BIOCHEMISTRY OF THE NERVOUS SYSTEM

Brain: general characteristics of the metabolism

- intensive metabolism (big glucose and oxygen demand; hypoxia as a great risk)
- background of the big energy demand (active transports, axonal transport, synthetic processes)
- characteristics of carbohydrate metabolism (GLUT-1,-3; intensive aerobic /+anaerobic/ glycolysis; basis of the classic PET diagnostics)

❖ acute hypoglycemic coma (essence, main causes)

❖ hyperglycemic coma and chronic hypoglycemic coma (main causes, characteristic metabolic disorder, risky consequences of ketosis)

- characteristics of lipid metabolism (brain as an organ enriched in lipids – main lipid types, characteristics of fatty acid metabolism, utilization of ketone bodies)
- characteristics of amino acid – protein metabolism (elimination of ammonia, neurotransmitters formed from amino acids, importance of the formation of cytoskeletal proteins)
- characteristics of nucleotide metabolism (main pathways)

❖ hereditary defects affecting the general metabolism of the central nervous system: sphingolipidoses (Nieman-Pick and Tay-Sachs disease), mucopolysaccharidoses, Lesch-Nyhan disease

The blood-brain barrier (BBB) and the cerebrospinal fluid

- structure of BBB and main transports through it (passive diffusion, facilitated transport)

❖ background of „kern-icterus" (pathological icterus/jaundice of neonates)

- main characteristics of the cerebrospinal fluid

General features of neurotransmission

- main pre- and postsynaptic processes (pre: synthesis of neurotransmitters, formation of synaptic vesicles, axonal transport, transmitter release)
- main characteristics of neurotransmitters and classification according to their chemical character (major group: amino acids, amines, amine derivatives; special types: peptides, purines, NO /gas/, lipid derivatives /endogenous cannabinoides/
- elimination of neurotransmitters (generally: breakdown, presynaptic reuptake)
- general characteristics of ionotropic receptors (structure, function, cation/anion flow and its consequence)
- chief examples for ionotropic receptors (Glu, nicotinic cholinergic, GABA and Gly receptors)
- general characteristics of metabotropic receptors (structure, linkage to G protein), and the two main ways of action (signalling pathways, opening ion channels)
- chief examples for metabotropic receptors (Glu, GABA, catecholamines, serotonin and muscarinic cholinergic receptors)

Cholinergic neurotransmission

- presynaptic synthesis of acetylcholine (enzyme, reaction with structures), sources for choline
- transport into the synaptic vesicles

- ❖ agents influencing the acetylcholine release (botulinum toxin, 4-aminopyridine, latrotoxin), their effect
- characteristics of the nicotinic receptor, the two types and their localization, function
- ❖ inhibitors of the nicotinic receptor (curare, succinyl-choline), their effect
- myasthenia gravis
- function of the muscarinic receptor, main types (characteristic localization, signalling, effect)
- ❖ inhibitors of the muscarinic receptor (atropin, scopolamine), their effect
- importance of cholinergic neurotransmission in the brain (learning, memory)
- breakdown of acetylcholine (enzyme involved and its characteristics)
- ❖ low-activity acetylcholine esterase: possible consequence of its presence
- ❖ inhibitors of acetylcholine degradation and their characteristic effect, reversible inhibitors (physostigmine, neostigmine), irreversible inhibitors (alkyl phosphates)

Catecholamines

- synthesis of catecholamines (reactions with structures, enzymes, cofactor names)
- main types of adrenergic receptors (characteristic localization, signalization, effect)
- dopaminergic neurotransmission (characteristic localization), function of the receptors
- transport of dopamine into the synaptic vesicles, presynaptic reuptake
- ❖ inhibition of presynaptic reuptake and its effect (cocain)
- ❖ Parkinson disease (background, main symptoms, treatment)
- ❖ the effet of excessive dopamine release (dopamine theory of schizophrenia, biochemistry of being in love)
- degradation of catecholamines (main breakdown enzymes, names of the endproducts)

Glutamate neurotransmission

- main charactersitics, lokalization, synthesis (Glu-Gln cycle, enzymes, structures)
- main types of ionotropic glutamate receptors, mechanism of action of the NMDA-receptor and its significance
- ❖ excessive functioning of the NMDA receptor in hypoxia
- metabotropic glutamate receptors: characteristics of their function
- elimination of glutamate

GABA and Gly neurotransmission

- synthesis of GABA (enzyme, coenzyme, structures)
- ionotropic and metabotropic GABA receptors and their function
- inactivation and degradation of GABA (enzymes, GABA-shunt)
- characteristics of Gly neurotransmission

Serotonin neurotransmission

- general chracteristics: localization, effects
- synthesis (enzymes, coenzymes, reactions with structure); presynaptic reuptake
- ❖ inhibitors of presynaptic reuptake (SSRI) and their effect
- general function of serotonin receptors

- breakdown of serotonin (enzymes, endproduct)
- ❖ serotonin-analog drug (LSD)

Other neurotransmitters

- histamine: formation (reaction with structures, enzyme, coenzyme), localization and effects
- ATP: formation and breakdown, receptors (purinergic)
- neuropeptides (e.g. endorphines/endogenous opiates: formation and main effect)
- endocannabinoids (membrane lipid derivatives), their function (modulation of inhibitory neurotransmission)
- NO / nitric monoxide (action of NO synthase, coenzymes, structures), degradation (formation of peroxynitrite), main effects, signalization