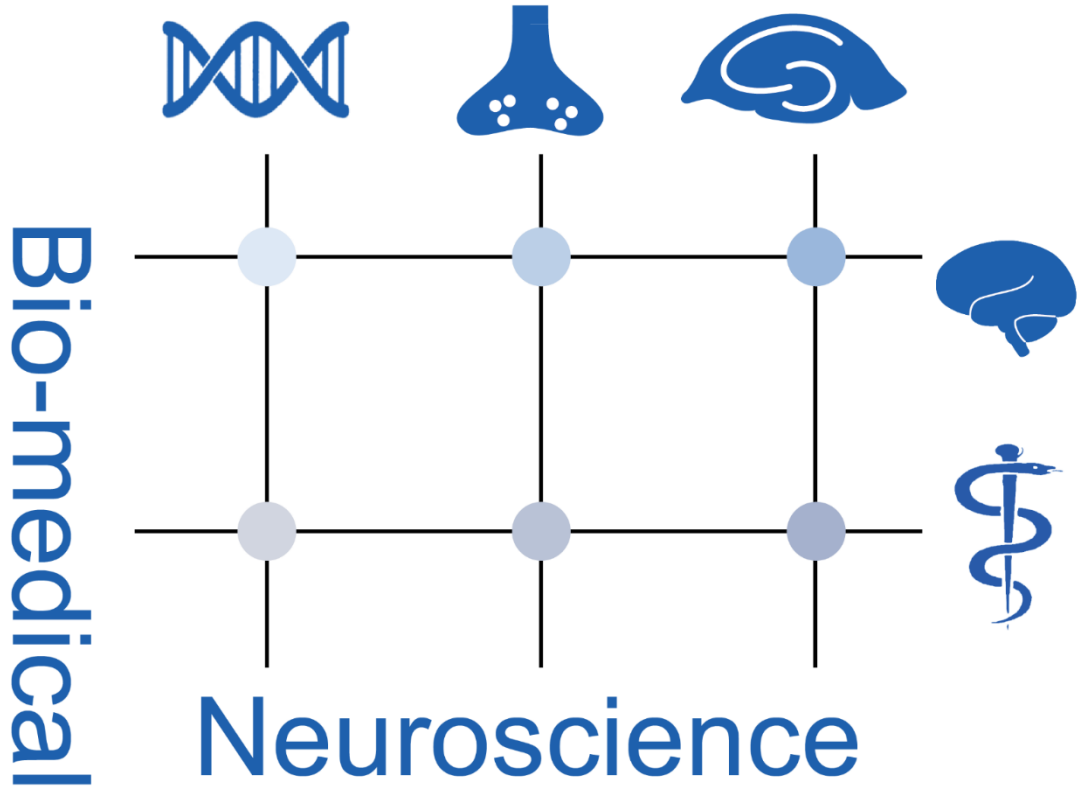
TUM School of Medicine and Health
Technical University of Munich

Module Description

Elite-Master Program Biomedical Neuroscience



Module description 01

Module number:	**MH560001**
Module name (Ger.):	**Molekulare Neurowissenschaften**
Module name (Eng.):	**Molecular Neuroscience**
Module level:	Master
Abbreviation:	MNs
Duration:	1
Frequency:	WS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

There will be a written exam (60 min). Passing this exam requires a detailed knowledge and the ability to apply this knowledge in problem-solving tasks on a theoretical level in the following topics that will be communicated during the lecture and seminar sessions of this module:

- Neurochemistry and metabolism of proteins in the central nervous system.
- Major signaling pathways in the nervous system.
- Biochemical, molecular and cell biological methods for the study of molecular neuroscience.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites:	none

Learning outcomes:

The focus of this module is to understand a) the function of the brain on the molecular level and b) modern biochemical and molecular biological tools used in science. After this module the students will know essential knowledge in neurobiochemistry, including neurons and glial cells. They will gain detailed knowledge about membrane biophysics and important signaling pathways and receptors in the nervous system. Furthermore, they will have an overview about experimental strategies to detect proteins with key functions in the nervous system. Moreover, they will understand the principles of electrophysiological measurements. Finally, based on the topics of the module they are able to develop strategies to answer scientific questions, like performing additional experiments or applying alternative methods.

Teaching/Learning methods:

Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory build-up of knowledge by eLearning using the method “Just-in-Time-teaching”. After that consolidation of the knowledge will be achieved in face-to-face focus seminars with experts and finally there will be application of the knowledge in problem-solving application tutorials. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:
The specific topics in this module are:

- Neurobiochemistry of neurons and glial cells.
- Major receptors and signaling pathways in the nervous system.
- Protein synthesis, modification, aggregation and degradation.
- Membrane biophysics.
- Relevant analytical techniques for neuroscience research, like mass spectrometry, immunoblots, electrophysiology, organelle and protein purification.

