers	Manuela Gernert, Malte Feja, Sarah Laaguidi	
Kind of course/SWS	Research project (11 SWS)	
Study performance	Participation in a research project, regular attendance	
Exam performance	Performance during course, project report, and oral presentation Weighting is 1/3 each	
ECTS-CP	15	

Study targets:
Planning and conduction of a research project
Ability to transfer academic problems into practicable methods
Analysis and documentation of results
Application competency
Ability to summarize important contents (project description)
Capacity for teamwork
Time management

Course contents:
Seminar:
Theoretical background of the research project
Practical course
Training in specific work techniques
Development of experimental designs
Conduction of experiments
Analysis of data
Illustration of results

Admissions requirements/recommended previous knowledge:
Module “Neuropharmacology” or other adequate achievements
Course "Versuchstierkunde/Tierschutz" gemäß Empfehlungen der RL 2010/63/EU für Personen, die Tierversuche durchführen, Tiere pflegen oder töten (Funktionen A, C, D gemäß RL 2010/63/EU)

Basic literature:
Literature relevant for the research project

Didactic aids:
Graphic and statistic software, group discussions

Exam requirements:
Internship presence, Preparation of research report, poster presentation

Time and effort involved in studying (in hours)**:** 450 hrs
Presence during studies 200 hrs
Self-study 250 hrs

Course/Module	Current research on the pathogenesis of neurological or gastrointestinal disorders	3206
Program	Cell Biology, Neurobiology, Developmental Biology	
Semester	3	
Lecturer and main supervisor/ Co-supervisors	Hassan Y. Naim/ Dalanda Wanes, Abdullah Hoter	
Course category /SWS	Scientific project (11 SWS)	
Study Performance	Participation in an ongoing research project in the area of pathobiochemistry of protein and membrane trafficking	
Examination requirements	1. Presentation of the project at the Department Meeting (60%) 2. Laboratory performance (40%)	
ECTS-CP	15	

Course targets:

- Practical implementation and expansion of the knowledge gained form the ZEN-lecture as well as the courses 2206 on the cellular and membrane trafficking via participating in an ongoing biomedical research project in the Naim laboratory.
- Unravelling cellular and biochemical mechanisms in the pathogenesis of neurological /or gastrointestinal disorders.
- Independent planning and execution of experimental protocols within a running research project.
- Poster presentation of the accomplished work in English language.

Course contents:

- ***Molecular Biology***:
  Site-directed mutagenesis of single nucleotide polymorphisms (SNPs) naturally occurring in cDNAs encoding lysosomal or intestinal proteins
- ***Cell Biology***:
  - Cell culture of mammalian cells
  - Transfection of cDNAs of wild type and mutant proteins into mammalian cells
  - Intracellular localization of expressed wild type and mutant proteins by immunofluorescence using confocal laser microscopy (***Q****: is altered localization indicative of potential pathogenicity*?)
- ***Biochemistry:***
  - Structural and functional analyses of wild type and mutant proteins (enzyme activity measurements and enzyme kinetics, Western blots) (***Q****: is reduced function indicative of potential pathogenicity*?)
  - Assessment of the glycosylation patterns of the mutant versus the wild type proteins as a criterion for trafficking competence and maturation (ER/ Golgi/Lysosome or ER/Golgi/cell surface) (***Q****: is altered glycosylation indicative of potential pathogenicity*?)
  - Separation of cellular compartments (ER, Golgi, lysosomes)
  - Analysis of protein folding (***Q****: is altered folding indicative of potential pathogenicity*?)
  - Isolation of membrane micro domains or lipid rafts (***Q****: is altered association with lipid rafts indicative of potential pathogenicity*?)

Admission requirements/recommended previous knowledge:
Successful participation in the courses/modules 2206 and/or 2213; alternatively good basic knowledge in the area of protein and vesicular trafficking is expected.

Appropriate literature:

- Alberts et al.: Molecular Biology of the Cell, Wiley-VCH
- Lodish et al.: Molecular Cell Biology
- Publications relevant to the topic

Didactic support:
The laboratory script of module/course 2206; Participation in the laboratory meetings; discussions within the group; frequent Q/A's.

