Detailed information on “UE Basics of Neuroscience”

301325-1 UE UE Basics of Neuroscience (2023S), ECTS: 15.00, SWS: 9.00 is one united block starting mid-March and ending mid-April. Each day the students will be involved from 9:00-12:00 and 13:00-16:00. Lab Coats are required.

Due to the scheduling conflicts of the involved researchers, the order of the Blocks may change.

Abbreviations used for the location of the course:
**CBR** Center for Brain Research, Spitalgasse 4, 1090 Vienna, large seminar room first floor
**CIN** Clinical Institute of Neurology, AKH, Level 4J (meeting point Leitstelle 4J)
**Neurology** BT86, AKH and **Hochfeld**
**NMR Block 7** Schwarzspanierstraße 17, I

<table>
<thead>
<tr>
<th>Neuroanatomy (CIN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer: Adelheid Wöhrer, Sigrid Klotz</td>
</tr>
</tbody>
</table>

**General goal and basic knowledge:** Based on autopsy cases of the Neurobiobank of the Medical University of Vienna, the students gain insight in the gross anatomy of the human brain, which will foster a broader understanding of the structural and functional organisation. Moreover the students will see different diseases affecting the central nervous system, including tumors, inflammation, and degenerative as well as vascular lesions.

**Practical skills:**
- Hands-on recapitulation of the gross-macroscopic organization of the human brain.
- Detailed inspection and characterization of diseased and non-diseased human brains.
- Correlation of anatomic changes and/or lesions to functional deficits. Diseased states cover various developmental, vascular, neoplastic, inflammatory and neurodegenerative pathologies.

<table>
<thead>
<tr>
<th>Block 1: Pathobiology (CBR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer: Johannes Berger, Isabelle Weinhofer, Margot Ernst</td>
</tr>
</tbody>
</table>

**General goal and basic knowledge:**
To learn how innate immune cell properties can determine brain inflammation, neurodegeneration and remyelination.

**Practical skills:**
MACS-bead isolation of specific cell types and determining their purity using FACS; in vitro differentiation of monocytes to macrophages; generation of lipophages by myelin phagocytosis, analyzing the morphological changes using microscopy, determining the phagocytosis rate using FACS; isolation and reverse transcription of RNA into cDNA; detection and quantitative analysis of gene expression using quantitative RT-PCR.
**Block 2: Neurophysiology** (CBR)
Lecturer: Ruth Drdla-Schutting, Mira Kronscläger

**General goal and basic knowledge:** The students should understand membrane properties and basic mechanisms underlying the communication between neurons: resting membrane potential, action potential and synaptic transmission.

**Practical skills:**
Realistic computer simulation of the electrical behaviour of a nerve cell; Nernst and Goldmann equation, respectively, are used to understand the flow of ionic currents through membranes and the resulting formation of cell potentials; Excitatory and inhibitory synaptic transmission, NMDA-receptors. Practical training: Patch-clamp recordings from spinal neurons in a slice preparation (in current- and voltage-clamp mode); Measurement of action potential firing patterns.

**Block 3: Receptor Structure, Function and Pharmacology** (CBR)
Lecturer: Wulf Haubensak, Sarah Melzer

**General goal and basic knowledge:**
Brain circuits are highly dynamic and always in flux. Students will be introduced into the modulation of neuronal circuits by neuropeptides, both experimentally and from mining public data bases in silico.

**Practical skills:**
Learn how to image neuromodulatory effects on neurons and neuronal circuits. Intracellular pathways; extracellular sensors; analysis of imaging data; prediction of neuromodulatory networks based on public databases. Explore public brain initiatives; extract connectomic and cell type data into circuit architectures; use connectivity matrix and cell type data to build networks of leaky integrate and fire neurons; simulate network activity and its modulation by drug and peptidergic signalling.

**Block 4: Histopathology/Neuroimmunology** (CBR)
Lecturer: Polina Kameneva, Johan Boström

**General goal and basic knowledge:**
The students will get an in-depth understanding of using immunohistochemical staining for profiling the cell types in CNS and PNS. In this part of the course, the students will learn the basic techniques for the preparation of the tissue for immunohistochemistry, multiplexing immunohistochemical staining, confocal imaging, and automated image analysis. As a case study, we will perform the multiplexed revealing of cells in the cell cycle labeled with thymidine analogs labeling (EdU, CldU, and others). The theoretical part will also include specifics of the analysis of cell cycle phases and length with thymidine analogs.

