COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
BIOELECTRIC PROCESSES	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: assoc. prof., dr. **Rokas Buišas** **Other(s):** O.Rukšėnas, I.Griskova-Bulanova, V.Kisnierienė, I.Lapeikaitė, D.Šimkutė, E.Pipinis, R.Guzulaitis, V.Valiulis, E.Ilkevič. ***Lectures (32 h., 1 gr.):*** R.Buišas (26 h.), V.Kisnierienė (2 h.), I.Griskova-Bulanova (2 h.), E.Ilkevič (2 h.). ***Lab. works (64 h. n gr.):*** I.Lapeikaitė (40 h. x n gr.), E.Pipinis (12 h. x n gr.), E.Ilkevič (12 h. x n gr.). ***Seminars (16 val., 1 gr.):*** O.Rukšėnas (4 h.), R.Guzulaitis (4 h.), V.Valiulis (2 h.), R.Buišas (2 h.), D.Šimkutė (2 h.), E.Ilkevič (2 h.).	Vilnius University, Life Sciences Center (LSC), Institute of Biosciences. Address: Saulėtekio av. 7, LT- 10257, Vilnius

Study cycle	Type of the course unit (module)
Master studies (Second cycle)	

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face (lectures, seminars, laboratory work)	Autumn semester only	English

Requirements for students	
Prerequisites: Basic understanding of Human Physiology, Neurophysiology. Fundamentals of Physics (electricity) and Statistical Analysis.	**Additional requirements (if any):** Basic skills required to work in a student teaching laboratory. Some laboratory work involves experimentation on animals or humans.

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
10	266	112	154

Purpose of the course unit (module): programme competences to be developed

- Ability to understand the principles of the structure and functioning of living systems in cellular and system level from bioelectrical phenomena by applying the concepts of physics, biology, chemistry and mathematics.
- Ability to apply the theoretical knowledge and practical skills in doing electrophysiological measurements.
- Ability to design electrophysiological life science based experiments, to collect and analyze data and present results.
- Ability to assess the abilities and limitations of the main electrophysiological techniques.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
Will be able to integrate topics and data about living	Lectures	Exam

system electric signals from molecular, cellular and systems level	Seminars Reading of textbooks and research papers	Seminars
Ability learn and improve further, to apply gained electrophysiological knowledge and skills in practice	Lectures Seminars Laboratory works Reading of textbooks and research papers	Exam Seminars Practices
Will have knowledge how to organize and set-up common electrophysiological experiment, how to choose appropriate methods for bioelectric signal registration and biological object electric stimulation	Lectures Seminars, discussions Reading of textbooks and research papers	Exam Seminars Practices
Will have knowledge how to choose appropriate electrodes for real biological experiments	Lectures Seminars, discussions Reading of textbooks and research papers	Exam Seminars
Will have knowledge how to properly measure bioelectric signal from cells, tissues, organs and skin surface	Lectures Seminars, discussions Reading of textbooks and research papers Laboratory works	Exam Seminars Practices
Will know the principles and limitation of the main electrophysiological techniques	Lectures Seminars, discussions Laboratory works Reading of textbooks and research papers	Exam Seminars Practices

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**
Lectures: Bioelectricity. Principles of Electrophysiology									
1. Introduction. Bioelectricity. Bioelectrical signals. Electrical engineering basic in modeling living systems. Principles of electrophysiology.	4						**4**	**4**	Reading lecture, compulsory and optional material, seminars
2. Bioelectric measurements. **Biopotential electrodes**: features, electric parameters, engineering, concepts of measurement, practical hints in application in biological experiments.	4						**4**	**4**	
Lectures: Bioelectric processes in cells									
3. Bioelectric processes in single cells: subthreshold and active behavior of cell membrane, bioelectric signal propagation in cells.									Reading lecture, compulsory and optional material, seminars
3.1 **Bioelectric processes in animal cells**	5						**5**	**4**	
3.2 **Bioelectric processes in plant cells**	2						**2**	**2**	
3.2 **Bioelectric processes in synapses**	2						**2**	**2**	
Lectures: Human surface biopotentials and its measurements									

