COURSE UNIT DESCRIPTION - MICROBIOLOGY

Course unit title	Code
MICROBIOLOGY	

Lecturer(s)	Department(s)
Coordinator: prof. Donaldas ČITAVIČIUS **Other(s):** Raimonda Petkauskaitė	Vilnius University, Department of Microbiology and Biotechnology, M.K.Čiurlionio g. 21/27, LT-03101 Vilnius

Cycle	Level of the course unit	Type of the course unit
Full-time studies (1st stage)	1 out of 1	Compulsory

Mode of delivery	Period of delivered	Language(s) of instruction
Face to face	6th semester, spring	Lithuanian

Prerequisites and corequisities	
Prerequisites: Organic chemistry, Biochemistry, Genetics	**Corequisities (if any):** None

Number of credits allocated to the course unit	Student's total workload	Contact hours	Self-study and research hours
7	**187**	**112**	**75**

Purpose of the course unit: programme competences to be developed

The course unit aims to develop:

Specific competences:

- knowledge and understanding of prokaryotes as a largest life domain , their cell structure diversity and features, the main metabolic processes, the significance of microorganisms in cell biology and biotechnology
- ability to select appropriate methods to assess the properties of prokaryotes;
- skills to work safely with microorganisms;
- ability to perform experiments and interpret the data obtained;
- ability to perform reliable measurements, document and analyse the results of the measurements.
- ability to apply theoretical knowledge in solving quantitative and qualitative problems of both familiar and unfamiliar nature

General competences:

- ability to communicate in written and verbal forms using correct Lithuanian in professional field;
- ability to use information sources in English in professional field;
- skills for self-development, learning skills in order to study general science resources;

Learning outcomes of the course unit	Teaching and learning methods	Assessment methods
• Describes the diversity of prokaryotic world, the diversity of cell morphology and physiology, features of metabolism; • Explains the concept of prokaryotic taxonomy and applies it in understanding diversity of prokaryotes. • Explains the connection of microbiology science with other branches of biology science and the influence of microbiology to the development and formation of other branches of biology science.	A problem based teaching in lectures, laboratory works, the work with literature independently	Test, defence of laboratory works, exam
• Explains the significance of microorganisms in the context of development of cell biology and biotechnology; • Demonstrates basic theoretical and practical	A problem based teaching in lectures, laboratory works, the work with literature independently	Test, defence of laboratory works, exam

skills for logical and critical evaluation of their study and future works. • Explains and applies the rules of safe work with microorganisms. • Describes and applies the methods of phenotypic analytical methods of microorganisms morphology, cytological analysis of the cell wall components, mobility of the prokaryotes, ability to form spores, the growth of microorganisms and catabolic repression assessment and methods of molecular microbiology.		
• Performs experiments, interprets the data, presents research-based conclusions; • Presents in written and verbal forms the knowledge and concepts of microbiology	A problem based teaching in lectures, laboratory works, the work with literature independently	Test, defence of laboratory works, 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. Short overview of the history of microbiology The major personalities whose formed micro-biology as a branch of science.	2						**2**	**4**	Search and analysis of additional literature of lecture topic
2. Taxonomic, phenotypic and genotypic categories describe diversity of microorganisms Cultivated and uncultivated prokaryotes. Taxonomic categories. The most commonly used categories. Polyphasic taxonomy – sources of phenotypic and genotypic information. Total genome, its fragments and genes of 16S rRNA, G+C content and DNA-DNA hybridization analysis in taxonomy. The use of 16S rDNA sequence for identification of taxa and phylogenetic analysis. Metagenomics principles.	5						**5**	**6**	Search and analysis of additional literature of lecture topic
3. The main differences between cells of three organisation levels: *Bacteria, Archea, Eukarya* The differences of organisations of genetic information, compartmentalization of intracellular process of ribosomal proteins, cells walls and membrane structure and metabolic processes.	5						**5**	**5**	Search and analysis of additional literature of lecture topic
4. Size and form of the cells The main morphological forms of prokaryotic cells: cocci – *Streptococci*, sticks – *bacilli*, pleomorphic and non-standard morphology characterized prokaryotic cells. Diversity of prokaryotic cell size, factors that influence cell size variation. Relationship of cell surface area and volume. Cell inclusions.	5						**5**	**4**	Search and analysis of additional literature of lecture topic
5. Cell growth and division of prokaryotic and eukaryotic organisms Division of eukaryotic and prokaryotic	4						**4**	**4**	Search and analysis of additional literature of lecture

