Module Number 1	**Title:** **Neuroanatomy and Neurophysiology**		
Module type: compulsory	**Language:** English		**Group Size:** 22 students
Study semester: 1	**Availability:** winter semester		**Duration:** 1 semester
Workload: 300 hrs	**Credits:** 10 CP	**Contact time:** 86 hrs	**Independent Study:** 214 hrs

1 Courses

a) Lectures 4 PPW
b) Practical course 1 PPW
c) Seminars 3 PPW

2 Intended Learning Outcomes

This first module will provide a common basis in neuroscience for all students being admitted from diverse BSc study programmes. Upon completion of this course the students should be able to describe and characterize the structural and functional organization of the nervous system and the neural basis of perception and movement. They are capable to localize those regions in post mortem brain tissue and in vivo brain images. They are capable to describe the molecular and cellular mechanisms, by which neurons code and convey information, how these mechanisms are modified by experience or disturbed by exemplary disease states. Students will be capable of applying these neurophysiologic basics to in vivo recordings of brain and muscle function. Students will be able to explain the working principles of selected perceptive organs (visual system, auditory system) and skeletal muscles.

3 Content

Preparatory self-study time:

In preparation to the topics presented in the lectures, practical courses and seminars, students will have one week prior to the official start of the module for focusing on the ontogenetic development of the human brain (Prereading Material: Keith L. Moore, Mark G. Torchia, T. V. N. Persaud; The Developing Human: Clinically Oriented Embryology; 10th edition, chapter 17 "Nervous System", pages 379-415). These topics will then be recapitulated at the beginning of the lectures and are relevant for passing the exam of the module.

Lectures:

The lectures will cover general principles in neuroanatomy and neurophysiology, sensory and motoric systems and integrative components of the nervous system and will highlight their relevance for clinical neurology. Specific topics in neuroanatomy cover: development of the nervous system, general structure of the human central and peripheral nervous system, organization of the brain based on the cellular and molecular architecture, cortical divisions and related functions, special senses and dedicated functional systems, spinal cord organization with ascending and descending fiber tracts, brain stem, cerebellum, diencephalon, basal ganglia, vascular blood supply, and cerebrospinal fluid system. Specific topics in physiology cover: molecular and cellular neurophysiology (properties of biological membranes, membrane potential, action potential, electrical and chemical synaptic transmission, somatodendritic integration, synaptic plasticity); skeletal muscle physiology (neuromuscular junction, electro-mechanical coupling, muscle mechanics; reflexes); sensory physiology (phototransduction, mechanotransduction, receptive field organization, central processing of sensory information); pathophysiologic principles (channelopathies, demyelination, basal ganglia degeneration, etc.). The lectures will conclude with histology, basics of human genetics and pathology (inherited, degenerative, inflammatory and oncological neurological diseases).

Practical courses:

Accompanying practical and theoretical exercises will deepen the lecture topics. The practical course in anatomy will concentrate on gross anatomy and histology of the human brain and spinal cord. Histology will cover examples of light microscopy as well as specific aspects of high-resolution methods such as electron microscopy and

	polarized light imaging. Gyri and sulci as well as the components of different functional systems will be identified in post-mortem brain sections. This knowledge will be transferred from basic neuroanatomy to neuroimaging and clinical applications using series of MR images. The practical course in physiology will cover the intrinsic properties of excitable membranes, the recording and interpretation of extracellular potentials in humans (EMG, EEG), and the clinical examination of the nervous and selected sensory systems. Students will perform the following methods: • Identification of different brain structures in hemispheres and sections on post-mortem brain and their association with functional systems • Microscopic delineation of brain areas in post-mortem brain sections • Cortex delineation on MR images • Recording and Interpretation of extracellular potential in humans (EMG, EEG) • Clinical examination of the nervous and selected sensory systems • Electrophysiological analysis of cellular electrical signals and synaptic transmission • Measurements of intracellular [Cl^-] in glioblastoma cells • Psychophysiological analysis of pain perception and somatic senses • Nerve propagation velocity, Hoffmann reflex (H-reflex) analysis **Seminars:** The seminars will focus on specific aspects of neuroanatomy and –physiology, which will allow students to apply their acquired knowledge to gain insight into more complex cognitive processes such as pain perception, communication, timing and music, as well as in a more detailed understanding of normal and pathologically altered synaptic transmission. Students will work on these topics based on prepared material and literature, enabling them to appreciate the relevance of a profound basis in neuroanatomy and –physiology for the evaluation of neuroimaging findings and mechanistic theories. **Recommended reading, lecture notes:** Jürgen Mai, George Paxinos: “The Human Nervous System”, Oxford University Press; Rudolf Niewenhuys, Jan Voogd, Christiaan van Huijzen: “The Human Central Nervous System: A Synopsis and Atlas”, Steinkopff / Springer; Mark Bear, Michael Paradiso, Barry W. Connors: “Neuroscience: Exploring the Brain”, Lippincott Williams & Wilki; J. Edward Bruni, Donald G. Montemurro: “Human Neuroanatomy: A Text, Brain Atlas, and Laboratory Dissection Guide” Oxford University Press; “Gray’s Anatomy” sections 3 and 4; Hammond “Molecular and Cellular Neurophysiology"
4	**Teaching methods** Lecture and practical training with accompanying theoretical exercises and seminars, self-study.
5	**Prerequisites** A Bachelor or equivalent certificate in neurosciences or natural sciences, or a medical degree (MD)**;** Basic knowledge in cell biology, biochemistry, and physics**;** Proficiency in English level B2 of Common European Framework of Reference for Languages (CEFR)
6	**Examination types** Written exam (multiple-choice format) (108 minutes)

7	**Requirements for award of credit points** Regular and active participation in the exercises, practical training and seminars, including participation in the entrance test, presenting the basics during seminars and passing written final examination.
8	**Module applicability (in other study courses)** Compulsory basic module, the completion of which is a prerequisite for enrolment in all other modules of the program. This module is not intended/suitable for use in other modules.
9	**Assessment** The mark given will contribute to the final grade in proper relation to its credits.
10	**Module convenor and main lecturers** Prof. Dr. Katrin Amunts, Dr. Hans-Jürgen Bidmon, Dr. Ariane Bruno, Dr. Evelyn Oermann, PD Dr. Christina Herold, Dr. Kimberley Lothmann, Dr. Manuel Marx, Dr. Thomas Mühleisen, Apl-Prof. Dr. Nicola Palomero-Gallagher, Dr. Felix Ströckens, Dr. Martin Stacho, Prof. Dr. Christoph Fahlke, Prof. Dr. Sascha Weggen, Prof. Dr. Orhan Aktas, Prof. Dr. Guido Reifenberger
11	**Further information** The regular participation in the lecture is strongly recommended. The content of the lectures is prerequisite for the practicals and the seminars. The module will partly be held at Forschungszentrum Jülich. A bus shuttle between HHU and Jülich will be available.