Media:
eLearning platform, power-point presentations, white board

Literature:
Textbook Essential Cell Biology (Alberts and others, Fifth Edition 2019)

Module coordinator:

First name:	Stefan
Last name:	Lichtenthaler
Email:	stefan.lichtenthaler@tum.de

Course:

Type:	Lecture/Seminar
Title:	Molecular Neuroscience
Hrs per week per semester	4
Lecturer (first name and last name):	Stefan Lichtenthaler, Mikael Simons, Angelika Harbauer and others

Module description 02

Module number:	**MH560002**
Module name (Ger.):	**Zelluläre Neurowissenschaften**
Module name (Eng.):	**Cellular neuroscience**
Module level:	Master
Abbreviation:	CNs
Duration:	1
Frequency:	WS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

There will be a written exam (60 min). Passing this exam requires a detailed knowledge and the ability to apply this knowledge in problem-solving tasks on a theoretical level in the following topics that will be communicated during the lecture and seminar sessions of this module:

- Cell biology in the nervous system.
- Principles of neural development.
- Modern approaches to neuronal cell biology and development – the major model organisms.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

The students will acquire an understanding of the general cell biology of the cells of the nervous system, including neurons and glia. They will learn how during development this diversity of cell types arises, how cells connect to form circuits to build and maintain a plastic nervous system. In this module the students will also acquire knowledge of how such insights arose from the study of model organisms, and gain insights into the methods and principles of neurodevelopmental biology.

Teaching/Learning methods:

Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory build-up of knowledge by eLearning using the method “Just-in-Time-teaching”. After that consolidation of the knowledge will be achieved in face-to-face focus seminars with experts and finally there will be application of the knowledge in problem-solving application tutorials. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:

The specific topics in this module are:

- Basic of neuronal cell biology.
- Principles of neural development.
- Comparative analysis of cell biological and developmental models.

Media:
eLearning platform, power-point presentations, white board

Literature:
Textbook Neuroscience (Purves and others, 6th Edition 2018)
Textbook Principles of Neurobiology (Luo, 2nd Edition 2020)

Module coordinator:

First name:	Thomas
Last name:	Misgeld
Email:	Thomas.misgeld@tum.de

Course:

Type:	Lecture/Seminar
Title:	Cellular neuroscience
Hrs per week per semester	4
Lecturer (first name and last name):	Thomas Misgeld, Helmuth Adelsberger, Monika Leischner-Brill and others

Module description 03

Module number:	**MH560003**
Module name (Ger.):	**Neuroanatomie und -pathologie**
Module name (Eng.):	**Neuroanatomy and Neuropathology**
Module level:	Master
Abbreviation:	NaP
Duration:	1
Frequency:	WS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

There will be a written exam (60 min). Passing this exam requires a detailed knowledge and the ability to apply this knowledge in problem-solving tasks on a theoretical level in the following topics that will be communicated during the lecture and seminar sessions of this module:

- Anatomy and histology of the central and nervous system with reference to disease processes.
- Cell biological basis of neuropathology and neurological disorders.
- Principles and methods of generating and analyzing disease models.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module the students will know the cell biological, histological and anatomic basis of neurological disease pathogenesis. They will have a basic understanding of neuropathology and will understand the strategies and techniques used to model disease from cells to vertebrate organisms.

Teaching/Learning methods:

Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory built-up of knowledge by eLearning using the method “Just-in-Time-teaching”. After that consolidation of the knowledge will be achieved in face-to-face focus seminars with experts and finally there will be application of the knowledge in problem-solving application tutorials. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:

The specific topics in this module are:

- Gross and fine anatomy of the nervous system of vertebrates.
- Basic principle of neuropathology.
- Disease modelling: Principles and approaches.

Media:

eLearning platform, power-point presentations, white board

Literature:
Textbook The mouse nervous system (Watson, Paxinos, Puelles, 2012)
Textbook The Central Nervous System (Brodal 5th edition, 2016)

Module coordinator:

First name:	Thomas
Last name:	Misgeld
Email:	thomas.misgeld@tum.de

Course:

Type:	Lecture/Seminar
Title:	Neuroanatomy and Neuropathology
Hrs per week per semester	4
Lecturer (first name and last name):	Thomas Misgeld, Silke Herzer, Monika Leischner-Brill and others

Module description 04

Module number:	**MH560004**
Module name (Ger.):	**Molecularbiology und –omics Technologien**
Module name (Eng.):	**Molecular biology and –omics approaches**
Module level:	Master
Abbreviation:	MoT
Duration:	1
Frequency:	WS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

In this course the students will get detailed knowledge about biochemical and molecular biology methods to study proteins in the nervous system. They will learn to choose the appropriate methods depending on specific scientific questions.

During the course the students have to perform practical tasks:

- Protein, DNA and RNA analytics
- Training in cell culture techniques
- Sample preparation for proteomic analysis

Active participation in the tasks and passing an oral exam at the end are the requirement to pass the course.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module the students will understand the principles of biochemical analysis and handling of biological macromolecules, in particular proteins and DNA, but also RNA. Typical methods will include electrophoresis, immunoblots and amplification/digestion of plasmid DNA. In addition, the students will know the function of mass spectrometers and examples of applications for protein analytics. The students will also understand how to overexpress and how to switch off (knock-down/knock-out) genes and proteins in cell lines and primary cells from the nervous system, including the use of viral systems for optogenetics and genetically encoded activity sensors. Furthermore, the students will be able to culture a mammalian cell line. At the end of the course the students will know the strengths and limitations of the different methods used to detect biological macromolecules.