microorganisms – cells division cycle and periods. Control of prokaryotic cells growth and division processes. Prokaryotic cytoskeletal elements.									topic
6. Gram$^+$ and Gram$^-$ prokaryotic cells wall components Structure and synthesis of the peptidoglycan layer of Gram$^+$ bacteria. Structural differences of peptidoglycan layer between Gram$^-$ bacteria. Three types of Archaea wall. Teichoic acids. Synthesis of peptidoglycan. Prokaryotic ytoplasmic membranes. Gram$^-$ bacteria outer membrane, structure and role of lipopolysaccharide. Bacterial capsules, their structure and role in cell biology.	5						**5**	**4**	Search and analysis of additional literature of lecture topic
7. Movement of prokaryotes Structures whose determine bacterial movement - composition differences of Gram$^+$ and Gram$^-$ bacteria. Synthesis steps of flagella and the main proteins generating the movement. Structures whose determine *archea* movement. Taxa and types of taxa. Mechanism of chemotaxis: chemoreceptors, memory of bacteria – methylation, demethylation and two-component signal transduction system.	5						**59**	**4**	Search and analysis of additional literature of lecture topic
8. Prokaryotes and the environment Environmental impact for fractionation of microorganisms physiological groups. - microorganisms ratio with molecular oxygen; - microorganisms ratio with temperature - thermophiles, psychrophiles; - influence of pH – acidophiles, alkalophiles; Impact of other environmental conditions – barophiles (piezophile). Mechanisms of resistance to influence of oxygen, temperature, pH.	5						**5**	**4**	Search and analysis of additional literature of lecture topic
9. Growth and growth rating of the microorganisms Growth and rating of microorganisms cultures - growth phases of microorganisms. Periodic, continuous and synchronized cultivation. The meaning and rating of the culture growth rate and doubling time.	5						**5**	**4**	Search and analysis of additional literature of lecture topic
10. Viruses, viroids and prions General properties of viruses and virions, hosts of viruses, viruses measurement of quantity. Bacterial viruses: virulence and conditional virulence. Retroviruses. The life cycle of viruses. Variation of viruses transliation processes. Viruses of yeast. Defective viruses, viroids, eucaryotic microorganisms prions.	5						**5**	**7**	Search and analysis of additional literature of lecture topic
11. Energy generation by microorganisms Fermentation, glycolysis, conversion of glucose molecule, enzymes needed for conversion. Substrate-level phosphorylation reactions and ATP production. Relation between glycolysis and glyconeogenesis. Respiration - three stage of respiratory. Relation between Krebs cycle and glyoxylic cycle. Phases of the Krebs cycle. Diversity of the respiratory chain in procaryotes. Aerobic and anaerobic	6						**6**	**7**	Search and analysis of additional literature of lecture topic