Examination requirements Active daily participation in the research project; drafting a report in manuscript format; poster presentation
Anticipated entire time required to cover the aims of the module: 450 hours Participation in the laboratory work: 250 hours Self-study : 200 hours Participants: 2 students (maximum)

Name of module	Experimental reproductive biology	3207
No. of semester	3	
Lectures	Harriëtte Oldenhof, Harald Sieme (TiHo-REPRO)), Willem F. Wolkers (TiHo-NIFE)	
Kind of course/SWS	lab rotation, 7-week scientific project	
Achievements in studies	perform experimental work, data analysis, and presentation	
Exam performance	written report, journal club and scientific seminar; each 1/2	
ECTS-CP	15	

Study targets:
- learn how to plan and perform (independently) a small scientific research project
- learn how to validate a specific experimental approach, and adjust if needed
- perform extensive data analysis, practice oral and written presentation skills (and present findings in a compact/efficient manner)
- be able to critically discuss experimental data, acquired during the course of the project, as well as data presented in the literature

Course contents:
- discussion about the research project, related work, and literature research
- perform lab work/experiments, analyze data and visualize the major outcomes
- journal club of a paper related to the topic (i.e. reproductive medicine/biology, biopreservation)
- oral presentation (labmeeting/seminar) of the performed research project
- written report (in paper format) on the research project

Admissions requirements/recommended previous knowledge:
general lectures, Methods in reproductive biology (Module 2208)

Basic literature:
see Modul2208

Didactic aids:
- lab equipment, computer analysis, internet literature searches, selected scientific papers

Exam requirements, examination:
basic knowledge in reproductive biology, with special emphasis on practical approaches
participation, oral presentation, written report

Time and effort involved in studying (in hours): 450
1. presence during work discussions and lab work: 150 (i.e. 5-7 weeks)
2. self-study: 300
max. number of participants at REPRO: 2

Name of module	Experimental techniques in reproductive medicine	3210
No. of semester	3	
Lecturers	Dagmar Waberski, Anne-Marie Luther	
Kind of course/SWS	Seminar, practical course	
Achievements in studies	Regular attendance, conduction of an experimental study	
Exam performance	Protocols and oral presentation (each 50%)	
ECTS-CP	15	

Study targets:

- Understanding and critical analysis of relevant literature
- Planning and conduction of a research project
- Documentation and analysis of results from own experiments
- Presentation and discussion of scientific results

Course contents:

Planning and conduction of a small research project that resides in one of the following topics: sperm physiology, sperm preservation, or sperm quality assessment. Dependent on the requirements of the experimental study the spectrum of spermatological techniques includes flow cytometry, computer assisted techniques (CASA), methods for assessing sperm-oviduct and sperm-oocyte interaction, respectively.

Admission requirements/recommended previous knowledge:

Lectures in:

- cellular, developmental and neurobiology
- methods of reproductive biology

Basic literature:

Busch, Waberski: Künstliche Besamung bei Haus- und Nutztieren, Schattauer Verlag
P.L. Senger: Pathways to Pregnancy and Parturition, Current Conceptions Inc.
Current project related literature will be provided

Didactic aids:

Specific literature related to research topic, e-learning program, computer with specific analysis software, internet resources

Exam requirements:

Independent conduction of research project; protocols and scientific presentation of project

Time and effort involved in studying (in hours): 450

Presence during studies	150 h
Self-study	300 h
Participants min./max.:	2 persons

Name of module	**Molecular basis of feto-maternal interaction in the model of bovine placenta**	**3211**
No. of semester	3	
Lecturers	Christiane Pfarrer	
Kind of course/SWS	Research project (11 SWS)	
Achievements in studies	Self-dependent conduction of a research project (after training)	
Exam performance	Written report of project work (70%), oral presentation of data (30%)	
ECTS-CP	15	

Study targets:
Ability to plan a research project, independently perform scientific experiments, validate experimental methods and write a scientific report where the study results are analysed and discussed in relation to the project and the relevant literature.
Ability to design a presentation and to present the study data orally.

