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

EXTRASYNAPTIC SIGNALING MECHANISMS IN THE BRAIN

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

Learning goals and objectives for the module is to understand and apply the basic experimental techniques of modern neuroscience, basic mechanisms of signal transmission in the brain and their methods of detection.

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. Structure of the module

Name of the module	Semester	Workload (hours)						Type of final certification
		Total	Total class room	Including classroom			Self-organized work	
				Lectures	Lab./seminars	Practice		
EXTRASYNAPTIC SIGNALING MECHANISMS IN THE BRAIN	1	72	72	18	18	0	36	Examination, Test

3.2. Contents of the module

3.2.1. Sections of the module and types of classes

№	Section (discipline) of the module	Semester	Types of classes, workload (hours)			Self-organized work
			Lectures	Lab./Seminars	Practice	
1.	EXTRASYNAPTIC SIGNALING MECHANISMS	1	18	18	0	36

	IN THE BRAIN					

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

1. CELLULAR COMPOSITION OF THE BRAIN AND METHODS OF ITS STUDY. (4 hours/4 hours)

Classification neurons. History of the Study of glia. The types of glial cells and their main functions. The main types of interaction between brain cells.

2. ELECTRICAL AND CHEMICAL SIGNALS (8 hours/8 hours)

Biophysics of ionic currents. Voltage-sensitive and ligand-controlled channels. Ion Transport. Resting potential and action potential. Calcium excitability.

3. ELECTRICAL AND CHEMICAL SYNAPSES (6 hours/6 hours)

Extrasynaptic interactions in the brain. Spillover. Four-synapse: presynaptic mechanisms. The cycle of synaptic vesicles. The mechanism of synaptic vesicles. Microdomains theory. Dale`s Principle.

4. Educational technologies

Lectures on discipline 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. Technology of registration of neuronal activity by the "patch-clamp".
2. Configurations registration mode patch-clamp
3. Anatomy of the hippocampus.
4. Basic mechanisms of neuron-glial interactions.
5. Basic methods for the study of optical activity in the brain.

6. Types of intracellular solutions and their applications

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

1. CELLULAR COMPOSITION OF THE BRAIN AND METHODS OF ITS STUDY. (10 hours)
2. ELECTRICAL AND CHEMICAL SIGNALS (12 hours)
3. ELECTRICAL AND CHEMICAL SYNAPSES (14 hours)

5.2. **Test questions**

1. Levels of brain research.
2. Methods for the experimental study of the brain.
3. Types of brain cells.
4. The compartments of the neuron.
5. Principles of classification of neurons.
6. The types of glial cells in the central nervous system and their functions.
7. Types of astrocytes in the human brain.
8. The main types of intercellular signaling in the brain.
9. What is the resting potential and how it is determined?
10. What is GAP-contacts?
11. The basic principle of synaptic transmission.
12. Two types of vesicular neurotransmitter release. Research methods.
13. The cycle of synaptic vesicles.
14. Microdomains theory of release vesicles.
15. Synaptic cycle of neurotransmitters.
16. Steam facilitation and depression.
17. Electrodiffusion of neurotransmitters in the synaptic cleft and buffering of neurotransmitters by transporters.
18. Spines, symmetrical and asymmetrical synapses.
19. Homeostatic function of astrocytes.
20. The ionotropic and metabotropic receptors.

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 considered positive.

6. Methodological and information support for the module

6.1. **Main literature:**

1. Walker MC and Semyanov A Regulation of Excitability by Extrasynaptic GABA(A) Receptors/ Inhibitory Regulation of Excitatory Neurotransmission Series: Results and Problems in Cell Differentiation, Darlison, Mark G. (Ed.)2007, Approx. 220 p., 24 illus., Hardcover ISBN: 978-3-540-72601-2 (chapter) Results Probl Cell Differ. 2008 V.44 P29-48

6.2. **Additional literature:**

1. Biphasic effect of gaba(a) receptor mediated tonic current. JOURNAL OF PHYSIOLOGICAL SCIENCES", 2009, V.59, I.1
2. Extrasynapticnmda receptors detect spikes and extracellular glutamate. JOURNAL OF PHYSIOLOGICAL SCIENCES", 2009, V.59, I.1
3. Backpropagating Action Potentials Enable Detection of Extrasynaptic Glutamate by NMDA Receptors. CELL REPORTS. 2012, V. 1, Is.5
4. Pavlov I, Savtchenko L, Kullmann DK, Semyanov A, Walker MC Outwardly rectifying tonically active GABAA receptors in pyramidal cells modulate neuronal offset, not gain / J.Neurosci. 2009, 29(48):15341-15350
5. Semyanov A Can diffuseextrasynaptic signaling form a guiding template? NeurochemInt. 2008 V.52 (1-2) P31-33
6. Wanaverbecq N, Semyanov A, Pavlov I, Walker MC and Kullmann DM Cholinergic Axons Modulate GABAergic Signaling among Hippocampal Interneurons via Postsynaptic 7 Nicotinic Receptors / J.Neurosci. 2007 V.27 (21) P5683–5693
7. Scimemi A, Semyanov A, Sperk G, Kullmann DM, Walker MC Multiple and plastic receptors mediate tonic GABAA receptor currents in the hippocampus / J.Neurosci. 2005 V.25(43) P10016-10024
8. Semyanov A., Walker M.C., Kullmann D.M. GABA uptake regulates cortical excitability via cell type-specific tonic inhibition Nature Neurosci 2003 V.6(5) P.484-490
9. Semyanov A., Kullmann D.M. Reduced picrotoxin sensitivity distinguishes ionotropic GABA receptors in hippocampal interneurons/ Neuropharmacology 2002 V.43 P.726-736

10. Kullmann D.M., Semyanov A. Glutamatergic modulation of GABAergicsignalling among hippocampal interneurons: novel mechanisms regulating hippocampal excitability / Epilepsia 2002 V.43 Suppl.5 P.174-178
11. .Semyanov A., Kullmann D.M. Kainate receptor-dependent axonal depolarisation and action potential initiation in hippocampal interneurons / Nature Neurosci 2001 V. 4(7) P718-723
12. Semyanov A., Godukhin O., Epileptiform activity and EPSP-spike potentiation induced in rat hippocampal CA1 slices by repeated high-K+: involvement of ionotropic glutamate receptors and Ca2+/calmodulin- dependent protein kinase II / Neuropharm. 2001 V.40 (2) P203-211
13. Semyanov A., Kullmann D.M. Modulation of GABAergic signaling among interneurons by metabotropic glutamate receptors / Neuron 2000 V. 25(3) P663-672
14. Semyanov A., Morenkov E., Savin A., Godukhin O. In vivo hippocampal kindling occludes the development of in vitro kindling-like state in CA1 rat hippocampal slices / Epilepsy Res. 2000 V. 38 (1) P75-85
15. Semyanov A., Morenkov E. and Godukhin O. The decreased susceptibility to the development of in vitro kindling-like state in hippocampal CA1 slices of rats sensitive to audiogenic seizures/ Neuroscience Letters 1997, V.230 P.187-190
16. Semyanov A., Godukhin O. Kindling-like state in rat hippocampal CA1 slices induced by the repeated short-term extracellular K+ increases: the role of L-type Ca2+- channels / Neuroscience Letters. 1997, V.223 P.177-180
17. Klement G., Druzin M., Haage D., Arhem P. and Johansson S. (2010) Spontaneous ryanodine-receptor-dependent Ca2+-activated K+ currents and hyperpolarizations in rat medial preoptic neurons. J. Neurophysiol.103, 2900-2911

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: Semyanov A.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"