

BOGOMOLETS NATIONAL MEDICAL UNIVERSITY
Educational and scientific institute of medicine
Department of medical biochemistry and molecular biology

APPROVE

Vice-Rector of the higher education institution
Bogomolets national medical university
for scientific, pedagogical and educational work,
doctor of medical sciences, Professor
Oleg VLASENKO

WORK PROGRAM OF THE DISCIPLINE

"MEDICAL BIOCHEMISTRY"

Educational level:	<u>Second (Master's)</u>
Field of knowledge:	<u>I "Health and social security"</u> <u>I2 "Medicine"</u>
Speciality:	<u>Educational and professional program</u>
Educational program:	<u>"Medicine" of the second</u> <u>(master's) level of higher education</u> <u>in the specialty I2 "Medicine"</u>

2025 - 2026 academic year
2026 - 2027 academic year



UB
НМУ імені О.О.Богомольця
№99/л-1 від 02.09.2025

Work program of the academic discipline "**Medical biochemistry**" for applicants for higher education in the direction of training specialists of the second (master's) level of higher education, specialty I2 "Medicine".

PROGRAM DEVELOPERS: head of the department, candidate of biol. science, associate professor Yanicka L.V., associate professor of the higher education institution, PhD, associate professor Slipets A.A.

The work program was discussed and approved at the meeting of the of Medical biochemistry and molecular biology department

Protocol № 1 of "26" August 2025

The work program was approved at the meeting of the Cycle methodological commission on natural sciences

Protocol № 2 of "29" August 2025

Head of the Department of medical biochemistry
and molecular biology, candidate of biol. science.,
associate professor

L.V. Yanicka

Head of the Cycle methodological commission
in natural disciplines, candidate of biol. science,
associate professor

L.V. Yanicka

Guarantor of the educational (educational and professional) program
doctor of medical sciences, professor,

V.S. Melnyk

Head of the Department of educational and methodological work,
licensing and accreditation, PhD, associate professor

I.I. Kucherenko

1. Description of the discipline OK11 "Medical biochemistry"

Name of indicators	Field of knowledge, specialty, educational level	Characteristic of the discipline	
		Full-time	Part-time study
Number of credits – 9	Field of knowledge: And "Health and Social Security"	Normative	—
	Direction of training: Master		
Modules – 1	Speciality: I2 "Medicine"	Year of preparation – I and II	—
Content modules – 4		Semester – I or II and III and IV	—
Individual scientific Research task			
Total credits/hours – 9/270			
Weekly hours for full-time education: classroom – 3.9; independent work of students – 1.1	Educational qualification level: Master of Medicine	Lectures: 44 hours;	—
		Practical: 135 hours;	
		Independent work: 91 hours ;	
		View control: Transfer Test, Exam	

2. Purpose, expected learning outcomes and criteria for evaluating learning outcomes

The purpose of teaching the discipline "**Medical biochemistry**" is: "Medical biochemistry" is a fundamental discipline of natural science training of a modern doctor, which studies the chemical composition and structure of bioorganic molecules, their properties and functions in the human body; metabolism and energy, biochemical processes underlying the functional activity of various organs and systems; general patterns of enzymatic catalysis; biochemical dynamics of transformation Substances; hormonal regulation of metabolic processes.

The ultimate goals of studying the discipline are established on the basis of the EP of training a doctor in the specialty "Medicine" in accordance with the content module (natural science training) and are the basis for building the content of the discipline. On the basis of the ultimate goals of studying the discipline, certain skills are formulated to interpret changes in biochemical indicators of metabolism of substances to diagnose the state of the body and correct possible pathologies, which is necessary for the professional activity of a doctor.

The program competencies under the educational and professional program of the specialty I2 "Medicine", the formation of which is provided during the training of the discipline "Medical Biochemistry" include (OK 11: GC 1-15; PC 21, 23-25; PLO 1-3, 21, 22, 24, 25, 27):

Integral competence: the ability to solve complex problems, including research and innovation in the field of medicine. Ability to continue learning with a high degree of autonomy;

general competencies (GC):

GC1. Ability to abstract thinking, analysis and synthesis.

GC 2. Ability to learn and master modern knowledge.

GC 3. Ability to apply knowledge in practical situations.

GC 4. Knowledge and understanding of the subject area and understanding of professional activities.

GC 5. Ability to adapt and act in a new situation.

GC 6. Ability to make informed decisions.

GC 7. Ability to work in a team.

GC 8. Ability to interpersonal interaction.

GC 9. Ability to communicate in a foreign language.

GC 10. Ability to use information and communication technologies.

GC 11. Ability to search, process and analyze information from various sources.

GC 12. Certainty and perseverance in terms of tasks and responsibilities.

GC 13. Awareness of equal opportunities and gender issues.

GC 14. Ability to realize their rights and obligations as a member of society, to realize the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.

GC 15. Ability to preserve and multiply moral, cultural, scientific values and achievements of society on the basis of understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technology and technology, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

special (professional, subject) competencies (PC):

PC 21. Clearly and unambiguously convey their own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists, in particular to students.

PC 23. Ability to develop and implement scientific and applied projects in the field of healthcare.