Course contents:

- Small research project dealing with relevant questions of the main research area. Students are expected to make plan their study (time and content; under guidance) and read the corresponding literature.
- Experiments will contain:
- Culture of mammalian cells, analysis of proliferation and migration, stimulation and inhibition experiments, Western blot, immunofluorescence, RT-PCR
- Finally the data will be analysed, condensed in a written report, discussed and presented during a seminar

Admission requirements/recommended previous knowledge:
Knowledge of biochemistry and cell biology, basic work techniques of molecular biology and cell culture
Please directly contact. Mrs. Pfarrer

Basic literature:
Alberts, Molecular Biology of the Cell
Recent and/or key publications (partly supplied by supervisors , partly own internet search)

Didactic aids:
Experimental protocols, recent dissertations and literature, presentations

Exam requirements:
Written report and presentation of results

Time and effort involved in studying (in hours): 450
Presence study 250 h
Self-study 200 h
Participants: min./max. 1 person

Name of module	Current research in cellular infection biochemistry	3212
No. of semester	3	
Lecturer	Maren von Köckritz-Blickwede, Nicole de Buhr, Timo Henneck, Marita Meurer, Marta Bonilla, Ahmed Mohamed	
Kind of course/SWS	Scientific project (11 SWS)	
Achievements in studies	Performance of an own research project	
Exam performance	Written report (50%) and presentation (50%)	
ECTS-CP	15	

Study targets:
Deepened understanding of biochemical and cellular mechanisms of host-pathogen interactions based on a small scientific project; self-critical design of experiments.

Course contents:

- Mammalian cell culture
- Isolation and cultivation of primary cells
- Methods to study the cellular host-pathogen interaction
- Basics in fluorescence microscopy
- Analysis of protein expression
- Analysis of enzymatic activity
- Participation in the biochemical seminar
- - Participation in the biochemical journal club

Admissions requirements/recommended previous knowledge:
Successful participation in the module 2206, 2207, 2212 or 2213

Basic Literature:
Voet et al.: Lehrbuch der Biochemie, Wiley-VCH
Alberts et al.: Molekularbiologie der Zelle, Wiley-VCH
Hacker/Heesemann „Molekulare Infektionsbiologie“
Recent publications (topic specific)

Didactic aids:
Material provided in the module 2206, 2207 or 2212, Software (Excel, GraphPad)

Exam requirements:
Performance of an own research project , written final report, project presentation

Time and effort involved in studying (in hours): 450
1. Presence during studies 250 h
2. Self-study 200 h
Participants: 1 person at least (max. persons after agreement)

Name of module	Biochemistry of Viral Protein Expression	3218
No. of semester	3	
Lecturers	Imke Steffen	
Kind of course/SWS	Experimental work (11 SWS), seminar (1 SWS)	
Achievements in studies	Experimental Work (Study design, conduct of study, analysis of study data, documentation and discussion of data)	
Exam performance	Examined oral presentation (50%), practical lab work (50%)	
ECTS-CP	15	

Study targets

1. Biosynthesis and processing of membrane and secretory proteins; membrane trafficking (ER, Golgi, endosomes, cell surface);
2. Structure and function of viral glycoproteins (viral protein expression and proteolytic processing, protein conformation, glycosylation, immune evasion, membrane fusion, drug targets);

Course contents

Aim: To understand mechanisms of viral entry into target cells, receptor interactions, virus-cell membrane fusion and principles of host mimicry and immune evasion (Current research topics focus on the influence of glycosylation on viral protein function and immune recognition, identification of virus receptors and inhibition of viral entry by small molecule compounds and neutralizing antibodies).

Experimental:

- Expression of wild type and mutant viral proteins in different cell types and detection by microscopy and Western blot
- Investigation of cholesterol dependence of viral protein trafficking
- Assessment of viral protein glycosylation by Endo H / PNGase F digest
- Assessment of viral protein processing by viral and/or host cell proteases
- Testing of protein function (fusogenic, proteolytic activity)

Admissions requirements/recommended previous knowledge:
Lecture in Cell, Developmental, and Neurobiology

Basic Literature:

Voet et al.: Lehrbuch der Biochemie, Wiley-VCH
Pingoud et al.: Arbeitsmethoden der Biochemie, de Gruyter
Alberts et al.: Molekularbiologie der Zelle, Wiley-VCH
Flint et al.: Principles of Virology, ASM Press
Specific project-related publications

Didactic aids:
Biochemistry and virology text books, original publications, experimental work plans

