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INTERNATIONAL EUROPEAN
UNIVERSITY



SCHOOL OF
MEDICINE

Biological
and bioorganic chemistry

2023



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Course Name				
		Biological and bioorganic chemistry		
Lecturer (s)				
		PhD in Chemistry, Associate Professor Olena Golodayeva Doc. of medical Sciences, Professor Liudmyla Hayova		
Lecturer's profile				
		https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin		
Consultations				
online consulting		Second Thursday of the month from 15:00 to 16:00		
offline consulting		Third Friday of the month from 15:00 to 16:00		
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Discipline page				
		https://medicine.ieu.edu.ua/pro-yemsh/kafedry/kafedra-fundamentalnykh-dystsyplin		
Form of final control		test	def. test	exam
		☐	☒	☐



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1 Brief discipline annotation

The discipline "Biological and bioorganic chemistry" studies the structure and reactivity of various classes of organic substances, and on their basis, the most important biologically active substances that are part of living organisms - low molecular weight biomolecules, biopolymers (proteins, nucleic acids, polysaccharides), natural and synthetic physiologically active compounds (hormones, vitamins, drugs, toxic substances, etc.). The tasks of bioorganic chemistry are to determine the structure of biomolecules, natural and synthetic bioregulators, to identify the relationship between their molecular and electronic structure and physiological, in particular pharmacological, effects, to identify patterns of their transformations. It lays the foundation for the formation of the following programmatic learning outcomes in accordance with the Standard of Higher Education of Ukraine for undergraduate training of specialists of the second (master's) level of the specialty "Medicine".

2 Background for studying discipline

The discipline "Bioethics and Medical Communications" has interdisciplinary links with the following disciplines: "Medical and biological physics. Medical Informatics", "Medical Biology", "Physiology". The knowledge gained is necessary in the study of clinical professional and practical disciplines, as well as in further professional activities.

3 Goal and objectives of the discipline

The purpose of teaching the discipline "Biological and Bioorganic Chemistry" is to study biomolecules and molecular organization of cellular structures, general laws of enzymatic catalysis and biochemical dynamics of transformation of the main classes of biomolecules (amino acids, carbohydrates, lipids, nucleotides, etc., porphyrins, etc.), molecular biology and genetics of informational macromolecules (proteins and nucleic acids), i.e. molecular mechanisms of heredity and realization of genetic information, hormonal regulation of metabolism and biological functions of cells, biochemistry of special physiological functions.

Objectives:

- to teach students the general principles of evaluating the chemical properties of organic compounds;
- to provide knowledge of the structure of substances that make up groups (proteins, carbohydrates, nucleic acids, lipids, vitamins, enzymes, hormones) based on knowledge of classes of compounds.
- to teach students to investigate and identify certain classes of biological compounds in the laboratory based on the properties of their functional groups;
- to carry out qualitative and quantitative reactions and evaluate indicators in laboratory biochemical research.

4 Learning outcomes

PLR 1

Have a thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integrating knowledge. To be responsible for professional development, the ability to further professional training with a high level of autonomy

PLR 2

Understanding and knowledge of basic and clinical biomedical sciences, at a level sufficient to solve professional problems in the field of health care

PLR 21

Find the necessary information in professional literature and databases of other sources, analyze, evaluate and apply this information



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4 Learning outcomes

PLR 22

Apply modern digital technologies, specialized software, statistical methods of data analysis to solve complex healthcare problems.

5 ECTS credits

8 ECTS credits / 240 academic hours, including lectures - 24, practical - 104, independent work - 112.

6 Course Content

Topic title	Audit			
	Total	Lectures	Practical	Individual

Section 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components

section 1. Theoretical foundations of the structure and reactivity of bioorganic compounds.

Topic 1. Classification, nomenclature and isomerism of bioorganic compounds. Classification of chemical reactions. Reactivity of alkanes, alkenes, arenes. The nature of chemical bonding.	7	1	3	3
Topic 2. Classification, nomenclature and isomerism of bioorganic compounds. The nature of chemical bonding.	6	-	3	3
Topic 3. Reactivity of alcohols, phenols, amines.	6	-	3	3
Topic 4. Structure and chemical properties of aldehydes, ketones.	7	1	3	3
Topic 5. Structure, properties and biological significance of carboxylic acids and their functional derivatives.	7	1	3	3
Topic 6. Higher fatty acids. Lipids. Phospholipids.	7	1	3	3
Topic 7. Structure, reactivity and biological value of heterofunctional compounds (α -, β -, γ -hydroxy acids, keto acids and pheno acids).	6	-	3	3

Content section 2. Structure and biological functions of carbohydrates.