Teaching/Learning methods:

Teaching in the course will be performed by a combination of theoretical parts giving insights in the technical and conceptual principle of different methods to detect and study biological macromolecules and a hands-on training in the laboratory. In this practical part the students will do protein and DNA analytics and apply them to standard experiments. The course structure of the theoretical part is designed by the method “Just-in-Time-teaching”. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:
The specific topics in this module are:

- Basis of mammalian cell culture
- Handling, analysis and amplification of plasmid DNA
- Protein analytics including immunoblots
- Viral expression systems
- Methods for sample preparation for mass spectrometric analysis

Media:
eLearning platform, hands-on training, power-point presentations, white board, script

Literature:
Textbook Essential Cell Biology (Alberts, 6th edition 2014)

Module coordinator:

First name:	Stefan
Last name:	Lichtenthaler
Email:	stefan.lichtenthaler@tum.de

Course:

Type:	Practical course
Title:	Molecular biology and –omics approaches
Hrs per week per semester	4
Lecturer (first name and last name):	Stefan Lichtenthaler, Dominik Paquet, Angelika Harbauer, Simon Schäfer and others

Module description 05

Module number:	**MH560005**
Module name (Ger.):	**Mikroskopie des Nervensystems**
Module name (Eng.):	**Microscopy of nervous system structure**
Module level:	Master
Abbreviation:	MNS
Duration:	1
Frequency:	WS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

In this course the students will be introduced to the basis of optics, wide field and fluorescence microscopy. It covers the theory as well as practical applications. Further topics are basic electrophysiology and imaging techniques. They will learn to choose the appropriate methods depending on specific scientific questions.

The course also includes practical tasks:

- Assembly of basic optical experiments
- Use of different microscopes (wide field, fluorescence and confocal laser scanning)
- Basic electrophysiological techniques

Active participation in these tasks and theoretical understanding of the principles are the requirement to pass the course.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites:	none

Learning outcomes:

After this module the students will know the principles of conventional optics and of wide-field microscopy. Furthermore, they will be able to explain the basis of conventional, fluorescence and laser scanning microscopy and to use these systems for scientific purposes. This includes the different options for excitation and detection of fluorescence. The students will also be able to perform and evaluate basic electrophysiological experiments.

Teaching/Learning methods:

Teaching in the course will be performed by a combination of theoretical parts giving insights in the technical principles of basic optics and different methods of light microscopy and a hands-on training in the laboratory. Furthermore, the students will have a theoretical and practical training in electronics and electrophysiological techniques. In the theoretical parts “Just in Time teaching” and activating learning methods like peer instruction are used to design learner-centered lessons.

Content:

The specific topics in this module are:

- Basic optics and wide-field microscopy
- Fluorescence and confocal scanning microscopy

- Systems for excitation and detection of fluorescence signals
- Basic electronics and applications for recording neuronal signals

Media:
eLearning platform, hands-on training, power-point presentations, white board, script

Literature:
Textbook From Photon to Neuron - Light, Imaging, Vision (Nelson, Princeton University Press 2017)
Textbook Understanding Light Microscopy (Sanderson, Wiley Press 2019)

Module coordinator:

First name:	Thomas
Last name:	Misgeld
Email:	thomas.misgeld@tum.de

Course:

Type:	Practical course
Title:	Microscopy of nervous system structure
Hrs per week per semester	4
Lecturer (first name and last name):	Thomas Misgeld, Helmuth Adelsberger, Sebastian Berger and others

Module description 06

Module number:	**MH560006**
Module name (Ger.):	**Wissenschaftliche Praxis**
Module name (Eng.):	**Scientific practice**
Module level:	Master
Abbreviation:	SP
Duration:	2
Frequency:	WS (Part I) / SS (Part II)
Language:	English
Credits:	4

Workload

Total hours:	120
Contact hours:	30
Self-study hours:	90

Description of achievement and assessment methods:
During this course the students have to demonstrate that they understand the ideas of scientific work, data evaluation and presentation. They have to apply the gained knowledge in exercises, in class or during self-study. The requirement to pass is to design and present a poster in a session at the end of the course.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:
(Recommended) Prerequisites: none

Contents:
Upon successful completion of the course scientific practice students are able…

- to elaborate upon the basic scientific concepts like experiment, induction, deduction, hypothesis, falsification, model, theory, empirical science, deductive science.
- to understand principles and rules of good scientific practice.
- to describe major steps in planning a scientific project.
- to describe problems which can be dealt with through science and to outline problem solving strategies and heuristic principles to solve these problems.
- to understand quality criteria of scientific research (i. e. validity, reliability, objectivity).
- to explain potentials and limitations of scientific enquiry.
- to analyze scientific argumentation and to evaluate own and other research in a critical manner.

Study goals:
The purpose of this course is to train students in key aspects of scientific practice. The main topics represent key competencies for professional scientific work, like principles of scientific enquiry, general problem-solving strategies, good scientific practice, principles of project management, strategies for scientific communication and dissemination and ethical principles as the overarching issue. Oftentimes, these competencies are developed indirectly through scientific practice. However, in this course, these transferable skills are the main educational objectives that students focus upon.
Teaching/Learning methods:
The seminar is characterized by a mixture of lectures, interactive single and group work activities and established didactical methods like think pair share, peer instruction, group discussion et cetera.

