Appendix 2: Description of modules comprising the Master's programme

Mast INS IN	**Introduction to Neuroscience**	OM	15 CP

Lecture series "Selected topics in neuroscience I "(WS) Content: Cellular, molecular and physiological background to the function of nerve and glia cells.Mechanisms of signal transduction. Plasticity, learning, memory, sensory systems, motor control, nervous system function, basis of cognition, development of the nervous system, rhythmic control of nerve function and anatomy of the human brain.

Lecture series "Selected topics in neuroscience II "(SS)

The lectures go into more detail about specific aspects of experimental neurology, pathology and diagnostics, including non-invasive analyses of the human brain, degenerative diseases of the nervous system and medical psychology.

Seminars relating to the Lecture series "Selected topics in neuroscience I and II

The students will assess research papers relevant to the lectures

Introductory session

Introducing neurobiology research in Frankfurt. Presenting the Master's programme.

Colloquium

Participating in 7 neurobiology oriented colloquia at the institutes

Weekend seminar

Presenting and discussing research projects within the Master's program

Competence:

The students gain broad interdisciplinary background knowledge about neurosciences and their possible applications. They learn about neuroscientific research concepts and should be in the position to link together various specific areas and paradigms in neurosciences. They will be able to critically assess scientific research papers in the form of an oral presentation.

Requirements for participating: None

Special note: Lectures and seminar presentations in English

Applicability for other courses: Master's programme of faculty 15

Times offered: Module covers the first two semesters of the programme and starts in the winter semester

Confirmation of module completion: Proof of participation in all sessions (except lectures), whereby participation in one of the two seminars relating to the lecture series includes a seminar talk.

Cumulative module exams: One written exam (60 minutes long) per set of lectures (each at the end of a semester).

Name of unit	**Form**	**SWH**	**Semester/CP**

			1	2	3	4
Lecture ”Selected topics in neuroscience 1”	L	4	6			
Seminar ”Selected topics in neuroscience 1”	S	1	2			
Lecture ”Selected topics in neuroscience 2”	L	2		3		
Seminar ”Selected topics in neuroscience 2”	S	1		2		
Introductory session	L/S	1	0.5			
Colloquium	Co	0.5	0.5			
Weekend seminar	S	1	1			

Mast INS MN	**Methods in Neuroscience**	OM 15 CP

Content: The module is a practical on “Introduction to scientific research techniques”. The aim is to teach the students as much as possible about the most important experimental techniques recommended for the specialised topics of their Master’s project so that their thesis work can be completed successfully in the time available.

Competence: After completing the module, the students will be familiar with the basic techniques that apply directly to a Master’s project in their chosen topic. They will be able to efficiently find information about methods from publications and the Internet and evaluate the feasibility of experimental approaches. They will be competent in criticizing methods and assessing artefacts.

Requirements for participating: Successful completion of the module “Introduction to Neuroscience” as well as at least 3 out of the 4 elective modules

Special note: -----

Applicability for other courses: None

Times offered: As of the third semester of the course (winter semester)

Confirmation of module completion: Non-graded certificate of participation in the form of a written practical protocol

Module completion exam: None

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Practical: Introduction to scientific research techniques	**P**	**15**			15	

Mast INS CC	**Current Concepts in Neuroscience**	OM 16 CP

Content: The module includes a practical project and a seminar that aims to provide the students with the most important theoretical background for developing a research concept in one neurobiological topic. After working on recent scientific papers, they should identify critical unanswered questions as well as develop research strategies to solve them.

Competence: After completing the module, the students will be familiar with developing scientific research concepts as well as how to incorporate these into grant applications. The students will develop critical skills to assess the relevance and validity of different or even contradictory theories and research concepts.

Requirements for participating: Successful completion of the module “Introduction to Neurosciences” as well as at least 3 out of the 4 elective modules; the weekend seminar has no participation requirements, so can be completed at any time that is convenient.

Special note: ------

Applicability for other courses: None

Times offered: As of the third semester of the degree course (winter semester)

Confirmation of module completion: 2 non-graded performance assessments, for a written research concept and for giving a talk in a seminar

Module completion exam: None

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Project work on developing a research concept	**Pr**	**15**			15	
Weekend seminar	**S**	**1**			1	

Mast INS MA	**Master's Thesis**	OM 30 CP

Content: As part of the Master's degree a student uses scientific methods to work intensively and in detail on a particular question for a period of 6 months. The work can be experimental, empirical or analytic. The results must be written up in a Master's thesis in the style of a scientific paper. The quality of the work will be assessed based on the written thesis by the supervisor and a second referee.

Competence / learning and qualification aims:

- Ability to work intensively and in detail on a scientific question
- Producing a written work in the style of a scientific publication
- Practical application of modern research methods

Timing and duration of the module: The timing is open, the duration is 6 months

Requirements for participation: At least 75 CP as well as completion of the modules Mast INS MN.

Special note: The Master's thesis is usually supervised by a university professor who regularly organises compulsory or elective units in the Master's programme.

Applicability for other courses: None

Conformation of completion (TN and/or LN): None

Module completion exam: Written in the form of a Master's thesis (the grades will carry double the weight of the grades in all other modules).

Requirement for gaining credit points for the module: Passing the module exam**.**

			Semester/CP			
Name of unit	**Type**	**SWH**	**1**	**2**	**3**	**4**
Master's thesis	**MA**					30

Specialised Modules

All specialised modules are elective modules and each contributes 11 CP to the Master's degree. The distribution of practicals, seminars and individual lectures within a specialized module varies depending on the subject area; similarly converting SWH to CP varies since conversion factors are different in the participating faculties. The four required elective modules are to be selected from at least two different subject areas of the Master's programme (see Appendix 1).

Specialized module subject area A: Basic Neurosciences

Mast INS A-1	**Cellular and Molecular Basis of Signal Transfer in the Nervous System**	EM	11 CP

Content: The practical focuses on basic techniques used in cellular and molecular neurobiology. The students work on their own project with supervision, and present the results in the form of a seminar talk. In another seminar talk they assess an original piece of research from the field of cellular and molecular neurobiology. They learn how to present scientific work through writing up an appropriate result protocol. The main topics are: protein biochemistry methods to study nerve function, including sub-cellular fractionation, the basics of working with neuronal cell culture, cell transfection, and cytology of cultured cells and tissue sections from the brain, as well as working with digital images.