Topic 8. Carbohydrates. Structure and chemical properties of monosaccharides.	7	1	3	3
Topic 9. Structure and functions of disaccharides and polysaccharides.	7	1	3	3

Content section 3. Biologically active heterocyclic compounds.

Topic 10. Classification, structure and significance of biologically important heterocyclic compounds.	7	1	3	3
Topic 11. Structure and biochemical functions of nucleosides and nucleotides.	6	-	3	3



SYLLABUS



6

Course Content

Topic 18. Study of the role of cofactors and coenzyme forms of vitamins in the catalytic activity of enzymes. Study of the participation of vitamins and coenzyme forms of vitamins in various biochemical processes.	9	2	3	4
Content section 6. Exchange of substances and energy.				
Topic 19. Study of oxidative phosphorylation and of ATP synthesis, inhibitors and uncouplers of oxidative phosphorylation. Exchange of substances and energy. Study of the functioning of the tricarboxylic acid cycle	9	2	3	4
Content section 7. Carbohydrate metabolism and its regulation				
Topic 20. Study of the peculiarities of carbohydrate digestion. Glycogen biosynthesis and catabolism. Conversion of other monosaccharides into glucose.	8	1	3	4
Topic 21. Study of anaerobic glucose oxidation. Biosynthesis of glucose - gluconeogenesis. Research on aerobic oxidation of glucose.	8	1	3	4
Topic 22. Research of aerobic oxidation of glucose. Pentose phosphate pathway of glucose conversion.	7	-	3	4
Content section 8. Lipid metabolism and its regulation.				
Topic 23. Structure and functions of cell membranes. Study of the peculiarities of digestion of lipids. Violation of lipid digestion and transport in the blood exogenous lipids.	9	2	3	4
Topic 24. Study of the metabolism of fatty acids and ketone bodies. Beta-oxidation of fatty acids. Biosynthesis and biotransformation of cholesterol. Study of the biosynthesis of fatty acids, triacylglycerols and phosphoglycerides. Disorders of lipid metabolism: obesity and fatty infiltration liver	9	2	3	4
Content section 9. Metabolism of amino acids. Enzymopathies of amino acid metabolism.				
Topic 25. Research of the chemical composition of gastric juice Peculiarities of digestion of proteins. Study of amino acid transformations (transamination, deamination, decarboxylation). Research of the processes of ammonia detoxification and urea biosynthesis. Specialized ways of metabolism of individual amino acids. Biosynthesis of creatine. Violation of amino acid metabolism.	8	4	2	2
Together for section 2	90	16	32	42
Chapter 3. Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.				
Content section 10. Fundamentals of molecular biology.				
Topic 26. Study of biosynthesis and catabolism of purine nucleotides. Determination of the final products of their exchange.	7	-	3	4
Topic 27. Research on the metabolism of pyrimidine nucleotides. Study of the composition of nucleic acids.	6	-	3	3
Topic 28. Study of DNA replication. Analysis of mechanisms of mutations and DNA repair. RNA transcription. Protein biosynthesis in ribosomes. Stages and mechanism of translation, regulation of translation. Antibiotics are inhibitors of transcription and translation.	7	-	3	4

