1. Okt- 2008

VO BASICS OF NEUROSCIENCE 3 st
Lectures from 8:15 - 10:30 from first week in October and from 8:15 - 9:45 in the following weeks
The lectures take place in the lecture room, 1st floor, Center for Brain Research, Spitalgasse 4, 1090 Vienna
and will be held in english language

Block 1: Neuroanatomy
1.10 Lecture 1: Histology of neurons, classification of neurons, gliacells; (CNS) astrocytes, oligodendrocytes, microgial, ependymal cells; (PNS) Schwann cells (Bauer)
1.10 Lecture 2: Central nervous system (from spinal cord to neocortex), meninges, ventricles, blood supply, peripheral nervous system (Bauer)
1.10 Lecture 3: Functional systems: reflexes, the sensomotoric und autonomic nervous system, from sensory organ to basal ganglia and neocortex (Bauer)

Block 2: Biochemistry and Pharmacology of the Nervous System
2.10 Lecture 4: General synaptic model: Ways for a molecule to pass a membrane; Ionophores; Aquaporins (Scholze)
2.10 Lecture 5: Ion channels: as examples: K_\text{v}-and Na_\text{v}-channels (Scholze)
2.10 Lecture 6: Carriers: as example: Na-K-ATPase; ABC-Transporter; general list of Neurotransmitters, including their biosynthesis and distribution (Scholze)
3.10 Lecture 7: excitatory vs. inhibitory neurotransmission; excitatory vs. inhibitory neurotransmission; ionotropic vs metabotropic receptors; Cys-Loop-receptors; as examples: (muscular and neuronal) nACH-Receptors (Scholze)
3.10 Lecture 8: GABA-, glycine– and ionotropic glutamate receptors: GABA receptors and their ligands (benzodiazepines, barbiturates,…); glycine–receptors and their anchoring at the synapse (gephyrin); ionotropic glutamate receptors (Scholze)
3.10 Lecture 9: P2X-receptors; neurotransmitter inactivation; neurotransmitter transporters; drugs acting on neurotransmitter transporters (cocain, ecstasy, amphetamines, SSRI,…) (Scholze)
6.10 Lecture 10: Metabotropic receptors: Types of G-coupled receptors; Trimeric G proteins; Genes affecting anxiety: serotonin receptors; chemical senses including odorant receptors (Kiebler)
6.10 Lecture 11+12: Intracellular communication and second messengers: Ca^{2+}/calmodulin – cAMP – PKA – CREB pathway in neurons and their biological functions; regulation of adenyl cyclase; retrograde messengers: NO, CO; molecular switches, Ras, regulation, G domain, structural insight into the loaded spring mechanism; signaling cascades at the synapse; CPEB: prions and memory
(Prerequisite for this lecture is: principles of signaling, second messengers: IP_3, Ca^{2+} and calmodulin, cAMP, PKA, PLC, adenylyl cyclase, CREB) (Kiebler)
7.10 Lecture 13+14: Synaptic structure and function: Receptor trafficking; synaptogenesis and spinogenesis; molecular architecture of dendritic spines and the postsynaptic density; NMDA Receptor complex; the role of adhesion molecules at the synapse; mitochondria at the synapse (Kiebler)
7.10 Lecture 15: Exocytosis and SNARE receptor hypothesis: The secretory pathway in neurons; The SNARE hypothesis; molecular mechanisms of vesicle docking and fusion; lipid RAFTS. (Kiebler)
Block 3: Neurophysiology

Membrane physiology
8.10 Lecture 16: The neuronal cell membrane and membrane proteins, diversity of ion channels, pumps and transporter, ion concentration differences and diffusion, electrochemical gradient and resulting driving force, equilibrium potential, Nernst equation (Schoffenegger)

8.10 Lecture 17: Resting membrane potential (basis for potential generation, electrical forces, chemical forces), Gibbs-Donnan equilibrium, leakage currents, Goldman equation, effects of changing extracellular ion concentration, cell capacitance (Schoffenegger)

8.10 Lecture 18: Fundamental electrical terms (current, voltage, resistance, capacitor...), electrical equivalent circuits, electrical model of a cell, membrane resistance and conductance, Ohm’s law, current-voltage response of an ideal membrane, passive electrical properties of a neuron, time constant of a neuron (Schoffenegger)

9.10 Lecture 19: Action potential (AP), ionic basis for APs, AP-threshold, different phases of an AP, refractory period as a function of Na⁺ channel property, membrane currents and conductances during different AP phases, AP firing patterns depend on ion channel equipment (Schoffenegger)

9.10 Lecture 20: Action potential propagation, specific membrane resistance, electrotonic potentials, length constant continuous and saltatory propagation; measuring active and passive membrane properties: the patch-clamp technique in the whole-cell mode (Schoffenegger)

9.10 Lecture 21: Electrophysiology of synaptic transmission, gap junctions as electrical synapses, chemical synapses: electrophysiological aspects of transmitter release from presynaptic boutons, postsynaptic currents and potentials at excitatory and inhibitory synapses (Schoffenegger)