Competence: Familiarity with isolating neuronal cell organelles, independently characterising organelle proteins, sterile work and cultivation and transfection of cells, independently using a fluorescence microscope and computer-aided evaluation of lab data and image data, familiarity with anesthetising lab animals, independently working on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Lectures and protocols in English

Applicability for other courses: Master's programme in faculty 15

Times offered: Twice per year in the winter and summer semester, each in the first half; 4 weeks of whole day block practicals as well as 4 hours per week of seminars.

Confirmation of module completion: Certificate of participation (written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on current publications)

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Cellular and molecular basis of signal transfer in the nervous system	P, S	11	11			

Mast INS A-2	**Auditory Neuroscience**	EM 11 CP

Content: The practical teaches basic electrophysiological conductance techniques and bio-acoustic measuring techniques to investigate the auditory system in laboratory mammals and insects in vivo. The students work on their own projects with supervision, and present their results in the form of a seminar talk. In a further seminar talk they present an original piece of research from the field of auditory neurobiology. They learn how to present scientific work through writing up an appropriate result report. The main topics are: physiological properties of nerves in the midbrain and cortex, investigating active sensory amplification mechanisms in the inner ear, psychoacoustic analyses in humans, use of computer/software in evaluating data and generating stimuli.

Competence: Familiarity with carrying out electrophysiological experiments, measuring otoacoustic emissions, familiarity with anesthetising and surgical procedures in animal experiments, application of neuroanatomical techniques, learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: Master's programme in faculty 15

Times offered: Twice per year in the winter and summer semester, each in the first half; 4 weeks of block practicals with seminars.

Confirmation of completion: Certificate of participation (written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers)

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Auditory neuroscience	**P, S**	**11**	11			

Mast INS A-3	**Molecular Control of Neuronal Differentiation**	EM 11 CP

Content: The practical addresses molecular biological, cell biological and immunohistological techniques for analysing neuronal differentiation. The students work on projects related to current research in the group and participate in the group's journal club and progress report seminars. In two seminar talks they present the thematic background to their project and their results. They learn how to present scientific work through writing up an appropriate result protocol.

Competence: Familiarity with carrying out molecular biological cell biological and immunohistological experiments, working on scientific questions.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: Master's programme in faculty 15

Times offered: Once a year in the winter semester, second half; 4-6 weeks block practical

Confirmation of completion: Certificate of participation (written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers)

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Molecular control of neuronal differentiation	**P, S**	**11**		**11**		

Mast INS A-4	**Functional Anatomy of the Retina**	EM 11 CP

Content: The practical introduces histological techniques for visualising and documenting neuronal structures (fixation, dissection, immunostaining, microscopy, micro-photography) and as an example a glimpse into the neuronal switching circuits that determine the function of the mammalian retina.
The students work on their own projects under supervision and present their results in the form of a seminar talk. In an additional seminar talk they assess an original piece of research from the field of visual neurobiology. They learn how to present scientific work through writing up an appropriate result protocol.

Competence: Familiarity with carrying out immunocytochemical staining, using microscopes, working on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: Master's programme in faculty 15

Times offered: Once a year in the winter semester, first half; 4-week block practical

Confirmation of completion: Certificate of participation (written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers)

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Functional anatomy of the retina	**P, S**	**11**	11			

Mast INS A-5	**Clock Mechanisms in Mammalian Neurons and Neuroendocrine Cells**	EM 11 CP

Content: The practical presents the basics of generating endogenous circadian rhythms in mammalian neurons. Here, the students analyze the cellular and molecular elements for chronobiological behaviour, working under supervision, and write up the results. Then the results obtained are presented in the form of a seminar talk. In a further seminar talk they present original research from the area of chrononeurobiology. The following techniques will be introduced: immunohistochemistry, protein gel electrophoresis, RNA extraction, RT-PCR, densitometry.

Competence: Basic knowledge about cell and molecular biology, basic skills in neuroanatomy of the mammalian brain, basics in chronobiological systems biology, learning to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: Master's programmes in faculty 15

Times offered: Once a year in the summer semester, first half; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Clock mechanisms in mammalian neurons and neuroendocrine cells	**P, S**	**11**		**11**		

Mast INS A-6	**Cellular and Molecular Biology of the Circadian System**	EM 11 CP

Content: The practical provides a look into the basic circadian system in mammals. The students also work on their own projects under supervision. The results are recorded in the form of a protocol and presented as a seminar talk. In a further seminar talk the participants present a recent research paper from the area of circadian rhythms. The following molecular biology and cell biology techniques will be used: PCR, cloning, handling cell cultures, transfection of cell lines, in situ hybridisation, immunohistochemistry, Western blotting.

Competence: Familiarity with basic molecular biology and cell biology. Learning to work on scientific questions based on relevant publications. Writing up scientific work in the form of a written practical protocol.

Requirements for participating: None

Special note: Protocols and seminar talks in English

Applicability for other courses: Master's programme in faculty 15

Times offered: Once a year in the second half of the summer semester; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Cellular and molecular biology of the circadian system	**P, S**	**11**		**11**		

Mast INS A-7	**Neurobiology of the nematode *Caenorhabditis elegans***	EM 11 CP

Content: This practical focuses on basic methods for investigating the nervous system of *Caenorhabditis elegans*. As well as more general molecular biology methods, this involves genetic methods (crosses, genotyping) as well as simple behaviour assays without and with the effect of specific agonists for ligand mediated ion channels (nicotinic acetylcholine receptors, GABA receptors) that are used for general characterization of the function of neuromuscular synapses. In addition, cell biology methods for expression analysis of transgenes (GTP-fusion proteins) or endogenous proteins (using specific antibodies) in relation to the genetic background are part of the lab's standard repertoire. More specialised methods that are used are exogenous stimulation of neurons in *C. elegans* by light, transmitted by the transgene expressed, photo-activated cation channel rhodopsin-2, as well as electrophysiological conductance from *C. elegans* muscle cells (the latter only as a demonstration, since the method is too complicated to learn in 6 weeks).

The students work on a current research project under the supervision of a PhD student and present the results in the form of a seminar talk. They learn how to present scientific work through writing up their result protocol.

Competence: Familiarity with standard methods to analyse an invertebrate nervous system, genetic methods for making crosses, cell biology methods, molecular biology methods, learning to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Protocol and seminar talk

Applicability for other courses: Master's programme in faculty 15, Master's programme in Biochemistry

Times offered: 4-6 weeks in the lab, full-time

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Neurobiology of the nematode *Caenorhabditis elegans*	**P, S**	**11**	11			

Mast INS A-8	**Neuropharmacology**	EM 11 CP

Content: The practical comprises working on a theme in neuropharmacology. The research group works with animal models of neurodegenerative diseases such as stroke and Alzheimer's disease. In addition to cell culture, methods involve the application of microdialysis, which allows access to the extracellular space. Under supervision the students learn how to carry out microdialysis experiments as well as measuring neurotransmitters (e.g. acetylcholine) and important metabolites (e.g. glucose, lactate). The main focus of the analyses will probably be central cholinergic functions as well as energy metabolism in the brain under ischemia and reperfusion.