Exam requirements: Successful completion of the research project, scientific presentation of the project

Time and effort involved in studying (in hours): 450

1. Presence during studies 250 h
2. Self-study 200 h
Participants: not specified

Name of module	Models in neuropharmacology	3220
No. of semester	**3**	
Lecturers	**Gericke, Feja, Richter Assencio**	
Kind of course/SWS	**Research project (11 SWS)**	
Study performance	**Independent work on a research project (after training)**	
Exam performance	**Performance during course, project report, and oral presentation** **Weighting is 1/3 each**	
ECTS-CP	**15**	

Study targets:
- Independent planning and working on a research project
- Transfer of theoretical questions to practical work
- Analysis of experimental results
- Summarize contents comprehensible
- Ability to organize and to work in a team

Course contents:
Preliminary talk:
- Background of the research project (depending on lecturer from the field Parkinson's disease or blood-brain barrier or epilepsy)

Practical course:
- Training in work techniques (*in vitro, ex vivo, in vivo*)
- Design the experiments
- Perform experiments
- Analyse and illustrate data

Admissions requirements/recommended previous knowledge:
Lecture: Cellular, development and systems neurobiology

Basic literature:
1 Project-dependent literature by lecturer and own research

Didactic aids:
Self-study of literature, databases on the internet, statistic and graphic programs

Exam requirements:
Internship presence, preparation of project report, oral presentation

Time and effort involved in studying (in hours)**:** 450 h
1. Presence during studies 200 h
2. Self-study 250 h

3rd Main topic:

Infection Biology

Name of module	**Current research topics on generation and characterization of recombinant vector vaccines**	**3301**
No. of semester	3	
Lecturers	Asisa Volz, Lisa-Marie Schünemann, Sabrina Clever	
Kind of course/SWS	Practical course/11 SWS + Seminar/1 SWS	
Achievements in studies	Planning, performing, documentation and discussion of experiments	
Exam performance	Protocol (1/3), presentation (1/3), experimental realisation(1/3)	
ECTS-CP	15	
Study targets: techniques in molecular virology, cell biology, and biochemical analyses of viral proteins, organisation and team work, critical discussion of results and scientific presentation		
Course contents: Isolation of nucleic acids, Cloning of cDNA in E. coli, Generation of transfer plasmids and recombinant viruses PCR assays, Detection of proteins by immunofluorescence microscopy and western blotting Virusitration Proteolytic cleavage of viral proteins Cell fusion assays		
Admission requirements/recommended previous knowledge: One of the Infection Biology modules of the second semester		
Basic literature: Flint, Enquist Racaniello, Salka: Principles of Virology - Molecular Biology, Pathogenesis, and Control of Animal Viruses, current publications		
Didactic aids: original publications and reviews, computer programs		
Exam requirements: Documentation and presentation of the results		
Time and effort involved in studying (in hours)**:** 450 Presence study: 250 h Self-study: 200 h Participants min./max.: 1 person		

Name of module	**Current research topics in bacterial virulence mechanisms**	**3302**
No. of semester	3	
Lecturers	Jochen Meens, Ralph Goethe, Peter Valentin-Weigand	
Kind of course/SWS	Practical course/11 SWS + Seminar/1 SWS	
Achievements in studies	Planning, performing, documentation and discussion of experiments	
Exam performance	Experimental Work 50% Protocol 25% Presentation 25%	
ECTS-CP	15	

Study targets:
techniques in molecular biology, cell biology and biochemical analyses of virulence mechanisms of bacteria, organisation and team work, critical discussion of results and scientific presentation

Course contents:
Experimental research on a project of one of the lecturers' research topics, standard techniques in molecular and cellular microbiology, independent working on solving scientific problems. Development and documentation of experimental concepts and protocols, presentation of the project during the Institute's seminar.