PC 24. Compliance with ethical principles when working with patients, laboratory animals.

PC 25. Observance of professional and academic integrity, to be responsible for the reliability of the scientific results obtained .

Program learning outcomes:

PLO 1. Have thorough knowledge of the structure of professional activity. Be

able to carry out professional activities that require updating and integration of knowledge. Be responsible for professional development, the ability to further professional training with a high level of autonomy.

PLO 2. Understanding and knowledge of fundamental and clinical biomedical sciences, at a level sufficient to solve professional problems in the field of healthcare.

PLO 3. Specialized conceptual knowledge, including scientific achievements in the field of health care and is the basis for research, critical reflection on problems in the field of medicine and related interdisciplinary problems, including the early intervention system.

PLO 21. To search for the necessary information in professional literature and databases of other sources, to analyze, evaluate and apply this information.

PLO 22. Apply modern digital technologies, specialized software, statistical methods of data analysis to solve complex health care problems.

PLO 24. Organize the necessary level of individual safety (own and those of the person he cares for) in case of typical dangerous situations in the individual field of activity.

PLO 25. Clearly and unambiguously convey their own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists.

PLO 27. Communicate fluently in the state and English languages, both orally and in writing to discuss professional activities, research, and projects.

Criteria for evaluating learning outcomes.

Assessment of the educational activities of HE applicants is regulated by the Regulation on "[Порядок оцінювання знань студентів під час поточного та кінцевого контролю з дисципліни в НМУ імені О.О. Богомольця](#)" (protocol of the meeting of the Academic Council of Bogomolets national medical university

№. 4 dated 28.11.2023).

Current control involves 100% of the survey of applicants in the group with a mandatory assessment of all the components of the lesson: independent work of the applicant, test control, oral questioning, written task, solving a situational problem and performing practical work. At each practical lesson, the teacher assesses the applicant's knowledge in points in accordance with the "Regulations for conducting practical classes and criteria for evaluating current control" with the subsequent conversion of points into an assessment on a four-point national scale ("5", "4", "3", "2"). If, when calculating the scores of all the constituent elements of the assessment of the current control, the sum of points will not be 1.1 points, then this will correspond to the total number of points – 0 and the score "2".

For current training, the applicant can receive a maximum of 80 points.

Criteria for evaluating current educational activities

The grade "Excellent" is given to the applicant who has qualitatively performed the applicant's independent work (SRS), took an active part in the discussion of the most difficult questions on the topic of the lesson, gave at least 90% of the correct answers to standardized test tasks, answered written tasks without errors, performed practical work and solved a situational problem with the design of the scheme of biochemical reactions (the structure of the main biomolecules) and a complete explanation of the medical and biological significance.

The grade "Good" is given to the applicant who has qualitatively completed the SRS, participated in the discussion of complex questions on the topic of the lesson, gave at least 75% of correct answers to standardized test tasks, but made some minor mistakes in answering written tasks, performing practical work and solving a situational problem (when drawing up a scheme of biochemical reactions and explaining medical and biological significance).

The grade "Satisfactory" is given to the applicant who has completed the SRS, did not take an active part in the discussion of the most difficult questions on the topic, gave at least 60% of the correct answers to standardized test tasks, made significant mistakes in answering written tasks, performing practical work and solving a situational problem (drawing up a scheme of biochemical reactions and explaining medical and biological significance).

The grade "Unsatisfactory" is given to an applicant who did not perform the CPS qualitatively or did not perform the CPS at all, did not take part in the

discussion of questions on the topic of the lesson, gave less than 60% of correct answers to standardized test tasks, made gross mistakes in answering written tasks or did not give answers to them at all, did not perform practical work, did not solve a situational problem and did not draw up a scheme of biochemical reactions with an explanation of medical and biological significance.

The applicant is admitted to the exam with the number of points that he received during the study of the discipline under current control and attended at least 75% of the classroom hours in the discipline.

Final control involves the evaluation of all the components of the exam: test control, written task and solving a situational problem. The examiner assesses the applicant's knowledge in points in accordance with the "Regulations for conducting and evaluating the exam". For the final control, the applicant can receive a maximum of 120 points.

The total number of points received by the applicant must be at least 111 points and not more than 200 points. The points received by the applicant for the discipline are converted into a grade according to the national scale "5", "4", "3", "2".

Exam Evaluation Criteria

The grade "Excellent" is given to the applicant who has given at least 90% of the correct answers to standardized test tasks, has given thorough complete answers to all theoretical questions. Demonstrates a comprehensive and deep assimilation of the educational material; has full practical skills; solves a situational problem with the design of a scheme of biochemical reactions (the structure of the main biomolecules) and a thorough explanation of medical and biological significance; understands the meaning of the discipline, its connection with professionally-oriented disciplines and future activities.

The "Good" grade is given to an applicant who has given at least 75% of the correct answers to standardized test tasks, has given answers to all theoretical questions with minor errors, has good practical skills, solves a situational problem with the design of a scheme of biochemical reactions and an explanation of medical and biological significance; understands the meaning of the discipline, its connection with professionally-oriented disciplines and future activities.