The experimental results will be recorded and prepared as a potential publication with graphical and statistical analyses of the data. In this way the students will learn the basic techniques of scientific work. After completion, the individual projects will be presented and discussed in the form of a seminar talk. In a further seminar talk the students will present an original piece of research from the area of neuropharmacology.

Competence: Familiarity with carrying out biological and analytic experiments, basic knowledge in animal experimental techniques, theory and practice in microdialysis, analysis of transmitters and metabolites using chromatographic and enzymatic procedures. Working on scientific questions based on relevant publications.

Requirements for participating: None

Special note: One talk should be held and discussed in English

Applicability for other courses: Master's program in faculty 15

Times offered: Once a semester; always in the second half of the semester; 4-week block practical

Confirmation of completion: Written practical protocol with data analysis, 2 seminar talks

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Neuropharmacology	**P, S**	**11**	**11**			

Mast INS A-9	**Cellular Neurophysiology of Dopaminergic Neurons**	EM 11 CP

Content: The practical covers basic electrophysiological single cell techniques (patch-clamp recordings & extracellular electrodes) of the dopaminergic midbrain system of mice in vivo and in vitro. The students work on their own projects under supervision and present their results in the form of a seminar talk. In a further seminar talk they present an original piece of research from the field of basal ganglia neurophysiology and pathophysiology (e.g. Parkinsos's disease, schizophrenia, drug addiction). The main focuses are measuring and evaluating neuronal activity (current-clamp) and measuring (voltage-clamp) as well as biophysical and pharmacological characterisation of this neuronal activity mediated by synaptic and post-synaptic mechanisms (e.g. ion channels) with various configurations of the patch-clamp technique. This also includes using statistical evaluation methods. The students learn about the associated stochastic background and how to use the relevant software, which involves interdisciplinary cooperation with the BSc/MSc programs in mathematics.

Competence: Familiarity with carrying out electrophysiological experiments, measuring and analysing electrical activity of dopaminergic neurons *in vivo* and *in vitro*, using and evaluating the patch-clamp technique to characterise biophysical and pharmacological properties of synaptic and post-synaptic ion channels. Combination of the patch-clamp technique with neuroanatomical and immunohistological analyses. Basic computer modelling of neuronal activity. Stochastic description and statistical analysis of the recorded time sequence data. Understanding the molecular pathophysiological correlation between important diseases of the dopaminergic system and their corresponding mouse models.

Requirements for participating: None

Special note: Talks and protocol in English

Applicability for other courses: None

Times offered: Once a year in the summer semester, first half; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Cellular neurophysiology of dopaminergic neurons	**P, S**	**11**		**11**		

Mast INS A-10	**Neurophysiology and Behaviour**	EM 11 CP

Content: The practical investigates the neurophysiological basis of behaviour control. The students work on their own project on a theme defined together beforehand. The techniques that are taught include: cell physiology (patch-clamp conductance, intracellular conductance, calcium imaging, cell culture); neuroanatomy (staining methods, brain preparation, confocal laser microscopy, fluorescence microscopy); behavioural experiments (behaviour pharmacology, extracellular conductance, learning and memory, social behaviour). Insects (honey bees, drosophila) are used as model organisms. The principle areas are: how ion channels and transmitter receptors work, neuromodulation, learning behaviour, olfactory memory formation, and social behaviour of bees.

The students present their results in the form of a seminar talk and poster. In a further seminar talk they learn how to critically assess analytic physiological and behavioural research papers. These presentations are held in English and the students receive comprehensive feedback about the content and style of the presentation. They become familiar with writing a scientific publication by producing a protocol in the form of a paper.

After the individual experimental steps have been explained, the students mostly work independently, from planning to carrying out, writing up and evaluating the research data.

Competence: Planning, carrying out and evaluating neurobiology experiments, measuring ion flow; observing and quantifying behaviour; neuroanatomical methods. How to approach scientific questions, working with publications. Preparing scientific papers and presentations.

Requirements for participating: None

Special note: Talks, protocol and poster in English

Applicability for other courses: Master's courses in faculty 15

Times offered: Twice a year in the winter and summer semester, each in the first half; 4-week block practical with seminars

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Neurophysiology and Behaviour	**P, S**	**11**	11			

Mast INS A-11	**Developmental Neurobiology**	EM 11 CP

Content: The practical course offers basic theoretical and experimental knowledge in the area of developmental neurobiology. Principal areas of research are the development and plasticity of the synapse as well as migration of neurons during cortex development. The students take part in ongoing experiments in the laboratory to elucidate the molecular mechanisms of these processes. Their work includes: basic mouse genetics techniques and the handling of a mouse colony, processing of brain tissue for in situ hybridisation and immunohistochemisty, isolation of primary hippocampal and cortical neurons from mice, transfection of primary neurons, immunofluorescence microscopy, confocal microscopy, biochemical techniques including protein gel electrophoresis, Western blotting and immunoprecipitation.

The results of the practical course are presented by every student in the form of a written protocol and a talk at the end of the course. The students also take part in the weekly lab meetings where they learn about the ongoing research of all the members of the group. In a Journal Club every student presents a recent publication in the field of their own practical project.

Competence: Students learn the basic techniques for studying cellular and molecular neurobiology (as described above). By the end of the course they have been in direct contact with mice and learn how to handle a mouse colony. The students work in an international environment and learn how to write and communicate their results in English.

Requirements for participating: None

Special note: Communication, talks and protocols in English

Applicability for other courses: Master's courses in faculty 15, particularly for "Cell Biology"

Times offered: Once a year in summer semester

Confirmation of completion: Written practical protocol, and 2 talks

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Developmental neurobiology	**P, S**	**11**	**11**			

Mast INS A-12	**The Neuro-Vascular Interface**	EM 11 CP

Content: The practical course offers basic theoretical and experimental knowledge about the brain vessel system in embryonic development and under pathological conditions. The research focus is on the development and maintenance of the blood-brain barrier (BBB), and its importance for neuronal function. The students participate in on-going experiments in daily lab work, which should contribute to our understanding of the molecular mechanisms of BBB formation. This work encompasses the following areas: basic work with transgenic mouse models (various reporter mouse lines to detect the Wnt signalling pathway, as well as conditional/inducible gain and loss of function lines), preparing brain tissue for in situ hybridisation and immunohistochemisty, isolation of cortical microcapillaries from mice, transfection and infection of cells, immunofluorescence, confocal and live-cell microscopy, biochemical techniques such as protein gel electrophoresis, Western blotting and immunoprecipitation.

