Module Manual

For the Master's programme

„Neuroscience “

Johannes Gutenberg-University Mainz; 01/2022

The module handbook serves as an overview of the content and organisation of the entire degree programme.

This handbook provides information on the following points:

- necessary prerequisites for completing a module,
- when a module and its courses are offered
- contents and learning objectives of the individual module or courses,
- type and degree of obligation of the module or courses,
- contact time (SWS) and workload per module and course,
- certificates of achievement to be provided for the individual courses,
- type of module examinations and composition of the module grade,
- number of credit points (LP) that students receive after successful completion of the module,
- the persons responsible for each module
- the further usability of a module in other degree programmes.

The module handbook contains a module overview and a study plan.

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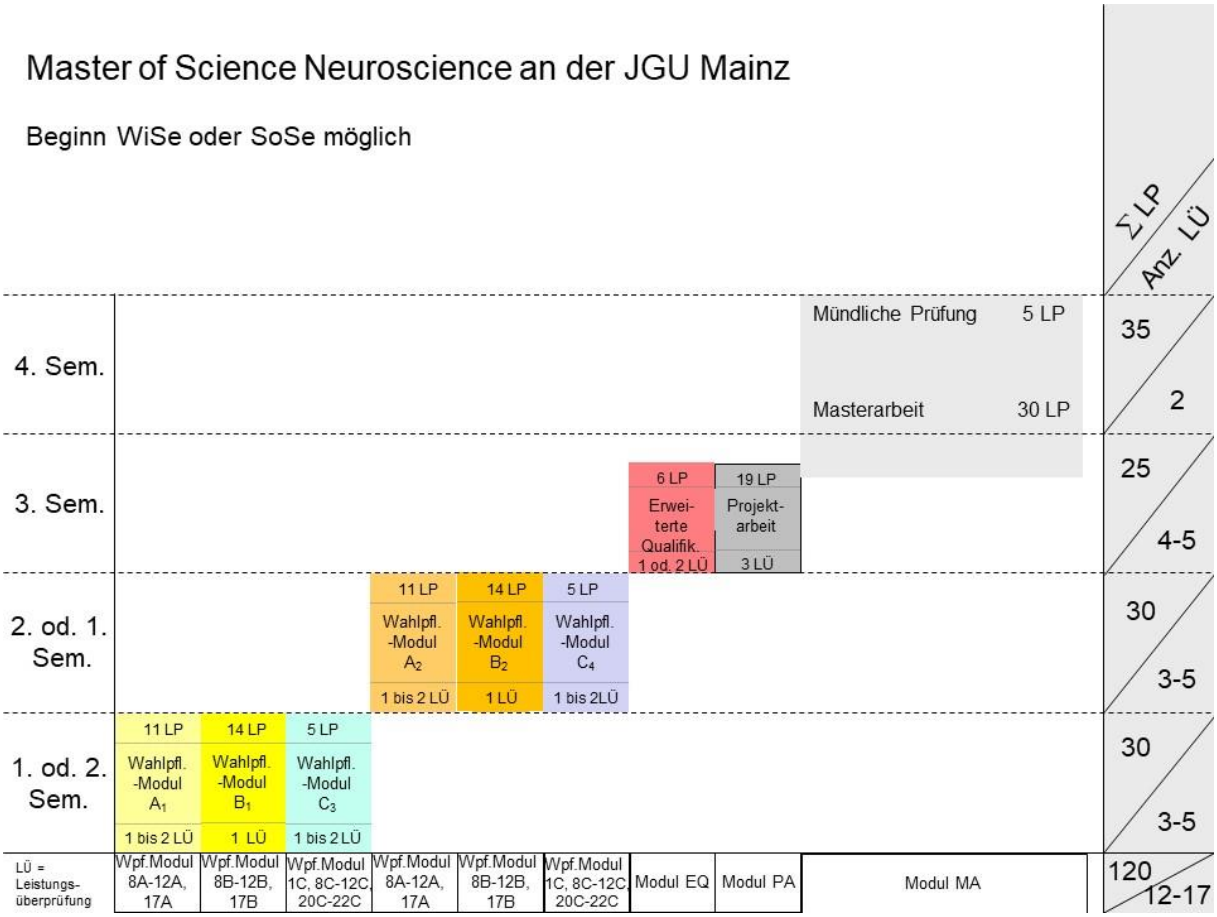
Study Plan


Master of Science Neuroscience an der JGU Mainz
Beginn WiSe oder SoSe möglich
Σ LP
Anz. LÜ
4. Sem.
Mündliche Prüfung 5 LP
Masterarbeit 30 LP
35
2
3. Sem.
6 LP
Erwei-terte Qualifik.
1 od. 2 LÜ
19 LP
Projekt-arbeit
3 LÜ
25
4-5
2. od. 1. Sem.
11 LP
Wahlpfl. -Modul A2
1 bis 2 LÜ
14 LP
Wahlpfl. -Modul B2
1 LÜ
5 LP
Wahlpfl. -Modul C4
1 bis 2LÜ
30
3-5
1. od. 2. Sem.
11 LP
Wahlpfl. -Modul A1
1 bis 2 LÜ
14 LP
Wahlpfl. -Modul B1
1 LÜ
5 LP
Wahlpfl. -Modul C3
1 bis 2 LÜ
30
3-5
LÜ = Leistungs-überprüfung
Wpf.Modul 8A-12A, 17A
Wpf.Modul 8B-12B, 17B
Wpf.Modul 1C, 8C-12C, 20C-22C
Wpf.Modul 8A-12A, 17A
Wpf.Modul 8B-12B, 17B
Wpf.Modul 1C, 8C-12C, 20C-22C
Modul EQ
Modul PA
Modul MA
120
12-17

Elective Modules of the 1st and 2nd Semester		
Module-No.	**Topic**	**Working Group**
Module 8A/B/C	Molecular Basis of Synaptic Plasticity I/II Information Processing in Neuronal Networks	Heine, Bikbaev (Functional Neurobiology)
Module 9A/B/C	Sensory Processing: Concept – Neural Circuits – Tools / Mechanisms of Visual/Olfactory Processing / *In vivo* Analysis of Neural Circuits	Silies, Martelli (Neurodevelopmental Biology)
Module 10A/B/C	Molecular Cell Biology I/II/C	Wolfrum (Molecular cell biology)
Module 11A/B/C	Neuronal Basis of Behaviour I/II/C	Strauß (Neurobiology I)
Module 12A/B/C	From Ion Channels to Behaviour, I/II / Cellular and Molecular Basics of Motoric behaviour	Duch (Neurobiology II)
Module 17A/B/C	Molecular Medicine I/II/C	May-Simera (Cilia Biology)
Module 1C	Protein Bioinformatics and Programming	Andrade (Bioinformatics)
Module 20C	Methods of Applied Bioinformatics	Andrade/Gerber (Computational Systems Genetics)
Module 21C	Rodent Models in Translational Neuroscience	Müller (Leibniz Institut für Resilienz Mouse Behaviour Unit)
Module 22C	Fluorescence Microscopy in Cell- and Neurobiology	Heine (Functional Neurobiology)

Compulsory Modules of the 3rd and 4th Semester		
Module-Nr.	**Name**	**Module Officer**
Module EQ	Advanced qualifications	Prof. Dr Thomas Hankeln
Module PA	Project work	Dean of the Department of Biology
Module MA	Master thesis	Dean of the Department of Biology

All working groups of the Institute of Developmental and Neurobiology of FB10 offer project work and master's theses; these can also be offered by FB04.

