ITMO University

Molecular Neuroscience

Course Workload		Assessment form (examination/ graded test/ ungraded test)
ECTS	Hours	
3	108	Exam

Students will know how to formulate the basic concepts of comparative and evolutionary molecular neuroscience; to describe the structural features and molecular mechanisms of the nervous system; to understand the neurophysiological mechanisms of cognitive functions; to justify the basic setup and the apparatus used for the solution of research tasks in the field of molecular neuroscience; to explain the principles of operation of modern technological equipment for scientific and research tasks in the field of molecular neuroscience; to describe the structure and principles of functioning of neuronal membranes, features of proteins, lipids and energy in the Central nervous system; to formulate molecular mechanisms of interneuronal interactions; to reproduce the main neurotransmitter systems, neurochemical mechanisms underlying the development of pathological conditions of the nervous system.

Course structure:

1. Introduction to neuroscience. Basic concepts

1.1. Neuroscience, an introduction to the discipline
1.2. Basic concepts, subject and tasks in neuroscience
1.3. The history of the formation and development of neuroscience
1.4. Neuroscience in Russia and abroad

2. Architectonics of the central nervous system

2.1. The structure of the nervous system
2.2. Neuron and glia
2.3. Characteristics of the main components of the cytoskeleton
2.4. Microtubules, intermediate filaments, actin microfilaments
2.5. Their assembly and lifetime
2.6. Transport of macromolecules in a nerve cell
2.7. Slow and fast axonal current
2.8. Myelin and its structure

2.9. Cells that form myelin in the nervous system
2.10. Myelin genes and regulation of their expression

3. Neurotransmitters and their receptors

3.1. Non-peptide and peptide neurotransmitters, general characteristics
3.2. Localization of neurotransmitters
3.3. Synaptic vesicles
3.4. Joint localization of classical and peptide mediators
3.5. Inhibitory and excitatory neurotransmitters
3.6. Synthesis and breakdown of neurotransmitters
3.7. Ionotropic and metabotropic receptors
3.8. The general scheme of the organization
3.9. Acetylcholine, glutamate, dopamine and serotonin, GABA and opioid receptors

4. Gene expression in the nervous system

4.1. Transcription factors
4.2. Inducible and constitutive transcription factors
4.3. Transcription factor CREB-structure and functions
4.4. CREB-dependent genes
4.5. Proto-oncogenes and their role in the development of the nervous system and its functioning
4.6. Steroid Hormone Receptors as transcription factors
4.7. Neurospecific genes

5. Neurotrophic factors

5.1. Neurotrophic factors and their characteristics
5.2. Families of neurotrophins. Nerve growth factor, a neurotrophic factor of the brain
5.3. Specificity of the synthesis and action of neurotrophins in the nervous system
5.4. Neurotrophic factor receptors and their functions in the nervous system
5.5. The mechanism of action of neurotrophins

6. Intracellular neuro signaling

6.1. Nerve cell receptors, their properties
6.2. Types of receptors: membrane, intracellular
6.3. The main membrane receptors: G-protein-associated receptors, channel-forming receptors, receptors with their own enzymatic activity
6.4. Membrane potential, selective membrane permeability, resting potential, ion channels and pumps
6.5. Neuronal stimulation, mechanosensitive channels, potential-sensitive channels, ligand-sensitive channels

7. Neurophysiological and molecular-genetic mechanisms of neuropsychiatric diseasesNeurophysiological and molecular-genetic mechanisms of neuropsychiatric diseases

7.1. Neurophysiological and molecular mechanisms of neuropsychiatric diseases
7.2. Neurodegenerative diseases: Parkinson's and Alzheimer's diseases, Epilepsy and schizophrenia
7.3. Depression and anxiety disorders
7.4. Alcohol and drug addiction
7.5. Possible approaches to the correction and treatment of these diseases
7.6. Gene therapy and cell therapy
7.7. Induced pluripotent stem cells and prospects for their use in neuroscience