The results of the practical course are presented by every student in the form of a written protocol and a talk at the end of the course. The students also take part in the weekly lab meetings where they learn about the ongoing research of other members of the group. In a Journal Club every student presents a recent publication on the theme of their own practical project.

Competence: Students learn the basic techniques for studying cellular and molecular neurobiology (as described above). By the end of the course they have experience with transgenic mice and/or collected cells *in vitro*, and have learnt how to prepare brain tissue from mice according to the subsequent methods. The students work in an international environment and learn how to write and communicate their results in English.

Requirements for participating: None

Special note: Communication, presentations and protocols in English

Applicability for other courses: Master's courses in faculty 15, particularly for "Cell Biology"

Times offered: Once a year, first half of the summer semester; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the practical results, 1 seminar talk on a recent publication (journal club)

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	Form	SWH	Semester/CP			
			1	2	3	4
The neuro-vascular interface	**P, S**	**11**		**11**		

Mast INS A-14	**Embryonic and Adult Neurogenesis**	EM 11 CP

Content: The practical course addresses underlying questions about neurogenesis in vertebrates. The focus is intrinsic mechanisms that control cell proliferation and differentiation of neural stem and precursor cells in embryonic and adult brain.

The students participate in on-going experiments in the lab, and under supervision work independently on scientific problems. The results obtained are presented in the form of a seminar in English. In addition, the participants present a recent original piece of work and discuss this based on the relevant literature. The results protocol can either be prepared in the form of a short publication or a short grant application, to gain preliminary experience in writing both these kinds of documents essential for scientific research.

Competence: Independent work on scientific problems using the basic techniques for studying cellular and molecular developmental neurobiology with model organisms of the mouse and hen. Main methods: working with transgenic animal models; retrovital gene transfer *in vitro* and *in vivo*; protein biochemistry methods (sub-cellular fractionation, purifying multi-protein complexes); cultivation and transfection of cell linesand primary cell culture (embryonic and adult stem and precursor cells); detecting gene products using immunocytochemistry and *in situ* hybridisation; data analysis.

Requirements for participating:

Special note: Talks and protocols in English

Applicability for other courses: Master's courses in faculty 15, particularly for "Cell Biology"

Times offered: Once a year, in the summer semester, first half; 4-week full-day block practical as well as 4 hours per week seminars

Confirmation of completion: Written practical protocol in the form of a short publication, 2 seminar talks (1 a talk on the project and the results: progress report; 1 seminar talk on a recent publication: journal club)

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	Form	SWH	Semester/CP			
			1	2	3	4
Embryonic and adult neurogenesis	**P, S**	**11**		**11**		

Mast INS A-15	**Electrophysiological recordings in freely behaving animals**	EM 11 CP

Content: In this module the participants will learn about techniques than enable the investigation of neuronal activity in vivo in conscious animals. The students will learn how to train animals in particular behavioural tasks, to make extracellular recordings on freely moving animals, to extrapolate relevant signal (spiking, local field potentials) from neuronal data, to analyse these signals and relate them to the behaviour of the animal. The neuronal recordings are made in cortical and subcortical structures during behaviour tests on special working memory and with operant conditioning. The collected and analysed data are presented at the end of the practical. In addition, a recent publication relevant to the work will be presented in a journal club.

Competence: Behavioural training with animals, basic knowledge about the techniques for collecting and analysing neuronal activity on freely moving animals, learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Useful previous knowledge:

Special note: Talks and protocols in English

Applicability for other courses:

Times offered: Twice a year, in the winter and summer semester

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of the participants own experiments

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Electrophysiological recordings in freely behaving animals	**P, S**	**11**	**11**			

Mast INS A-16	**Neuroscience of Visual Perception**	EM 11 CP

Content: This course covers the core methods, concepts and findings in neuroscience of visual perception of the primate brain. Topics include: Subcortical & cortical circuits, motion perception & decision making, face perception, eye movements, attention & consciousness. Methods covered include those to read out brain activity (psychophysics, extracellular electrophysiology, fMRI) as well as those to experimentally manipulate it (lesions, pharmacology, microstimulation, optogenetics).

The practical part covers experimental design & programming in Matlab, psychophysical experiments, participation in ongoing electrophysiology experiments, analysis of electrophysiology (single units, local field potentials)& fMRI data in Matlab.

Competence: Fundamental knowledge of the central research questions, designs and methods, programming of experiments and analysis in Matlab, preparation of extra-cellular recordings

Requirements for participating: None

Helpful previous knowledge: Basic knowledge of Matlab

Special note: Talks and protocols in English

Suitable for other courses: Master course in Faculty 05 Psychology

Times offered: Winter semester, 4 weeks lab course (block practical) with seminar

Confirmation of completion: Certificate of participation (written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on current publications)

Module completion exam: Written exam (45 min) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of module	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Neuroscience of Visual Perception	**S, P**	**11**	**11**			

Mast INS A-0	**External practical module "Basic Neuroscience"**	EM 11 CP

Content: This elective practical teaches basic methods and techniques in the area of neurobiological sciences. The students work on their own projects under supervision and present their results in the form of a seminar talk. They learn how to present scientific work through writing up an appropriate results protocol.

The Module can be offered by departments at the Goethe University, by other universities in Germany or abroad as well as external research establishments, usually the Max Planck Institute for Brain Research. Max Planck Institute for Biophysics, the Ernst Strüngmann Institute (ESI), Frankfurt Institute for Advanced Studies (FIAS), Paul-Ehrlich-Institute.

Competence: Familiarity with carrying out basic scientific experiments in the area of neurobiology. Learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Responsible for the module is the chairperson of the Examination board. Talks and reports in English. The module is an external module that replaces an elective module in area A and requires the approval of the examination board. It represents an extension to the modules offered in the Master's course INS and is co-supervised by the chairperson of the Examination board.

Applicability for other courses: ------

Times offered: by arrangement

Confirmation of module completion: Depends on who provides the course. If the organizer has not planned a certificate, a practical report must be prepared and 1 seminar talk given on the results of the participant's own research.

