COURSE UNIT DESCRIPTION - ENZYMOLOGY

Course unit title	Code
ENZYMOLOGY	

Lecturer(s)	Department(s)
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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
Lectures, exercises	6th semester, spring	Lithuanian (English)

Requirements for students	
Prerequisites: General and physical chemistry, organic chemistry and biochemistry	**Corequisities (if any):**

Number of credits allocated to the course unit	Student's total workload	Contact hours	Self-study and research hours
5	**133**	**64**	**69**

Purpose of the course unit: programme competences to be developed

Upon the successful completion of this course, students will acquire:

Subject-specific competences:

- knowledge on the steady-state kinetics of enzyme catalyzed reactions, enzyme regulation, factors affecting the rate of enzyme reactions, on basic strategies and principles of enzyme catalysis;
- knowledge about modern methods of enzymology;
- skills to select methods of enzymology to assess the properties of biological molecules and biological processes ;
- skills to apply theoretical knowledge in solving quantitative and qualitative problems of both familiar and unfamiliar nature.

General competences:

- 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 patterns of enzyme structure, understands structure and function relationship, is able to characterize the enzyme activity quantitatively. • Demonstrates the ability to analyze and evaluate enzymology information related to this topic.	Lectures, exercises, self-directed learning	Midterm exam, final exam
• Describes the principles of single-substrate and two-substrate enzyme kinetics. • Demonstrates the ability to solve problems of enzyme kinetics; is able to analyze and evaluate enzymology information related to this topic.	Lectures, exercises, self-directed learning	Midterm exam, final exam
• Describes the principles of enzyme inhibition and regulation; knows the factors that affect enzyme activity and understands the principles of these effects.	Lectures, exercises, self-directed learning	Final exam

• Demonstrates the ability to analyze and evaluate enzymology information related to this topic.		
• Describes the pronciples of enzymatic catalysis. Understands the principles of enzyme classification, knows their relationship to the mechanisms of action of enzymes. • Demonstrates the ability to analyze and evaluate enzymology information related to this topic.	Lectures, exercises, self-directed learning	Final exam
• Explains the enzymology relationship with other sciences. Explains the importance of enzymes in biotechnology, industry, and medicine; • Demonstrates the ability to analyze and evaluate enzymology information related to this topic.	Lectures, exercises, self-directed learning	Final 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. Structure and function of enzymes	**9**			**11**			**20**	**27**	Self-directed learning of the topic-related textbook material, analysis of the topic-related scientific papers and analysis of enzyme databases.
Enzymes are biocatalysts. A brief history of enzymology. Relationship of enzymology with other sciences.	1						**1**	2	
Structure of enzymes. Monomeric and oligomeric enzymes. Cofactors: metal ions and coenzymes. Synzymes, abzymes, ribozymes.	2						**2**	4	
Hypotheses of enzyme-substrate interaction. Active site of enzymes. Specificity of enzyme action. Types of specificity.	1						**1**	6	
EC classification of enzymes. Oxidoreductases, transferases, hydrolases, lyases, isomerases, ligases.	4			3			**7**	7	
Multi-functional enzymes.	1						**1**	2	
k_{cat}, enzyme activity, specific activity, unit of enzyme activity. Solutions of practical problems.				8			**8**	6	
2. Principals of enzyme kinetics	**4**						**4**	**7**	Self-directed learning of the topic-related textbook material, analysis of the topic-related scientific papers.
Basic principles of chemical catalysis. Transition state theory.	2						**2**	3	
Mechanisms of enzymatic catalysis: covalent catalysis, general acid-base catalysis, metal ion catalysis, coordinated catalysis.	2						**2**	4	
3. The steady-state kinetics of an enzyme catalyzed reaction.	**15**			**19**			**34**	**26**	Self-directed learning of the topic-related textbook material,

									analysis of the topic-related scientific papers.
Michaelis and Menten, Van Slyke, Cullen, Brigs, Haldane works, the main principal of steady-state.	2						**2**	2	
The kintetics of single-substrate enzyme reactions: the initial reaction rate and substrate concentration relationship. Derivation of steady-state rate equation: the method of King and Altman.	4			9			**13**	8	
Kinetics of two-substrate enzyme reaction. Kinetics of allosteric enzymes.	2						**2**	1	
Enzyme inhibition, reversible and irreversible inhibitors. Competitive, noncompetitive, uncompetitive and mixed enzyme inhibition.	3			6			**9**	6	
Regulation of enzyme activity: partial proteolysis, covalent modifications, allosteric regulation.	2			2			**4**	5	
The dependence of enzyme activity on temperature and pH.	2			2			**4**	4	
4. Application of enzymology.	**4**			**2**			**6**	**9**	Self-directed learning of the topic-related textbook material, analysis of the topic-related scientific papers, operations with bioinformatics tools.
Enzyme extraction and purification.	1			2			**3**	2	
„Alternative" enzymes. Enzyme engineering and modeling.	2						**2**	4	
Enzymes in industry and medicine.	1						**1**	3	
Total	**32**			**32**			**64**	**69**	

Assessment strategy	**Weight,%**	**Assessment period**	**Assessment criteria**
Three midterms	30	until 12th week of the course	Tasks of midterms are analogous to tasks studied during exercises. Assessment: less than 40 % of possible points – insufficient 40–50 % of possible points – 5 (sufficient) 50–60 % of possible points – 6 (satisfactory) 60–70 % of possible points – 7 (highly satisfactory) 70–80 % of possible points – 8 (good) 80–90 % of possible points – 9 (very good) at least 90 % of possible points – 10 (excellent)
Homework	20	7th to 12th week of the course	The analysis of chosen enzyme should be performed. The enzyme should be characterised according to the course material, the newest scientific information using bioinformatic methods. Assessment: 7 (highly satisfactory) – detailed analysis with factual inaccuracies 8 (good) – incomplete, but accurate analysis 9 (very good) – comprehensive, detailed, coherent analysis with minor shortages 10 (excellent) – comprehensive, detailed, coherent, accurate analysis If homework is incomplete with factual inaccuracies, it should be revised and improved.
Exam	50	16th week of the course	The final exam will cover all lectures. Assessment: less than 40 % of possible points – insufficient 40–50 % of possible points – 5 (sufficient) 50–60 % of possible points – 6 (satisfactory)

			60–70 % of possible points – 7 (highly satisfactory) 70–80 % of possible points – 8 (good) 80–90 % of possible points – 9 (very good) at least 90 % of possible points – 10 (excellent)
Total	100		Final assessment is cumulative.

Author	Year of publica-tion	Title	Issue of a periodical or volume of a publication	Publishing place and house or web link
Compulsory reading				
Arvydas Markuckas	2008	Essential Enzymatic Catalysis: e-textbook (in Lithuanian)	577-d / Ma-469	KTU publishing house „Technologija“
Optional reading				
Ed. Julio Paulina, Andrew P. MacCabe	2007	Industrial Enzymes: Structure, Function and Applications.	ISBN-10: 1402053762 (Library of VU)	Springer
Hans Bisswanger	2004	Practical enzymology.	U-angl. / 577.1 / Bis-62 (Library of VU)	Wiley-Blackwell
Ross L. Stein	2011	Kinetics of Enzyme Action.	ISBN 978-0-470-41411-8	John Wiley & Sons
Ed. Daniel L. Purich	2007	Contemporary Enzyme Kinetics and Mechanism.	ISBN: 978-0-12-378608-1	Elsevier Inc.
Jeannine Yon-Kahn, Guy Herve	2010	Molecular and Cellular Enzymology.	ISBN 978-3-642-01227-3	Springer