The compulsory elective modules A/B can be freely combined and are offered alternately in the summer and winter semesters.

Explanation of terms:

- **work load** = credit points x 30 or contact time + self-study.
- **SWS**, semester hours per week (contact time): 1 SWS = 1 hour per week over the whole semester
- **LP**, Leistungspunkte = CP, credit points According to the ECTS system (European Credit Transfer System): a system that makes modules internationally comparable in terms of workload, contact time, learning effort and degree of difficulty.
- **SoSe,** Sommersemester = summer semester
- **WiSe**, Wintersemester = winter semester
- **WPf,** Wahlpflichtfach = compulsory optional subject
- **Pf,** Pflichtfach = compulsory subject

I. Compulsory Electives - Offers for the 1st and 2nd Semesters

Module 8A	**Molecular Basis of Synaptic Plasticity I**					
Compulsory or elective module	**WPf** (elective)					
Credit points (LP) and workload	**11 LP = 330 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5 h	1 LP
Tutorial (Übung)	Ü	1	Pf.	7 SWS (73,5 h)	136,5 h	7 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	According to § 5 Para. 3, seminar presentation in the literature seminar					
Course achievement(s)	Written exam (60 min.) and, if applicable, oral supplementary exam (§13[5])					
Module exam	Protocol in the style of a scientific paper					

Qualification goals/learning outcomes/competences

Neurons communicate primarily via chemical synapses that operate as probabilistic devices transmitting and modulating information transfer. The modulation of synaptic activity within neuronal networks is one major variable for processes like learning and memory formation. Within the module, we aim to discuss the structure and function of synapses, as well as the molecular mechanisms known to participate in synaptic plasticity.
The students will be introduced to the microarchitecture of the synapse and learn how fast and slow mechanisms of synaptic plasticity function and influence each other. Synaptic plasticity comprises three categories such as short- and long-term as well as homeostatic plasticity. However, the temporal classifications often represent only one aspect, whereas plasticity processes are mutually dependent at many timescales. With the deeper understanding of underlying molecular mechanisms, one can not only describe synapses better but also manipulate with synaptic plasticity directly. Key effector molecules as voltage-gated calcium channels, adhesion molecules and transmitter receptors are connected to intracellular signalling pathways that will be described within the lectures. Both pre- and postsynaptic mechanisms, as well as glia-derived factors and structures that contribute to synaptic plasticity will be discussed. In addition, the students will learn about the impact of the extracellular matrix as an additional structure that affects synaptic plasticity. Within the practical course, the participants will get a brief overview of optical and electrophysiological approaches to investigate synapses in different neuronal preparations.

Content

Lecture, Seminar and Exercise contain the following:
- Function of short- and long-term plasticity of mammalian glutamatergic synapses
- Neuromuscular and sensory synapses as specialized structures with a particular function
- Molecular composition of pre- and postsynaptic compartments of central synapses
- Forms and features of presynaptic short and long-term plasticity
- Induction, expression and maintenance of long-term plasticity
- Plasticity of GABAergic synapses
- Homeostatic plasticity
- Impact of glial cells on the expression and maintenance of synaptic plasticity

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	11/114
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	According to §5 par. 5
Module Officer	Prof. Dr Martin Heine

Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology, Master's programme M.Ed. Biology
Other	**Recommended reading:** Bear, Connors, Paradiso (2018) Neuroscience. Heidelberg: Spektrum. Dudel, Menzel, Schmidt (2001) Neuroscience. Berlin, Heidelberg: Springer. Motor skills: ch.6-8. Sheng, Sabatini, Südhof (2012) The Synapse. Cold Spring Harbor Laboratory Press

Module 8B	**Molecular Basis of Synaptic Plasticity II**					
Compulsory or elective module WPf	**WPf** (elective)					
Credit points (LP) and workload	**14 LP = 420 h**					
Module duration (According to study plan) 1 semester	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial (Übung)	Ü	1	Pf.	13 SWS (136,5 h)	253,5 h	13 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	According to § 5 par. 3					
Course achievement(s)						
Module exam	Protocol in the style of a scientific paper and presentation on the project in the laboratory seminar					

Qualification goals/learning outcomes/competences
Students will learn and apply optical and electrophysiological methods to investigate synaptic activity and plastic changes on the level of single molecules, synapses or neuronal networks. Here, they will work mainly in primary neurons from rodents or on the neuromuscular junction of Drosophila larvae. During this module, the students will learn to conduct neurobiological experiments, as well as to analyse and interpret the results. Here they will apply statistical and analytical tools to evaluate the experimental data and judge their validity. Within the lab meetings, students will report their results, discuss problems and data with the members of the lab. The outcomes will be then summarized and presented in a frame of ongoing studies in the lab.
Contents
Applying methods of neurogenetics (particularly optogenetics, RNAi-interference, Cre-induced temporal deletion or expression) Applying methods of immunocytochemistry in cultured neurons or brain slices Applying methods for quantification of protein expression (western blot, localization microscopy) Analysing principles of network activity within cultured neurons or organotypic brain slices

Access requirement(s)	successful participation in module 8A
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	14/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	According to §5 par. 5
Module Officer	Prof. Dr Martin Heine
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology

Other	**Recommended reading:** -Heck et al. (2019), Transient Confinement of CaV2.1 Ca (2+)-Channel Splice Variants Shapes Synaptic Short-Term Plasticity, Neuron 103: 66-79 -Heine et al. (2020), Dynamic compartmentalization of calcium channel signalling in neurons, Neuropharmacology 169: 107556 -Groc, Choquet (2020) Linking glutamate receptor movements and synapse function, Science 368: 1-9

Module 8C	**Information Processing in Neuronal Networks**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
In order to be able to complete the module, the following achievements must be made:						
Presence						
Active participation	pursuant to § 5 para. 3					
Course achievement(s)	Lecture in the literature seminar					
Module exam	Written exam (60 min) on the lecture; supplementary oral exam if necessary (§13[5])					

Qualification goals/learning outcomes/competences

In this module, students will gain theoretical background in mechanisms of the transfer, processing and storage of information in mammalian brain. Lectures will cover main aspects of the network activity and neuronal communication, from synaptic transfer of information between individual neurons to large-scale population activity on the systems levels. Main emphasis will be made on existing experimental and computational approaches to evaluate the formation, maintenance and experience-dependent modification of connectivity in spiking neuronal networks. The contents of the proposed module will be structurally connected to modules on the computational neuroscience and artificial neural networks.

Contents

- Neuronal plasticity as fundamental feature of the CNS; forms of learning and memory;
- Neuron as an information processing unit, membrane potential dynamics as a mechanism to encode information;
- Stochasticity and variability in neuronal spike trains; physiological sources and significance of noise in neuronal networks;
- Main principles of encoding and decoding information by neurons; rate and temporal coding schemes;
- Synaptic transmission of information between neurons; transfer and integration of postsynaptic potentials in somato-dendritic compartment;
- Local field potentials and network oscillations; their role in associative learning.
- Dynamics and hierarchical structure of the brain network; complex network analysis.
- The seminar will include students' presentation and discussion of individual aspects of information processing in neuronal networks *in vivo* and *in vitro*.