Media formats:
Visual media, film; reader, PowerPoint, whiteboard, flipchart; exercise sheets, Moodle

Literature:
The art of Scientific storytelling: Transform your research manuscript using a step-by-step formula, R.E. Luna, 2013

Module coordinator:

First name:	Angelika
Last name:	Harbauer
Email:	Angelika.Harbauer@tum.de

Course:

Type:	Seminar
Title:	Scientific practice
Hrs per week per semester	1
Lecturer (first name and last name):	Angelika Harbauer, Thomas Misgeld and others

Module description 07

Module number:	**MH560007**
Module name (Ger.):	**Leben & Wissenschaft – Kultur- und geisteswissenschaftliche Studien für die Neuro- und Lebenswissenschaften**
Module name (Eng.):	**Life & Science – Cultural Studies and Humanities for the Neuro- and Life Sciences**
Module level:	Master
Abbreviation:	LaS
Duration:	2
Frequency:	WS (Part I) / SS (Part II)
Language:	English
Credits:	6

Workload

Total hours:	180
Contact hours:	30
Self-study hours:	150

Description of achievement and assessment methods:
The two seminars of this module are assessed through two written examination protocols. The students are free to choose in which seminar they take the written exam as long as they take one exam in each of the two seminars.

Coursework and Examination Requirements:
The two seminars of this module are assessed through written examinations: each of the two seminars requires the application of one comment (app. 15.000 characters) and one position paper (app. 1.500 characters). The students are free to choose on which topic of the respective seminar they want to write their position paper and comment. To pass these written exams students have to show a more-in-depth critical examination of the chosen topic and prove a self-critical awareness of their own position and perspective.
The position paper has to be submitted one week before the lesson of the chosen topic. It requires students to give an account of the topic's main points via an analysis of the article that has to be read in preparation for the lesson. It further requires students to state two questions concerning the topic to further discuss and deepen the understanding of the subject.
The comment has to be submitted two weeks after the lesson of the chosen topic. It requires students to give an account of the article that has to be read in preparation of the lesson as well as an account of the lesson and its discussion itself. It further requires students to elaborate on their own point of view concerning the subject and the epistemological consequences of that decision.
The grade of each position paper represents 20% of the final grade. The grade of each comment represents 30% of the final grade.

Possibility of retaking

Repeat examination in following semester:	yes
Repeat examination at end of semester:	no

Description:

(Recommended) Prerequisites:	none

Contents:
This module aims at broadening the personal horizon of the students and expanding their professional dimension with a far-reaching critical understanding of both science and life, in order to cultivate a well-considered and responsible professional identity. Therefore, it is divided into two seminars:

(I) ‘What is (Life) Science?’ focuses on the terms, conditions and consequences of scientific observation and scientific knowledge taking into consideration epistemological, historical, cultural, social-political, anthropological and technical aspects. Students will observe, reconstruct and reflect scientific “findings” and lines of reasoning and thereby analyze the crucial factor of human subjectivity in any emergence of human knowledge.
(II) ‘What is Life?’ focuses on the very subject of all life sciences by using primarily literary fiction, art pieces and film scenes as vivid impulses for challenging bioethical questions and ambiguous perceptions and conceptions of "life". Students will analyze and outline these challenges and ambiguities and develop and discuss their own answers and solutions while considering the many differences "life" is composed of.

Study goals:

- Upon successful completion of the first seminar "What is (Life) Science?" students are able
- to retrace the ways in which personal, social, cultural and scientific knowledge is produced
- to understand the conditions and consequences of knowledge and its production
- to analyze the distinctive feature of neuroscience and life sciences knowledge
- to intellectually deconstruct established forms of knowledge, standard (scientific) thinking and text-book operations
- Upon successful completion of the second seminar "What is Life?" students are further able
- to compare and outline different and ambiguous perceptions and conceptions of "life" and "being" as well as "consciousness" and "perception"
- to intellectually deconstruct paradigms, implicit presupposition, assumptions and convictions of what e.g. "life" is and/or has to be
- Upon successful completion of the module ""Life & Science"" students are moreover able
- to monitor their own position and perspective as well as their personal and professional development
- to communicate with others (about complex and ambiguous topics) in a well-considered and open minded manner

Teaching/Learning methods:
Every session of the two seminars has at least one certain theoretical and/or artistic impulse (text, image, film or else) as its starting and its focal point. Depending on the impulse the students are encouraged to closely examine this impulse either before or during the session. Also depending on the impulse, the students are then stimulated through a certain reflective or creative task to develop a personal statement regarding the given impulse. Finally, the students bring their results up for an open and unbiased discussion.

Media formats:
Visual media, film; reader, PowerPoint, whiteboard, flipchart; exercise sheets

Literature:
Why is consciousness puzzling? Bieri P. in: Conscious Experience by Metzinger T., Thorveton Paderborn 1995 (pp 45-60)

Module coordinator:

First name:	Moritz
Last name:	Schumm
Email:	moritz.schumm@tum.de

Course:

Type:	Seminar
Title:	Life & Science – Cultural Studies and Humanities for the Neuro- and Life Sciences
Hrs per week per semester	1
Lecturer (first name and last name):	Moritz Schumm and others

Module description 08

Module number:	**MH560008**
Module name (Ger.):	**Datenerhebung, Analyse und Präsentation**
Module name (Eng.):	**Data acquisition, analysis and presentation**
Module level:	Master
Abbreviation:	DaAP
Duration:	3
Frequency:	WS/SS
Language:	English
Credits:	4

Workload

Total hours:	120
Contact hours:	112
Self-study hours:	8

Coursework and Examination Requirements:

Description of coursework and examination requirements:

In this four weekly classes the students will have theoretical as well as practical training in defined scientific methods of their interest used in neuroscience. At the end of each week they have to summarize the gained knowledge in a written report of 2-3 pages.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	*yes*

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module the students will have detailed knowledge of different modern methods in neuroscience, including application examples and limitations. Furthermore, they will be able to choose appropriate methods to address specific scientific questions and are trained in analyzing scientific literature and data.