The grade "Satisfactory" is given to the applicant who has given at least 60% of the correct answers to standardized test tasks, has made significant mistakes in answering theoretical questions, a situational task (drawing up a scheme of biochemical reactions and explaining medical and biological significance);

demonstrates mastering only the basics of educational material; has not fully mastered practical skills.

The "Unsatisfactory" grade is given to the applicant who gave less than 60% of the correct answers to standardized test tasks, made gross mistakes in answering theoretical questions or did not give answers to them at all. Demonstrates a lack of systematic knowledge, does not have practical skills, cannot solve a situational problem (draw up a scheme of biochemical reactions and explain the medical and biological significance

Competency matrix

	IR	GC	PC 21	PC 23-25	PLO 1-3	PLO 21	PLO 22	PLO 24	PLO 25	PLO 27
OK 11	+	+	+	+	+	+	+	+	+	+

Matrix of compliance of the competencies defined by the Standard with the PLO descriptors

Classification of competencies according to the PLO	Knowledge Kn1 Specialized conceptual knowledge, which includes modern scientific achievements in the field of professional activity or field of knowledge and is the basis for original thinking and research Kn2 Critical Thinking on Problems in the Field and at the Frontier of Knowledge Fields	Skills/Abilities Um1 Specialized Skills/Problem-Solving Skills Required for conducting research and/or conducting innovation activities for the purpose of development Um2 Ability integrate knowledge and solve complex problems in broad or multidisciplinary contexts Um3 Ability taking into account aspects of social and ethical responsibility	Communication C1 Clear and unambiguous communication of own knowledge, conclusions and arguments to specialists and non-specialists, in particular to students C2 The use of foreign languages in professional activities	Responsibility and autonomy of R&A1 Management of work or training processes that are complex, unpredictable and Neednew strategic approaches R&A2 Responsibility for contributing to professional knowledge and practice and/or evaluating the performance of teams and collectives R&A 3 Ability to continue learning with a high degree of autonomy
1	2	3	4	5
General competencies				
GC1. Ability to abstract thinking, analysis and synthesis.	Kn1	Sk1	C1	R&A 1
GC 2. Ability to learn and to master modern knowledge.	Kn1	Sk3	C2	R&A 3
GC 3. Ability to apply knowledge in practical situations.	Kn1	Sk2	C1	R&A 1
GC 4. Knowledge and understanding subject area and understanding of professional activity.	Kn2	Sk2	C2	R&A 2

GC 5. Ability to adapt and act in a new situation.	-	Sk3	-	R&A 2
GC 6. Ability to make informed decisions.	Kn1	Sk3	C1	R&A 1
GC 7. Ability to work in a team.	Kn2	Sk3	C1	R&A 2
GC 8. Ability to interpersonal interaction.	Kn1	Sk3	C1	R&A 2
GC 9. Ability to communicate in a foreign language.	-	-	C2	-
GC 10. Ability use information and communication technologies.	Kn2	Sk3	C2	R&A 3
GC 11. Ability to search, process and analyze information from various sources.	Kn2	Sk2	C2	R&A 2
GC 12. Determination and perseverance in terms of tasks and undertakings Duties.	Kn2	Sk3	-	R&A 3
GC 13. Awareness of equal opportunities and gender issues.	Kn2	Sk1	C1	R&A 1
GC 14. Ability to realize one's rights and duties as a member of society, to realize the values of civic (free democratic) society and the need for its sustainable development, rule of law, rights and freedoms of man and citizen in Ukraine.	Kn1	Sk2	C1	R&A 3

GC 15. Ability to preserve and multiply the moral, cultural, scientific values and achievements of society based on an understanding of history and regularities of the development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, engineering and technology, to use various types and forms of motor activity for active rest and leading a healthy lifestyle.	Kn2	Sk3	-	R&A 3
Special (professional) competencies				
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
PC 21. Clear and ambiguously convey their own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists, in particular to persons who are studying.	Kn2	Sk3	C2	R&A 2
PC 23. Ability to develop and implement scientific and applied projects in the field of healthcare.	Kn2	Sk3	C2	R&A 3
PC 24. Compliance with ethical principles when working with patients, laboratory Animals.	Kn1	Sk2	C1	R&A 1

PC 25. Compliance professional and academic integrity, to carry responsibility for reliability of the scientific results obtained.	Kn2	Sk2	C2	R&A 3
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Matrix of compliance with learning outcomes and competencies defined by the Standard

PL O*	General competencies															Professional competencies																										
	G C 1	G C 2	G C 3	G C 4	G C 5	G C 6	G C 7	G C 8	G C 9	G C 10	G C 11	G C 12	G C 13	G C 14	G C 15	P C 1	P C 2	P C 3	P C 4	P C 5	P C 6	P C 7	P C 8	P C 9	P C 10	P C 11	P C 12	P C 13	P C 14	P C 15	P C 16	P C 17	P C 18	P C 19	P C 20	P C 21	P C 22	P C 23	P C 24	P C 25		
PL O 1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
PL O 2				+		+				+	+	+				+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+	+				+				
PL O 3	+	+	+			+	+		+	+	+	+	+	+	+	+	+	+								+						+	+	+	+	+	+	+	+	+	+	+
PL O 21		+							+	+																	+															
PL O 22					+																							+						+								
PL O 24						+																								+					+	+						
PL O 25					+	+																				+						+				+						
PL O 27					+	+	+	+								+											+						+			+	+					

