MEDICAL CHEMISTRY AND BIOCHEMISTRY 1	
GENERAL INFORMATION	
Course coordinator	Professor Ljubica Glavaš-Obrovac, PhD
Assistant/Associate	Asst. Prof. Marijana Leventić, PhD Asst. Prof. Katarina Mišković Špoljarić, PhD Asst. Prof. Teuta Opačak-Bernardi, PhD Asst. Prof. Barbara Viljetić, PhD
Study Programme	Integrated undergraduate and graduate university study of Medicine
Status of the course	Mandatory
Year of study, semester	1st year, 1st semester
ECTS	**8**
Workload (hours)	Lectures (30); Seminars (30); Exercises (30)
Expected number of students	70
COURSE DESCRIPTION	
Course objectives	
Acquisition of knowledge and skills related to the structure of organic and inorganic chemical compounds, that are integral parts or are the basis for the: synthesis of the constituent parts of the cell, chemical and energy changes during their transformations, electrochemical processes, and kinetics of chemical reactions. In addition, the acquisition of knowledge about thermodynamic relationships essential for understanding metabolism in physiological and pathophysiological conditions, as well as by understanding the relationship between structure and reactivity, which is manifested in biological reactions and the effects of drugs on biological reactions.	
Enrolment requirements and entry competencies	
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Learning outcomes at the Programme level	
1.1., 2.1., 3.4., 3.5.	
Learning outcomes (5-10)	
After attending lectures, participating in seminars and exercises, self-study and passing the examination, students will be able to: **1.** Evaluate the principles of chemical bond formation and the principles of chemical laws in the formation of organic and inorganic chemical compounds **2.** Compare solutions, types of solutions, electrolytes, acids and bases. 3. Predict the influence of chemical laws and physical factors on chemical kinetics, the order of a chemical reaction, and the equilibrium of a chemical reaction. 4. Draw conclusions about thermodynamic quantities, bioenergetics, and how energy is supplied to biological systems. 5. Explain biological oxidations and their importance to the normal functioning of the organism. 6. Evaluate the chemical properties, structural characteristics, and characteristic chemical reactions of simple and complex biologically significant organic compounds. 7. Explain enzymatic reactions and the factors affecting enzymatic catalysis. 8. Apply the theoretical knowledge acquired to solving computational chemistry problems, as well as problems through laboratory exercises. 9. Independently carry out quantitative and qualitative chemical analysis using standard	

chemical methods (weighing, pipetting, titration, pH measurement, centrifugation, polarimmetry, spectrophotometry, separation of substances by chromatographic methods).

Course content

Lectures

Solutions. Structure and properties of water. Colligative properties of aqueous solutions. Electrolyte solutions. pH and buffers. Action mechanisms of buffers. Biological buffers.

Colloidal solutions. Macromolecular colloids. Donnan's equilibrium.

Basics of bioinorganic chemistry. Biological role of essential metals. Toxic metals. Biological significant inorganic compounds. Complex compounds. Metal complexes (chelates). Biological chelates. Application of chelators in medicine.

Chemical kinetics. The rate of chemical reactions and factors affecting the rate. Catalysis. Collision theory. Transition state theory. Order and molecularity of the reaction.

Photochemical reactions. Absorption of light in solution. Lambert-Beer law. Chemiluminescence. Application of chemiluminescence in medicine.

Thermodynamics. Basic terms. Principle of conservation of energy (paragraph I of thermodynamics). Thermodynamic quantities – functions of the state of the system. II. paragraph of thermodynamics. Free (Gibbs) energy and direction of chemical reactions.

Bioenergetics. Supplying biological systems with energy. Energy-rich compounds (ATP). Energy value of a chemical bond. Energy-rich compounds (ATP). The energy value of a chemical bond.

Biological oxidation. Biological redox systems. Standard redox potential of biological systems. Gibbs energy of the redox system.

Chemical balance. Law on mass action. Equilibrium constant. Kinetic and thermodynamic equilibrium condition. The influence of external factors on balance. La Chatelier's principle. The law of dilution. Equilibrium in a homogeneous and heterogeneous system.

Electrochemical processes. Galvanic article and reactions on electrodes. Standard potential. EMS article. Nernst equation. Biological redox systems. Standard redox potential of biological systems.

