GENERAL INFORMATION		
Course	**Medical Biochemistry**	
Course coordinator	**Prof. Ljubica Glavaš-Obrovac, MScBiotechnol, PhD**	
Assistant/Associate	Assoc. Prof. Stana Tokić, MBiolMol, PhD Asst. Prof. Goran Ćurić, MD, PhD Asst. Prof. Teuta Opačak-Bernardi, MBiolMol, PhD, Asst. Prof. Barbara Viljetić, MBiol et Chem, PhD	
Study Program	**Integrated undergraduate and graduate university study of Medicine in German language**	
Status of the course	Mandatory	
Year of study, semester	1st year, 2nd semester	
Grading scale and workload	ECTS	**8**
	Hours (L+S+E)	**115** (40+35+40)

COURSE DESCRIPTION

Course objectives

Students will learn about biochemical mechanisms and their regulation in the human body, which form the basis for understanding life processes in the healthy and diseased state of the organism.The goal of the course is to provide students with knowledge of biochemical processes that enable living organisms to function normally, maintain optimal concentrations of constituents in cells and body fluids, and the processes involved in growth and reproduction.

Enrolment requirements and entry competencies

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Learning outcomes at the Program level

1.1., 2.1., 2.2., 2.3., 3.4., 3.5., 4.2.

Learning outcomes (5-10)

After successfully completing the course, students will be able to:

1. explain the principles of biochemical and energetic changes in the human body.
2. integrate knowledge of biochemical reactions in metabolism and metabolic changes at the cellular, tissue, and whole organism levels.
3. evaluate mechanisms of regulation of metabolism of carbohydrates, lipids, proteins, information, and signaling molecules.
4. critically evaluate the metabolic background of disorders caused by defects in the structure of molecules, biochemical reactions, or biochemical processes.
5. evaluate the application of biochemical methods in biochemistry and various biochemical laboratory tests in the diagnosis and treatment of disease.
6. select IT tools and databases to solve problems related to metabolism and disorders in metabolism.
7. independently perform qualitative and quantitative methods of biochemical analysis to detect pathological or normal components in biological fluids or simple solutions.

8. apply knowledge in the interpretation of the results obtained.

Course content

Introduction to biochemistry: the importance of biochemistry in the diagnosis and treatment of various diseases.
Enzymes: properties of enzymes. Gibbs free energy of activation. The active site of the enzyme. Specificity of substrate binding. Affinity and catalytic site. Classification of enzymes according to their specificity for the type of reaction. Distribution and metabolic role. Role of serum proteins and enzymes in the diagnosis of diseases. *Cofactors and coenzymes*. Structure of coenzymes. Prosthetic groups and cofactors. General aspects of intermediary metabolism. General aspects of regulation of metabolic pathways. Oxidation processes in the cell related to energy production.
Kinetics and regulation of enzymatic reactions. Mechanism of enzymatic catalysis. Kinetics of enzymatic reactions. Michaelis-Menten model. Expressions of enzymatic activity. Allosteric enzymes. Regulation of catalytic activity of enzymes. *Respiratory chain and oxidative phosphorylation*. Mitochondrion - structure of membranes, enzyme systems. Metabolic pathways active in mitochondria. Role of mitochondrial respiratory chain in conversion of energy from food. Redox potential and free energy change. Four complexes of the respiratory chain: 3 proton pumps and succinate Q reductase. Respiratory electron chain. Incomplete reduction and formation of toxic derivatives of molecular oxygen. ATP biosynthesis - proton gradient. ATP synthase (complex V). Hormonally regulated proton channel allows controlled release of heat. Malate-aspartate shuttle. *Carbohydrates*: Digestion of carbohydrates; decomposition and biosynthesis of carbohydrates. Regulation of carbohydrate metabolism; diseases associated with disorders of carbohydrate metabolism. Lipids: digestion of lipids. Cellular degradation and biosynthesis of simple and complex lipids. Metabolism of cholesterol and bile acids. Lipoprotein metabolism. Metabolism of eicosanoids. Regulation of lipid metabolism. Diseases associated with disorders of lipid metabolism. *Amino acids*: Protein digestion. Intracellular degradation of proteins. Decomposition of amino acids. Biosynthesis of non-essential amino acids. Regulation of the rate of amino acid metabolism. Diseases associated with disorders of amino acid metabolism. Amino acids as a source of substances for biosynthesis. Conversion of amino acids into specialized products; porphyrins and bile pigments. Amino acids as precursors of many biomolecules. Synthesis of NO. Glutathione. Peptide hormones. Porphyrin biosynthesis. Disorder in porphyrin biosynthesis - porphyria. Decomposition of heme. Urea cycle.
Nucleotides: Biosynthesis and degradation of nucleotides. Regulation of nucleotide metabolism. Diseases associated with defects in nucleotide metabolism. Nucleic acids: structure and properties of DNA. DNA replication and repair. RNA biosynthesis. Post-transcriptional modifications. Regulation of RNA biosynthesis. Degradation of nucleic acids. The genetic code. Genetic diseases.
Proteins: Biosynthesis of proteins. Post-translational modifications. Regulation of the rate of protein biosynthesis. Biosynthesis of specific (selected) proteins. Diseases associated with defects in the synthesis and regulation of protein synthesis.
Fundamentals of genetic engineering. Recombinant DNA technology. Application of recombinant DNA technology in medicine.
Hormones and mediators: Mechanisms of intercellular communication. Concept of target cell. Factors determining the response of the target cell to the hormone. The central role of hormone receptors. Specificity and selectivity of hormone receptors. Comparison of receptors and protein carriers. Classification of hormones. Classification of hormones according to the mechanism of action. Chemical diversity of hormones. Synthesis and excretion of steroid and peptide hormones. Degradation of hormones. Mechanisms of hormone action. Cellular signal transduction. The role of hormones in the regulation of