*Program learning outcomes

3. Structure of the discipline

Name of content modules and topics	Number of hours			
	Full-time form			
	Just	Lecture	Practical classes	SRS
1	2	3	4	5
<i>1 year</i>				
<i>Content module 1. Structure, reactivity and properties of bioorganic compounds.</i>				
Topic 1. Chemical composition of the human body. The nature of chemical bonds in biomolecules. Classification and nomenclature of bioorganic compounds.	4,5	1	3	0.5
Topic 2. Isomerism of organic compounds. Reactivity of biomolecules.	4,5	1	3	0.5
Topic 3. Aqueous solutions of electrolytes and non-electrolytes. Acid-base equilibrium and pH of biological fluids. Buffer systems.	6,0	2	3	1.0
Topic 4. Structure, classification and properties of alcohols, phenols, aldehydes and ketones.	5,0	1	3	1.0
Topic 5. Structure, classification, nomenclature and properties of carboxylic acids, their functional derivatives	4,5	1	3	0.5
Topic 6. Structure, properties and biological significance of higher fatty acids, triacylglycerols, phospholipids. Biologically important steroids.	6,0	2	3	1
Topic 7. Classification, nomenclature, structure and properties of amino acids. General ways of transformation of α -L-amino acids of the human body.	5,0	1	3	1
Topic 8. Structural organization and physicochemical properties of proteins. The role of proteins in the human body.	5,0	1	3	1
Topic 9. Classification of carbohydrates. Monosaccharides: structure, chemical properties and biological significance.	4,5	1	3	0.5
Topic 10. Structure, properties and biological significance of di- and polysaccharides	5	1	3	1
Topic 11. The structure of heterocyclic	5	1	3	1

compounds and their biological significance for the human body.				
Topic 12. Nucleosides, nucleotides, nucleic acids - structure and biological functions.	5	1	3	1
Total for content module 1	60	14	36	10
<i>2nd Course</i> <i>Content module 2. General patterns of metabolism of substances and energy in living organisms.</i>				
Topic 1. Biochemical functions of the cell as the main component of the body's vital activity. Implementation of genetic information: replication, transcription, translation.	4.0	-	3	2.0
Topic 2. Structure, physicochemical properties of enzymes. Nomenclature and classification of enzymes. Mechanism of action of enzymes.	6.5	1	3	2.0
Topic 3. The role of coenzymes and cofactors. Coenzyme functions of water-soluble vitamins.	6.0	0.5	3	2.0
Topic 4. Regulation of enzymatic processes. Enzyme diagnostics. Enzyme therapy.	6.0	0.5	3	2.5
Topic 5. Molecular mechanisms of action of hormones.	7,5	2.0	3	2.5
Topic 6. General pathways of catabolism of biomolecules. Functioning and regulation of the tricarboxylic acid cycle.	6,5	1.0	3	2.5
Topic 7. Biological oxidation, tissue respiration and oxidative phosphorylation. Mechanism of action of inhibitors and disconnectors of oxidative phosphorylation.	6,5	1.0	3	2.5
Total for content module 2	43	6	21	16
<i>Content module 3.</i> <i>Metabolism of carbohydrates, lipids, amino acids, basic principles of its regulation and the role of vitamins.</i>				
Topic 8. Digestion and absorption of carbohydrates, their transmembrane transfer into cells.	6.0	0.5	3	2.5
Topic 9. Aerobic and anaerobic oxidation of glucose: metabolic features and subcellular localization.	6.0	0.5	3	2.5

Topic 10. Glycogen metabolism and its regulation.	6.5	1.0	3	2.5
Topic 11. Hexose monophosphate (pentose phosphate) shunt. Gluconeogenesis. Hormonal regulation of blood glucose levels.	6.5	1.0	3	2.5
Topic 12. Metabolism of galactose and fructose.	6.5	1.0	3	2.5
Topic 13. Digestion and absorption of lipids, their transport into cells.	6.5	1.0	3	2.5
Topic 14. Lipolysis and its regulation. β -oxidation of fatty acids and glycerol.	6.5	1.0	3	2.5
Topic 15. Metabolism of ketone bodies, their biological significance in normal and pathological conditions.	6.5	1.0	3	2.5
Topic 16. Biosynthesis of higher fatty acids, triacylglycerols and phospholipids.	6.5	1.0	3	2.5
Topic 17. Biosynthesis and biotransformation of cholesterol. Plasma lipoproteins.	6.5	1.0	3	2.5
Topic 18. Digestion of proteins and absorption of amino acids. Putrefaction of proteins in the small and large intestines.	6.5	1.0	3	2.5
Topic 19. Ways of formation and neutralization of ammonia in organs and tissues.	6.5	1.0	3	2.5
Topic 20. Amino acid metabolism: phenylalanine, tyrosine, tryptophan	5.75	0.25	3	2.5
Topic 21. Metabolism of biogenic amines (GABA, histamine, serotonin, catecholamines)	5.75	0.25	3	2.5
Topic 22. Biosynthesis of heme and heme proteins (uroporphyrinogen III-cosynthase, ferrochelatase)	5.75	0.25	3	2.5
Topic 23. Metabolism of purine and pyrimidine nucleotides.	5.75	0.25	3	2.5
Topic 24. Water-soluble vitamins B1, B2, B3, B6, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	6.5	1.0	3	2.5