Module completion exam: Graded report

Name of unit	**Form**	**SWS**	**Semester/CP**			
			1	**2**	**3**	**4**
External practical module in Basic Neuroscience	**P,S**	**11**	11			

Specialised module subject area B: Clinical Neurosciences

Mast INS B-1	**Ageing and Neurodegeneration**	EM	11 CP

Content: The practical course introduces basic analysis techniques for mouse models of the neurodegenerative diseases Parkinson's and ataxia. The students are trained in objective methods to measure motor and behaviour patterns (Offenfeld, Rotarod, etc.), statistical evaluation for progression analyses (ANOVA, Regression, etc.) as well as molecular genetic mutation tests (tail biopsy, DNA extraction, quantitative PCR) and analysing the expression profile of mutated tissue. They work on current projects under supervision, report on up to date science in a Journal Club, and present the experimental results in the form of a seminar talk. They learn how to present scientific work through writing up a result protocol.

Competence: Basic knowledge about designing and carrying out motor-behaviour analyses in rodents as well as statistical evaluation. Learning methods in cell biology (fibroblasts/cell culture, transfection), molecular genetics/biology (quantitative PCR, Western blots), histological methods, learning to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and protocol in English

Applicability for other courses: None

Times offered: Twice a year, in the second half of the summer or winter semester; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Ageing and neurodegeneration	**P, S**	**11**	11			

Mast INS B-2	**Physiology and Pharmacology of Pain**	EM 11 CP

Content: The practical focuses on basic methods for investigating the mechanisms of how pain arises and particularly the pharmacology of this in various human, animal and cell culture models. Under supervision the students perform and document the experiments themselves in small groups. At the end of the practical the results are presented and discussed in a seminar talk. Current topics in pain research are presented and discussed in a Journal Club accompanying the practical, where each student prepares a talk on an recent research paper.

Competence: Familiarity with human pain models, observing the behaviour of experimental animals and presenting various pain models, preparing tissue for immunohistochemistry and Western blots, setting up neuronal cell culture, introduction to calcium imaging, measuring primary sensory neurons and pharmacological effects, learning about *in vitro* cell culture models for investigating the pharmacology of inflammation mechanisms, measuring inflammation mediators in a cell culture model, preparing scientific papers, preparing one's own results in the form of a talk and written protocol.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: No

Times offered: Once a year in the winter semester, first half; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Physiology and pharmacology of pain	**P, S**	**11**	11			

Mast INS B-3	**Human Neuroanatomy and Neurohistology**	EM 11 CP

Content: The module provides basic knowledge in human neuroanatomy and neurohistology and comprises lectures and a practical.

The topics addressed in the lectures are: meninges, blood vessels supplying the brain, development of the central nervous system, parts of the brain, building blocks of the nervous system, spinal cord with brachial and lumbosacral plexus, ascending and descending nerve tracts, rhombencephalon and mesencephalon, brain nerves, vestibular organs, cerebellum, diencephalons and neuroendocrine system, eyes and optical nerve, auditory tract, olfactory system, limbic system and neocortex.

The four-day practical concentrates on macroscopic anatomy of the brain and spinal cord, meninges, blood vessel supply, analysis of brain sections, and thin slice anatomy with imaging procedures; also working on microscopic anatomy of the spinal cord, cortex and cerebellum in terms of cyto-architecture, immunocytochemistry and Golgi silver staining. There is also a brief introduction to the neuropathology of neurodegenerative diseases (Parkinson's, Alzheimer's).

Competence: Knowledge about macro and micro-anatomy of the human brain; learning about the morphological background to understanding imaging procedures and structurally oriented neurobiology research methods, propaedeutic to neuropathology

Requirements for participating: None

Special note: None

Applicability for other courses: Master's programme in faculty 15

Times offered: Once a year in the winter semester, second half

Confirmation of completion: Regular attendance required

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Human neuroanatomy and neurohistology	**P, L**	**11**	11			

Mast INS B-4	**Plasticity in Hippocampus – Morphology, Physiology, and Clinical Relevance**	EM 11 CP

Content: The practical and seminars provide an interdisciplinary overview of the plasticity of the hippocampus. Physiological experiments include conductance of electrical potential in vivo in hippocampal sections and section cultures, as well as how they are affected by electrical stimuli and pharmaceuticals. The aim is to learn the various standard techniques for analysing hippocampal plasticity and comparing how they are applied in research. Anatomical experiments demonstrate analyses of changes in cellular morphology following central nervous system damage, or neuronal over-stimulation.

The accompanying seminars compare the experimental models used for neurological diseases. The relevance of animal experimental models for understanding human diseases are discussed using examples from recent research papers.

Competence: Basic electrophysiological and anatomic techniques; preparing tissue slices and organ-specific slice cultures; confocal microscopy; learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: Molecular medicine

Times offered: Once a year; second half of the summer semester; 4-week block practical.

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Plasticity in hippocampus – morphology, physiology, and clinical relevance	**P, S**	**11**		**11**		

Mast INS B-5	**Motor Cortex Neurophysiology**	EM 11 CP

Content: The practical teaches basic stimulation techniques (transcranial magnetic stimulation) for non-invasive and painless neurological analyses of the human corticospinal tract and motor cortex. The students learn about stimulation methods to determine the excitability of stimulatory and inhibitory networks in the motor cortex, and to characterise connections between the pre-motor region and the primary motor cortex. They work on current projects under supervision and present their results in the form of a seminar talk. They learn how to produce a scientific paper by writing a results protocol. In another seminar talk they present and critically assess a recent research paper on the theme of excitability / plasticity in the motor cortex.

Competence: Basic knowledge about designing and carrying out clinical neurophysiological experiments in humans, learning about physiolological methods (transcranial magnetic stimulation (TMS), MR-navigated TMS, electromyography), learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and reports in English

Applicability for other courses: None

Times offered: Once a year in the summer semester, second half; 4-week block practical.

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers).

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Motor cortex neurophysiology	**P, S**	**11**		**11**		

Mast INS B-6	**Brain Damage and Neuroprotection**	EM 11 CP

Content: The practical involves experiments using the following methods: cultivating neuronal cells (primary cells and neuronal cell lines), inducing ischemia *in vivo* in rats, *in vitro* hypoxia/ischemia, application of further stress stimuli *in vitro*, assessing neuronal cell death and neuroprotection by cytokines and pharmaceuticals *in vitro* and *in vivo*, detecting proteins and other compounds in the cell using fluorescence and laser scanning microscopy, transcriptional stress responses in neurons as well as transfection techniques and live cell imaging.

Competence: Familiarity with cell culture techniques and molecular biological techniques in experimental neurosciences, knowledge about anesthetising and surgical approaches in animal experiments, learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Practical / lab hospital block, talks and reports in English

Applicability for other courses: None

Times offered: Once a year in the summer semester, second half; 3-4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers).