metabolic processes. The role of hormones in maintaining homeostasis.
Molecular motors: Movement within the cell. Structure of myosin, kinesin and dynein. Polymerization of actin. Muscle contraction - movement of myosin along actin fibers. Mechanism of movement of kinesin and dynein along microtubules. Role of microtubules in the cell. Structure of flagellin. Components of the flagellin motor. Chemotaxis and signaling pathways that stop the flagellin motor.
Metabolism of xenobiotics: Pharmacokinetic availability. Entry of xenobiotics into the body. Cytochromes P450 (structure, division, substrate specificity). Metabolism of xenobiotics by CYP (cytochrome P450). Monoxygenation of the substrate. Metabolism of organochlorine hydrocarbons, aromatic compounds, ethanol. Toxic effects of xenobiotics. Activity of enzymes involved in metabolism of xenobiotics. Some important drug reactions are due to mutated or polymorphic forms of enzymes or proteins. Pharmacogenomics. *Nutrition, digestion, and absorption*. Micronutrients and macronutrients.
Extracellular space: Structure of the extracellular space. Molecules of the extracellular matrix. Classes of macromolecules: collagens, elastic fibers, proteoglycans, hyaluronic acid, adhesion glycoproteins. Collagen - molecular structure, types, assembly. Defects in collagen biosynthesis and their modifications. Elastic fibers - types, structure, assembly. Defects in structure and demolition.
Regulation of metabolic pathways and interrelationships of intermediary metabolism. Biosynthetic and degradative metabolic pathways. Tissue specificity of energy metabolism. Regulation of metabolic pathways. Metabolic relationships between tissues in a well-fed organism, after a meal, and in a state of starvation.

Mode of teaching	☒lectures ☒seminars and workshops ☒exercises ☐distance education ☐field teaching	☐independent tasks ☐multimedia and network ☒laboratory ☐mentoring work ☐other

Student obligations

Attending lectures, seminars and exercises. Exercises: taking entrance exams, keeping a work diary, writing reports, taking the final exam. Seminars: passing the stoichiometry exam. Part of the seminar will be in the form of a focused discussion, so students should prepare for the seminar. Passing the partial exam, a written final exam and an oral exam.

Monitoring student work

Attending classes	x	Class activity	x	Seminar work		Experimental work	x
Written exam	x	Oral exam	x	Essay		Research	
Project		Continuous knowledge verification	x	Paper		Practical work	x
Portfolio							

Grading and evaluation of student work during classes and of the final examination

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Grade points	
					Min.	Max.
Lectures	0.5	1-8	Class attendance	Attendance record	1	2
Seminars	1.5	1-6	Preparation and presentation	Seminar presentation	11	18

			of seminar			
Exercises	1	7-8	Entrance exams, performing exercises, keeping work diary	work diary, entrance exam	12	20
Knowledge test (partial exams)	2	1-8	Studying for partial exams	2 partial exams	8	30
Final exam	3	1-8	Studying for the final exam	Written exam	18	30
Total	**8**				**50**	**100**

Evaluation of the final written exam:

Correct answers	Grade points
36	18
37-38	19
39-40	20
41-42	21
43-44	22
45-46	23
47-48	24
49-50	25
51-52	26
53-54	27
55-56	28
57-58	29
59-60	30

Calculation of final grade:
Based on the total sum of the points awarded during the course and the final exam, the final grade is determined according to the following distribution:
A – excellent (5): 90-100 grade points; B – very good (4): 70-79,99 grade points; C – good (3): 60-69,99 grade points; D – sufficient (2): 50-59,99 grade points

Required reading

1. Florian Horn: Biochemie des Menschen: Das Lehrbuch für das Medizinstudium. 8., überarbeitete und erweiterte Auflage, Thieme, 2021
2. Glavas-Obrovac Lj. et al. Medizinische Biochemie. Handbuch für Seminare und Übungen, Medizinische Fakultät Osijek, 2022

Additional reading

1. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto jr. Lubert Stryer Biochemie, 8. Auflage, Springer Verlag, 2018

Number of copies of required literature in relation to the number of students currently attending classes in the course

Title	Number of copies	Number of students
Florian Horn: Biochemie des Menschen: Das Lehrbuch für das Medizinstudium. 8.,		

überarbeitete und erweiterte Auflage, Thieme, 2021	
Glavas-Obrovac Lj. et al. Medizinische Biochemie. Handbuch für Seminare und Übungen, Medizinische Fakultät Osijek, 2022.	

Course evaluation procedures
Anonymous, quantitative, standardized student survey providing feedback on the course as well as on the work of course coordinators and their assistants/associates is being conducted by the QA Office of the Faculty of medicine Osijek.