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	5/114 LP

Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Martin Heine; Dr Artur Bikbaev
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** • Buzsaki (2011) Rhythms of the Brain. Oxford University Press. • Kandel et al (Eds) (2012) Principles of Neural Science. McGraw-Hill. • Squire et al (Eds) 2008 Fundamental Neuroscience. Academic Press; Elsevier. • Stone (2018) Principles of Neural Information Theory: Computational Neuroscience and Metabolic Efficiency. Sebtel Press.

Module 9A	**Sensory Processing: Concept – Neural Circuits - Tools**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**11 LP = 330 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Sensory Processing: Concept – Neural Circuits - Tools	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
Literature Seminar Sensory Processing	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Sensory Processing: Concept – Neural Circuits - Tools	Ü	1	Pf.	7 SWS (73,5 h)	136,5 h	7 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	pursuant to § 5 para. 3; Seminar Lecture in the literature seminar					
Course achievement(s)	Written exam (60 min.) and, if applicable, oral supplementary exam (§13[5])					
Module exam	Protocol in the style of a scientific paper					
Qualification goals/learning outcomes/competences						
How does a nervous system process sensory signals such as odours or visual information? Students will consider and experimentally investigate this question at different levels: from the molecular mechanisms of sensory processing, to neuronal cell types and their organization in networks, to the control of behaviour. In doing so, they will learn numerous current molecular, neurogenetic, and neurophysiological methods, and use diverse behavioural experiments and modern microscopy techniques. Students will further learn to perform, statistically evaluate, and describe scientific experiments. With guidance, they will be able to interpret experimental results, develop causal relationships, and summarize results in a scientific format (protocol).						
Contents						
Lecture, Seminar and Exercise contain the following:						

- Basics of sensory processing (vision, olfaction, taste, audition, touch) in invertebrates and vertebrates
- molecular mechanisms (genetic analyses, receptors, channels, etc.)
- neurogenetics
- neuronal mechanisms: cell types, neuronal circuits, behavioural control
- experimental analysis of neuronal circuits (activation and inactivation of neuronal cell types, „functional connectomics“)
- neurophysiology (in vivo calcium imaging, confocal and 2-photon microscopy)
- electrophysiology
- behavioural analyses data analysis: signal processing, image processing, statistical methods

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	11/114
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Marion Silies
Usability of the module in other degree programmes	Master’s programme M.Sc. Neuroscience, Master’s programme M.Sc. Biology, Masterstudiengang M.Ed. Biologie
Other	**Recommended reading:** Kandel, Koester, Mack, Siegelbaum (2018) Principles of Neural Science. 6th edition, Mc Graw Hill. Luo (2001) Principles of Neurobiology. 2nd edition: CRC Press

Module 9B	**Mechanisms of Visual/Olfactory Processing**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**14 LP = 420 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Group Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial (Übung)	Ü	1	Pf.	13 SWS (136,5 h)	253,5 h	13 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	pursuant to § 5 para. 3					
Course achievement(s)						
Module exam	Protocol in the style of a scientific paper and presentation on the project in the laboratory seminar					
Qualification goals/learning outcomes/competences						
Students will actively work on a current research topic of the research group. They will have a structured knowledge in the field of neurobiology, especially in the field of sensory processing. They will be proficient in methods of neurogenetics, neurophysiology and behavioural analysis. For this purpose, students will acquire statistical methods and basic programming skills. They will be able to independently conduct and quantify a scientific experiment and to access and use scientific literature. Students will be able to independently interpret and document experimental results and present them in the form of a short scientific protocol and an oral presentation in English. In our workgroup seminar, they will participate in discussing methods and scientific questions related to our group research.						
Contents						

- Basics of sensory processing (focus: vision and olfaction) in *Drosophila*.
- Molecular mechanisms (genetic analyses, receptors, channels, etc.)
- Neurogenetics
- Neuronal mechanisms: cell types, neuronal networks, control of behaviour
- Experimental analysis of neuronal networks (activation and inactivation of neuronal cell types, "functional connectomics")
- Neurophysiology (in vivo calcium imaging, confocal and 2-photon microscopy)
- Behavioural analysis
- Data analysis: signal processing, image analysis, statistical methods, basic programming skills (MATLAB, Python)

Access requirement(s)	Protocol in the successful participation in module 9A
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	14/114 LP
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Marion Silies
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** Kandel, Koester, Mack, Siegelbaum (2018) Principles of Neural Science. 6th edition, Mc Graw Hill. Luo (2001) Principles of Neurobiology. 2nd edition: CRC Press

Module 9C	***In vivo* Analysis of Neural Circuits**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
In order to be able to complete the module, the following achievements must be made:						
Presence						
Active participation	pursuant to § 5 para. 3					
Course achievement(s)	Lecture in the literature seminar					
Module exam	Written exam (60 min) on the lecture; supplementary oral exam if necessary (§13[5])					
Qualification goals/learning outcomes/competences						
How do nerve cells within the brain communicate to guide behaviour? In the lectures, students will acquire advanced knowledge in the organization and function of neural circuits in vertebrate and invertebrate systems *in vivo*. This systems neuroscience module will convey the state-of-the-art analysis of network function in living animals, and discuss common computational principles of brain organization and function. Recent advances (e.g., in artificial intelligence -based methods) allow an unprecedented analysis of neural circuit function, from the network level to the analysis of behaviour within the natural environment of the animal, which will be discussed. Students will further learn to extract information from scientific primary sources, and present and critically discuss them in a literature seminar.						
Contents						

- Organizational and computational principles of neural networks
- *In vivo* analysis of brain activity in constrained and behaving animals
- *In vivo* manipulation of brain function in behaving animals
- All-optical approaches to neural network analysis
- Model organisms and non-model organisms in neuroscience research
- Behavioural analysis in constrained lab environments
- Behavioural analysis and segmentation using machine learning algorithms
- Animal behaviour in the natural environment

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Marion Silies
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** Kandel, Koester, Mack, Siegelbaum (2018) Principles of Neural Science. 6th edition, Mc Graw Hill.

Module 10A	**Molecular Cell Biology I**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**11 LP = 330 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Molecular Cell Biology	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Molecular Cell Biology I	Ü	1	Pf.	7 SWS (73,5 h)	136,5 h	7 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	pursuant to § 5 para. 3; in the seminar (Seminar Lecture in the literature seminar)					
Course achievement(s)	Written exam (60min) and, if applicable, oral supplementary exam (§13[5])					
Module exam	Written final report (portfolio) or oral follow-up report (presentation)					
Qualification goals/learning outcomes/competences						
Students will be able to demonstrate an in-depth knowledge of an important subfield of modern biology by solving complex problems. They can demonstrate basic knowledge in planning and design of scientific experiments. They are able to perform sophisticated biochemical, cellular and molecular biology experiments under supervision, relate results to structural and functional relationships, confidently assess the importance of control experiments, maintain an electronic laboratory notebook and record and interpret results. They are able to present the results in a lecture. They are able to demonstrate teamwork skills when working in small groups.						
Contents						
Exemplarily, students work on problems from molecular cell biology: - Transformation of bacteria; DNA isolation from bacteria; restriction digestion. - Cultivation of eukaryotic cells						