Topic 29. Study of molecular and cellular mechanisms of hormone action on target cells. Hormones pituitary gland and hypothalamus. Study of the action of hormones of the pancreas and the gastrointestinal tract. The mechanism of metabolic disorders in diabetes.	6	-	3	3
Topic 30. Hormonal regulation of blood glucose level. Construction of sugar curves. Adrenal hormones glands Hormonal regulation of calcium metabolism. Studies of iodine in the thyroid gland. Physiologically active eicosanoids.	5	-	3	2
Topic 31. Steroid hormones of gonads. Hormonal regulation of biochemical transformations of substances during nutrition. Regulation of metabolism during starvation. Interrelationship of all types of metabolism and its regulation.	5	-	3	2
Content section 12. Biochemistry and pathobiochemistry of blood				
Topic 32. Research of the chemical composition and acid-base state of blood. Determination of residual blood nitrogen. Research of coagulation, anticoagulation and fibrinolytic systems of blood.	6		3	3
Topic 33. Research of the chemical composition of erythrocytes. Normal and pathological forms of hemoglobin. Research of end products of heme catabolism. Pathobiochemistry of jaundice.	6	-	3	3
Content section 13. Biochemistry of tissues and organs.				
Topic 34. Liver biochemistry. Microsomal oxidation, cytochromes P-450. Study of types of biological oxidation. The role of fat-soluble vitamins in the functioning of tissues and organs. Study of normal and pathological components of urine	5	-	3	2
Topic 35. Biochemistry of connective tissue.	5	-	3	3
Topic 36. Biochemistry of nervous tissue.	4	-	2	2
Together for section 3	60	-	32	28
Together, for all sections of the discipline	240	24	104	112

Chapter 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components

1. Classification, nomenclature and isomerism of bioorganic compounds. The nature of chemical bonding. Classification of chemical reactions. Reactivity of alkanes, alkenes, arenes.
2. Reactivity of alcohols, phenols, amines. Structure and chemical properties of aldehydes, ketones. Structure, properties and biological significance of carboxylic acids and their functional derivatives. Higher fatty acids. Lipids. Phospholipids.
3. Structure, reactivity and biological significance of heterofunctional compounds (α -, β -, γ -hydroxy acids, keto acids and pheno acids).
4. Carbohydrates. Structure and chemical properties of monosaccharides. Structure and functions of disaccharides and polysaccharides.
5. Classification, structure and significance of biologically important heterocyclic compounds. Structure and biochemical functions of nucleosides and nucleotides.

6. Structure and biological role of nucleic acids.
7. Amino acid composition of proteins and peptides. Structural organization of proteins. Physicochemical properties of proteins. Protein precipitation reactions. Denaturation.

Chapter 2. General patterns of metabolism. Metabolism of carbohydrates, lipids, proteins and its regulation.

1. Subject and problems of biochemistry. Study of the structure and physical and chemical properties of proteins. Quantitative determination of protein by the biuret method. Proof of the protein nature of enzymes.
2. Study of the structure and physical and chemical properties of enzymes.
3. Determining the activity of enzymes, studying the kinetics of enzymatic catalysis and the influence of activators and inhibitors.
4. Study of the role of cofactors and coenzyme forms of vitamins in the catalytic activity of enzymes. Study of the participation of vitamins and coenzyme forms of vitamins in various biochemical processes.
5. Studies of oxidative phosphorylation and ATP synthesis, inhibitors and uncouplers of oxidative phosphorylation. Metabolism and energy. Study of the functioning of the tricarboxylic acid cycle. Study of the peculiarities of carbohydrate digestion. Biosynthesis and catabolism of glycogen. Conversion of other monosaccharides to glucose.
6. Study of anaerobic oxidation of glucose. Biosynthesis of glucose - gluconeogenesis. Study of aerobic oxidation of glucose. Pentose phosphate pathway of glucose conversion.
7. Structure and function of cell membranes. Study of the features of lipid digestion. Disorders of lipid digestion and transport of exogenous lipids in the blood. Beta-oxidation of fatty acids. Biosynthesis and biotransformation of cholesterol. Studies of the biosynthesis of fatty acids, triacylglycerols and phosphoglycerides. Lipid metabolism disorders: obesity and fatty liver infiltration.
8. Study of the chemical composition of gastric juice. Features of protein digestion. Study of amino acid transformations (transamination, deamination, decarboxylation). Studies of ammonia detoxification and urea biosynthesis. Specialized metabolic pathways of individual amino acids. Creatine biosynthesis. Disorders of amino acid metabolism.

Chapter 3. Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.