Topic 25. Water-soluble vitamins B5, B9, B12, C and H, their biochemical properties, clinical signs and deficiency symptoms	6.5	1.0	3	2.5
Topic 26. Fat-soluble vitamins, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	7,5	2.0	3	2.5
Total according to the content module 3	120.5	16	57	47.5
<i>Content module 4. Biochemistry of intercellular communications, tissues and physiological functions.</i>				
Topic 27. Biochemical functions of the liver. Metabolism of proteins, lipids, carbohydrates.	6.5	1.0	3	2.5
Topic 28. Detoxification function of the liver (cytochrome P-450, UDP-glucuronyltransferase, animal indican, ornithine cycle (urea).	6.5	1.0	3	2.5
Topic 29. Biochemical functions of blood. Functions of erythrocyte and its metabolism. Biochemical basis of hemolytic anemias.	6.5	1.0	3	2.5
Topic 30. Normal and pathological forms of hemoglobin. Molecular mechanisms of hemoglobinosis development.	6.5	1.0	3	2.5
Topic 31. Biochemistry and pathobiochemistry of plasma proteins (alpha-1-antitrypsin, ceruloplasmin, haptoglobin, C-reactive protein, cryoglobulin).	6.5	1.0	3	2.5
Topic 32. Biochemical mechanisms of the coagulation, anticoagulation and fibrinolytic systems of the blood. The role of vitamin K and Ca^{2+} in the activation of factors of the hemostasis system.	6.5	1.0	3	2.5
Topic 33. The mechanism of contraction and relaxation of skeletal muscles, types of muscle contractions. Biochemical markers of osteogenesis and resorption (alkaline phosphatase, oxyproline).	7.5	2.0	3	2.5
Total for content module 4	46,5	8	21	17,5
IN TOTAL	270	44	135	91

4. Lecture topics

№	Lecture topics	Hours
1 YEAR (I or II semester)		
1	Chemical composition of the human body. Classification, nomenclature and isomerism of organic compounds. Reactivity of biomolecules.	2
2	Solutions. Acid-base equilibrium. Buffer systems, their importance in the homeostasis of the human body.	2
3	Classification, nomenclature, structure and properties of oxygen-containing organic compounds.	2
4	Structure and properties of higher fatty acids, triacylglycerols, phospholipids and sphingolipids.	2
5	Amino acid composition, structural organization and physicochemical properties of proteins.	2
6	Classification of carbohydrates. Structure, chemical properties and biological significance of mono-, di- and polysaccharides	2
7	Biologically active heterocyclic systems. Nucleotides. Nucleic acids.	2
TOTAL for the first year:		14
2 YEAR (III semester)		
1	Biochemistry as a science. Structure, properties, classification and mechanism of action of enzyme proteins. Coenzyme functions of water-soluble vitamins. Regulation of enzymatic reactions. Medical enzymology.	2
2	Molecular mechanisms of action of hormones.	2
3	General pathways of catabolism of biomolecules. Tricarboxylic acid cycle. Respiratory chain of electron transport and oxidative phosphorylation in mitochondria.	2
4	Digestion and absorption of carbohydrates. Oxidation of glucose under aerobic and anaerobic conditions. Glycogen metabolism.	2
5	Hexose monophosphate shunt. Fructose and galactose metabolism. Gluconeogenesis. Regulation of blood glucose levels.	2
6	Digestion and absorption of lipids. Lipolysis. β -oxidation of fatty acids. Metabolism of ketone bodies.	2
7	Biosynthesis of fatty acids, triacylglycerols, phospholipids and sphingolipids. Synthesis and biotransformation of cholesterol.	2
TOTAL for the third semester:		14
2 YEAR (IV semester)		
8	Digestion of proteins and absorption of amino acids. General amino acid conversion pathways. Ammonia metabolism in organs and tissues.	2

9	Specialized amino acid conversion pathways. Metabolism of purine and pyrimidine nucleotides.	2
10	Water-soluble vitamins, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	2
11	Fat-soluble vitamins, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	2
12	Biochemical functions of the liver.	
13	Blood biochemistry.	2
14	Biochemical systems and blood parameters.	2
15	Biochemistry of muscle tissue.	2
TOTAL for the IV semester:		16
IN TOTAL		44

5. Topics of seminar classes

N/a.