- Recombinant expression of proteins in eukaryotic cells
- Expression of recombinant proteins in heterologous cell systems
- Isolation of native proteins from cells and tissues
- Protein Analysis (protein determination, SDS-PAGE, Western blot)
- Analysis of protein-protein interactions
- Analysis of cell death, growth and invasion
- Immunocyto- and/or -histochemistry of cells and tissues
- Life cell imaging
- Light and electron microscopy of cells and tissues
- Immunoelectron microscopy

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	11/114
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Uwe Wolfrum
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology, Masterstudiengang M.Ed. Biologie
Other	**Recommended reading:** Molecular Biology of the Cell, 2015, Garland Science

Module 10B	**Molecular Cell Biology II**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**14 LP = 420 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial (Übung)	Ü	1	Pf.	13 SWS (136,5 h)	253,5 h	13 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	pursuant to § 5 para. 3					
Course achievement(s)						
Module exam	Protocol in the style of a scientific paper or oral final report (presentation)					

Qualification goals/learning outcomes/competences

Students will be able to demonstrate reliable experimental laboratory work and in-depth understanding in a current research project in the field of molecular cell biology focussing on retinal neurons and glia cells. They are able to plan and perform scientific experiments under supervision and to present and interpret their results. They are able to propose relevant working methods extracted from self-researched literature and apply them specifically under guidance. They are able to keep a laboratory book, evaluate the importance of control experiments and can develop such experiments under guidance. They are able to evaluate the experimental results as well as to formulate them appropriately in terms of language and to present them as a short presentation
They are able to present publications of the current literature on cell biology and sensory cell biology in an oral presentation.

Contents

In-depth scientific treatment of a selected sub-topic from the current research projects in molecular cell biology of the retina, sensory-neuronal degenerative diseases (e.g., retinal ciliopathies) as well as pharmacological

interventions and gene therapy for preclinical treatment of these diseases. In addition to standard techniques and methods from biochemistry and molecular cell biology (see module ...a), hands-on laboratory exercises will include methods from the field of affinity proteomics and other omics applications as well as low and medium through-put screens of compound libraries. Basic principles of experimental design, performance, analysis, presentation and discussion of results.	
Access requirement(s)	Successful participation in the module 10A
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	14/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Uwe Wolfrum
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience/Neurobiology, Master's programme M.Sc. Biology
Other	**Recommended reading:** -Molecular Biology of the Cell, 2015, Garland Science -Nagel-Wolfrum K, Möller F, Penner I, Baasov T, Wolfrum U (2016) Targeting nonsense mutations in diseases with translational read-through-inducing drugs (TRIDs). BioDrugs 30(2):49-74. doi: 10.1007/s40259-016-0157-6.PMID: 26886021 -May-Simera H, Nagel-Wolfrum K and Wolfrum U (2017) Cilia - the sensory antennae in the eye. Prog Retinal Eye Res. 60:144-180. PMID: 28785766 -Knapp B, Roedig J, Boldt K, Krzysko J, Horn N, Ueffing M, Wolfrum U (2019) Affinity proteomics identify novel functional modules related to adhesion GPCRs. Ann N Y Acad Sci 1456:144-167. doi: 10.1111/nyas.14220. Epub 2019 Aug 22. PMID: 31441075 -Reiners J, Nagel-Wolfrum K, Jürgens K, Märker T, Wolfrum U (2006) Molecular basis of human Usher syndrome: deciphering the meshes of the Usher protein network provides insights into the pathomechanisms of the Usher disease. Exp Eye Res 83:97-119

Module 10C	**Molecular Cell Biology - C**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
In order to be able to complete the module, the following achievements must be made:						
Presence						
Active participation	pursuant to § 5 para. 3					
Course achievement(s)	Lecture in the literature seminar					
Module exam	Written exam (60 min) on the lecture; supplementary oral exam if necessary (§13[5])					
Qualification goals/learning outcomes/competences						

Students will be able to answer questions on basic knowledge in modern cell biology. They are able to present the current literature on cell biology and/or cellular neurobiology in a presentation in English.
Contents
Students are taught the fundamentals and current issues in molecular cell biology. Emphasis is placed on the following: - structure and function of the eukaryotic cell - intracellular transport - signalling pathways in cells - cilia biology - disease-induced changes in eukaryotic cell functions - ciliopathies - gene-based therapies - methods to address research questions in molecular cell biology - discussion of problems in current cell biology

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	According to § 5 para.5
Module Officer	Prof. Dr Uwe Wolfrum
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** Molecular Biology of the Cell, 2015, Garland Science

Module 11A	**Neuronal Basis of Behaviour I**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**11 LP = 330 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Neural Basis of Behaviour	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
Literature Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Methods of Behavioural Quantification	Ü	1	Pf.	7 SWS (73,5 h)	136,5 h	7 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	Ü
Active participation	pursuant to § 5 para. 3; in the seminar (Seminar Lecture in the literature seminar)
Course achievement(s)	Written exam (60 min.) and, if applicable, oral supplementary exam (§13[5])
Module exam	Protocol in the style of a scientific paper

Qualification goals/learning outcomes/competences
Students will acquire solid and structured knowledge in neurobiology going beyond basic principles with a focus on the analysis of central processes of behavioural control (motivation, attention), motor control as well as learning and memory (in man, *Drosophila*, other model animals). They command central working methods of *Drosophila* neurogenetics and the quantification of behaviour including the pertinent statistical methods. Students are able to carry out meaningful scientific experiments under guidance and to evaluate their data statistically.

They can interpret their data under guidance, document them obeying the standards of good scientific practice, and summarize them in the form of a scientific report (protocol). In our literature seminar, students learn to decipher scientific primary sources and to report and explicate them in a structured talk.
Contents
- Learning and representations in the brain (comparative view man / model animals) - Control of motivation and attention - Functional principles of motor control (comparative view man / model animals) - Structure and function of the vertebrate and insect brain - Methods of behavioural physiology and statistics - Methods of neurogenetics and insect neuroanatomy - Methods for the quantification of behaviour - Technical and medical applications

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	11/114
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Roland Strauß
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology, Masterstudiengang M.Ed. Biologie
Other	**Recommended reading:** Bear, Connors, Paradiso (2018) Neuroscience. Heidelberg: Spektrum. Dudel, Menzel, Schmidt (2001) Neuroscience. Berlin, Heidelberg: Springer. Motorik: Kap.6-8.

