

# **Syllabus of the course «Molecular Mechanisms of the Brain»**

(4 ECTS)

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## **1. Course Description**

### **a) Pre-requisites**

None

### **b) Abstract**

«Molecular Mechanisms of the Brain» is an elective course showing that the brain is the most important and sophisticated organ that, as “a conductor”, provides the regulation of the central and peripheral functions and the integration of the whole organism. This is a necessary condition for the survival of the organism and the conservation of animal species. In addition, it is emphasized that the brain is a substrate for learning, memory and consciousness. In sum, this course provides basic information on the cellular, genetic and molecular mechanisms of brain functioning in norm and their impairment in pathology.

The first part of the course is devoted to the analysis of the current concept of the structural and functional organization of the brain - from gene expression in individual neurons to behavior, which is the highlight of the Program “Brain Initiative Program” (USA). Particular attention is paid to the organization of neural networks that regulate specific functions by transmitting information from a neuron to a neuron via specialized contacts, the so-called synapses, using chemical signals, neurotransmitters. A variety of neurons in accordance with their phenotype and a wide range of chemical signals used for intraneuronal communication provide specific regulation of the brain functioning. Noteworthy that the implementation of the genetic program, the expression of the phenotype and the functioning of neurons can significantly change when the environment of the neuron changes, that is, under the influence of the so-called epigenetic factors. This unique phenomenon is a background of high brain (neuro)plasticity.

The second part of the course is devoted to the evaluation of the cellular and molecular mechanisms of brain degradation and its consequences for the functioning of the whole organism at aging, as well as at acute (trauma, stroke) and chronic (Parkinson’s disease, Alzheimer’s disease, etc.) brain diseases. In this context, particular attention is paid to the current insight into the etiology, pathogenesis, diagnosis and treatment of the diseases. Throughout the course, it is emphasized that understanding the cellular and molecular mechanisms of brain functioning in norm and pathology is only possible when using a multidisciplinary approach to study it at different levels of organization, from isolated neurons (in vitro) to the entire brain (in vivo) using invasive and non-invasive methods. Fundamental knowledge of the molecular mechanisms of brain diseases in accordance with the principles of translational medicine opens up unlimited possibilities for the development of innovative technologies for the diagnosis and treatment of patients.

Thus, this course will serve to understand the cellular, genetic and molecular mechanisms underlying brain functioning in norm and pathology.

The lecturer of this course has a long-term experience as a visiting Professor in the teaching of cellular and molecular mechanisms of the brain functioning in norm and pathology at different universities: University P. and M. Curie in Paris (France, 1993-2010), University Medical School in Tokushima (Japan, 1988-89), University Medical School in Ulm (Germany, 1993) and a number of others Universities in France, Italy and USA. When staying in these countries, the lecturer of this course was the supervisor of PhD students – ten of them defended “European theses”.

## 2. Learning Objectives

1. To provide basic knowledge about the cellular, genetic and molecular mechanisms of brain functioning in norm and pathology;
2. To introduce the methodology and advanced techniques for the study of the brain functioning - from gene expression to the behavior;
3. To consider preventive, translational and personalized medicine as a methodology for the development of innovative technologies for the diagnosis and treatment of brain diseases.

## 3. Learning Outcomes

1. Gaining knowledge about the cellular, genetic and molecular mechanisms of brain functioning in norm and pathology;
2. Learning the main approaches - experimental models and methods for studying the brain functioning from gene expression to behavior;
3. Getting a skill to critically evaluate previous and current studies of the brain and develop an optimal experimental design to solve specific basic and applied issues.

## 4. Course Plan

Nº	Topic
1	The current concept of the organization and functioning of the brain
2	Methodology and techniques for brain research with a focus on neurodegeneration and neuroplasticity
3	Specific functions of the brain
4	Brain development and its regulation
5	The role of the brain in the development of the whole organism
6	Brain diseases – etiology, pathogenesis, diagnosis and treatment
7	Neurodegenerative diseases as a challenge of the 21 <sup>st</sup> century.

## 5. Reading List

### a. Required

- George J. Siegel, MD. Basic Neurochemistry molecular, cellular and medical aspects. Seventh edition/ Elsevier Academic Press, 2006;
- Jerrold S. Meyer, Linda F. Quenzer. Psychopharmacology. DRUGS, THE BRAIN, AND BEHAVIOR/ Sinauer Associates, Ins., 2005
- Duane E. Haines. Fundamental Neuroscience for Basic and Clinical Applications. Third edition. Elsevier Inc.,2006

Michael J. Zigmond, Nicholas C. Spitzer, James L. Roberts. Fundamental neuroscience. Second edition/ Academic press (An imprint of Elsevier Science), 2003.  
Michael J. Zigmond et al. (eds) Neurobiology of Brain Disorders. Biological Basis of Neurological and Psychiatric Disorders. Academic Press, Amsterdam. 2015  
Jacques Neirynck. Your Brain and Your Self: What You Need to Know/ Springer, 2009

## **b. Optional**

«Физиология человека» (под ред. Р. Шмидта и Г. Тевса). Пер. с англ. В 3-х томах. Москва, издательство: МИР. 2005  
«Медицинская физиология» (Гайтон А., Холл Дж.). Пер. с англ. Москва, издательство: Логосфера, 2008  
«От нейрона к мозгу» (Дж. Г. Николлс, А.Р. Мартин, Б.Дж. Валлас, П.А. Фукс) Пер. с англ. Москва, издательство «Едитораал УРСС». 2003  
«Основы нейробиологии» Учебник для ВУЗов (М.А. Каменская, А.А. Каменский). Москва, издательство ДРОФА. 2014  
«Нейродегенеративные заболевания: от генома до целостного организма» ( под ред. М.В. Угрюмова). В 2-х томах. Москва, издательство «Научный мир». 2014

## **6. Grading System**

Test score will be given on an examination on a ten-point scale. The grade will be determined by 50% average accumulation (answers to questions – 20%, critical analysis of selected papers - 20%, lecture attendance – 10%) and 50% final exam.

### **Table of grade correspondence**

Ten-point grading
1 – very bad
2 - bad
3 - no pass
4 - pass
5 – highly pass
6 - good
7 – very good
8 – almost excellent
9 - excellent
10 - perfect

## **7. Examination Type**

Oral

## **8. Methods of Instruction**

1. Lectures with the use of multimedia presentations;
2. Seminars with oral presentations of students and general discussion;
3. Self-study of recommended literature

## **9. Special Equipment and Software Support (if required)**

Lectures and seminars require a computer and acoustic systems for multimedia presentations and video.