BVO BASICS OF NEUROSCIENCE II WS 2023/24

30 lectures (45 min each) from January 9th to January 30th, 2024 in the morning of Tuesday, Wednesday and Friday three lectures each day. Lectures are from 8:15 to 09:00, 09:00 to 9:45 a 15 min. break and from 10:00 to 10:45. The lectures will take place in the large lecture room, 1st floor, Center for Brain Research, Spitalgasse 4, 1090 Vienna and will be held in English.

Block 1: Fundamentals (9 Units)

Developmental Neurobiology:
09.01 Lecture 1.1- 1.2
I will talk about the general principles of neural development and major cell types playing a role in this dynamic process. I will go through new exciting methodology, including single cell sequencing and clonal analysis, and related most recent discoveries in the field. (Adamayeko)

Neuroanatomy:
09.01 Lecture 1.3
Brief comparison of the gross anatomy of the human and mouse brain, starting at the brain surface and continuing with coronal sections and selected neuroanatomical structures/systems. (Voigtländer)

Basics of neurophysiology:
10.01 Lecture 1.4 – 1.6
Cell membrane, ion concentration differences in neurons, electrical and chemical gradients, resting membrane potential, action potential, AP propagation, synaptic transmission, currents and potentials at excitatory and inhibitory synapses, synaptic plasticity, patch-clamp (Drdla-Schutting)

Neurotransmission:
12.01 Lecture 1.7 – 1.9
Classical and non-classical neurotransmitters including their biosynthesis, release and their receptors (excitatory vs. inhibitory, ionotropic vs. metabotropic receptors). Intracellular effects of receptor activation, with focus on the effects of monoamine neuromodulators and neuropeptides. Termination of neurotransmission through neurotransmitter transporters and peptidases. Clinical relevance of receptors and transporters (Melzer)

Block 2: Neuronal circuits of behaviour and cognition (9 Units)

Neuronal oscillations and synchrony:
16.01 Lecture 2.1
We will explore how two neurons can synchronize their activity and how such concepts can be extended to large neuronal ensembles. We will discuss the relationship between neuronal synchrony, network oscillations, brain states and behaviour. Furthermore, we will determine neuronal mechanisms underlying brain waves detected in EEG recordings. (Klausberger)

Autonomous system:
16.01 Lecture 2.2
I will address the importance of brain-periphery communication to orchestrate responses to environmental challenges and threats. The role of peripheral hormones in affecting the brain, particularly the hypothalamus will be discussed. I will then dissect the neuroanatomy of some neuroendocrine command modules including peripheral outputs and intracerebral connectivity. Focus will be on the regulation of food intake and temperature sensation (primarily heat but also cold), and addressing ‘why we do not eat after being in the sauna’, and conversely, ‘why we eat when exposed to cold’. Snippets of information on single-cell techniques, optical and chemical tools to manipulate neuroendocrine circuits will also be provided. (Harkany)
Spatial representation and Memory:
16.01 Lecture 2.3 – 17.01 Lecture 2.4
Hippocampal circuitry, place cells, grid cells, Theta and gamma oscillations, sharp-wave ripples, memory, multiunit recordings (tetrodes, silicon probes) (Malagon-Vina)

Motor system:
17.01 Lecture 2.5
Organization of the motor system: spinal cord, brain stem, cerebellum, basal ganglia, and motor cortices. Description of the spatiotemporal organization of the movement and formation of a motor plan. Decision-making process in the selection, planning, and control of goal-directed movements. (Espinoza)

Pain and touch: (this year this lecture is shifted from Block 3)
17.01 Lecture 3.6
Peripheral receptors and fibre types for touch and pain; affective touch; somatosensory cortex and tactile perception; nociception and pain, nociceptive system; modulation of nociception; acute vs chronic pain; pain in the brain; tactile-induced analgesia; Touch-induced pain (tactile allodynia) (Drdla-Schutting)

Smell, Taste, Auditory system, Vestibular system:
19.01 Lecture 2.7
Structure and function of the inner ear and hair cells for auditory and vestibular processing; auditory pathways in the CNS; olfactory and gustatory signal processing and their pathways in the CNS. (Merino)