1. Study of biosynthesis and catabolism of purine nucleotides. Determination of the end products of their metabolism.
2. Study of the metabolism of pyrimidine nucleotides. Study of the composition of nucleic acids. Study of DNA replication. Analysis of the mechanisms of mutations and DNA repair. RNA transcription. Protein biosynthesis in ribosomes. Stages and mechanism of translation, regulation of translation. Antibiotics - inhibitors of transcription and translation.
3. Study of molecular and cellular mechanisms of hormone action on target cells. Pituitary and hypothalamic hormones. Study of the action of pancreatic and gastrointestinal hormones. Mechanism of metabolic disorders in diabetes mellitus.
4. Hormonal regulation of blood glucose levels. Construction of sugar curves. Hormones of the adrenal glands. Hormonal regulation of calcium metabolism. Study of iodine in the thyroid gland. Physiologically active eicosanoids.
5. Steroid hormones of the gonads. Hormonal regulation of biochemical transformations of substances during nutrition. Regulation of metabolism during fasting. Interrelation of all types of metabolism and its regulation.
6. Study of chemical composition and acid-base state of blood. Determination of residual blood nitrogen. Study of coagulation, anti-coagulation and fibrinolytic blood systems.
7. Study of the chemical composition of red blood cells. Normal and pathological forms of hemoglobins. Study of the end products of heme catabolism. Pathobiochemistry of jaundice.



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7 List of obligatory tasks

8. Biochemistry of the liver. Microsomal oxidation, cytochromes P-450. Study of types of biological oxidation. The role of fat-soluble vitamins in the functioning of tissues and organs. Study of normal and pathological components of urine.
9. Biochemistry of connective tissue. Biochemistry of nervous tissue.

8 List of selective tasks

1. Create multimedia presentations on the topics of practical classes
 2. Creating chemical crosswords
 3. Making tables
 4. Participation in the work of the scientific and student circle
 5. Participation in the student olympiad in the discipline
 6. Participation in scientific and practical conferences
 7. Organization and visiting of thematic museums
 8. Publication of abstracts of scientific conference reports in co-authorship with a teacher
- For completing selective tasks, 12 points are added to the student's academic rating

9 Discipline features

Period of teaching	Semester	International disciplinary integration	Year of study	Courses: general training/ professional training/elective
2 semester	3,4 semester	available	1,2	General training

10 Rating system and requirements

The current performance of students is assessed on a 4-point scale (2; 3; 4; 5) at each practical, taking into account the approved evaluation criteria for the relevant discipline. The student must receive a grade for each topic for further conversion of grades into points on a multi-point (200-point) scale.

Criteria for assessing current academic performance:

Excellent ("5") - the student answered 90-100% of the questions correctly. Solves situational problems of increased complexity, is able to summarize the material.

Good ("4") - the student answered 70-89% of the questions correctly. The student has the necessary practical skills and techniques to perform them to an extent that exceeds the required minimum.

Satisfactory ("3") - the student answered 50-69% of the questions correctly. Has only the required minimum of research methods.

Unsatisfactory ("2") - the student answered 50% of the questions correctly. When answering and demonstrating practical skills, he/she makes significant, gross mistakes.

Evaluation of students' independent work in preparation for classroom practical classes is carried out during the current control of the topic at the relevant classroom.

11 Assessment system and requirements. General system of discipline assessment

A condition for student admission to the final control is the absence of missed or completed practical classes, as well as an average current grade of at least 3 points on a 4-point scale \ 120 points on a 200-point scale.

<https://ieu.edu.ua/docs/rate-of-study.pdf>



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12 Discipline policy

In order to achieve the learning objectives and successfully complete the course, it is necessary from the first day to actively engage in the work, attend lectures regularly, prepare for practical classes in advance, not be late or miss classes, come to class dressed in a medical gown, perform all necessary tasks and work on self-improvement every day, be able to work with a partner or as part of a group, ask for help and receive it when you need it.

In the classroom, students should exclude the possibility of using a mobile phone, tablet or other mobile devices, not resort to cheating and plagiarism, adhere to the cooperation and solidarity of the teacher and students, contact the teacher to help organize and consult on scientific, search and research work, participate in scientific circles; The teacher, in turn, must ensure the full implementation of the curriculum is mandatory, not to be late for lectures, practical (seminar) classes, objective. It is important to prevent any manifestations of corruption. First of all, the teacher should monitor the chemical classrooms, pay special attention to students in practical classes when working with chemical equipment and reagents. And it is important to avoid prejudice and discrimination regardless of race, ethnicity, or religious beliefs.

13 Policy on missing classes and completing assignments late

A student who, for valid reasons, confirmed by documentary evidence, was not subject to current control has the right to undergo current control within two weeks after returning to study.