Admission requirements/recommended previous knowledge:
One of the Infection Biology modules of the second semester

Basic literature:
Salyers/Whitt „Bacterial Pathogenesis", recent project-related publications

Didactic aids:
original publications and reviews, computer programs

Exam requirements:
Documentation and presentation of the results

Time and effort involved in studying (in hours): 450
1. Presence study: 250 h
2. Self-study: 200 h
Participants: not specified

Name of module	Current studies on fish pathogens	3303
No. of semester	3	
Lecturers	Verena Jung-Schroers, Mikolaj Adamek	
Kind of course/SWS	practical course	
Achievements in studies	Regular attendance, seminar presentation	
Exam performance	Examined oral presentation, scientific report (50/50)	
ECTS-CP	15	
Study targets: conducting a scientific research project, using IT to record results and present information to a range of audiences, applying and designing experimental procedures, reviewing the results of scientific experiments, producing reports and recording results of experiments in laboratory record books, undertaking bibliographic research, reading and reviewing literature and reports		
Course contents: Comment on the theoretical background of the scientific research project in a kick-off meeting, training in appropriate methodology (in respect to the specific research project): (i) molecular diagnostic of virus infections in fish, (ii) analysis of innate immune responses of fish to viral infection, or (iii) analysis of the microbial community on fish skin/ aquaculture systems. Conduction and evaluation of relevant experiments. Evaluating, reporting and discussing of relevant findings.		
Admissions requirements/recommended previous knowledge: Basic Knowledge in virology and patho-biochemistry		
Basic Literature: Hacker/ Heesemann: Molekulare Infektionsbiologie Current publications (upon consultation)		
Didactic aids: group discussions, hand-outs, publications, evaluation programmes		
Exam requirements: Self-dependent conduction of a research project, Evaluation of generated data, PowerPoint seminar presentation, writing of a scientific report		
Time and effort involved in studying (in hours): 450 1. Presence during studies 250 h 2. Self-study 200 h		

Name of module	Research on host-pathogen interactions	3304
No. of semester	3	
Lecturers	Bernd Lepenies, Hans-Joachim Schuberth	
Kind of course/SWS	practical work (11 SWS), seminar (1 SWS)	
Achievements in studies	Planning, realisation, evaluation, documentation and discussion of results	
Exam performance	Practical lab work (50%); final presentation (50%)	
ECTS-CP	15	

Study targets:
Ability to analyse experimental results; Creativity and flexibility in the application of methods; Ability to organize the work and to work in a team: Ability to summarize and to communicate a professional topic in a coherent way.

Course contents:
Independent and cooperative work on a limited scientific topic in the framework of actual immunological research.
Result-oriented application of project-relevant techniques (molecular, humoral, cellular immunology)
Scientific evaluation and presentation techniques
Group-discussions

Admissions requirements/recommended previous knowledge:
Successful attendance of the module **'**Acquisition and assessment of immune mechanisms'

Basic Literature:
Janeway, Travers, Walport, Shlomchik : Immunobiology

Didactic aids:
Original scientific literature; evaluation programs

Exam requirements:
Practical lab work, Scientific PowerPoint presentation

Time and effort involved in studying (in hours): 450

1. Presence during studies	250 h
2. Self-study	200 h
Participants:	2 person (1 Attendees per Lecturer)

Name of module	Current research in molecular parasitology	3305
No. of semester	3	
Lecturers	Stefanie Becker	
Kind of course/SWS	Practical (11SWS) + Seminar (1 SWS)	
Achievements in studies	Experimental Work (Study design, conduct of study, analysis of study data, documentation and discussion of data)	
Exam performance	Examined oral presentation	
ECTS-CP	15	
Study targets: Competence of self-planning, conduct, analysis, and scientific reporting of a molecular-parasitological research project		
Course contents: Learning and practicing of backgrounds and methods in molecular parasitology in an own project as part of the current research. Study design, performing (standard-) techniques in molecular parasitology to work independently on a specific question including generation of a study protocol and data analysis. Final presentation of the results.		
Admissions requirements/recommended previous knowledge: A FELASA course could be necessary. For this, please contact Mrs. Becker.		
Basic literature: “Der Experimentator: Molekularbiologie / Genomics“ von C. Mühlhardt; „Gentechnologie für Einsteiger“ von TA Brown **Further Literature:** Specific publications		
Didactic aids: Literature, software		
Exam requirements: Scientific presentation of the project		
Time and effort involved in studying (in hours): 450 Presence during studies 115,5 h Self-study 334,5 h Participants: not specified		

