Ministry of Education and Science of the Russian Federation
Federal State Autonomous Educational Institution of Higher Education
Lobachevsky State University of Nizhni Novgorod
National Research University

The school of "Neurobiotechnology"

APPROVED:
The head of the school of
"Neurobiotechnology"
_____V.B.Kazantsev
«30» 10 2014 г.

Work program of the module

BIOLOGICAL NEURAL NETWORK
Name of the module

Area of Studies
01.04.03 "Radiophysics", 03.01.02 "Biophysics"

General profile of training with instruction in English

Core Module

PhD-student

Form of training
full-time

Nizhni Novgorod
2014

CONTENT

1. Learning goals and objectives for the module

The formation of the students ' knowledge about the basic concepts and methods of modern neuroscience, theoretical concepts about the structure and function of different types of neural networks of the brain; the study of the basic mechanisms of the formation of neural networks in ontogenesis.

2. Place of the module in the structure of the general education program

Prerequisite knowledge for the learning of this subject: synapse physiology, cellular neurophysiology, modern techniques of research in neurobiology

3. The structure and content of the module

The overall workload of the module is 2 credits, 72 hours.

3.1. Structureofthemodule

Nameofthemodule	Semester	Workload (hours)						Typeof finalcertification
		Total	Total classroom	Includingclassroom			Self-organized work	
				Lectures	Lab./seminars	Practice		
BIOLOGICAL NEURAL NETWORK	1	72	36	18	18	0	36	Examination, Test

3.2. Contentsofthemodule

3.2.1. Sections of the module and types of classes

№	Section (discipline) of the module	Semester	Types of classes, workload (hours)			Self-organizedwork
			Lectures	Lab./Seminars	Practice	
1.	BIOLOGICAL NEURAL NETWORK	1	18	18	0	36

3.2.2. The content of the sections (disciplines) of the module

1. INTRODUCTION. (4 hours/4 hours)

The structure of the neural networks of the brain. The formation of neural networks in ontogenesis.The basic principles of cellinteraction in the neural networks of the brain. The structure and function of synaptic contacts in the local neural networks.

2. SYNAPTIC AND NETWORK PLASTICITY(8 hours/8 hours)

Synaptic plasticity as basis of network plasticity of adult brain. Mechanisms of short-term and long-term synaptic plasticity.Mechanismsspike-dependent synaptic plasticity. Homeostatic plasticity.

3. NEURON-GLIAL-EXTRACELLULAR MATRIX INTERACTIONS(2 hours/2 hours)

The role of glia in the CNS. Classification of glial cells. Glia interaction with other cells. Gliotransmitters. Molecules of a brain extracellular matrix. Perineuronal network.

4. FUNCTION NEURAL NETWORK(4 hours/4 hours)

Functional brain network. Study methods of the brain networks or functional connectivity.

4. Educationaltechnologies

Lectures on discipline "the Neuronal network of the brain" taught using multimedia equipment. Discussion on the results of independent work of students on practical training in the form of a seminar.

There is a wide use of active and interactive forms of acquisition of new knowledge, including the module-rating system, educational discussions, "Brain storming" in which the learning material is divided into logical parts (modules), after studying which provides for the certification exam

5. Methodological support for students' self-organized work. Evaluation tools for monitoring students' current progress and for interim assessment based on the learning of the module material

As a kind of independent work of the student selected out-of-class independent work in the form of the creative brief is writing an essay. The control procedure of doing the work is the discussion at the seminar

Thesis topics:

1. The neuron as a structural and functional unit of the CNS.
2. The formation of neural networks in ontogenesis

3. Convergent, divergent and ring neural circuits of the Central nervous system.

4. The mechanism of synaptic transmission CNS.

5. Features of synaptic transmission of excitation and conduction of excitation in neural pathways of the Central nervous system.

6. Inhibition in the CNS. Mechanisms of inhibition. Coordinating the activity of the Central nervous system.

7. The role of glia in the CNS. Classification of glial cells. Glia interaction with other cells. Gliotransmitters

8. The molecule content of perineuronal network.

9. Study methods of the brain neural networks.

5.1. **Topics for self-organized work**

1. INTRODUCTION(10 hours)
2. SYNAPTIC PLASTICITY(12 hours)
3. NEURON-GLIAL INTERACTIONS(6 hours)
4. FUNCTION NEURAL NETWORK (8 hours)