Module 11B	**Neuronal Basis of Behaviour II**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**14 LP = 420 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Group-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Projects – Neural basis of Behaviour	Ü	1	Pf.	13 SWS (136,5 h)	253,5 h	13 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	pursuant to § 5 para. 3; Lecture on the project in the laboratory seminar					
Course achievement(s)						
Module exam	Protocol in the style of a scientific paper					
Qualification goals/learning outcomes/competences						

Students will apply solid and structured knowledge in neurobiology going beyond basic principles with a focus on the analysis of central processes of behavioural control (motivation, attention), motor control as well as learning and memory (in man, *Drosophila*, other model animals). They command central working methods of *Drosophila* neurogenetics and the quantification of behaviour including the pertinent statistical methods. Students are able to carry out a meaningful scientific project independently and to evaluate their data statistically. They can interpret their data independently, document them obeying the standards of good scientific practice, and summarize their project in the form of a scientific report (protocol) and a seminar talk. In our Journal Club students learn to investigate neuroscience journals, to assess articles pertinent to the projects of the group and the use of data bases. In our workgroup seminar they can discuss with us methodical and scientific strategical questions of the group.
Contents
- Applying methods of neurogenetics (particularly thermogenetics, optogenetics, RNAi-interference) - Applying methods of insect neuroanatomy (particularly immunohistology) - Applying methods used to quantify behaviour - Applying methods of behavioural physiology and statistics - Analysing biochemical signalling pathways of learning and brain-mapping of memories - Analysing sensory modulation of behaviour - Analysing function principles of motor control - Analysing neuronal basis of visual perception

Access requirement(s)	Successful participation in the module 11A
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	14/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Roland Strauß
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** Bellen et al. (2010) 100 years of *Drosophila* research and its impact on vertebrate neuroscience. Nat Rev Neurosci 11:514-522. Ries A-S, Hermanns T, Poeck B, Strauss R (2017) Serotonin modulates a depression-like state in Drosophila responsive to lithium treatment. Nature Comm. 8: Art. No. 15738.

Module 11C	**Neuronal Basis of Behaviour - C**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Neural Basis of Behaviour	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
In order to be able to complete the module, the following achievements must be made:						
Presence						
Active participation	pursuant to § 5 para. 3					
Course achievement(s)	Lecture in the literature seminar					

Module exam	Written exam (60 min) on the lecture; supplementary oral exam if necessary (§13[5])

Qualification goals/learning outcomes/competences

Students will acquire solid and structured knowledge in neurobiology going beyond basic principles with a focus on the analysis of central processes of behavioural control (motivation, attention), motor control as well as learning and memory (in man, *Drosophila*, other model animals). Under guidance, they can interpret experimental results reported in scientific papers. In our literature seminar, students learn to decipher scientific primary sources and to report and explicate them in a structured talk.

Contents

- Learning and representations in the brain (comparative view man / model animals)
- Control of motivation and attention
- Functional principles of motor control (comparative view man / model animals)
- Structure and function of the vertebrate and insect brain
- Methods of behavioural physiology and statistics
- Methods of neurogenetics and insect neuroanatomy
- Methods for the quantification of behaviour
- Technical and medical applications

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	According to §5 par. 5
Module Officer	Prof. Dr Roland Strauß
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** Prof. Dr Roland Strauß; Dr Burkhard Poeck, Dr Jürgen Schramme; Staff of the Institute of Developmental Biology and Neurobiology / AG Neurobiology

Module 12A	**From Ion Channels to Behaviour, I**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**11 LP = 330 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial (Übung)	Ü	1	Pf.	7 SWS (73,5 h)	136,5 h	7 LP

In order to be able to complete the module, the following achievements must be made:

Presence	Ü
Active participation	pursuant to § 5 para. 3; in the seminar (Seminar Lecture in the literature seminar)
Course achievement(s)	Protocol of the exercise in the laboratory book
Module exam	Written exam (60 min.) and, if applicable, oral supplementary exam (§13[5])

Qualification goals/learning outcomes/competences

Neurons are the key elements of information coding and processing in neural circuits. Nervous system function thus depends on both, the excitability of individual neurons and their synaptic connections. Students will acquire solid and structured knowledge in neurophysiology with a focus on how different combinations of voltage and ligand gated ion channels determine the excitability of neurons and the communication between neurons to produce adequate neural circuit function and behaviour. Given that nervous systems must function reliably over time, but also be adaptive in the context of different internal and external conditions, students will be introduced to the concepts of neuromodulation and homeostatic control of excitability. Methodologically, students will acquire skills in neurogenetics, electro- and optophysiolocal methods, high resolution microscopy, and quantitative behavioural analysis. In a literature seminar series, students learn to work with original scientific publications, to integrate the knowledge into a broader scientific context, and to present this knowledge in a structured oral presentation.

Contents

- The ionic basis of excitable membranes (comparative view / model animals)
- Ion channel function in synaptic transmission, plasticity, and synaptic vesicle recycling
- Control of locomotion (comparative view mammals / invertebrates)
- Modulation of excitability
- Electro- and optophysiological methods to measure neuronal activity and excitability
- Quantitative behavioural analysis
- Neurogenetic and optophysiological techniques
- High resolution confocal laser scanning microscopy
- Technical applications and translational aspects

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	11/114
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Carsten Duch
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience/Neurobiology, Master's programme M.Sc. Biology, Masterstudiengang M.Ed. Biologie
Other	**Recommended reading:** -Fundamental Neuroscience (2014) 4th Edition, Academic Press. -Ion Channels of Excitable Membranes (2001) 3rd Edition, Bertil Hille, Sinauer Associates. -Cellular and Molecular Neurophysiology (2015) 4th Edition, Constance Hammond, Elsevier

Module 12B	**From Ion Channels to Behaviour II**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**14 LP = 420 h**					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Laboratory seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial (Übung)	Ü	1	Pf.	13 SWS (136,5 h)	253,5 h	13 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü					
Active participation	pursuant to § 5 para. 3;					
Course achievement(s)						

Module exam	Protocol in the style of a scientific paper and presentation on the project in the laboratory seminar

Qualification goals/learning outcomes/competences

Students will apply the theoretical and methodological knowledge acquired in module A to plan, conduct, and analyse hypothesis driven research projects. The experimental projects will be carried out in the Drosophila genetic model system, with a focus on motor control principles. All experiments will be embedded in the research concept of the lab and will be conducted with modern research instrumentation. Students will be enabled to plan and carry out modern electro- and optophysiological as well as behavioural and neuroanatomical experiments under guidance and analyse their data quantitatively and statistically. They can trouble shoot experimental pitfalls, interpret their data under guidance, and document them both orally (presentation) and written (protocol in form of a scientific publication) According to the standards of good scientific practice.
In our institutional (iDN) and campus wide (FTN, functional translational neuroscience centre) seminar series, students will be exposed to expert scientific talks and discussion. Conceptual and methodological links to the module will be discussed in class. In our workgroup seminar students will be involved in scientific research planning, data analysis and interpretation, and collaborative project conception. Students will also be involved in methodological and strategic scientific discussion within our research team.

Contents

- Applying methods of genetic intervention (particularly optogenetics, thermogenetics, RNAi-interference, use of mutants)
- Applying electro- and optophysiological methods to measure neuronal activity and membrane excitability (particularly calcium imaging, extracellular recordings, intracellular recordings in current and voltage clamp mode)
- Applying quantitative behavioural analysis
- Applying immunocytochemistry and high-resolution confocal laser scanning microscopy and image analysis tools
- Applying biochemical and molecular techniques (e.g., Western blotting, PCR, etc).
- Statistical analysis of quantitative data
- Applying high speed video analysis
- Analysing the neuronal basis of locomotion

Access requirement(s)	Successful participation in the module 12A
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	14/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Carsten Duch
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** Review articles and original research articles will change with research project focus and will be provided

Module 12C	**Cellular and Molecular Basics of Motoric Behaviour**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Laboratory seminar	V	1	Pf.	2 SWS (21 h)	69 h	3 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	
Active participation	pursuant to § 5 para. 3
Course achievement(s)	Lecture in the literature seminar
Module exam	Written exam (60 min) on the lecture and, if applicable, oral supplementary exam (§13[5])

Qualification goals/learning outcomes/competences

We aim to strengthen the teaching content that was given in the basic practical course in neurobiology (Bachelor). Basics of molecular experiments, neuroethology, neuroanatomical approaches as well as electrophysiological and optogenetical experiments will be discussed to illustrate their impact and application in Neurobiology. A hypothesis driven design of experiments for the evaluation of biological questions will be discussed. Basics of statistical data analysis and critical evaluation and interpretation of original scientific publications in reflection to current knowledge will be part of the seminar, including a paper presentation of the participants.

