COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Methods of Brain Research	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Dr. Vladas Valiulis/ 32 h lectures; 10 h seminars; 22 h practice.	Vilnius University, Life Sciences Center, Institute of Biosciences, Department of Neurobiology and Biophysics, Saulėtekio al. 7, Vilnius, LT-10257

Study cycle	Type of the course unit (module)
Second cycle	Elective

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Auditorium – lectures, seminars	Autumn	Lithuanian, English

Requirements for students	
Prerequisites: Basic understanding of neuroanatomy	**Additional requirements (if any):** None

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	133	64	69

Purpose of the course unit (module): programme competences to be developed		
Understanding of physical principles of brain imaging research method. Study of the main principles of the of imaging of brain structures and functions as well as non-invasive neuromodulation. Understanding of physical principles of brain research methods, knowledge of history of these methods and fields of their application. To provide knowledge about main methods of brain imaging, such as computerized tomography (CT), magnetic resonance imaging (MRI), single photon emission computerized tomography (SPECT), positron emission tomography (PET), brain bioelectrical activity recording (EEG) and evoked potentials (EP), as well as Transcranial Magnetic Stimulation (TMS) are studied.		
Learning outcomes of the course unit (module)	**Teaching and learning methods**	**Assessment methods**
Will know the basic methods of the brain imaging, their physical principles. On the basis of the understanding of physical principles will be able to assess the advantages and disadvantages of the studied methods.	Problem-oriented teaching, demonstrations, active learning (group discussion), elements of investigation (search for information).	Continuous evaluation during course and exam test (open and multiple choice questions)
Will know the areas of application of brain imaging techniques, which method is more suitable for solving different neuroscientific problems and why, what are the most important results of the application of these methods.	Problem-oriented teaching, demonstrations, active learning (group discussion), elements of investigation (search for information, reading of literature).	Analysis of scientific papers
Will get acquainted with the neurophysiological methods of brain research – EEG and evoked potentials, the basics of their recording and analysis. Will get acquainted with non-invasive neuromodulation method – transcranial magnetic stimulation (TMS) and the basics of motor cortex stimulation.	Problem-oriented teaching, demonstrations, active learning (group discussion), elements of investigation (search for information, reading of literature)	Continuous evaluation during course and exam test (open and multiple choice questions)

Will learn to record EEG and ERPs, perform basic analysis. Will be able measure motor cortex activation threshold via TMS.	Laboratory work, demonstrations, active learning (group discussion)	Continuous evaluation during laboratory work and exam test (open and multiple choice questions)

Content: breakdown of the topics	**Contact hours**							**Self-study work: time and assignments**	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work placement	**Contact hours**	**Self-study hours**	**Assignments**
1. Introduction – overview of the course contents	2						2	4	
2. The beginnings of brain imaging - computerized tomography (CT) and its main principles	2						2	4	
3. CT application, its strengths and limitations	2		2				4	4	
4. Magnetic resonance imaging (MRI) – nuclear magnetic resonance phenomenon and its application for tomography	2		2				4	4	
5. MRI methods and images types, application fields, strengths and limitations	2		2				4	4	
6. Diffusion tensor imaging (DTI)	2						2	4	
7. Functional MRI (fMRI), its physical principals, physiological background, application for brain function studies, its strengths and limitations	2		2				4	4	
8. Single-photon emission computerized tomography (SPECT) – physical principles and field of application	2						2	4	
9. Positron emission tomography (PET), its physical principles and areas of application: glucose consumption, studies of neuromediators and receptors	2		2				4	4	Analysis of the scientific paper
10. Electroencephalography (EEG) and its application for brain functions imaging	2						2		
11. Recording and analysis of brain evoked potentials (EP). EP application for brain functions imaging	2			6			8	5	Measurement of P300 LDAEP potentials
12. Analysis of P300 and LDAEP potentials	2			6			8	4	EP analysis
13. Transcranial magnetic stimulation and its application in clinical and research fields	2			8			10	5	Motor threshold evaluation
14. Additional brain stimulation methods, their principles and practical application	2						2	5	
15. Brain function research using invasive molecular methods.	2						2	5	Spectral analysis of the EEG.
16. . Final review of brain research methods: comparison of structural and functional methods. Brain imaging in solving neurobiological problems.	2			2			4	5	Measurement of ERPs parameters
Total	**32**		**10**	**22**			**64**	**69**	

Assessment strategy	Weight, %	Assessment period	Assessment criteria
Practical activity during laboratory work	50	During semester	2 points: Analysis of scientific paper reporting original study with application of imaging methods. 2 points: Recording and analysis of ERPs. 1 point: Motor threshold evaluation.
Exam: test	50	During exam session in January	5 points: Test is composed of 25 multiple-choice questions. Evaluation: 1 correct answer = 0.2 points. Maximum grade 5 points.

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
1. Dapšys K.	2007	Smegenotyros metodai		Vilniaus universiteto leidykla
2. Eds. D. Dougherty, S. Rauch, J. Rosenbaum	2004	Essentials of neuroimaging for clinical practice		American Psychiatric Publishing
3. Steven J. Luck	2005	An Introduction to the Event-Related Potential Technique		MIT Press
Optional reading				
1. Huettel S.A., Song A.W., McCarthy G.	2004	Functional Magnetic Resonance Imaging		Sinauer Associates
2. Eds. Bailey D.L., Townsend D.W., Valk P.E., Maisey M.N.	2005	Positron Emission Tomography: Basic Sciences		Springer
3. Ernst Niedermeyer, Fernando Lopes da Silva	2004	Electroencephalography: Basic Principles, Clinical Applications, and Related Fields		Lippincott Williams & Wilkins
4. Edmund S. Higgins ir Mark S. George	2009	Brain Stimulation Therapies for Clinicians		American Psychiatric Publishing Inc
5. Irving M. Reti	2015	Brain Stimulation Methodologies and Interventions		Wiley Blackwell