COURSE UNIT (MODULE) DESCRIPTION

Course unit (module) title	Code
Single-molecule and cellular biophysics methods	

Lecturer (s)	Department (s)
Koordinatorius: Dr. Marijonas Tutkus **Kiti:**	GMC

Cycle	Level of the course unit	Type of the course unit
1st stage bachelor studies	NA	Facultative

Mode of delivery	Period of delivered	Language(s) of instruction
Lectures/seminars	Spring	LT/EN

Prerequisites and corequisites	
No prerequisites. **corequisites**	**No corequisites**

Number of credits allocated to the course unit (module)	Total student's workload	Contact hours	Self-directed learning hours
5	130	48	82

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

Single-molecule methods changed our understanding of macromolecular interactions, revealing hidden details that were hidden in ensemble-type measurements. The course offers an introduction to the areas of experimental biophysics, single molecule biophysics, and cell biophysics. In this course, we will explore technologies / methods such as single-molecule fluorescence, force measurements, and single-cell detection. They allow the imaging of high-precision molecules in vitro and in cells (in vivo, in cellulo). In addition, we will discuss topics in genomic engineering, cell mechanics, and optogenetics.

The course is designed for those who want to better understand these methods and how they can be applied to reveal the mechanisms of macromolecular interactions. Particular attention will be paid to understanding and critically evaluating the results and data of the studies in question.

Each student will have to read two articles and submit a written work - an analysis of the article. Each student will have to present an article. An article will be presented during the presentation and examined in detail during the discussion. The biological system and methods presented should be explained during the presentation. Students who do not present at the time must have read the article and be prepared to ask questions.

Learning outcomes of the course unit (module)	Teaching and learning methods	Assessment
Will be able to learn and improve, critically evaluate scientific articles.	Active lectures, problem solving, case studies	Discussion, seminars, exam.
Will know the principles and possibilities of the most important methods of biophysics of individual molecules and cells.	Active lectures, problem solving, case studies	Discussion, seminars, exam.

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**. Classical "multi-molecule" methods. Length, force, energy, time scales and concentration. Thermodynamics and the concept of functionality.	3		0				**3**	**8**	Reading lecture material.
2. Biomolecules. Introduction. Atomic concept of single biological molecules. Cells and intracellular architectures. Amino acids, peptides, proteins, and other biomolecules. "Central Dogma" of Molecular Biology. Biomolecule interactions.	1		3				**4**	**8**	Reading lecture material. Analysis of articles.
3. Single-molecule methods that use visible light. Introduction. Optical magnification and contrast. Dyes, fluorescent proteins. FCS, FLIM, Super-resolution. Multi-dimensional imaging.	1		3				**4**	**8**	Reading lecture material. Analysis of articles.
4. Single molecule methods that do not use visible light. Introduction. Scanning probe microscopy, Raman spectroscopy, etc.	1		3				**4**	**8**	Reading lecture material. Analysis of articles.
5. Force measurement and manipulation in measurements of single molecules. Introduction. Optical, magnetic tweezers. AFM. Theory.	1		3				**4**	**8**	Reading lecture material. Analysis of articles.
6. Biophysical methods of single molecules for cell mechanics research. Introduction. Studies of different parts of the cell.	1		4				**5**	**8**	Reading lecture material. Analysis of articles.
7. Molecules from outside the cell. Introduction. Receptors and ligands in the membrane. Endocytosis and exocytosis. Virus invasion.	1		4				**5**	**8**	Reading lecture material. Analysis of articles.
8. Membranes. Introduction. Application of biophysical single molecule methods to molecular transport (pairs, pumps and pumps) and motors.	1		4				**5**	**8**	Reading lecture material. Analysis of articles.
9. Inside the cell. Introduction. Application of biophysical single molecule methods to cytoplasmic diffusion (free and energy requiring) studies of biomolecules. Also, the application of these methods to nucleic acid-protein interaction studies (chromosomes, DNA, RNA, translocation, transcription, genetic code, etc.).	1		8				**9**	**10**	Reading lecture material. Analysis of articles.
10. Biophysics of single molecules beyond single cells and single molecules. Introduction. Biophysics of single molecules in complex organisms. Bionanotechnology and synthetic biology.	1		4				**5**	**8**	Reading lecture material. Analysis of articles.
Viso	**12**		**36**				**48**	**82**	

Assessment strategy	Weight, %	Assessment period	Assessment criteria
Presentation of a scientific article.	60	During course	The student receives 6 points out of 10 after completing the presentation of the article

Final exam: written analysis of the assigned article.	40	After the course	Gains 4 more points for written analysis of the assigned article.
Total	100		The final score depends on the points earned. <50% of possible points - not passed (insufficient) 50-55% - 5 (weak), 56-60% - 6 (enough) 61-70% - 7 (average), 71-80% - 8 (good) 81-90% - 9 (very good),> 90% - 10 (excellent)

Author	**Year of publica-tion**	**Title**	**Issue of a periodical or volume of a publi-cation**	**Publishing place and house or weblink**
Privaloma literatūra				
Mark C. Leake	2012	Single-Molecule Cellular Biophysics		Cambridge University Press