Contents

- Neuronal control of locomotion
- Function of ion channels, neuronal excitability, propagation of electrical information, synaptic transmission
- Theoretical basics in neuroanatomy, histology, immunohistochemistry, confocal scanning microscopy, electrophysiology, behaviour analysis
- Statistical analysis of experimental data

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language German or English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Carsten Duch
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** • Fundamental Neuroscience, by Larry Squire, Darwin Berg, Floyd E. Bloom, Sascha du Lac, • Anirvan Ghosh, Nicholas C. Spitzer (Eds.), Academic Press, 4th Edition. • From Neuron to Brain, by John G. Nicholls and A. Robert Martin, Sinauer, 5th Edition. • Ion Channels of Excitable Membranes, by Bert Hille (Ed.), Sinauer.

Module 17A	**Molecular Medicine I**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**11 LP = 330 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**

Molecular Medicine	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
Literature Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial Molecular Medicine I	Ü	1	Pf.	7 SWS (73,5 h)	136,5 h	7 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	Ü
Active participation	pursuant to § 5 para. 3; im Seminar (Seminar Lecture in the literature seminar)
Course achievement(s)	Written exam (60 min) on the lecture and, if applicable, oral supplementary exam (§13[5])
Module exam	Protocol in the style of a scientific paper

Qualification goals/learning outcomes/competences
This course aims to provide a broad training in the scientific aspects of biomedical sciences with an emphasis on translational research. The students will be guided through various molecular genetic and biochemical experiments, so that they gain experience and confidence to work in a research lab. They will also learn to analyse, document and present their scientific findings. Critical examination of the latest scientific literature will be coupled with scientific talks given by national and international experts in their relevant fields.
Contents
Practical: Site directed mutagenesis, Cell Culture, Transfection, Microscopy, Protein analytics, Protein interactions, Western blot, SDS-PAGE, Software programs: Benchling, ImageJ, Inkscape. Seminars and Talks: We will explore a wide range of topics including: Genetic Disorders, Neurodegeneration, Stem Cell therapy, Gene therapy, Molecular Parasitology, Biofilms and Drug Research and Antibody therapy.

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	11/114
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Helen May-Simera
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology, Masterstudiengang M.Ed. Biologie
Other	

Module 17B	**Molecular Medicine II**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**14 LP = 420 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Laboratory-Seminar	S	1	Pf.	1 SWS (10,5 h)	19,5	1 LP
Tutorial Molecular Medicine II	Ü	1	Pf.	13 SWS (136,5 h)	253,5 h	13 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	Ü
Active participation	pursuant to § 5 para. 3
Course achievement(s)	

Module exam	Protocol in the style of a scientific paper and presentation on the project in the laboratory seminar

Qualification goals/learning outcomes/competences
Students will learn to plan and perform scientific experiments as part of an active research project in a medical research laboratory. They will learn to critically evaluate primary scientific literature in the field, and extract research methods and ideas relevant to their project. They will interpret and document experimental results and present them in the form of a short scientific paper and oral presentation.
Contents
Applying methods of neurogenetics (particularly optogenetics, RNAi-interference, Cre-induced temporal deletion or expression) Applying methods of immunocytochemistry in cultured neurons or brain slices Applying methods for quantification of protein expression (western blot, localization microscopy) Analysing principles of network activity within cultured neurons or organotypic brain slices

Access requirement(s)	Successful participation in the module 17A
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	14/114 LP
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Helen May Simera
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	

Module 17C	**Molecular Medicine C**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Vorlesung	V	1	Pf.	2 SWS (21 h)	69 h	3 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	Ü
Active participation	pursuant to § 5 para. 3
Course achievement(s)	Lecture in the literature seminar
Module exam	Written exam (60 min) on the lecture and, if applicable, oral supplementary exam (§13[5])

Qualification goals/learning outcomes/competences
This course aims to provide a broad training in the scientific aspects of biomedical sciences with an emphasis on translational research. The students will be guided through various molecular genetic and biochemical experiments, so that they gain a theoretical basis for work in a research lab. They will also learn to analyze, document and present their scientific findings. Critical examination of the latest scientific literature will be coupled with scientific talks given by national and international experts in their relevant fields.
Contents

- The seminar topics will be genetic disorders, neurodegeneration, stem cell therapy, gene therapy, molecular parasitology, antibody therapy, biofilms and drug research

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr. Helen May-Simera
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	

Module 1C	**Protein Bioinformatics and Programming C**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Protein Bioinformatics	V	1	Pf.	2 SWS (21 h)	69 h	3 LP
In order to be able to complete the module, the following achievements must be made:						
Presence						
Active participation	pursuant to § 5 para. 3					
Course achievement(s)	Lecture in the literature seminar					
Module exam	Written exam (60 min) on the lecture and, if applicable, oral supplementary exam (§13[5])					

Qualification goals/learning outcomes/competences

The students will receive an introduction to (i) a programming language of wide use in Bioinformatics and (ii) a logically ordered series of topics describing the computational analysis, data types and databases used in diverse aspects of the study of genes, genomes, gene expression, DNA-protein interactions, protein sequence and structure, and protein-protein interactions. Special emphasis will be put in explaining how evolutionary analysis can be applied to these topics, and how these methods and databases can be used to predict protein function and mechanisms of disease.

Contents

- Neuronal plasticity as fundamental feature of the CNS; forms of learning and memory;
- Neuron as an information processing unit, membrane potential dynamics as a mechanism to encode information;
- Stochasticity and variability in neuronal spike trains; physiological sources and significance of noise in neuronal networks;
- Main principles of encoding and decoding information by neurons; rate and temporal coding schemes;
- Synaptic transmission of information between neurons; transfer and integration of postsynaptic potentials in somato-dendritic compartment;
- Local field potentials and network oscillations; their role in associative learning.
- Dynamics and hierarchical structure of the brain network; complex network analysis.

- The seminar will include students' presentation and discussion of individual aspects of information processing in neuronal networks *in vivo* and *in vitro*.

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Miguel Andrade
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** • Bioinformatics for Dummies (Jean-Michel Claverie, Cedric Notredame) • Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Baxevanis and Ouellette Eds.) • Introduction to Protein Structure (Branden and Tooze)

Module 20C	**Methods of Applied Bioinformatics**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study SoSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	
Active participation	pursuant to § 5 para. 3
Course achievement(s)	Lecture in the literature seminar
Module exam	Written exam (60 min) on the lecture and, if applicable, oral supplementary exam (§13[5])

Qualification goals/learning outcomes/competences

This course is an introduction to data analysis with R and Python.
Lectures will cover basic clustering and prediction algorithms, processing and visualization of data, handling of noisy or missing data, and statistical analysis of genomes.
Students will be introduced to different sequencing techniques like the sequencing of genomic DNA or single stranded RNA, ATACseq, ChIPseq and nanopore sequencing. First, they will learn about the theory and ideas behind the different strategies, then they will be shown the bioinformatic methods of sequence analysis (Genomics, GWAS, Transcriptomics, Metadata analysis).
In order to handle the amount of data, traditional clustering, dimension reduction and prediction algorithms (k-means, PCA) but also neural networks and methods of time-series analysis will be introduced.