6. Topics of practical classes

№	Topic of the practical lesson	Hours
1 YEAR (I or II semester)		
1.	The chemical composition of the human body. The nature of chemical bonding in biomolecules. Classification and nomenclature of bioorganic compounds.	3
2.	Isomerism of organic compounds. Reactivity of biomolecules.	3
3.	Aqueous solutions of electrolytes and non-electrolytes. Acid-base equilibrium and pH of biological fluids. Buffer systems.	3
4.	Structure, classification and properties of alcohols, phenols, aldehydes and ketones.	3
5.	Structure, classification, nomenclature and properties of carboxylic acids, their functional derivatives	3
6.	Structure, properties and biological significance of higher fatty acids, triacylglycerols, phospholipids. Biologically important steroids.	3
7.	Classification, nomenclature, structure and properties of amino acids. Common ways to convert α -L-amino acids of the human body.	3
8.	Structural organization and physicochemical properties of proteins. The role of proteins in the human body.	3
9.	Classification of carbohydrates. Monosaccharides: structure, chemical	3

	properties and biological significance.	
10.	Structure, properties and biological significance of di- and polysaccharides	3
11.	The structure of heterocyclic compounds and their biological significance for the human body.	3
12.	Nucleosides, nucleotides, nucleic acids - structure and biological functions.	3
In just 1 course		36
2 YEAR (III semester)		
1.	Biochemical functions of the cell as the main component of the body's vital activity. Implementation of genetic information: replication, transcription, translation.	3
2.	Structure, physicochemical properties of enzymes. Nomenclature and classification of enzymes. Mechanism of action of enzymes.	3
3.	The role of coenzymes and cofactors. Coenzyme functions of water-soluble vitamins.	3
4.	Regulation of enzymatic processes. Enzyme diagnostics. Enzyme therapy.	3
5.	Molecular mechanisms of action of hormones.	3
6.	General pathways of catabolism of biomolecules. Functioning and regulation of the tricarboxylic acid cycle.	3
7.	Biological oxidation, tissue respiration and oxidative phosphorylation. Mechanism of action of inhibitors and disconnectors of oxidative phosphorylation.	3
8.	Digestion and absorption of carbohydrates, their transmembrane transfer into cells.	3
9.	Aerobic and anaerobic oxidation of glucose: metabolic features and subcellular localization.	3
10.	Glycogen metabolism and its regulation.	3
11.	Hexose monophosphate (pentose phosphate) shunt. Gluconeogenesis. Hormonal regulation of blood glucose levels.	3
12.	Metabolism of galactose and fructose.	3
13.	Digestion and absorption of lipids, their transport into cells.	3
14.	Lipolysis and its regulation. β -oxidation of fatty acids and glycerol.	3
15.	Metabolism of ketone bodies, their biological significance in normal and	3

	pathological conditions.	
Only for the 2nd year of the III semester		45
16.	Biosynthesis of higher fatty acids, triacylglycerols and phospholipids.	3
17.	Biosynthesis and biotransformation of cholesterol. Plasma lipoproteins.	3
18.	Digestion of proteins and absorption of amino acids. Putrefaction of proteins in the small and large intestines.	3
19.	Ways of formation and neutralization of ammonia in organs and tissues.	3
20.	Amino acid metabolism: phenylalanine, tyrosine, tryptophan	3
21.	Metabolism of biogenic amines (GABA, histamine, serotonin, catecholamines)	3
22.	Biosynthesis of heme and heme proteins (uroporphyrinogen III-cosynthase, ferrochelatase)	3
23.	Metabolism of purine and pyrimidine nucleotides.	3
24.	Water-soluble vitamins B1, B2, B3, B6, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	3
25.	Water-soluble vitamins B5, B9, B12, C and H, their biochemical properties, clinical signs and deficiency symptoms	3
26.	Fat-soluble vitamins, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	3
27.	Biochemical functions of the liver. Metabolism of proteins, lipids, carbohydrates.	3
28.	Detoxification function of the liver (cytochrome P-450, UDP-glucuronyltransferase, animal indican, ornithine cycle (urea).	3
29.	Biochemical functions of blood. Functions of the erythrocyte and its metabolism. Biochemical bases of hemolytic anemias.	3
30.	Normal and pathological forms of hemoglobin. Molecular mechanisms of hemoglobinosis development.	3
31.	Biochemistry and pathobiochemistry of plasma proteins (alpha-1-antitrypsin, ceruloplasmin, haptoglobin, C-reactive protein, cryoglobulin).	3
32.	Biochemical mechanisms of the coagulation, anticoagulation and fibrinolytic systems of the blood. The role of vitamin K and Ca^{2+} in the activation of factors of the hemostasis system.	3

33.	The mechanism of contraction and relaxation of skeletal muscles, types of muscle contractions. Biochemical markers of osteogenesis and resorption (alkaline phosphatase, oxyproline).	3
Only for the 2nd year of the III semester		54
IN TOTAL		135

7. Topics of laboratory classes

N/a.