Teaching/Learning methods:

The students will have intensive hands-on training under close supervision of experienced scientists. The scientists will teach the students in both theory and practice of the specific methods they have chosen.

Content:

The students select the laboratories for their internships according to their individual preferences and interests by direct interaction with the group leaders. These choices define the specific methods in which they will gain theoretical and practical experience. During their stays the students will be integrated in the groups and participate in lab meetings and other scientific events.

Media:

practical lab work, hands-on training, scientific literature, eLearning platform

Literature:

Not specified

Module coordinator:

First name:	Helmuth
Last name:	Adelsberger
Email:	h.adelsberger@tum.de

Course:

Type:	practical course
Title:	Data acquisition, analysis and presentation
Hrs per week per semester	2
Lecturer (first name and last name):	Helmuth Adelsberger and others

Module description 09

Module number:	**MH560009**
Module name (Ger.):	**Nervensystem- und Netzwerkentwicklung**
Module name (Eng.):	**Nervous system and circuit development**
Module level:	Master
Abbreviation:	Nsd
Duration:	1
Frequency:	SS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

There will be a written exam (60 min) consisting of free text and multiple-choice questions. In this exam it will be tested whether the students understand the development of different brain structures and the generation of connectivity. Furthermore, they have to understand modern methods to study brain activity strategies to analyse the phenotype of control and disease model systems.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

Students are able to explain how during development this diversity of cell types arises, how cells connect to form circuits to build and maintain a plastic nervous system. The students can also describe how such insights arose from the study of model organisms, and they can explain methods and principles of neurodevelopmental biology. Furthermore, they have an overview about strategies to study impairments of normal brain function in animal models.

Teaching/Learning methods:

Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory built-up of knowledge by eLearning using the method “Just-in-Time-teaching”. After that consolidation of the knowledge will be achieved in face-to-face focus seminars with experts and finally there will be application of the knowledge in problem-solving application tutorials. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:

The specific topics in this module are:

- Principles of neuronal development.
- Formation and reorganization of neuronal connections
- Functional connectivity in local networks.
- Comparative analysis of cell biological and developmental models.

Media:

eLearning platform, power-point presentations, white board

Literature:
Textbook Developmental Neurobiology (Bianchi, 2018)
Textbook Principles of Development (Wolpert and others, 6th edition 2019)

Module coordinator:

First name:	Leanne
Last name:	Godinho
Email:	Leanne.godinho@tum.de

Course:

Type:	Lecture/Seminar
Title:	Nervous system and circuit development
Hrs per week per semester	4
Lecturer (first name and last name):	Leanne Godinho, Thomas Misgeld, Monika Leischner-Brill and others

Module description 10

Module number:	**MH560010**
Module name (Ger.):	**Systemische Neurologe und Neurowissenschaften**
Module name (Eng.):	**Systems neurology and neuroscience**
Module level:	Master
Abbreviation:	Snn
Duration:	1
Frequency:	SS
Language:	English
Credits:	5
Workload	
Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:
Description of coursework and examination requirements:
There will be a written exam (60 min). Passing this exam requires a detailed knowledge and the ability to apply this knowledge in problem-solving tasks on a theoretical level in the following topics that will be communicated during the lecture and seminar sessions of this module:

- Strategies to study neuronal circuits in health and disease.
- Modern methods for the direct investigation of circuits, including optical imaging, electrophysiology, optogenetics, computer tomography (CT), magnetic resonance tomography (MRI) and positron emission tomography (PET).
- Physiology and Pathophysiology of higher brain functions.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:
(Recommended) Prerequisites: none

Learning outcomes:
After this module the students will have a detailed knowledge about methods and strategies to study mechanisms of neuropsychiatric disorders from the cellular to the network level. Furthermore, they will know the principles and applications of most commonly used techniques, i.e. optical imaging techniques as well as CT, MRI and PET. The students will be able to choose the appropriate method for the study of animal models of neuropsychiatric diseases, like Alzheimer´s and Parkinsons´s disease.

Teaching/Learning methods:
Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory built-up of knowledge by eLearning using the method “Just-in-Time-teaching”. After that consolidation of the knowledge will be achieved in face-to-face focus seminars with experts and finally there will be application of the knowledge in problem-solving application tutorials. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:
The specific topics in this module are:

- Structure and function of the intrinsic brain connectivity.
- Methods for the analysis of the pathophysiology of neuropsychiatric disorders from cells to circuits, with special focus on cutting-edge technologies

Media:
eLearning platform, power-point presentations, white board

Literature:
An updated introduction to electroencephalogram-based brain monitoring during intended general anesthesia, Height et al., Can J Anesth/J Can Anesth, 2019
https://en.wikipedia.org/wiki/Stroke
https://www.khanacademy.org/science/health-and-medicine/nervous-system-diseases/multiple-sclerosis/v/what-is-multiple-sclerosis

Module coordinator:

First name:	Helmuth
Last name:	Adelsberger
Email:	h.adelsberger@tum.de

Course:

Type:	Lecture/Seminar
Title:	Systems neurology and neuroscience
Hrs per week per semester	4
Lecturer (first name and last name):	Christian Sorg, Jan Kirschke, Thomas Fenzl, Simon Jacob and others

Module description 11

Module number:	**MH560011**
Module name (Ger.):	**Erkrankungen des Nervensystems**
Module name (Eng.):	**Nervous system disorders and treatment**
Module level:	Master
Abbreviation:	NSD
Duration:	1
Frequency:	SS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

There will be a written exam (60 min). Passing this exam requires a detailed knowledge and the ability to apply this knowledge in problem-solving tasks on a theoretical level in the following topics that will be communicated during the lecture and seminar sessions of this module:

- Pathophysiology and molecular mechanisms of neurological diseases
- Diagnostics and molecular imaging of neurological diseases
- Established and emerging approaches to treat neurological diseases
- Translational strategies and disease models in neuroscience

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

The focus of this module is to understand the pathophysiological changes and the molecular mechanisms of neurological disorders. After this module the students will know the molecular basis, the neuropathology, the clinical manifestation, the diagnostic tools and the possibilities and limits of therapeutic interventions of neurological diseases. They will gain detailed knowledge about the different neuroimmunological, neurodegenerative and neuropsychiatric disorders and how such diseases can be modeled in animal models for mechanistic insight. This module also teaches the translational principle of applying basic science research to human subjects and moving discoveries and knowledge into initial clinical testing.

Teaching/Learning methods:

Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory build-up of knowledge by eLearning using the method “Just-in-Time-teaching”. After that consolidation of the knowledge will be achieved in face-to-face focus seminars with experts and finally there will be application of the knowledge in problem-solving application tutorials. Activating learning methods like peer instruction are used to design learner-centered lessons.

Content:

The specific topics in this module are:

- Molecular mechanisms of neurological disorders.

- Genetics, neuropathology, imaging, and clinical manifestation of nervous system diseases.
- Current treatments and emerging strategies to treat neurological diseases.
- Animal models for neurological diseases.
- The translational principle of connecting basic science and clinical application.

Media:
eLearning platform, power-point presentations, white board

Literature:
Animal Models of Neurodegenerative Diseases, Dawson et al., Nat Neurosci. 2018
Parkinson's disease, Kalia, Lancet 2015

Module coordinator:

First name:	Mikael
Last name:	Simons
Email:	mikael.simons@dzne.de

Course:

Type:	Lecture/Seminar
Title:	Nervous system disorders and treatment
Hrs per week per semester	4
Lecturer (first name and last name):	Mikael Simons, Thomas Korn, Stefan Lichtenthaler, Dietmar Edbauer, Arthur Liesz, Paul Lingor and others

Module description 12

Module number:	**MH560012**
Module name (Ger.):	**Datenanalyse und Modellierung**
Module name (Eng.):	**Computational analysis and modelling**
Module level:	Master
Abbreviation:	CAM
Duration:	1
Frequency:	SS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:

Description of coursework and examination requirements:

The focus of this course is to train students in bio-mathematical methods and strategies, to enable them to develop quantitative analysis strategies and to identify the optimal presentation formats. After an optional refreshing course in basic mathematics and statistics, the focus will be an intense training in the use of Python, as a common platform for the analysis of scientific data. In relation to specific experimental examples, the students will be trained to improve their use of statistical methods. Finally, they will obtain insights into basic aspects of bioinformatics.

As a proof of their competence the students will design and execute Python-based analyses and presentations, as well as the implementation of statistical tests.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module, the students will be able to use Python as the programming language to develop software routines for the analysis of different types of biological signals. This includes electrophysiological as well as imaging data. Furthermore, they will have a detailed knowledge in descriptive and analytical statistics.

Teaching/Learning methods:

Teaching will be performed in a three-step process for each topic of the module. The first step is preparatory build-up of knowledge by eLearning. Next, the consolidation of the knowledge will involve face-to-face focus seminars with experts and, moreover, practical application of the knowledge in problem-solving tutorials.

Content:

The specific topics in this module are:

- Use of Python as the programming language
- Development of Python scripts for the analysis of scientific data including electrophysiological and imaging data
- Bioinformatics
- Descriptive and analytical statistics
- Selection of appropriate statistic tests for the planning of scientific experiments
- Interpretation of statistics in scientific literature

Media:
eLearning platform, Computer programming, power-point presentations, white board, script

Literature:
Python Programming: An Overview of Scientific Literature, D. Soulé, linkedin 2023

Module coordinator:

First name:	Ruben
Last name:	Portugues
Email:	ruben.portugues@tum.de

Course:

Type:	Practical course
Title:	Computational analysis and modeling
Hrs per week per semester	4
Lecturer (first name and last name):	Ruben Portugues, Sebastian Berger, Moshen Kaboli and others

Module description 13

Module number:	**MH560013**
Module name (Ger.):	**Neurobildgebung und Elektrophysiologie**
Module name (Eng.):	**Neuroimaging and electrophysiology**
Module level:	Master
Abbreviation:	NiE
Duration:	1
Frequency:	SS
Language:	English
Credits:	5

Workload

Total hours:	150
Contact hours:	60
Self-study hours:	90

Coursework and Examination Requirements:
In this course the students will get detailed knowledge about technical principles and the use of equipment for recording of biological signals with optical and electrical methods. Further topics are preparation and fixation of tissues and standard histological techniques to study healthy and diseased structures. They will learn to choose the appropriate methods depending on specific scientific questions.
During the course the students have to perform practical tasks:

- Processing of biological tissues and labeling techniques
- Generation of organoids
- Use of different devices to understand the principles of the detection of electronic and optical signals from biological materials
- Imaging of calcium signals with different systems
- The students will also be able to process biological tissues and to perform important histological techniques, e.g. electron microscopy, immunohistochemistry and in situ hybridization.