Name of module	**Current research project on the role of innate immunity during infections**	**3309**
No. of semester	3	
Lecturers	Bernd Lepenies	
Kind of course/SWS	Research project (11 SWS), accompanying seminar (1 SWS)	
Study performance	Design and performance of a research project	
Exam performance	Practical lab work (50%); final presentation (50%)	
ECTS-CP	15	

Study targets:

- Self-independent experimental design and performance
- Analysis, discussion, and critical review of experimental data
- Deeper insight into scientific questions in molecular biology and immunology
- - State-of-the-art immunological methods: ELISA, flow cytometry, pathogen arrays

Course contents:

- Cloning and eukaryotic expression of pattern recognition receptors in innate immunity (so-called C-type lectin receptors)
- Protein purification and quantification using ELISA-based methods, Western blot, and flow cytometry
- Binding studies to screen for novel C-type lectin receptor ligands on pathogens (by ELISA, flow cytometry, glycan array)
- Functional characterization of pathogen/C-type lectin receptor interactions using cell stimulation assays (determination of cell activation, cytokine production etc.)

Admissions requirements/recommended previous knowledge:
Basic knowledge of immunology; Motivation and interest in practical lab work, particularly in molecular biology, cell biology, and immunology

Basic literature:
Murphy, Travers, Walport: Janeway's Immunobiology, Taylor & Francis
Gabius (Hrsg.): The Sugar Code – Fundamentals of Glycosciences, Wiley-VCH
Varki et al.: Essentials of Glycobiology, 2nd Edition, Cold Spring Harbor Press, Part IV + V
Relevant peer-reviewed publications (will be provided)

Didactic aids:.
Immunology textbooks and original publications; Statistics software

Exam requirements:
Successful completion of the research project; Final oral presentation

Time and effort involved in studying (in hours)**:** 450
Presence during studies: 250 h
Self-study: 200 h
Participants: 1 person

Name of module	Molecular biology of RNA viruses	3312
No. of semester	3	
Lecturers	Martin Ludlow	
Kind of course/SWS	Practical course/10 SWS, Seminar/1SWS	
Achievements in studies	Regular attendance, protocol, oral presentation	
Exam performance	examined oral presentation (50%), written final report (50%)	
ECTS-CP	15	

Study targets:
Understanding of how application of modern molecular biology techniques is integral to the generation of recombinant viruses and discovery of novel viruses; Ability to summarize and present complex subjects to an audience.

Course contents:
Practical course e.g.:
Introduction to molecular biology software packages, cloning of viral and host genes, expression of viral proteins, RNA extraction, RT-PCR, generation of variant viruses, virus rescue, growth of recombinant viruses
Seminar:
Oral presentation of scientific literature

Admissions requirements/recommended previous knowledge:
Attendance at lecture series “Infection Biology”, basic knowledge in molecular biology technologies

Basic literature:
Dr. Cornel Mülhardt: Der Experimentator: Molekularbiologie/ Genomics
Flint, Enquist, Racaniello, Skalka: Principles of Virology

Didactic aids:
PowerPoint presentations, relevant literature, experimental work plans, handouts

Exam requirements:
Knowledge about the content of lectures and seminar; understanding of the methods used in the practical course

Time and effort involved in studying (in hours)**:** 450

Presence study:	200 h
Self-study:	250 h
Participants:	min. / max. 1 person

Name of module	Current Methods of Bioinformatics for Infection Research	3313
No. of semester	3	
Lecturers	Klaus Jung	
Kind of course/SWS	Practical course (11 SWS), seminar (1 SWS)	
Study performance	Planning, data generation and analysis, documentation and discussion of a research project	
Exam performance	Project report (2/3), oral presentation (1/3)	
ECTS-CP	15 (3. Sem.)	

Study targets:

- Ability to comparatively select a bioinformatics software for a specific biological question
- Ability to analyse standard high-throughput data from genomics and transcriptomic, as well as visualization and interpretation
- Ability to write small programming scripts under R or Linux

Course contents:

Introduction to common data types and analysis strategies in bioinformatics. Implementation of a current research project in bioinformatics (sequence or expression analysis, or machine learning).
The project will mainly consist of a systematic comparison of softwares for a specified problem.
Using simulation studies, the pros and cons of each software will be systematically determined and rated.