8. Independent work

№	Topic of the practical lesson	Hours
1 YEAR (I or II semester)		
1.	The chemical composition of the human body. The nature of chemical bonding in biomolecules. Classification and nomenclature of bioorganic compounds.	0.5
2.	Isomerism of organic compounds. Reactivity of biomolecules.	0.5
3.	Aqueous solutions of electrolytes and non-electrolytes. Acid-base equilibrium and pH of biological fluids. Buffer systems.	1.0
4.	Structure, classification and properties of alcohols, phenols, aldehydes and ketones.	1.0
5.	Structure, classification, nomenclature and properties of carboxylic acids, their functional derivatives	0.5
6.	Structure, properties and biological significance of higher fatty acids, triacylglycerols, phospholipids. Biologically important steroids.	1
7.	Classification, nomenclature, structure and properties of amino acids. Common ways to convert α -L-amino acids of the human body.	1
8.	Structural organization and physicochemical properties of proteins. The role of proteins in the human body.	1
9.	Classification of carbohydrates. Monosaccharides: structure, chemical properties and biological significance.	0.5
10.	Structure, properties and biological significance of di- and polysaccharides	1
11.	The structure of heterocyclic compounds and their biological significance for the human body.	1
12.	Nucleosides, nucleotides, nucleic acids - structure and biological functions.	1
In just 1 course		10

2 YEAR (III semester)		
34.	Biochemical functions of the cell as the main component of the body's vital activity. Implementation of genetic information: replication, transcription, translation.	1,0
35.	Structure, physicochemical properties of enzymes. Nomenclature and classification of enzymes. Mechanism of action of enzymes.	2.5
36.	The role of coenzymes and cofactors. Coenzyme functions of water-soluble vitamins.	2.5
37.	Regulation of enzymatic processes. Enzyme diagnostics. Enzyme therapy.	2.5
38.	Molecular mechanisms of action of hormones.	2.5
39.	General pathways of catabolism of biomolecules. Functioning and regulation of the tricarboxylic acid cycle.	2.5
40.	Biological oxidation, tissue respiration and oxidative phosphorylation. Mechanism of action of inhibitors and disconnectors of oxidative phosphorylation.	2.5
41.	Digestion and absorption of carbohydrates, their transmembrane transfer into cells.	2.5
42.	Aerobic and anaerobic oxidation of glucose: metabolic features and subcellular localization.	2.5
43.	Glycogen metabolism and its regulation.	2.5
44.	Hexose monophosphate (pentose phosphate) shunt. Gluconeogenesis. Hormonal regulation of blood glucose levels.	2.5
45.	Metabolism of galactose and fructose.	2.5
46.	Digestion and absorption of lipids, their transport into cells.	2.5
47.	Lipolysis and its regulation. β -oxidation of fatty acids and glycerol.	2.5
48.	Metabolism of ketone bodies, their biological significance in normal and pathological conditions.	2.5
Only for the 2nd year of the III semester		36
49.	Biosynthesis of higher fatty acids, triacylglycerols and phospholipids.	2,5
50.	Biosynthesis and biotransformation of cholesterol. Plasma lipoproteins.	2,5
51.	Digestion of proteins and absorption of amino acids. Putrefaction of proteins in the small and large intestines.	2,5
52.	Ways of formation and neutralization of ammonia in organs and tissues.	2,5

53.	Amino acid metabolism: phenylalanine, tyrosine, tryptophan	2,5
54.	Metabolism of biogenic amines (GABA, histamine, serotonin, catecholamines)	2,5
55.	Biosynthesis of heme and heme proteins (uroporphyrinogen III-cosynthase, ferrochelatase)	2,5
56.	Metabolism of purine and pyrimidine nucleotides.	2,5
57.	Water-soluble vitamins B1, B2, B3, B6, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	2,5
58.	Water-soluble vitamins B5, B9, B12, C and H, their biochemical properties, clinical signs and deficiency symptoms	2,5
59.	Fat-soluble vitamins, their biological role in the implementation of cellular functions. Hypovitaminosis and vitamin deficiencies.	2,5
60.	Biochemical functions of the liver. Metabolism of proteins, lipids, carbohydrates.	2,5
61.	Detoxification function of the liver (cytochrome P-450, UDP-glucuronyltransferase, animal indican, ornithine cycle (urea).	2,5
62.	Biochemical functions of blood. Functions of the erythrocyte and its metabolism. Biochemical bases of hemolytic anemias.	2,5
63.	Normal and pathological forms of hemoglobin. Molecular mechanisms of hemoglobinosis development.	2,5
64.	Biochemistry and pathobiochemistry of plasma proteins (alpha-1-antitrypsin, ceruloplasmin, haptoglobin, C-reactive protein, cryoglobulin).	2,5
65.	Biochemical mechanisms of the coagulation, anticoagulation and fibrinolytic systems of the blood. The role of vitamin K and Ca^{2+} in the activation of factors of the hemostasis system.	2,5
66.	The mechanism of contraction and relaxation of skeletal muscles, types of muscle contractions. Biochemical markers of osteogenesis and resorption (alkaline phosphatase, oxyproline).	2,5
Only for the 2nd year of the III semester		45
IN TOTAL		91

9. Individual tasks

Individual tasks are creative, exploratory in nature, contribute to the development of cognitive activity of applicants, which are performed

independently or under the guidance of a teacher. These are additional tasks that allow the applicant to deepen his knowledge of the discipline and get additional points, for example, for speaking at a conference, printing abstracts in accordance with the research topic of the department, prizes in the Olympiad in the discipline among applicants for their universities and higher educational institutions of Ukraine. The maximum number of points awarded to applicants for individual work is 3.5 points.

10. Teaching methods

10.1. Methods of organization and implementation of educational and cognitive activities in the study of the discipline:

Verbal: safety briefing for laboratory tests, lecture, story, explanation, educational discussion.

Visual: demonstration, illustration.

Practical: laboratory research.