Contents

- Theory of sequencing genomic DNA, ssRNA, and of ATACseq and ChIPseq techniques.
- Data analysis: General introduction into programming and data analysis with the programming tools R, Python and Matlab.
- Analysis and visualization of data from various NGS-based sequencing techniques
- Statistical genetics and Genomics
- Theory and analysis of nanopore sequencing data
- Data Science and with machine learning methods
- Neural networks for dimension reduction, clustering and prediction

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	once a year, in the summer semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Miguel Andrade in collaboration with Prof. Dr Susanne Gerber
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	

Module 21C	**Rodent Models in Translational Neuroscience**					
Compulsory or elective module	**WPf**					
Credit points (LP) and workload	**5 LP = 150 h**					
Module duration (According to study plan)	**1 Semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP

In order to be able to complete the module, the following achievements must be made:	
Presence	
Active participation	pursuant to § 5 para. 3
Course achievement(s)	Lecture in the literature seminar
Module exam	Written exam (60 min) on the lecture and, if applicable, oral supplementary exam (§13[5])

Qualification goals/learning outcomes/competences

The burden of neuropsychiatric disorders continues to grow with significant impacts on health and major social, human rights and economic consequences in all countries of the world. One of the critical roadblocks in transferring knowledge from basic science into clinical practice are reductionist animal models with limited validity. In this module, we will overview and critically discuss the use of rodent translational models to tackle the neurobiological mechanisms of mental disorders. Main emphasis will be made on the existing classical experimental and emergent computational approaches ("computational ethology") to analyse and understand rodent behaviour in the context of mental disease conditions. Recently, behavioural scientists have started to develop data-driven analytic frameworks to identify causal relations between individual behavioural signatures of mental health phenotypes and underlying processes derived through multimodal imaging, network physiology and systems biology. Lectures will provide an introduction into basic rodent behaviour, and cover timely approaches to model a variety of stress conditions as one of the major risk factors for mental disorders during particular vulnerable windows across life-

span. In addition, this module will introduce into animal experimental approaches to understand and investigate "resilience mechanism", i.e., mechanisms that maintain mental health in the face of adversity.
The contents of the proposed module will be structurally connected to modules on the neuronal basis of behaviour, *in vivo* analysis of neural circuits and molecular medicine.

Contents

- Basics of rodent behaviour: focus on emotion, cognition, social behaviour
- Behavioural assessments in rodents: classical approaches
- Data-driven approaches to understand complex behaviour: longitudinal monitoring in observer-independent conditions ("computational ethology")
- Basics of translational neuroscience
- Animal models for neuropsychiatric disorders
- Stress models: vulnerable windows across life-span
- Resilience

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Marianne Müller
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology
Other	**Recommended reading:** • Animal Behaviour (McFarland)An Introduction to Behavioural Ecology (Krebs) • Neurobiology of Mental Illness (Charney) • Conn's Translational Neuroscience (Conn)

Module 22C	Fluorescence Microscopy in Cell- and Neurobiology	

Compulsory or elective module	**WPf**
Credit points (LP) and workload	**5 LP = 150 h**
Module duration (According to study plan)	**1 Semester**

Courses/ Forms of learning	Type	Standard semester at start of study WiSe	Commitment level	Contact time (SWS)	Self-study	Credit points
Literature-Seminar	S	1	Pf.	1 SWS (10,5 h)	49,5	2 LP
Lecture (Vorlesung)	V	1	Pf.	2 SWS (21 h)	69 h	3 LP

In order to be able to complete the module, the following achievements must be made:

Presence	
Active participation	pursuant to § 5 para. 3
Course achievement(s)	Lecture in the literature seminar
Module exam	Written exam (60 min) on the lecture; supplementary oral exam if necessary (§13[5])

Qualification goals/learning outcomes/competences

Fluorescence microscopy is one of the leading techniques currently used in cell biology. Recent, fast development of many novel fluorescence approaches gives wide spectrum of possibilities to gain insight into cellular structures and processes at many time and spatial resolutions. In this module, we will focus on explaining principals of optical microscopy and fluorescence. We will introduce a different fluorescence microscopy type including wild-filed, confocal and super resolution techniques with examples of application in cell biology and neurobiology. We will discuss variety of fluorophores and labelling strategies used in different types of microscopy. Additionally, the course will cover topics of fluorescence sensors used in cell biology and neurobiology (e.g. neurotransmitters sensors, ions sensors), and optogenetic approaches. The goal of the course is to give overview of existing fluorescence microscopy techniques and explain how to choose the best technique and labelling depending of the research question and model organism.

Contents

- Principals of fluorescence and optics in light microscopy
- Principals of fluorescence microscopy (types of microscopes, filters, objectives, light sources, detectors)
- Introduction to wild-filed, TIRF and confocal microscopy
- Introduction to super resolution microscopy (STORM, PALM, STED, SIM, light sheet microscopy)
- Microscopy methods to look at dynamics: FRAP, FLIP, FCS, single molecule tracking
- Lifetime based methods: FLIM, FRET, FLIM-FRET, smFRET
- Overview of fluorophores and labelling strategies used in microscopy
- Optical sensors for synaptic activity (e.g., calcium, neurotransmitters, voltage, pH sensors)
- Introduction to optogenetic (optogenetic methods to manipulate neurons activity, move organelles inside the cell)
- Overview of recent development in the field of fluorescence microscopy

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English Exam language English
Weight of the module grade in the overall grade	5/114 LP
Frequency of the offer	Once a year, in the winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Martin Heine
Usability of the module in other degree programmes	Master's programme M.Sc. Neuroscience, Master's programme M.Sc. Biology

Other	**Recommended reading:** • Principles of fluorescence spectroscopy (Lakowicz) • Fundamentals of light microscopy and electronic imaging (Murphy) • Super-Resolution Microscopy Techniques in the Neurosciences (Fornasiero and Rizzoli) • Fluorescence Spectroscopy and Microscopy (Engelborghs and Visser)

Module EQ	**Advanced Qualifications**					**Identification number**
Compulsory or elective module	**Pf.**					
Credit points (LP) and workload	**6 LP = 180 h** from the range of electives below					
Module duration (According to study plan)	**1 semester**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe (SoSe)**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Workshop Career Orientation	S	3. od. 4.	voluntary	1 SWS	0	no LP
Studium generale Lecture	V	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Studium generale Tutorial	Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Project Manager Genetic Engineering §15b GenTSV (ZWW)	V/Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Radiation Protection (ZWW)	V	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Radiation Protection (ZWW)	Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Laboratory Animal Science	V	3. (3.)	WPf	1 SWS (10,5 h)	49,5 h	2 LP
Laboratory Animal Science	Ü	3. (3.)	WPf	2 SWS (21 h)	99 h	4 LP
Computer Applications		3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
IMB-Lectures WiSe Epigenetics	V	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
IMB-Lectures SoSe Genome Stability	V	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
IMB-Workshop WiSe Image Processing & Analysis	V/Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Patent Law for Biologists I	V/Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Patent Law for Biologists II	V/Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
English for Scientists (ISSK)	Ü	3. (3.)	WPf	2 SWS (21 h)	69 h	3 LP
Scientific Writing (FB10)	V/Ü	3. (3.)	WPf	4 SWS (42 h)	138 h	6 LP
In order to be able to complete the module, the following achievements must be made:						
Presence	Ü, V varies depending on the degree of legal obligation (e.g., GenTSV).					
Active participation	pursuant to § 5 para. 3					

Course achievement(s)	
Module exam	depending on the course, oral, written or practical (computer), no grading

Qualification goals/learning outcomes/competences

Students acquire additional competences in areas that go beyond pure subject knowledge. There is a choice of topics with a scientific-theoretical and ethical-philosophical orientation ("Studium generale"), as well as decidedly application-oriented courses with regard to additional professional qualifications. The wide range of compulsory elective courses enables students to pursue personal interests and set corresponding focal points.