Biological neural networks
10.10 Lecture 22: General aspects of biological neural networks; Information flow through nervous systems; Neurons and synapses as elements of biological neural networks (Gingl)

10.10 Lecture 23: Mechanisms of information processing, e.g. feedback, feedforward, parallel processing, lateral inhibition, etc...; examples of simple networks, e.g. human stretch reflex, Clione and Leech swimming behaviour (Gingl)

10.10 Lecture 24: The Stomatogastric Ganglion in lobster as example of a complex neural network, binaural sound location in owls as example of temporal processing in biological neural networks (Gingl)

Sensory Physiology
13.10 Lecture 25: Fundamentals of sensory systems, sensory input and perception, sensory modality, converting external signals into neuronal information, signal transduction, encoding sensory information (Heinke)

13.10 Lecture 26: Example: nociception, signal processing under physiological and pathophysiological conditions exemplified by acute and by neuropathic pain mechanisms (Heinke)

Learning, Memory and Synaptic Plasticity
14.10 Lecture 27: Types and processes of memories, physiological and structural changes at synapse level, Hebb&LTP, facilitation, depression, depotentiation, properties, phases, cellular mechanisms, link between LTP and learning, role of dendritic spines in memory processing (Jäger)

Microscopic methods for the detection of fluorescence
14.10 Lecture 28: Fluorescence microscopy, confocal microscopy, 2-photon-laser-scanning microscopy; Principles, advantages & disadvantages of each method, stainings, examples of use in neurobiology (Jäger)

Block 4 Pathobiology of the Nervous System
Disorders of Neurotransmitter dysfunction
15.10 Lecture 29: Disorders of Neurotransmitter dysfunction
Epilepsy: imbalance of excitatory and inhibitory transmission; the molecular mechanisms of the Fragile X syndrome; insight into addiction; cannabinoids, endocannabinoids (Kiebler)
15.10. Lecture 35: Depression and Schizophrenia
Monoamine and other biological hypotheses, neurocircuitry changes, animal models, mechanisms of action of antidepressant and antipsychotic drugs (Pifl)

De- and Regeneration
16.10. Lecture 30: Mechanisms of neuronal degeneration; outside and inside signals: excitotoxicity, energy failure, oxidative damage, non-classical cell death pathways, neuronal dysfunction due to damage of neuronal cell processes (Lassmann)

16.10. Lecture 31: Axonal degeneration and regeneration in the peripheral nervous system; Injury signals, Wallerian Degeneration, debris removal, mechanisms of normal and abnormal regeneration (Lassmann)

17.10. Lecture 32: Axonal regeneration in the CNS; Differences to PNS; mechanisms of inhibition; cellular sources of inhibitory molecules; (Lassmann)

17.10. Lecture 33: Generation and regeneration of myelin in the CNS and PNS; Basics of Schwann cell and oligodendrocyte development; essential differences between both types of cells (Lassmann)

20.10. Lecture 34: Stem cells as therapeutic tools for CNS injuries; stem cells in the healthy CNS; current approaches and problems (Lassmann)

20.10. Lecture 36: Alzheimer’s Disease; General introduction, genetic, pathology, molecular mechanisms (Berger)

21.10. Lecture 37: Parkinson’s disease; Neuropathology, neurochemistry, neurocircuitry changes involved in clinical signs, mechanisms of therapy, pathogenetic mechanisms of neurodegeneration, concepts for etiology (Pifl)

21.10. Lecture 38: The special role of lipids in the nervous system; Special functions of different lipid classes in the nervous system, metabolism of lipids in the CNS, “Brain food” ω3 polyunsaturated fatty acids (Berger)

22.10. Lecture 39: Cellular Organelles and there special role in the nervous system; Energy metabolism in the brain; intracellular degradation; leukodystrophies (Berger)

22.10. Lecture 40: Myelin proteins and Leukodystrophies; The major myelin proteins and their functions; Differences between the PNS and the CNS; Lessons from dys- and demyelinated animal models; Dysfunctions lead to inherited diseases (Berger)

Neuroimmunologie
23.10. Lecture 41: Interaction of the nervous system with the immune system; innate (microglia cells, perivascular macrophages) and adaptive arms (T cells) of the immune system in the intact CNS; blood-brain barrier; immune surveillance, development of immune responses (Bradl)

23.10. Lecture 42: Degeneration as trigger for CNS inflammation; Effects of degeneration on immune surveillance and inflammation; examples of human diseases and experimental models (Bradl)

24.10. Lecture 43: Infection and inflammation in the CNS; most common pathogens (bacteria/viruses), routes of infection, mechanisms of tissue damage, mechanisms of immune control (Bradl)

24.10. Lecture 44: Autoimmune diseases in the nervous system; Discussion of antibody-mediated and T cell mediated diseases of the CNS and PNS, and of diseases with complex pathogenesis (Bradl)

24.10. Lecture 45: CNS injury-induced immunodepression; Stroke; damage and local immune reactions in the CNS; anti-inflammatory pathways in the periphery induced by CNS injury; cholinergic anti-inflammatory pathway (Bradl)