respiratory processes. Respiratory process differences between prokaryotic and eukaryotic cells. Photosynthetic microorganisms, photosynthesis. Technologies of procaryotic metabolic processes analysis - secretome, proteome, transkriptome, metabolome.									
12. Nitrogen cycle Processes of ammonification, nitrification, fixation of nitrogen, assimilation, dissimilation and prokaryotes associated with these activities	2						**2**	**4**	Search and analysis of additional literature of lecture topic
13. Sulphur cycle and microorganisms associated with sulphur cycle Reduction of sulphates, oxidation of sulphur, tiosulphates and sulphites. Fermentation of tiosulphates and sulphites. Mineralization of organic sulphur.	2						**2**	**4**	Search and analysis of additional literature of lecture topic
14. Prokaryotic resting state Spores producing microorganisms. Checkpoints which initiate the activation of sporulation mechanism. Morphological and biochemical changes of the cell during sporulation. The main functions of protein kinase sigma factors, reactions of phosphorylation and dephospho-rylation in the regulation of sporulation process. Germination states of spores.	3						**3**	**6**	Search and analysis of additional literature of lecture topic
15. Nutritional modes of prokaryotes The connections between nutritional modes of prokaryotes and catabolism, anabolism. Modes of interactions among prokaryotes – neutralism, mutualism, commensalism. Syntropy, symbiosis, antagonism.	3						**3**	**4**	Search and analysis of additional literature of lecture topic
16. Prokaryotes in geological processes and the application in nanotechnologies Accumulation and dissolution of metals. Aggregates of proteins and structures of accumulated metals in nanotechnologies.	2						**2**	**4**	Search and analysis of additional literature of lecture topic
Total	**64**						**64**	**75**	
Laboratory works									
Rules of the safe work in the microbiological laboratory.					**3**				
Risk groups of microorganisms. Laboratory biosafety levels. Sterility. Methods of sterilization. Microbiological culture media: composition and classification					**3**				
Pure culture. Obtaining of pure cultures: serial dilution, cloning, selective conditions, selective and differential-selective media.					**3**				
Morphology of microorganisms. Vital and fixed samples. Simple staining.					**3**				
Differential staining. Gram staining. Rapid method to determine Gram staining type.					**3**				
Influence of lysozyme on Gram staining of Gram-positive bacteria.					**3**				
Metabolic reserves in microorganisms: glycogen, poly-β-hydroxyalkanoates, acido- calcisomes. Motility of microorganisms: examination under microscope and using SIM medium.					**6**				
Endospores. Differential staining of endo- spores. Morphology of bacterial colonies.					**4**				

Test (The test includes 10 questions. Each correct answer adds one point. The test is scored if ≥5 answers are correct).									
Antibioticograms. Sensitivity of Gram-positive and Gram-negative bacteria to β-lactams and chloramphenicol.					**4**				
Introduction to catabolite repression.					**3**				
The growth of procaryotic and eucaryotic microorganisms. Determination of a bacterial growth curve using different carbon sources.					**9**				
Defense of laboratory work reports. The student must correctly choose the culture of microorganisms and the strain, and prepare one sample. Students microbiological technique is also evaluated.					**4**				
Total	**64**				**48**		**112**	**75**	

Assessment strategy	**Weight,%**	**Assessment period**	**Assessment criteria**
Written tests 1-3 during semester. Mean evaluation of three tests (time allowed for each test is no longer than 1,5 hours, each test includes 70-90 questions). Tests are obligatory.	0-100	First test in March Second test in April Third test in May	10 - excellent performance, outstanding knowledge and skills, no less 95% correct answers; 9 - strong performance. good knowledge and skills, no less 90% correct answers; 8 - Above the average performance, knowledge and skills, no less 80% correct answers; 7 - average performance, knowledge and skills with unessential shortcomings (highly satisfactory), no less 70% correct answers; 6 - below average performance, knowledge and skills with substantial shortcomings (satisfactory), no less 60% correct answers; 5 - knowledge and skills meet minimum criteria (sufficient), no less 50% correct answers; 4 - knowledge and skills do not meet minimum criteria/below minimal criteria (insufficient), no less 40% correct answers. If mean test evaluation is 8-10, exam is not required.
Exam	100	During session	If mean evaluation of three tests is 5-7., exam is required. Exam is in written, includes three summarized questions from all topics covered by the course. Assessment criteria are the same as for tests.
	0		If mean evaluation of three tests is 4, . exam is not allowed. Course repeating is required.

Author	**Year of publication**	**Title**	**Issue of a periodical or volume of a publication**	**Publishing place and house or web link**
Compulsory reading				
Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark	2012	Biology of Microorganisms		http//bookmedico.blogspot.com Benjamin Commings, Boston, New York, Paris
Kuisienė N.	2008	Molecular taxonomy (in Lithuanian)		Technologija, Kaunas
Larry L. Barton	2005	Structural and Functional Relationships in Prokaryotes		Springer Science+Business Media, New York
Optional reading				

Larry L. Barton	2005	Structural and Functional Relationships in Prokaryotes		Springer Science+Business Media, New York
Lansing M. Prescitt, John P. Harley, Donald A. Klein	2002	Microbiology		The McGraw-Hill Companies