Contents

- **VL/Ü *Studium generale*:** Students are introduced to interdisciplinary basics and basic problems of science as well as to interdisciplinary and transdisciplinary approaches and methods. Exemplary central scientific-theoretical, philosophical, ethical and cultural-scientific questions are discussed and illustrated by means of current developments in science, society and culture. The following four topics are offered alternately: (1) Fundamentals of scientific knowledge, (2) Basic questions of ethics, (3) Culture and cultural encounter, (4) Argumentation, logic, rhetoric (in German/English).
- **VL/Ü Project Manager Genetic Engineering According to §15 GenTSV:** The participants gain knowledge in matters of biological safety. The teaching content is imparted in accordance with §15 Para. 2 of the Genetic Engineering Safety Ordinance and is a prerequisite for professional activities as a genetic engineering project manager.
- **VL/Ü Radiation Protection Course:** Obtaining the certificate of competence According to §30 of the Radiation Protection Ordinance. Enables professional activity as a radiation protection officer.
- **VL/Ü Laboratory Animal Science:** Participants receive legal and biological expertise in laboratory animal husbandry and animal experimental studies (in German/English)
- **VL/Ü Computer Course:** Participants learn how to use various computer tools, e.g., Microsoft Office, databases (SQL), HTML, graphics programmes, UNIX, statistics (SPSS), MatLab (in German/English).
- **VL IMB-Lectures:** WiSe Epigenetics, SoSe Genome Stability, Participants acquire biological expertise in epigenetics and/or mechanisms of genome stability (in English).
- **VL/Ü IMB-Workshop Image Processing & Analysis:** WiSe, Participants receive an overview of microscopic methods, analysis possibilities, applications (in English).
- **VL Patent law for Biologists I and II:** Participants acquire legal expertise in patent law. (German)
- **English for scientists**: Participants learn and improve their ability to express themselves in English scientific texts.
- **Scientific writing:** Participants learn how to write scientific publications and how to conceptualise scientific project proposals (in English)

Access requirement(s)	B.Sc. Biology or comparable degree
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Language of instruction English/German Exam language English/German
Weight of the module grade in the overall grade	No grade relevance
Frequency of the offer	at least once per academic year, summer or winter semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	Prof. Dr Thomas Hankeln
Usability of the module in other degree programmes	Master's programme M.Sc. Biology
Other	

Module PA	**Project Work**	
Compulsory or elective module	**Pf**	
Credit points (LP) and workload	**19 LP = 570 h**	
Module duration	**1 Semester**	

(According to study plan)						
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Project Work		3	Pf.	14 SWS (147 h)	423 h	19 LP

In order to be able to complete the module, the following achievements must be made:	
Active participation	pursuant to § 5 para. 3
Course achievement	Regular, active participation; independent performance of experiments
Module Exam	Module examination: Evaluation of proposal (2 LP), practical work plus protocol (14 LP), presentation and poster (3 LP)

Qualification goals/learning outcomes/competences
The students are able to demonstrate and practically implement an in-depth understanding and knowledge in an area of neurobiology on a research-related topic. They are able to familiarise themselves with the scientific principles of the project with the help of specialist literature and to prepare a written project outline (proposal). After methodical-practical familiarisation with their special topic, they can plan and conduct scientific experiments independently; present the results; interpret them. In particular, they can critically evaluate the significance of their results; confidently assess the significance of the controls; independently extract the essential findings from their data; present their project and the results in a scientific poster. They are able to work as a team member of a research group.
Contents
In-depth scientific treatment of a selected special topic within the chosen focus area. Planning in the form of a proposal (1 to 2 pages); implementation and evaluation (with experimental protocol); presentation of the results in the form of a poster.

Access requirement(s)	Already acquired at least 30 LP and completed another A- or C-module)
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Examination language English/German. The project work should preferably be written in English.
Weight of the module grade in the overall grade	19/114 LP
Frequency of the offer	Each semester
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	The Dean of the Department of Biology
Usability of the module in other degree programmes	Master's Programme M.Sc. Neuroscience
Other	

The project work and Master's thesis are to be regarded as coherent and cross-semester in terms of implementation and time distribution, i.e., the Master's thesis, which is more extensive in terms of time, extends into the 3rd semester. This results in the unequal number of credit points for the 3rd semester (project work plus advanced qualifications, 25 LP) and the 4th semester (Master's thesis plus final oral examination, 35 LP).

Module MA	**Master Thesis**					
Compulsory or elective module	**Pf.**					
Credit points (LP) and workload	**35 LP = 1050 h**					
Module duration (According to study plan)	**2 semesters**					
Courses/ Forms of learning	**Type**	**Standard semester at start of study WiSe**	**Commitment level**	**Contact time (SWS)**	**Self-study**	**Credit points**
Master's thesis		3./4.	Pf.		900 h	30 LP
Final examination		4.	Pf.		150 h	5 LP
In order to be able to complete the module, the following achievements must be made:						
Course achievement	Timely submission of the Master's thesis, participation in the final examination					
Module Exam	The assessment of the Master's thesis and the assessment of the final oral examination (45 min) are combined into the module grade According to the ratio of credit points (30:5) (see §17 of the M.Sc. Biology Examination Regulations).					

Qualification goals/learning outcomes/competences
The students are able to scientifically work on a topic in their chosen special field. They are able to introduce this topic in the form of a scientific paper (master's thesis), to describe and document their results and to interpret and discuss them in the light of the relevant literature. They are also able to present and defend their master's thesis as a scientific paper and also to answer questions on the topic as well as on peripheral areas (final examination).
Contents
Master's thesis: Composition of a scientific paper on the topic, consisting of the following parts: Summary (max. 1 page), introduction including objectives, material & methods as well as results, discussion, bibliography; an appendix can be added to document further primary data. Final examination: Presentation of the results as a lecture (length approx. 20 min.), oral defence and answering also marginal questions, max. examination duration 45 min.

Access requirement(s)	Module PA successfully completed; 60 LP already acquired
Recommended prerequisite(s) for the module or for individual courses of the module	
Language(s) of instruction and examination(s)	Examination language English/German. The thesis should preferably be written in English.
Weight of the module grade in the overall grade	35/114 LP
Frequency of the offer	anytime
Reasons for compulsory attendance Events	pursuant to § 5 para. 5
Module Officer	The Dean of the Department of Biology
Usability of the module in other degree programmes	Master's Programme M.Sc. Neuroscience
Other	