Module Number	Title:
3b	**Cellular and Molecular Analyses of Brain Function**

Module type: compulsory elective	**Language:** English	**Group Size:** 4 students
Study semester: 1	**Availability:** winter semester	**Duration:** 1 semester

Workload:	Credits:	Contact time:	Independent Study:
420 hrs	14 CP	225 hrs	195 hrs

1 Courses

a) Practical course: 18 SWS
b) Lectures and Workshop: 2 SWS
a) Seminar: 1 SWS

2 Intended Learning Outcomes

The students are able to describe and apply the fundamental concepts and techniques of fluorescence-based immunohistochemistry. They can use these concepts for the identification of various cell types and brain structures and make judgments regarding physiological and development-related questions. Students can use advanced techniques in light and fluorescence microscopy and adequately develop and evaluate the resulting documentation. They will know how to study basic physiological properties of brain cells using different techniques such as dynamic ion imaging and properly record, store, analyze, and illustrate the experimental data obtained with the specific techniques presented. They will learn to critically evaluate and interpret their experimental findings. They are able to give an informative overview of scientific questions, experimental design, results and interpretation of the performed experiments both in oral and in written form.

3 Content

Lecture: Molecular and cellular analyses of brain function

The basics of light microscopy: optics and lenses, structure of a microscope, optical path, aberrations, types of microscopes. Basics of fluorescence microscopy and immunohistochemistry. Fluorochromes, illumination, artifacts. Cell-type-specific labeling of neural cells with diagnostic antibodies.

Brain development on the basis of selected brain regions (cortex, hippocampus, cerebellum).

Maturation and function of neurons and glial cells in vertebrate brains and synapse formation.

Molecular and cellular basis of neuronal and glial cell function, properties of glial cells and neuron-glia interaction, basic concepts of extra- and intracellular ion homeostasis, activity-related extra- and intracellular ion signaling (calcium, potassium, sodium, pH). Excitotoxicity and role of ion dysbalance in brain pathology. Glial cells as central elements in brain pathology.

Workshop: Fluorescence microscopy, Imaging, Electrophysiology

Basics of dynamic fluorescence imaging: Wide-field, confocal, multiphoton microscopy and FLIM. Superresolution microscopy: STED, SIM and PALM/STORM.

Imaging of ion-sensitive fluorescent dyes (sodium, calcium, pH, etc.).

Basics of electrophysiological techniques: whole-cell patch-clamp, ion-sensitive microelectrodes, field-potential recordings. Calculation of ion transporter properties.

General lab work, statistical analysis, presentation of data.

Practical course: Immunohistochemistry and Physiology

Immunohistochemistry: Primary and secondary immunofluorescence, identification of neural cell types, determination of the maturation stages of glial cells and neurons, marking of functionally relevant membrane structures in neurons and glial cells.

	Fluorescence microscopy: Components of a light microscope, epifluorescence microscopy, confocal laser microscopy, camera-assisted documentation, image processing. *Physiology:* Preparation of acute tissue slices of the mouse brain. Dynamic life imaging of intracellular ion signals under physiological and pathophysiological conditions (e. g. calcium imaging, sodium imaging and/or imaging of pH dynamics). Measurement of extracellular ion dynamics using ion-selective microelectrodes. **Recommended reading, lecture notes:** Imaging in Neuroscience and Development: A Laboratory Manual. Cold Spring Harbor Laboratory Press Development of the Nervous System. Sanes, Reh & Harris, Elsevier 2012. Additional scripts and other documents will be available electronically through ILIAS.
4	**Teaching methods** Lecture and Workshop, Practical course, Seminar
5	**Prerequisites** **Formal:** Successful completion of module 1; Proficiency in English level B2 of Common European Framework of Reference for Languages (CEFR) **With regards to content:** Knowledge of cell biology, chemistry, physics, mathematics as well as basic knowledge of neurobiology required.
6	**Examination types** **Cumulative examination:** 1. Written examination about the contents of the lecture (70% of overall mark), 2. Description of analyses by pictures and notes, performance of experiments and analysis (15% of overall mark) 3. Presentation: drafting of project, graphical description of project, presentation and discussion (15% of overall mark)
7	**Requirements for award of credit points** Regular and active attendance at the practical course. Successful completion of a course project. Oral presentation in a seminar with an accompanying written hand out. The final grade is calculated from the mark of the written exam (weigh 70% of final grade) and the description of analyses, performance of experiments and the presentation (weigh 30%).
8	**Module applicability (in other study courses)** M.Sc. Biologie M.Sc. Translational Neuroscience M.Sc. Molecular Biomedicine
9	**Assessment** The mark given will contribute to the final grade in proper relation to its credits.
10	**Module convenor and main lecturers** Dr. N. Gerkau, Prof. Dr. C. R. Rose, Dr. K. Kafitz
11	**Further information** The regular attendance at the lectures and workshop is strongly recommended. The content of the lectures is prerequisite for the practical course and the seminar.