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Brain Damage and neuroprotection	**P, S**	**11**		**11**		

Mast INS B-7	**Clinical Paediatric Neurology**	EM 11 CP

Content: The practical investigates neurological questions in children. The main themes are developmental neurobiology in the first year of life, applied neurophysiology in children, neuropaedriatric medicine including epilepsy syndromes and neurotraumatology. The students take part in relevant investigations, write up an experimental protocol and present their results in the form of a seminar talk. They give an additional seminar talk on recent original research papers.

Competence: Familiarity with standard methods in clinical neuropaediatry, acquiring experience in handling patients as well as classifying typical clinical symptoms, learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: 2-4 weeks of practicals and hospital work

Applicability for other courses: None

Times offered: Once a year in the winter semester, second half

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Clinical paediatric neurology	**P, S**	**11**	11			

Mast INS B-8	**Clinical Neuroimaging**	EM 11 CP

Content: The practical provides an introduction to basic image analysis, image interpretation and acquiring data by examining the CNS (cerebral and spinal) with neuroradiological imaging procedures. The following procedures are used: molecular resonance tomography (MRT) of the head and spinal column, computer tomography (CT) of the skull and spinal column, digital cerebral and spinal subtraction angiography (DSA) as well as an introduction to basic neuroradiological intervention measures.

In addition, the practical presents the theoretical / physical background to individual analysis procedures in neuroradiology focussing on nuclear resonance tomography. This will deal with the physical basis of MRT / image composites, sequences and sequence parameters of MRT, diffusion and perfusion weighted MRT imaging, tractography (fibre tracking), functional MRT (fMRT), nuclear resonance spectroscopy analysis (MR spectroscopy).

The students compile a written protocol on the investigations carried out and present this along with the theoretical background in the form of a seminar talk.

Competence: Familiarity with neuroanatomy (cerebral/spinal) as well as the skull and spinal column; basic knowledge about relevant neurological diseases. Learning about indications for neuroradiological examination, acquiring and interpreting images as well as assigning them to typical individual clinical pictures.

Requirements for participating: None

Special note: None

Applicability for other courses: None

Times offered: In both halves of the winter and summer semester; each with a 6-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the methods covered and their practical / theoretic background.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Clinical neuroimaging	**P, S**	**11**	11			

Mast INS B-9	**Clinical Auditory Neuroscience**	EM 11 CP

Content: The practical provides knowledge about the most important objective and subjective audimetric measuring techniques for differential diagnosis of hearing impairment. This includes using sound and speech audiometry as well as the application of otoacoustic emissions, impedance audiometry, and various techniques of brain stem audiometry (BERA, CERA, ASSR, MMN). Providing the hearing impaired with implantable hearing aids and cochlea implantations will be demonstrated in practical applications. The application of intra-operative electrophysiological signals will be demonstrated.

In the context of the module the student will work under supervision on an individual in-going project. The results are presented as a seminar talk. An additional seminar talk is scheduled for presenting original research from the field of electrophysiological stimulation/derivation of auditoric potentials. Preparing a results report should teach the students about methods in scientific writing. The main focus is: psychoacoustic measurements of auditory perception by electrical stimulation via cochlea implants, investigating new derivation techniques for frequency-specific diagnosis of hearing impairments, computer/software control to collect data and generate stimuli.

Competence: Familiarity with carrying out psychoacoustic experiments, measuring evoked acoustic potentials, basic knowledge about audiometry, learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Talks and protocols in English

Applicability for other courses: Master's degree course in faculty 15

Times offered: Twice a year in the winter semester and summer semester, each in the first half; 4-week block practical with seminars

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of the participant's own experiments, 1 seminar talk on a recent paper

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Clinical auditory neuroscience	**P, S**	**11**	11			

Mast INS B-0	**External practical module "Clinical Neuroscience"**	EM 11 CP

Content: This elective practical focuses on methods and techniques in the area of clinical neurosciences. The students work on their own projects or assess clinical data under supervision and present their results in the form of a seminar talk. They learn how to present scientific work through writing up an appropriate results protocol.

The Module can be offered by departments at the Goethe University, by other universities in Germany or abroad as well as non-academic research establishments, usually the Max Planck Institute for Brain Research. Max Planck Institute for Biophysics, the Ernst Strüngmann Institute (ESI), Frankfurt Institute for Advanced Studies (FIAS), Paul-Ehrlich-Institute.

Competence: Familiarity with carrying out scientific experiments in the area of clinical neurosciences. Learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Responsible for the module is the chairperson of the Examination board. Talks and reports in English. The module is an external module that replaces an elective module in area B and requires the approval of the examination board. It represents an extension to the modules offered in the Master's programme INS and is co-supervised by the chairperson of the Examination board.

Applicability for other courses: None

Times offered: by arrangement

Confirmation of module completion: Depends on who provides the course. If the organizer has not planned a certificate, a practical report must be prepared and 1 seminar talk given on the results of the participant's own research.

Module completion exam: The regulations of the organizer of the chosen module apply. If the organizer does not plan to give grades, assessment of the module is by a graded practical report.

Name of unit	**Form**	**SWS**	**Semester/CP**			
			1	**2**	**3**	**4**
External practical module in Clinical Neuroscience	**P,S**	**11**	11			

Specialised module subject area C: Cognitive and computational neuroscience

Mast INS C-1	**Modern Non-Invasive Methods in Human Cognition Research**	EM	11 CP

Content: The practical focuses on non-invasive techniques for measuring brain activity in humans that have significantly influenced recent cognition research. This includes functional magnetic resonance tomography (fMRT), EEG, including stimulation correlated potentials (SCP), and magnetic encephalography (MEG). Following a theoretical introduction to the basics of each method, the students carry out their own experiments on central cognitive functions such as perception, attention, working memory and speech. They should be made aware of the advantages and disadvantages of each method and learn the main steps in evaluating the results. The project topics should be related to current projects in the participating research groups in cognitive neurology and the Institute for Medical Psychology who are responsible for supervising the students. The results should be presented in the form of a seminar talk. A protocol should be written up in the style of a scientific paper. In an additional seminar talk the students should present and critically assess recent published research on a related theme.

Competence: Basic knowledge about the design and carrying out of cognitive experiments in humans, learning about relevant physiological methods (fMRT, EEG, MEG), learning about working on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Protocols and seminar talks in English

Applicability for other courses: None

Times offered: Once a year in the summer semester, first half; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers.