Active participation in these tasks and theoretical understanding of the principles are the requirement to pass the course.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites:	none

Learning outcomes:
After this module the students will understand the principles of different electronic and optic devices and their application to detect neuronal activity on the cellular as well as on the network level. Furthermore, they know the function and application of the most commonly used imaging systems with a focus on different techniques for in vivo detection of brain activity. In addition, the students will be able to apply calcium imaging in different animal models, as this is one of the most widely used modality of functional in vivo imaging. Finally, they will know techniques to process biological tissues and to perform important histological techniques, e.g. electron microscopy, immunohistochemistry and in situ hybridization. A further part gives insights into the generation of organoids. At the end of the course the students will know the strengths and limitations of the different methods used to detect biological signals.

Teaching/Learning methods:
Teaching in the course will be performed by a combination of theoretical parts giving insights in the technical and conceptual principle of different methods to detect biological signals and a hands-on training in the laboratory. To learn optional and electronic applications of different devices they will perform standard experiments. In the theoretical parts “Just in Time teaching” and activating learning methods like peer instruction are used to design learner-centered lessons.

Content:
The specific topics in this module are:

- Processing of biological tissue material for electron microscopy, immunohistochemistry and in situ hybridization
- Generation of organoids
- Use of equipment for the recording of electrical signals from single cells and networks (i.e. electroencephalogram, amplifiers for extracellular and patch-clamp recordings)
- Methods for calcium and voltage-sensitive dye imaging of neuronal activity on the cellular and population level (i.e. two-photon imaging, CCD-camera and optic fiber based recording)

Media:
eLearning platform, hands-on training, power-point presentations, white board, script

Literature:
Brain organoids: an ensemble of bioassays to investigate human neurodevelopment and disease, Sidhaye and Knoblich, Cell Death & Differentiation 2021)

Module coordinator:

First name:	Helmuth
Last name:	Adelsberger
Email:	h.adelsberger@tum.de

Course:

Type:	Practical course
Title:	Neuroimaging and electrophysiology
Hrs per week per semester	4
Lecturer (first name and last name):	Helmuth Adelsberger, Markus Ploner, Christine Preibisch, Simon Schäfer, Marina Fetting, Monika Leischner-Brill and others

Module description 14

Module number:	**MH560014**
Module name (Ger.):	**Qualifizierungskolloquium**
Module name (Eng.):	**Qualifying colloquium**
Module level:	Master
Abbreviation:	QC
Duration:	1
Frequency:	WS
Language:	English
Credits:	2

Workload

Total hours:	60
Contact hours:	30
Self-study hours:	30

Coursework and Examination Requirements:

Description of coursework and examination requirements:

The qualifying colloquium is assessed through a 30min presentation (including handout) followed by a 15min discussion. To pass this colloquium students have to prove that they can incorporate the outcomes of the module "Scientific ethics, management, communication and dissemination" and of the module "Life & Science – Cultural Studies and Humanities for the Neuro- and Life Sciences" into their upcoming master thesis and perform an understandable presentation for their peers.

Repeat examination in following semester: no
Repeat examination at end of semester: no

Description:

(Recommended) Prerequisites: Module: "Scientific ethics, management, communication and dissemination",
Module: "Life & Science – Cultural Studies and Humanities for the Neuro- and Life Sciences"

Learning outcomes:

Upon successful completion of this qualifying colloquium students are able

- to monitor their own projects as well as the project of their peers in the light of professional scientific project management and self-critical life sciences
- to explain and illustrate their projects to their teachers and peers
- to discuss own projects as well as the projects of their peers in a constructive and open minded manner.

Teaching/Learning methods:

In every session of the qualifying colloquium at least one and at most two students are presenting their own projects to their teachers and peers preparing a 30min presentation as well as a corresponding handout. After the presentation there will be at least 15min feedback and further discussion.

Content:

As preparation for the master thesis and in addition to the final master-colloquium all students have to present the concept of their master project to their peers and teachers and thereby focus primarily on all aspects of the two transferable skills and professional competence modules. The purpose of this colloquium is to verify the personal and professional development of each student as measured by the way they present themselves as future neuro-scientists and by the way they approach, explain and contextualize their upcoming master project.

