Course unit (module) title	Code
Systems biology	

Lecturer(s)	Department(s) where the course unit (module) is delivered
Coordinator: Violeta Mikštienė, PhD, Audronė Jakaitienė, PhD **Other(s): E. Pranckevičienė, PhD, A. Urnikytė, PhD, E. Siavrienė, PhD, K. Šablauskas, G. Alzbutas, PhD, S. Gražulis, PhD, L. Petkevičius, PhD**	Faculty of Medicine

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

Mode of delivery	Period when the course unit (module) is delivered	Language(s) of instruction
Face-to-face, self-study Lectures, seminars and practice	3rd semester	English

Requirements for students	
Prerequisites:	**Additional requirements (if any):**

Course (module) volume in credits	Total student's workload	Contact hours	Self-study hours
5	140	66	74

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

The purpose of the course is to provide students with the understanding of the most important computational methods used in systems biology, as well as provide them with the insights into common wetlab experiments used in generating the data. After completing this course, students should be capable of designing experiments to answer broad biomedical questions at the levels of the organism, tissue or cell.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment methods
2.1. Be able select an appropriate modelling strategy for a given biological domain and problem	Lectures, debates, group discussion, journal club	Two presentations; Written examination.
2.2. Be able to gather and analyse information on subjects related to systems biology with a critical approach, and to carry out a technological watch	Lectures, debates, group discussion, journal club	
3.1 Be able to apply modern research methods in systems biology	Lectures, debates, group discussion	
4.1. Design computational biology experiment to solve practical issues in basic and applied life science.	Debates, group discussion s	
5.1 Be able to work autonomously and as a part of a multidisciplinary team; act honestly and according to ethical obligations	Lectures, debates, group discussion	

Content: breakdown of the topics	Contact hours							Self-study work: time and assignments	
	Lectures	Tutorials	Seminars	Exercises	Laboratory work	Internship/work	**Contact hours**	**Self-study hours**	**Assignments**
1. Object of Systems biology Tutors: V. Mikštienė, A. Jakaitienė	2						**2**	**6**	Self-study of scientific papers on overview of the System Biology. Recommended literature: Alon, U. (2019). An introduction to systems biology: design principles of biological circuits: https://sysbio.mx/wp-content/uploads/2021/02/Uri-Alon-An-Introduction-to-Systems-Biology_-Design-Principles-of-Biological-Circuits-CRC-Press-2020.pdf
2. Phylogenetic analysis of genomes and metagenomes Tutor: G. Alzbutas	4			4			**8**	**9**	Mamal virus filogenetic analysis
3. ChIP-seq analysis; DNA-protein interactions and Sequence Motifs Tutor: E. Pranckevičienė	4			4			**8**	**9**	Self-study of background papers on ChIP-seq technology and motif analysis. Open access Pubmed Central IDs: PMC4121056,PMC4763482,PMC5444249, PMC4022013. Reproduction and discussion of the ChIP-seq analysis exercise in Galaxy Training Material https://training.galaxyproject.org/training-material/topics/epigenetics/tutorials/tal1-binding-site-

									identification/tutorial.html . Group study of the analysis protocol used in the underlying example paper of Wu et al., Genome Research 2014, PMC4248312.
4. Gene Regulatory Networks Tutor: A. Urnikytė	2			4			**6**	**8**	Self-study of Tutorials material provided by the lecturer. Preparation for practice assignment. Recommended reading: M.arian Walhout, M. Vidal, J. Dekker. Handbook of Systems Biology (2012), Chapter 4.
5. Discovering Quantitative Trait Loci (QTLs) Tutor: E. Siavrienė	2			4			**6**	**7**	Self-study (reading and analysing related literature). Recommended reading: R. J. Brooker (2006), Chapter 25
6. Metabolomic pathways and Pathway Enrichment Tutor: dr. J. Songailienė	4			4			**8**	**9**	**S**elf-study (reading and analysing related literature). Recommended reading: Uttam Garg Laurie Smith Biomarkers in Inborn Errors of Metabolism (2017)
7. Source of data in experimental structural biology: CryoEM, X-ray crystallography Tutor: S. Gražulis	2			2			**4**	**5**	Self-study (reading and analysing related literature (recommended reading: Structural Bioinformatics (Methods of Biochemical Analysis, V. 44) by Philip E. Bourne, Helge Weissig (Editors)); and available open access databases (PDB, COD)). Submission of

									computational assignments.
8. Markov and Hidden Markov Models of Genomic and Protein Features Tutors: E. Pranckevičienė, A. Jakaitienė	4			4			**8**	**10**	Self-study (reading and analysing topic related papers). Recommended reading: L. Wasserman (2004), Chapter 23 Practical analysis of the HMM algorithm application for classification of 16S rRNA gene sequences from https://doi.org/10.1016/j.ygeno.2012.01.008. Retrieval of 16S sequences and analysis of the analysed algorithm reproducibility.
9. Deep Learning in Computational Biology Tutor: K. Šablauskas, Linas Petkevičius	4			4			**8**	**9**	TBA
10. Synthetic Biology and Novel therapeutics Tutor: K. Šablauskas, V. Mikštienė	4		4				**8**	**9**	Self-study of scientific papers on principles and design of novel therapeutics – bioengineering, genome-driven pharmacotherapy, stem cell therapy, gene/genome editing.
Total	**32**		**4**	**30**			**66**	**75**	

Assessment strategy	**Weight, %**	**Deadline**	**Assessment criteria**
Seminar/Practice assessment	50%	Topics 2-10	Students perform and submit all exercises/tasks/presentations in each topic. The performance of seminar/practical work is assessed on a scale of 1-10 in each topic. Weighted average is calculated. The weights correspond to the practice part of the topic throughout the course
Exam	50%	3 working days after last lecture or seminar	Test type exam from all topics (2 questions from each topic)

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsary reading				

Marian Walhout, Marc Vidal, Job Dekker	2012	Handbook of Systems Biology: Concepts and Insights	ISBN: 978-0-12-385944-0	Academic Press
Rober J. Brooker	2006	Genetics analysis and principles, 3rd edition	ISBN-13: 978-0071287647	Academic Press
Larry Wasserman	2004	All of statistics: a concise course in statistical inference (Vol. 26).	ISBN 978-1-4419-2322-6	New York: Springer.
Should be added				
Optional reading				
Lawrence R. Rabiner	1989	A tutorial on hidden Markov models and selected applications in speech recognition.		Proceedings of the IEEE 77, no. 2 (1989): 257-286 https://web.ece.ucsb.edu/Faculty/Rabiner/ece259/Reprints/tutorial%20on%20hmm%20and%20applications.pdf

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