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Modern non-invasive methods in human cognition research	**P, S**	**11**		11		

Mast INS C-2	**Cognitive Development across the Life-Span**	EM 11 CP

Content A: The module provides an introduction to numerous psychological methods, test procedures and techniques for measuring cognitive abilities in people from different age groups (infants, young children, school children, young adults, older people). These will be taught using examples of on-going experiments, available archived material as well as recent data and video material. One part of the course will address simultaneous psychological and fMRT measurements. With reference to early development stages of cognitive function, FIAS modelling adapted development steps will be carried out together with groups using connectionistic models.

Content B: Knowledge about the origin and changes in the cognitive system over the lifespan taking into account various development phases (normal versus atypical development); knowledge about experimental design and methods; acquiring information on human development at different levels (behaviour, brain activation, modelling) and linking these.

Competence: Familiarity with developmental psychology and the range of methods. Correlating psychological, behaviour-based measurements and imaging procedures; acquiring basic knowledge about modelling early cognitive development.

Requirements for participating: None

Special note: None

Applicability for other courses: BSc (diploma) and/or Master's programme in psychology (extra experience with research orientated practical and seminar)

Times offered: Practicals in the research unit Developmental Psychology are offered continuously, with space for ca. 2-3 practical students in the various projects following arrangement with the leader of the research unit. Seminars are held during the time of lectures.

Confirmation of completion: A talk (possibly poster presentation) as well as written practical protocol

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Cognitive development across the life-span	**P, S**	**11**		**11**		

Mast INS C-3	**Modelling and Simulation**	EM 11 CP

Content: This module is equivalent to the module M-SIM 1c: Modelling and Simulation 1, offered in the Master's programme "Informatics", Faculty 12 (Computer Science and Mathematics). It consists of a lecture (SIM1) and a practical course (SIM1-PR). The lecture imparts: 1) Introduction to vector analysis: functions of several variables, derivatives and integrals, integral theorems. 2) Modelling: Modelling approaches, conservation equations, constitutive relations. 3) Simulation methods:
a) Finite-difference methods for ordinary differential equations: consistency, convergence, stability.
b) Discretisation methods for partial differential equations: Finite differences, finite elements.

Competence: Familiarity with the basics of modelling and numerical simulation.

Requirements for participating: None

Helpful previous knowledge: Basic lectures in mathematics and "Introduction to numerical mathematics", skills in programming

Special note: Teaching is usually in German

Suitable for other courses: Master's programme in "Informatics", Faculty 12

Times offered: Throughout the winter semester

Confirmation of completion: See module completion exam

Module completion exam: Oral exam or written exam (180 min) on the lecture SIM1, depending on the number of participants; practical work in SIM1-PR

Name of module	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Modelling and simulation	**L, P**	**11**	**11**			

Mast INS C-4	**Virtual Hippocampus – Introduction to Computational Neuroscience**	EM 11 CP

Content: This practical and seminar give an overview of computer modelling neuronal systems with particular focus on the modelling of neurons and networks in the hippocampus. The course is an introduction to computer neurosciences, which investigates the brain at various levels (from synapses and dendrites to neurons and neuronal circuits) using computer models. The aim is to learn about the standard techniques for building, managing and applying models that are closely linked to experimental data, particularly those that include the cells of the hippocampus with complex anatomical and biophysical properties. Included in the planned computer experiments (*in slico*) are large-scale network stimulations in biophysical realistic and data-driven models of the hippocampus, as well as single cell stimulation in morphologically reconstructed neurons of the hippocampus.

Accompanying seminars will discuss the relevance of computer models for understanding the function of the brain using examples from the latest research articles.

Competence: Basic knowledge about compartment and network modelling; learning about using NEURON (software for biologically inspired simulations of neurons and networks of neurons, http://www.neuron.yale.edu/neuron); learning about working on scientific problems based on the relevant literature.

Requirements for participating: Background in physics, mathematics or informatics would be helpful but not essential

Special note: Talks and practical protocols in English.

Applicability for other courses: possibly Master's programme in computer sciences

Times offered: Twice a year, first half of winter semester; second half of summer semester; 4-week block practical

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers

Module completion exam: Practical exam (computer task)

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Virtual hippocampus – introduction to computational neuroscience	**P, S**	**11**	11			

Mast INS C-5	**Studying Human Cognition with Magnetoencephalography**	EM 11 CP

Content: This practical teaches basic research techniques in non-invasive neuroimaging using magnetoencephalography (MEG) in humans using a “perceptual closure” paradigm.

The students will independently produce stimulation material (so-called Mooney Faces) from images of human faces. Here, they will learn about important principles of feature-based visual perception compared to knowledge-based perception. The created stimulus material will then be used in the students’ own experimental protocol for neurophysiological measurements using MEG. Under supervision, the students will evaluate the collected MEG data and compare their results with those of a current study from the MEG laboratory.

Competence: Knowledge about signal generation in magnetoencephalography and the underlying analyses (event-related potentials, analysis of stimulus-induced oscillatory activity), creating experimental protocols using the program “Presentation”, and independently carrying out an MEG measurement following established standards. Critical comparison and discussion of their own results compared to the literature is a central part of the results report. Presentation of results in a lab seminar.

Requirements for participating: None

Special note: Practical protocols in English. There is an opportunity to gain assistance in (scientific) writing in the Writer’s Club of the MEG laboratory.

Applicability for other courses: None

Times offered: Winter semester, second half; 4-week block practical

Confirmation of completion: Practical protocol, 1 seminar talk

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Studying human cognition with magnetoencephalography	**P, S**	**11**	11			

Mast INS C-7	**Cognitive Neuroscience – Higher Cognitive Functions**	EM 11 CP

Content: This practical provides a glimpse into investigating the neuronal basis of higher cognitive skills using on-going projects in the area of working memory, speech processing, motion imagery, or executive control, also in part with children of primary school age. The practical enables students – depending on the on-gong research projects – to participate in neurocognitive studies (fNIRS, fMRT, EEG, behavioural measurements) as well as in the area of processing neurological data. The aim is to learn about the theoretical background of the project as well as he collection, evaluation and interpretation of such data. The students are encouraged to work independently and carry out part of the study on their own.

The students prepare a practical report on their own work. In a supplementary seminar series current studies from the area of cognitive neurosciences are discussed. In this context the students hold a talk.

Competence: Cognitive and neurocognitive models, experimental psychological methods, basics of collecting and evaluating neurocognitive data. Learning about working on scientific problems based on the relevant literature.

Requirements for participating: None

Special note: Practical protocols and seminars in English; talks usually in English. Useful background: basic knowledge of Matlab, Python or other programming experience.