Admissions requirements/recommended previous knowledge:

Ring lecture cell, development and neurobiology; Module “Bioinformatics Freeware and Online-Tools for Infection Research” (2nd Semester); basic knowledge of a programming language is of advantage but not mandatory

Basic literature:

- Anders, S., & Huber, W. (2012). Differential expression of RNA-Seq data at the gene level–the DESeq package. *Heidelberg, Germany: European Molecular Biology Laboratory (EMBL)*.
- Dobin, A., Davis, C. A., Schlesinger, F., Drenkow, J., Zaleski, C., Jha, S., ... & Gingeras, T. R. (2013). STAR: ultrafast universal RNA-seq aligner. *Bioinformatics*, *29*(1), 15-21.

Didactic aids: Expert literature, software manuals

Exam requirements: Performing a research project; preparation of a project report and oral presentation of the project

Time and effort involved in studying (in hours)**:** 450

Presence during studies:	200 h
Self-study:	250 h
Participants:	min. 1 / max. 3

Name of module	Aktuelle Forschungen zu den molekularen Mechanismen des viralen Zelleintritts	3314
No. of semester	3	
Lecturers	Alexander Postel	
Kind of course/SWS	Practical course (11 SWS), seminar (1 SWS)	
Study performance	Planning, implementation, evaluation, documentation and discussion of the experiments	
Exam performance	Project report (1/3), final presentation (1/3), experimental implementation (1/3)	
ECTS-CP	15	

Study targets:
Practical application of virological, cell biological and molecular biological methods,
Planning, implementation, evaluation, and interpretation of experiments, scientific presentation

Course contents:
Get to know and apply virological and molecular biological laboratory techniques. Active participation within current doctoral projects is made possible. The aim is to investigate the molecular determinants of viral cell entry in veterinary RNA viruses. Among other things, PCR techniques, cloning of viral genes, mutagenesis of nucleic acids, production and genetic characterization of knockout cells using CRISPR / Cas technology, handling of cell cultures, recombinant protein expression, establishment of a system for the production of viral pseudo types.

Admissions requirements/recommended previous knowledge:
Successful participation in one of the infection biological modules of the second semester

Basic literature:
Flint, Enquist Racaniello, Salka: Principles of Virology - Molecular Biology, Pathogenesis, and Control of Animal Viruses,
Aktuelle Publikationen

Didactic aids:
Original literature, evaluation programs

Exam requirements:
Independent implementation of experiments, record keeping and scientific presentation of the project

Time and effort involved in studying (in hours):450
Presence during studies: 250 h
Self-study: 200 h
Participants: min./max.: 1 person

Name of module	Public and Animal Health aspects of helminths and arthropods	3315
No. of semester	3	
Lecturers	Christina Strube, Marie-Kristin Raulf, Andrea Springer	
Kind of course/SWS	Internship (11SWS) + Seminar (1 SWS)	
Achievements in studies	Experimental work (study planning, execution, evaluation, documentation, discussion)	
Exam performance	Experimental laboratory work (50%), protocol (25%), final report (25%)	
ECTS-CP	15	

Study targets: Competence to plan, conduct and evaluate a parasitological research project and critically evaluate the results in a final report with respect to relevant literature.

Course contents:
Answering current basic research and/or epidemiological questions on helminths and arthropods as part of a project. Design of experiments, learning and applying skills and methods of molecular parasitology (e.g. collection and cultivation of parasites and their developmental stages with subsequent protein isolation and analysis, differentiation and quantification of zoonotic and veterinary-relevant helminths, arthropods and vector-borne pathogens using different nucleic acid-based methods), work on a specific question with the preparation of an experimental protocol and subsequent data evaluation. Summary and critical evaluation of the results within a final report.

Admissions requirements/recommended previous knowledge:
A FELASA certificate or a TBEV vaccination may allow a more comprehensive insight into some projects, but are not required.

Basic literature:
“Parasitologie für die Tiermedizin“, Peter Deplazes et al.; “Molekularbiologische Methoden“, Thomas Reinard

Didactic aids:
Textbooks, current research publications, software

Exam requirements:
Experimental laboratory work, protocol and writing of a final report

Time and effort involved in studying (in hours): 450

Presence during studies	250 h
Self-study	200 h
Participants:	not specified