4. Bioelectromagnetics fields. Bioelectric sources and conductors. Surface biopotentials.									Reading lecture, compulsory and optional material, seminars
4.1. **Bioelectric phenomena in brain and its electric measurement**: EEG.	4						**4**	**3**	
4.2. **Bioelectric phenomena in heart ant its electric measurement**: ECG, Vector ECG.	4						**4**	**2**	
4.3. **Bioelectric phenomena in muscles and its electric measurement**: EMG.	1						**1**	**2**	
4.4. **Bioelectric phenomena in eyes and its electric measurement**: EOG, ERG.	2						**2**	**2**	
Lectures: Other bioelectric phenomena									
5. Bioelectric phenomena in electric fishes	4						**4**	**2**	Reading lecture, compulsory and optional material, seminars.
Laboratory work									
1**. Practical work**: Subthreshold and active bioelectric behavior of spinal cord motoneuron membrane (computational work, raw data analysis from real experiments)					8		**8**	**12**	Practical work
2**. Practical work**: Human arm Nerve Conduction Study					4		**4**	**4**	Practical work
3. **Practical work**: Locust wing stretch receptor bioelectric properties (demonstration and computational work, raw data analysis from real experiments)					8		**8**	**12**	Practical work
4. **Practical work**: Rat brain visually evoked potentials (VEP) (computational work, raw data analysis from real experiments)					8		**8**	**12**	Practical work
5. **Practical work**: Subthreshold and active bioelectric behavior of plant (algae) cell membrane (demonstration and computational work, raw data analysis from real experiments)					12		**12**	**12**	Practical work
6. **Practical work**: Measurement of human brain surface potentials using EEG (Electroencephalography) (demonstration and computational work, raw data from real experiments)					12		**12**	**12**	Practical work
7. **Practical work:** Measurements of human body surface potentials: EMG, ECG, EDR and EOG.					12		**12**	**12**	Practical work
Seminars									
6-8 common discussion seminars on specific topic moderated by one of the lecturers.			16				**16**	**21**	Reading literature for seminar
Preparing for Exam								**30**	
Total	**32**		**16**		**64**		**112**	**154**	

Assessment strategy	**Weight,%**	**Deadline**	**Assessment criteria**
Participation in the discussions (seminars)	0	Till exam session	Seminars are compulsory. • Attendance in seminars must be at least 80%. One seminar may be missed without a valid

			reason. If student misses more seminars student must prepare scientific essay on the topic of the missed seminar. • Students must read specific literature before seminar (when it needed) and participate in discussion during seminars.
Laboratory work	40	Till exam session	Practices are compulsory. All laboratory works must be done correctly and on time. Evaluation criteria: • There are 4 groups of laboratory works. Students can get 1 point per group if they do all laboratory works in each group: 4 groups x 1 point = 4 points. • Student must attend lab. work, perform all practical tasks and prepare lab. work report (presentation of results).
Exam	60	During exam session	Student has the right to take the exam (test) only if he done all laboratory works and attended seminars! Electronic test using Vilnius University, Virtual Learning Environment. 60 multiple-choice questions Each correctly answered question = max. 1point. (60 points in test = 6 points of final mark) Evaluation criteria: • 5.5-6.0 points: Perfect knowledge /skills (55-60 correct answers) • 4.5-5.0 points: Very good knowledge/skills (45-50 correct answers) • 3.5-4.0 points: Average knowledge/skills (35-40 correct answers) • 2.5-3.0 points: Knowledge/skills are below average (25-30 correct answers) • 1.5-2.0 point: Knowledge/skills still correspond to minimal (15-20 correct answers) • 0-1.0 points: Knowledge/skills are below minimal requirements (0-10 correct answers)
Accumulation of mark	40+60		Laboratory work (max. 4 points) + exam (electronic test) (max. 6 points) = 10 (full mark)

Author	Year of publication	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
Kandel R. E., et al.	2021	Principles of Neural Science	6th ed.	McGraw-Hill Professional
Silverthorn D.U., et. al.	2018	Human Physiology: An Integrated Approach	8th ed.	Pearson
Malmivuo J., Plonsey R.	1995	Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields		Oxford University Press
Optional reading				
Brette R., Destexhe A.	2012	Handbook of neural activity measurement		Cambridge University Press
Bullock T.H., et al.	2005	Electroreception		Springer
Nunez P.L., Srinivasan R.	2006	Electric Fields of the Brain	2nd ed.	Oxford University Press
Plonsey R., Barr C. R.	2007	Bioelectricity: A Quantitative Approach	3rd ed.	Springer
Tan S. D. Nijholt A.	2010	Brain-Computer Interfaces		Springer
Volkov A.G.	2012	Plant electrophysiology: theory and methods		Springer
Original scientific papers on course related topics				

Updated: 2024-03-29