5.2. **Testquestions**

1. The concept of biological neural networks. Hierarchical and local neural network.

2. General properties of structural interaction of neurons in the local network.

3. Physiology of the nervous centers. General properties of the nerve centers.

4. Regularity of the proceedings on the local network of neurons.

5. Inhibition in the CNS. Mechanisms of inhibition. Coordinating the activity of the Central nervous system.

6. The interactions of neurons in the network (electrical synapse, chemical synapse).

7. Types of synaptic and network plasticity.

8. Glia interaction with other cells. The concept of gliotransmitters. Calcium signaling in astrocytes.

9. Imaging methods for measuring the activity of neurons.

10. Measurement methods of structural-functional relationships in neural networks of the brain

5.3. **Assessment criteria**

"Excellent" – the student displays in-depth knowledge of the main material without any mistakes and errors, has acquired all the competences (parts of competences) relating to the given subject completely and at a high level, a stable system of competences has been formed;

"Good" - the student has the knowledge of the main material with some noticeable mistakes and has acquired in general the competences (parts of competences) relating to the given subject);

"Satisfactory" - the student has the knowledge of the minimum material required in the given subject, with a number of errors, can solve main problems, the competences (parts of competences) relating to the subject are at the minimum level required to achieve the main learning objectives;

"Unsatisfactory" - the knowledge of the material is insufficient, additional training is required, the competences (parts of competences) relating to the subject are at a level that is insufficient to achieve the main learning objectives;

"Poor" - lack of knowledge of the material, relevant competences have not been acquired.

The grades "excellent", "good", "satisfactory" are consideredas positive mark.

6. Methodological and information support for the module

6.1. Mainliterature:

1. Fundamental Neuroscience, 4th edition, Edited byLarry Squire, Darwin Berg, Floyd E. Bloom, 2012
2. Neuroscience, 2nd editionEdited by Dale Purves, George J Augustine, David Fitzpatrick, Lawrence C Katz, Anthony-Samuel LaMantia, James O McNamara, and S Mark Williams, 2001
3. Guyton, A., Hall, J. Textbook of Medical Physiology Eleventh Edition, Philadelphia, Elsevier Inc.2006
4. Auld D.S., Robitaille R. Glial cell and neurotransmission: An inclusive view of synaptic function // Neuron. 2003. Vol. 40. P.389-400.

6.2. Additionalliterature:

1. Bullmore E. and Sporns O. Complex brain networks: graph theoretical analysis of structural and functional systems. Nature reviews/Neuroscience. 2009, 10:186-198
2. Damien A. Fair., Alexander L. Cohen., Jonathan D. Power, Nico U. F. Dosenbach, Jessica A. Church, Francis M. Miezin, Bradley L. Schlaggar, Steven E. Petersen. Functional Brain Networks Develop from a ''Local to Distributed'' Organization. PLoS Computational Biology, 2009, 5(5): e1000381 / www.ploscompbiol.orgDouglas Fields R. and Beth Stevens-Graham. New insights into neuron-glia communication. Science, October, 18, 2002.
3. Gary P. Schools, Min Zhou, and Harold K. Kimelberg. Development of gap junctions in hippocampal astrocytes: evidence that whole cell electrophysiological phenotype is an instrinsic property of the individual cell. Journal of Neurophysiology 96, June, 14, 2006.Pfrieger F.W. Role of glia in synapse development // Curr. Opin. Neurobiol. 2002. Vol. 12. P. 486-490
4. Introduction to Neurons and Neuronal Networks, Neuroscience Online (electronic neuroscience textbook)

5. Jonathan D. Power, Damien A. Fair, Bradley L. Schlaggar, and Steven E. The Development of Human Functional Brain Networks. Neuron. 67(9): 2010 735-748
6. Perea G, Navarrete M, Araque A. Tripartite synapses: astrocytes process and control synaptic information. Trends Neurosci. 2009 Aug;32(8):421-31
7. Tonifei Wang, Chen Zhou, Aihui Tang, Shiqiang Wang, Zhen Chai. Cellular mechanism for spontaneous calcium oscillations in astrocytes. ActaPharmacologicaSinica, July, 2006. 27(7).

7. Logistical support for the module

Lectures using multimedia technologies will be presented in classrooms 417 (UNN Building 1) and 3^{d} floor (UNN Building 7), equipped with an overhead projector and a screen.

Authors: Mukhina I.V.

Head of the school of "Neurobiotechnology"

The program is approved by the methodological commission of the school of "Neurobiotechnology".

Minutes of the meeting No. 3 dated 30.10.2014

Chairman of the methodological commission of the school of "Neurobiotechnology"