**Practical skills:**
Students will learn:
- Sample preparation for the cryosectioning and cryosectioning
- Immunohistochemical staining combined with click chemistry reaction to reveal EdU signal
- Confocal microscopy
- Automated analysis of images with Cell Profiler
This Block combines two different topics **Synaptogenesis** (Lecturer: Ruth Herbst, General goal and basic knowledge: Introducing the neuromuscular synapse as a model system. Focus on the molecular mechanisms that lead to synapse formation in particular accumulation of neurotransmitter receptors during postsynaptic differentiation.

Practical skills:
- Acetylcholine receptor clustering assay (differentiation and induction of muscle cell cultures, acetylcholine receptor staining, fluorescence microscopy)
- Purification and analysis of acetylcholine receptors (acetylcholine receptor labelling and pull-down, generation of cell lysates, SDS-PAGE, Western blotting, quantification of acetylcholine receptors)
- Tutorial on image analysis using ImageJ

**Light sheet microscopy of cleared specimens** (Lecturer: Klaus Becker, Hans-Ulrich Dodt)

General goal and basic knowledge: Introduction to microscopy in general and especially to light sheet microscopy. Introduction to tissue clearing.

Demonstration and practical exercise: Demonstration of cleared specimens and of recording of fluorescently labelled specimens with light sheet microscopy and of image processing

**Block 6: Molecular Neuroscience** (CBR) Lecturer: Roman Romanov, Erik Keimpema, Valentina Cinquina, Zsofia Hevesi

General goals and basic knowledge: The students should obtain insights into different transgenic mouse models and their experimental uses. They will learn how the combination of transgenic mouse Cre lines and viruses can be used for identifying cell origin, type morphology, connectivity, and functions. Mouse brain atlas in stereotaxic coordinates and principles of stereotaxic viral injections.

Practical skills:
Familiarity with fixed brain tissues and their processing, work with reporter mice (GFP labeled neurons), imaging (fluorescence and confocal laser scanning). Familiarity with fresh brain tissue dissection and preparation for further biochemical analysis (protein/ RNA extraction, Western blotting and qPCR). Understanding of the procedure of searching and ordering transgenic animal lines and commercially available viruses (Jax Mice, Addgene, Penn Vector Core, etc) for experimental use.
Block 7: Mouse models/Behavior analysis (Schwarzspanierstraße 17, I)
Lecturer: Daniela Pollak

General goal and basic knowledge: The students will learn the basics about the pathophysiology of psychiatric disorders and available mouse models and behavioral tests. They will be introduced into behavioral phenotyping methods, including considerations for the design and practical execution of these experiments as well as behavioral pharmacological approaches. Pitfalls and limitations will be analyzed and discussed. Background about the framework for application for animal licenses (“Tierversuchsantrag”) will be provided.

Practical skills: - Behavioral tests in mice, including neurological observational battery, Open Field, Rota Rod, Elevated Plus Maze, Forced Swim Test, Tail Suspension Test, Social Interaction Test and Fear conditioning and respective analysis
- Evaluation of mouse maternal behavior and pup ultrasonic vocalizations and analysis
- Data evaluation and interpretation.
- Theoretical design of a project involving mouse behavioral analysis and application for an animal license (“Tierversuchsantrag”)

Block 8: Cognitive Neurobiology (CBR)
Lecturer: Hugo MalagonVina, Paul Anderson, Balint Lasztóczi, Claudia Espinoza

General goals and basic knowledge: The students should become familiar with the planning of a complex behavioral/electrophysiological experiment and subsequent histological analysis, and obtain insight into network dynamics and behavior-dependent neuronal correlates.

Practical skills: Rodent brain slicing, immunohistochemistry in free-floating brain slices, evaluation of multiple fluorescent IHC experiments, preparation for electrophysiological single-cell and neuronal population recordings, using stereotaxic instruments for orientation, behavioral experiments in real- and virtual-environment, use of light microscope and neuronal reconstruction for identifying cell types.

Block 9: Magnetic Resonance and Brain Stimulation (CBR, Neurology and Hochfeld NMR)
Lecturer: Roland Beisteiner, Simon Robinson, Eva Matt

General goal and basic knowledge: The students should understand the principles of signal generation with magnetic resonance technologies. Further they should learn which are the major magnetic resonance effects which can be used for neuroscientific investigations and clinical research and what are the benefits of ultra-high field systems. This concerns particularly the monitoring of human brain function, the monitoring of structural brain changes (neuroplasticity) and the monitoring of brain pathology.

Practical skills: The students will be introduced to practical handling of functional magnetic resonance imaging (fMRI) experiments and they will perform analysis of fMRI data with standard software packages like SPM or FSL.