Media:
PowerPoint, whiteboard, flipchart

Literature:
Not specified

Module coordinator:

First name:	Pascal
Last name:	Berberat
Email:	berberat@tum.de

Course:

Type:	Colloquium
Title:	Qualifizierungskolloquium / Qualifying colloquium
Hrs per week per semester	2
Lecturer (first name and last name):	Pascal Berbert, Moritz Schumm and others

Module description 15

Module number:	**MH560015**
Module name (Ger.):	**Laborrotation I**
Module name (Eng.):	**Lab rotation I**
Module level:	Master
Abbreviation:	LRI
Duration:	1
Frequency:	WS
Language:	English
Credits:	12

Workload

Total hours:	360
Contact hours:	240
Self-study hours:	120

Coursework and Examination Requirements:

Description of coursework and examination requirements:

During the lab rotation the students will perform a subscribed scientific project in a lab of choice. At the end of the rotation they have to present the background of the project, the methods they used and the results they collected in an oral presentation of 20 min.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	*yes*

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module the students will be able to define circumscribed scientific questions, including planning of the experiments, selecting the appropriate methods as well as evaluation and presentation of the acquired data. In addition they will also be able to perform a detailed literature research.

Teaching/Learning methods:

The students will be fully integrated in a group and supported to perform their scientific projects. This includes literature search, discussion of the related scientific background, instructions to perform the experimental work and the evaluation of the own data. Regular meetings with the instructors will be held to guide the students to the lab rotations. Furthermore they will participate in journal clubs, progress reports and scientific discussions with the other group members.

Content:

The students choose the focus of the lab rotation according to their interests. Besides teaching specific experimental skills a major goal of the rotation is to provide the students with the knowledge to design and perform scientific projects.

Media:

practical lab work, hands-on training, scientific literature, eLearning platform

Module coordinator:

First name:	Helmuth
Last name:	Adelsberger
Email:	h.adelsberger@tum.de

Course:

Type: Lab rotation

Title:	Lab rotation I
Hrs per week per semester	16
Lecturer (first name and last name):	Helmuth Adelsberger and others

Module description 16

Module number:	**MH560016**
Module name (Ger.):	**Laborrotation II**
Module name (Eng.):	**Lab rotation II**
Module level:	Master
Abbreviation:	LRII
Duration:	1
Frequency:	WS
Language:	English
Credits:	12

Workload

Total hours:	360
Contact hours:	240
Self-study hours:	120

Coursework and Examination Requirements:

Description of coursework and examination requirements:

During the lab rotation the students will perform a subscribed scientific project in a lab of choice. At the end of the rotation they have to present the background of the project, the methods they used and the results they collected in an oral presentation of 20 min.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	*yes*

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module the students will be able to define circumscribed scientific questions, including planning of the experiments, selecting the appropriate methods as well as evaluation and presentation of the acquired data. In addition they will also be able to perform a detailed literature research.

Teaching/Learning methods:

The students will be fully integrated in a group and supported to perform their scientific projects. This includes literature search, discussion of the related scientific background, instructions to perform the experimental work and the evaluation of the own data. Regular meetings with the instructors will be held to guide the students to the lab rotations. Furthermore they will participate in journal clubs, progress reports and scientific discussions with the other group members.

Content:

The students choose the focus of the lab rotation according to their interests. Besides teaching specific experimental skills a major goal of the rotation is to provide the students with the knowledge to design and perform scientific projects.

Media:

practical lab work, hands-on training, scientific literature, eLearning platform

Module coordinator:

First name:	Helmuth
Last name:	Adelsberger
Email:	h.adelsberger@tum.de

Course:

Type: Lab rotation

Title:	Lab rotation II
Hrs per week per semester	16
Lecturer (first name and last name):	Helmuth Adelsberger and others

Module description 17

Module number:	**MH560017**
Module name (Ger.):	**Masterarbeit und Kolloquium**
Module name (Eng.):	**Master´s Thesis and Colloquium**
Module level:	Master
Abbreviation:	MTC
Duration:	1
Frequency:	SS
Language:	English
Credits:	30

Workload

Total hours:	900
Contact hours:	300
Self-study hours:	600

Coursework and Examination Requirements:

Description of coursework and examination requirements:

The students will perform a scientific project in one of the laboratories offering slots. They will determine the scientific question and the experimental design in accordance with their mentor. They will perform the necessary experiments and the required analyses under the supervision of their mentors. The results will be presented in the form of a thesis and an oral presentation/examination in a colloquium. The oral examination consists of a talk (30 min length) and a scientific discussion of the topic of the thesis (30 min length). The grades for the written thesis and the colloquium are weighted 2 to 1.

Repeat examination in following semester:	yes
Repeat examination at end of semester:	yes

Description:

(Recommended) Prerequisites: none

Learning outcomes:

After this module, the students will be able to carry out a scientific project, under appropriate supervision by a mentor. This includes the design and realization of the experimental work, as well as data evaluation. Furthermore, they will be able to present their scientific results in a written form and in as an oral presentation.

Teaching/Learning methods:

To perform this module the students will be supervised by personal mentors guiding them through all steps of the Master´s thesis.

Content:

The specific topics in this module are:

- Literature search and planning of the experiments.
- Choice of the appropriate methods.
- Performing of the planned experiments.
- Data evaluation and statistics.
- Summarizing and presentation of results.

Media:

eLearning platform, scientific literature, practical lab work, hands-on training

Module coordinator:

First name:	Helmuth
Last name:	Adelsberger
Email:	h.adelsberger@tum.de

Course:

Type:	Scientific work and presentation
Title:	Master´s Thesis and Colloquium
Hrs per week per semester	20
Lecturer (first name and last name):	Helmuth Adelsberger and others

Technical University of Munich
TUM School of Medicine and Health

Ismaninger Straße 22
81675 München

www.med.tum.de