Applicability for other courses: None

Times offered: Once a year: second half of the summer semester; 4-week block practical

Confirmation of completion: Practical protocol, 1 talk on recent literature or on the results of one's own experiments, 1 seminar talk in the form of a review or on scientific work on a relevant theme

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Cognitive neuroscience – higher cognitive functions	**P, S**	**11**		**11**		

Mast INS C-8	**Cognitive and sensorimotor aspects of speech**	EM 11 CP

Content: This module introduces students to the executive function of the human brain using the examples of language and speech. This is particularly interesting because by using this system one can investigate lateralisation procedures of the brain. Our group investigates mechanisms that underlie the exchange of information between individual brain regions, and thus make it possible to study the formation of functional networks. We examine volunteers and patient groups using magnetic encephalography and functional nuclear spin tomography. In addition, we record electrocorticographic data from patients during a waking operation that enables the maximum artefact-free high-resolution investigation of the speech network. Through participating in this module students can learn about either the methods above, or gain a glimpse into the cognitive functions that so clearly distinguish us from other animals.

The students will independently or under supervision carry out small behavioural experiments and/or functional experiments using fMRT or MEG. In accompanying two-weekly seminars they obtain a glimpse into the corresponding research literature and learn how to criticise this scientifically. Thus in addition to general skills, they gain the ability to plan and carry out scientific experiments in the area of cognition and/or speech.

Competence: Collecting and evaluating image and/or neurophysiological data as well as behavioural parameters from conscious volunteers and patients, learning about processing scientific problems based on the relevant literature.

Requirements for participating: Matlab

Special note: Lectures and protocols in English

Applicability for other courses: None

Times offered: Once a year, in the summer semester; three days a week during the semester

Confirmation of completion: Written practical protocol, 1 seminar talk on the results of one's own experiments, 1 seminar talk on recent scientific papers

Module completion exam: Written exam (45 minutes) or graded report; the form of assessment will be made known in good time, e.g. at the start of the semester

Name of unit	**Form**	**SWH**	**Semester/CP**			
			1	**2**	**3**	**4**
Cognitive and sensorimotor aspects of speech	**P, S**	**11**		11		

Mast INS C-0	**External practical module ”Cognitive/ Computational Neuroscience“**	EM 11 CP

Content: This elective practical teaches basic methods and techniques in the area of cognitive and/or theoretical neurosciences. The students work on their own projects under supervision and present their results in the form of a seminar talk. They learn how to present scientific work through writing up an appropriate results protocol.

The Module can be offered by departments at the Goethe University, by other universities in Germany or abroad as well as non-academic research establishments, usually the Max Planck Institute for Brain Research. Max Planck Institute for Biophysics, the Ernst Strüngmann Institute (ESI), Frankfurt Institute for Advanced Studies (FIAS), Paul-Ehrlich-Institute.

Competence: Familiarity with carrying out experiments in the area of cognitive neurosciences and/or computer-based modelling of neurobiological questions. Learning how to work on scientific questions based on relevant publications.

Requirements for participating: None

Special note: Responsible for the module is the chairperson of the Examination board. Talks and reports in English. The Module is an external module that replaces an elective module in area C and requires the approval of the examination board. It represents an extension to the modules offered in the Master's programme INS and is co-supervised by the chairperson of the Examination board.

Applicability for other courses: None

Times offered: by arrangement

Confirmation of module completion: Depends on who provides the course. If the organizer has not planned a certificate, a practical report must be prepared and 1 seminar talk given on the results of the participant's own research.

Module completion exam: The regulations of the organizer of the chosen module apply. If the organizer does not plan to give grades, assessment of the module is by a graded practical report.

Name of unit	**Form**	**SWS**	**Semester/CP**			
			1	**2**	**3**	**4**
External practical module in Cognitive/ Computational Neuroscience	**P,S**	**11**	11			

Mast INS WP-0	**Free-choice studies**	EM 11 CP

Content: See description of the selected modules. Possible modules can be from Master's programs in the disciplines Informatics and Mathematics (faculty12), Biochemistry, Chemistry and Pharmacy (faculty14), Biosciences (faculty 15), Philosophy and History of Science (faculty 8), or Psychology and Sport Sciences (faculty 5). The module can also be from other universities in Germany or abroad. Alternatively, an industry-related or research practical can be carried out at a university, external research establishment or company.

Competence: See description of selected module

Requirements for participating: None

Special note: Responsible for the module is the chairperson of the Examination board. The module is an external module that replaces an elective module in area A, B, or C, and requires approval of the examination board. It represents an extension to the modules offered in the Master's course INS.

Applicability for other courses: None

Times offered: by arrangement

Confirmation of module completion: Depends on who provides the course. If the organizer has not planned a certificate, a scientific presentation/practical report must be prepared and 1 seminar talk given on the results of the participant's own research.

Module completion exam: The regulations of the organizer of the chosen module apply. If the organizer does not plan to give grades, assessment of the module is by a graded practical report.

Name of unit	**Form**	**SWS**	**Semester/CP**			
			1	**2**	**3**	**4**
See name of the selected module	**P,S**	**11**	11			

Appendix 3: Example of a course timetable

Semester	Unit	CP	Time required / when
1	Introductory unit (module: Introduction to Neuroscience)	0.5	1 week, half-day, at semester start
	Lecture "Selected topics in neuroscience I " with seminar (module: Introduction to Neuroscience)	8	5 SWH
	Colloquium (choice of 1. or 2. semester) (module: Introduction to Neuroscience)	0.5	0.5 SWH
	Weekend seminar (module: Introduction to Neuroscience)	1	1 SWH
	Elective module 1	11	1st semester half
	Elective module 2	11	2nd semester half
2	Lecture "Selected topics in neuroscience II" with seminar (module: Introduction to Neuroscience)	5	3 SWH
	Colloquium (choice of 1 or 2 semesters) (module: Introduction to Neuroscience)		Listed for 1st semester
	Elective module 3	11	1st semester half
	Elective module 4	11	2nd semester half
3	Project work (module: Current Concepts in Neuroscience)	16	16 SWH, 6 weeks
	Module: Methods in Neuroscience	15	15 SWH, 6 weeks
4	Master's project and thesis	30	6 months
Total		120	

Compulsory module "Introduction to Neuroscience" in 1st and 2nd sem. (15 CP) comprises

Introductory session (1 week); Lecture series 1 + 2 with seminars (WS & SS);

Colloquium; weekend seminar

Compulsory module "Current Concepts in Neurosciences" in 3rd semester (16 CP) comprises

Project work; weekend seminar

Compulsory module "Methods in Neurosciences" in 3rd semester (15 CP) is a practical