A student who was absent from classes without valid reasons, did not participate in current control activities, did not eliminate academic debt, is not allowed to take the final semester control of knowledge in this discipline, and on the day of the exam, the academic staff member assigns a grade of "not admitted" in the examination record. Retaking a differentiated test in the discipline is assigned subject to the completion of all types of educational, independent (individual) work provided for by the working curriculum of the discipline and is carried out in accordance with the schedule of liquidation of academic debt approved by the directorate. <https://ie.u.edu.ua/docs/050.pdf>

14 Policy of absence and late task performance

Participants in the educational process are guided by the principles of academic integrity
<https://ie.u.edu.ua/docs/011.pdf>

15 Recommended sources of information

Primary literature:

1. Biological and bioorganic chemistry: in 2 books: textbook. Book 1. Biological chemistry / B.S. Zimenkovsky, V.A. Muzychenko, I.V. Nizhenkovska, G.O. Syrova; edited by B.S. Zimenkovsky, I.V. Nizhenkovska - 2nd ed.
2. Biological and bioorganic chemistry: in 2 books: textbook. Book 2. Biological chemistry / Y.I. Gubsky, I.V. Nizhenkovska, M.M. Korda et al. eds.
3. Bioorganic Chemistry: textbook / Yu. Gubskiy. - 2nd ed. - Vinnitsa: Nova Knyha, 2019/ - 224p.
4. Biological chemistry = Biological chemistry: textbook / edited by Yu. Gubskiy. - 3rd edition. - Vinnytsia: Nova Knyha, 2020. - 488p.

Supporting literature

1. Biochemistry: a textbook / edited by Prof. A.L. Zahayko, Prof. K.V. Aleksandrova - Kh.
2. Biological and bioorganic chemistry: in 2 books: textbook. Book 1. Bioorganic chemistry (IV year of study) / edited by B.S. Zimenkovsky, I.V. Nizhenkovska - VVV "Medicine" - 2014. - 272 p.
3. Gonsky Y.I., Maksymchuk TP, Kalynsky M.I. Human biochemistry. Textbook. - Ternopil: Ukrmedkniga. - 2013. - 744 p.



SYLLABUS



15

Recommended sources of information

4. Biological and bioorganic chemistry [Text]: a textbook for students of higher educational institutions / O.O. Mardashko, L.M. Mironovych, H.F. Stepanov. - Odesa: Odesa Medical University, 2011. 235 p.
5. Functional biochemistry: a textbook for students of higher pharmaceutical educational institutions. IV level of accreditation / A.L. Zagayko [et al.
6. Role of science and education for sustainable development: Collective monograph / Edited by Magdalena Wierzbik-Strońska and Iryna Ostopolets / Publishing House of University of Technology. - Katowice, 2021. -p.168-176
7. Bobrova M. S., Holodaieva O.A., Koval S.Yu. The effect of hypothermia on the state of the prooxidant-antioxidant system of plants // REVISTA DE LA UNIVERSIDAD DEL ZULIA. 3ª época. Año 12 N° 33, 2021. DOI : <http://dx.doi.org/10.46925//rdluz.33.07> (Web of Science, Italy, article in English)

Information resources:

1. <http://guides.lib.vt.edu/oer/chemistry> - Books on chemistry.
2. www.ncbi.nlm.nih.gov/PubMed - free access to the database of scientific data in the field of biomedical sciences.
3. <https://pubchem.ncbi.nlm.nih.gov/> - free access to the database of scientific data in the field of biomedical sciences.
4. www.biochemistry.org.ua - official website of the Palladin Institute of Biochemistry of the National Academy of Sciences of Ukraine.
5. www.bpci.kiev.ua - the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
6. www.xumuk.ru- articles on biochemistry in free access.
7. www.pereplet.ru/cgi/soros/readdb.cgi - Soros Educational Journal - free access to popular science articles on biochemistry, biology and chemistry.
8. <https://ojs.tdmu.edu.ua/index.php/ijmr> - International Journal of Medicine and Medical Research
9. <https://ojs.tdmu.edu.ua/index.php/bmb> - Journal of Medical and Biological Research

16

Tips on successful study during the course

Attendance at classes

Dialogue with the teacher on all issues of the curriculum

Completion of assignments in accordance with the program

Writing essays on the topics of the program

Discussion of topics and assignments in groups outside of class time

Use of Internet resources