Neuronal circuits of decision-making:
19.01 Lecture 2.8
This lecture will cover: neurobiological models of decision making; the brain regions involved in decision-making, including their anatomy and development; the distinct roles of specific brain regions in computations underlying decision-making (Anderson)

Neuronal circuits for emotion:
19.01 Lecture 2.9
Emotions are a biomedically important part of our mental self; you will learn about concepts of emotions and affective value, the encoding of salience and valence in brain circuits; we will discuss prediction errors, engrams of emotional memory and the control of affective behaviors. (Haubensak)

Block 3: Neuropathology (12 Units)

Drugs and neurotransmitters:
23.01 Lecture 3.1 – 3.2
Basic pharmacology and neurotransmitter inactivation; neurotransmitter transporters; drugs acting on neuro-transmitter transporters (cocaine, ecstasy, amphetamines, SSRI) (Scholze)

Neuroimmunology:
23.01 Lecture 3.3
I will introduce you to immunoprivilege and the blood-brain barrier. I will show how pathogens overcome this barrier, and explain to you how the pathogens themselves and immune responses against these pathogens cause damage to the CNS (Bradl)

24.01 Lecture 3.4
Degeneration as trigger for CNS inflammation; Effects of degeneration on immune surveillance and inflammation; examples of human diseases and experimental models (Lassman)

Axonal degeneration and regeneration:
24.01 Lecture 3.5
Cellular and molecular mechanism of axonal degeneration and regeneration: basic principles and major differences in PNS and CNS (Kameneva)

02.01.2024
**Attention and visual representations:** (this year this lecture is shifted from Block 2)

24.01 Lecture 2.6
Processing and interpreting visual information in the central nervous system. Center-surround receptive field organization and emergence of feature selectivity. Principles and advantages of population coding. Ventral and dorsal visual streams, recognition of objects and faces. Attentional selection of information – basic mechanisms. *(Lasztočzi)*

**Epilepsy:**
26.01 Lecture 3.7
Imbalance of excitatory and inhibitory transmission; the molecular mechanisms of the Fragile X syndrome *(Scholze)*

**Alzheimer:**
26.01 Lecture 3.8
Protein misfolding diseases, basic mechanism, Prion disease, Alzheimer's disease; genetic, pathology, molecular mechanism *(Berger)*

**Parkinson:**
26.01 Lecture 3.9
Epidemiology, genetics, pathophysiology and mechanisms of neurodegeneration (motor/non-motor symptoms and underlying neurocircuits, neuropathology, alpha-synuclein proteostasis, mitochondrial dysfunction, oxidative stress, neuroinflammation, neurotoxicants), therapeutic and experimental treatment options, animal models *(Steinkellner)*

**Addiction:**
30.01 Lecture 3.10
Neuronal circuits affected by addictive drugs. Testing drug effects in animal models. Long-lasting modifications of gene expression exposing to relapse. *(Hevesi)*

**Schizophrenia:**
30.01 Lecture 3.11
Schizophrenia is a psychiatric syndrome associated with a bundle of seemingly unrelated risk factors (urban upbringing, genetic vulnerability, season of birth etc.); risk factors converge on subcortical dopamine transmission for mediating psychotic symptoms. This lecture will present evidence and ideas on how these elements contribute to the expression of the syndrome *(Willeit)*

**Depression:**
30.01 Lecture 3.12
Major depression is one of the most common and distressing brain disorders. Genetic studies, brain imaging studies and animal models not only reveal the biological nature of depression, they also tell us something about how we as humans think, feel and act. *(Godbersen)*

**Organoids, Assembloids and the Future of Human Neuroscience:**
30.01 Lecture 3.13
Over the last decade, three-dimensional cell culture models derived from patient iPS cells have emerged as innovative methods for the analysis of human brain development and brain disorders. The lecture will cover the basic principles underlying organoid culture and illustrate the various disorders that were recapitulated using this methodology. I will describe, how organoids are used to model circuits of the human brain and give an outlook into the future of this important new technology that has the potential to revolutionize neuroscience. *(Knoblich)*