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

«DATA ANALYSIS IN NEUROSCIENCE»

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

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1. Learning goals and objectives for the module

1) Learn basics of statistical and mathematical analysis of various experimental data of brain activity, in particular - from brain slices and cell cultures.

2) Process and analyze recordings of electrical signals of neural networks

3) Develop methods of data analysis in different programming languages.

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

Before study the student must have basic knowledge about statistics, mathematical analysis, neural cells signaling and principles of action potential transmission on cell membrane.

3. The structure and content of the module

The overall workload of the module is 1 credits, 36 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		
DATA ANALYSIS IN NEUROSCIENCE	1	36	108	13	13	0	10	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.	DATA ANALYSIS IN NEUROSCIENCE	1	13	13	0	10

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

1. INTERCOURSE TO BIOELECTRICAL SIGNALS IN NEURAL NETWORKS (3 hours/3 hours)

Neuron. Action potential. Bioelectrical activity. Neural network. Signal registration methods in neural networks.

2. ANALYSIS OF THE SIGNALS IN NEURAL NETWORKS. (5 hours/5 hours)

Preliminary analysis of the signals in neural networks. Statistical and mathematical analysis of the signals.

3. MAIN INSTRUMENTS IN DATA ANALYSIS (5 hours/5 hours)

Integration and interpretation of the experimental results. Development of analysis methods in Matlab and Labview. Statistical methods in different science areas - biology, physics and economics.

4. Educational technologies

Lectures in "Data analysis in neuroscience" are held using multimedia projectors. During the course the results of home work are discussed during lectures in form of seminars

Wide use of active and interactive forms of acquisition of new knowledge are provided, including the module-rating system in which learning material is divided into logically complete parts (modules), after which the study is provided in the form of 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

Independent work of the student is chosen in the form of reading primary and secondary literature. The procedure for monitoring the implementation of independent work - discussion at the seminar.

5.1. Topics for self-organized work

1. INTERCOURSE TO BIOELECTRICAL SIGNALS IN NEURAL NETWORKS (3 hours)
2. ANALYSIS OF THE SIGNALS IN NEURAL NETWORKS. (4 hours)
3. MAIN INSTRUMENTS IN DATA ANALYSIS (3 hours)

5.2. Test questions

1. History, kinds and types of research in the bioelectric activity of the brain.

2. Methodology and Theory of registration of electrical signals from the point of view of physics.

3. Methods for detecting signals: a patch-clamp, confocal neuroimaging, multielectrode arrays.

4. The general principles of generating the electrical signals in the neural cells.

5. The characteristics of the signals.

6. Detection of pulse activity in the multichannel signals.

7. Statistical processing of signal characteristics.

8. Fundamentals of statistical analysis. Evaluation of the set of experimentally obtained data.

9. Comparison of the distributions of the variables. The significance of differences.

10. Correlation and wavelet analysis.

11. Basic tools for data analysis: processing data files, work with a grid of values and plotting distributions of the variables, statistical hypothesis testing.

12. Developing applications processing and analysis of the recorded signals in real time.

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. Shahaf G. and Marom S. Learning in networks of cortical neurons // J. Neurosci. 2001. V. 21. P. 8782–8788.

6.2. **Additional literature:**

1. Shahaf G. and Marom S. Learning in networks of cortical neurons // J. Neurosci. 2001. V. 21. P. 8782–8788.

2. Marom S., Shahaf G. Development, learning and memory in large random networks of cortical neurons: lessons beyond anatomy // Q. Rev. Biophys. 2002. V. 35. P. 63-87.
3. le Feber J, Stegenga J, Rutten WLC. The Effect of Slow Electrical Stimuli to Achieve Learning in Cultured Networks of Rat Cortical Neurons // PLoS ONE. 2010. 5(1): e8871. doi:10.1371/journal.pone.0008871.
4. Shahaf G., Eytan D., Gal A., Kermany E., Lyakhov V., et al. Order-Based Representation in Random Networks of Cortical Neurons // PLoS Comput Biol. 2008. 4(11): e1000228. doi:10.1371/journal.pcbi.1000228.
5. Wagenaar D.A., Madhavan R., Pine J., Potter S.M. Controlling bursting in cortical cultures with closed-loop multi-electrode stimulation. J. Neurosci. 2005; 25: 680-688.

7. Logistical support for the module

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

Authors: Pimashkin A.S.

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"