Chemistry of organic compounds. Division of organic compounds. Types of reactions in the chemistry of organic compounds. Isomers and isomerisms. Organic compounds containing oxygen: alcohols and phenols, ethers, aldehydes and ketones, carboxylic acids and their derivatives. Chemical properties and characteristic reactions. Biologically significant representatives. Organic compounds with nitrogen and sulfur: chemical properties and characteristic reactions. Biologically significant representatives. Heterocyclic compounds. Biologically significant derivatives.

Amino acids. Proteinogenic amino acids. Peptides: construction principle and sequence determination. Physiologically active peptides.

Proteins: Structural levels in protein architecture. Hemoglobin and myoglobin: structure and role.

Enzymes: distribution and metabolic role. Kinetics of enzymatic reactions and regulation of activity. Coenzymes: division, structure and role in the biocatalysis.

Respiratory chain and ATP synthesis. Mitochondrion - structure of membranes, enzyme systems. Metabolic pathways active in mitochondria. The role of the mitochondrial respiratory chain in the 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 enables controlled release of heat. Malate aspartate shuttle.

Seminars

Biogenic elements. Acids, bases and simple salts. Stoichiometry. Buffer solutions. Photochemical reactions. Equilibrium in solutions. Izmoeria. Characteristic reactions of alcohol, aldehyde and

ketone. Simple and complex carbohydrates. Amino acids, peptides and protein. Enzymes and enzymatic reactions.

Laboratory Exercises

By applying basic laboratory techniques and work methods in the laboratory (weighing, pipetting, titration, pH measurement, centrifugation, polarimmetry, spectrophotometry, separation of substances by chromatographic methods), specific problems in chemical analysis and interpretation of the obtained results are solved.

Mode of teaching

Lectures; Seminars; Laboratory exercises

Student obligations

Students are expected to attend all class sessions, as well as to take all the examinations. However, they are allowed for excused absences, totalling 30% of all classes.
Exercises: taking the entrance exams, keeping a work diary, writing reports, taking the final exam. Part of the seminar is conducted in the form of a focused discussion, so students should prepare for the seminar in advance. Passing a partial and final written exam, as well as an oral exam.

Monitoring student work *(alignment of learning outcomes, teaching methods, and grading)*

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Grade points	
					Min.	Max.
Class attendance	0.5	1-9	Class attendance; exercises	Evidence sheet; evaluation	1	4
Seminars	1.5	1-8	Seminar work	Presentation	7	14
Exercises	1.0	8,9	Entrance colloquium, practical work, writing a diary from the exercises	Diary, entrance colloquium	6	12
Knowledge check (partial tests)	2.0	1-9	Learning for the partial tests	2 partial tests	12	30
Final exam	3	1-9	Learning for the exams	Grading of the written exam	12	20
				Grading of oral the exam	12	20
Total	**8**				**50**	**100**

Evaluation/grading of the final written examination:

Percentage of correct answers (%)	Grade points
60.00-64.99	12
65.00-69.99	13
70.00-74.99	14
75.00-79.99	15
80.00-84.99	16
85.00-89.99	17

90.00-94.99	18
95.00-100	20

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 (available in the library and through other media)

Title	Number of copies in the library	Availability through other media
1. R.K. Murray, D.A. Bender, K.M. Botham, P.J. Kennelly, V. W. Rodwell, P.A. Weil. Harperova ilustrirana biokemija, 28 izdanje Medicinska naklada 2011.	21	
2. John McMurry. Osnove organske kemije, hrvatsko izdanje, Urednice: Č. Milin i G. Čanadi Jurešić, Zrinski, Čakovec 2014.	13	
3. Glavaš-Obrovac Lj. i sur. Priručnik za seminare i vježbe iz Medicinske kemije i biokemije 1, Medicinski fakultet Osijek, 2022.	80	

Additional reading

1. I. Filipović, S. Lipanović, Opća i anorganska kemija, Školska knjiga, Zagreb, 1991.
2. R. Chang, General chemistry, The essential concepts, McGraw Hill, 2006.

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.

Note /Other

E-learning does not count towards course contact hours, but is being used in teaching and comprises links to various web pages, as well as video and audio materials available on web pages.