10.2. The methods are different in the logic of transmitting and perceiving educational information:

The analytical method involves the logical decomposition of the whole into parts in order to study their essential features and properties.

Inductive - generalization of the studied paths of biochemical transformations from single to general.

Deductive - based on the study of educational material from general to separate, single.

The traductive implies conclusions from the single to the singular, from the partial to the partial, from the general to the general.

10.3. Methods of different levels of independence of thinking:

Problem involves the creation of a problem situation by the teacher, assistance to applicants in identifying and "accepting" a problem task.

Partially-exploratory includes applicants in the search for ways, techniques and means of solving a cognitive task.

The research method is aimed at involving applicants in the independent solution of a cognitive task using the necessary equipment.

11. Methods and forms of control, distribution of points received by students, assessment

Current control:

- independent work of the applicant in the workbook, which is carried out outside of curricular time.

- test control (performance of test tasks of format "A" from collections of test tasks for passing the licensed integrated exam "Step 1");
- oral survey of theoretical material, based on the study by the applicant of theoretical questions from the methodological recommendations of the department;
- performance of practical work with the obligatory formulation of conclusions on the results of biochemical studies;
- solution of a situational problem close to clinical cases in medicine.

Distribution of points received by applicants during the current control:

Trad. Score	MARK	Conversion to points						IW**
		Oral experience.	tests. control	Prakt. Skills	writing. Rob.	situation. Task	IWA*	
"5"	1.7	0.3	0.3	0.2	0.3	0.3	0.3	3,5
"4"	1.4	0.25	0.25	0.15	0.25	0.25	0.25	
"3"	1.1	0.2	0.2	0.1	0.2	0.2	0.2	
"2"	<1.1	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2	

IWA* - independent work of the applicant

IW* - individual work of the applicant

Independent work of the applicant is a generally obligatory task that the applicant must perform for each practical lesson (synopsis according to theoretical issues, performing tasks in a workbook, preparing a protocol for practical work, studying vocabulary and terminology, processing additional literature in Ukrainian and English according to the methodological recommendations of the department).

The individual work of the applicant is carried out under the guidance of a teacher/supervisor, which contributes to the deepening of knowledge in the discipline in the form of preparing essays on the research topics of the department (participation in research and registration of the scientific results obtained in the form of publications, speeches at conferences), obtaining prizes at the university and all-Ukrainian Olympiad. Applicants receive additional points in accordance with the scale of assessment of the discipline.

Final control (exam):

The exam is a form of final control of the identification of theoretical knowledge and practical skills formed in higher education applicants for the entire period of study of the discipline "Medical Biochemistry".

A higher education applicant is admitted to the exam with the number of points that he received for the entire period of studying the academic discipline and

attended at least 75% of classroom hours.

COMPONENTS OF THE EXAM:

Test control - 60 test tasks of the "A" format (35% in English), covering the full course of the curriculum in the discipline "Medical Biochemistry".

Testing knowledge of basic terms and concepts (18 tasks with one correct answer) - assessment of the knowledge of a higher education applicant of fundamental terms and concepts in medical biochemistry, which are key to understanding the functioning of the human body in normal and pathological conditions.

Control of practical skills is a test of the skills of a higher education applicant to use basic biochemical research methods (qualitative and quantitative), followed by the execution of a protocol and conclusions.

The answer to the theoretical question is the assessment of basic theoretical knowledge in the form of a complete answer with a sequential schematic presentation of biochemical transformations, their localization, regulatory enzymes, regulatory pathways and biological significance for the functioning of the human body.

Solution of the situational problem - assessment of the ability to interpret biochemical indicators to establish a preliminary diagnosis, analytical explanation of the diagnostic value of the obtained results of biochemical studies with a complete analysis and characterization of the causes of violations of biochemical processes or their regulation.

Exam Evaluation Criteria

The grade "Excellent" is given to a higher education applicant who has given 90-100% of correct answers to standardized test tasks and basic terms and concepts; has full practical skills; has a thorough complete answer to the theoretical question; has demonstrated a comprehensive and deep assimilation of the educational material in solving a situational problem with the design of a scheme of biochemical processes (the structure of basic biomolecules) and thoroughly explained the medical and biological significance biochemical process; understands the meaning of the discipline, its connection with professionally-oriented disciplines and future activities.

The grade "Good" is received by a higher education applicant who gave 75-89% of correct answers to standardized test tasks and basic terms and concepts; has good practical skills; with minor errors gave an answer to a theoretical question; solved a situational problem with the design of a scheme of biochemical processes and an explanation of medical and biological significance; understands the meaning of the discipline, its connection with professionally-oriented disciplines and the future activities of the doctor.

The grade "Satisfactory" is received by a higher education applicant who gave 60-74% of correct answers to standardized test tasks and basic terms and concepts; has satisfactory practical skills; made significant mistakes in answering a theoretical question and a situational task; made significant mistakes in the design of the scheme of the biochemical process and in the explanation of medical and biological significance; demonstrates the assimilation of only the basic concepts of the educational material.

The grade "Unsatisfactory" is given to a higher education applicant who has violated academic integrity; has given 59% or less of correct answers to standardized test tasks and basic terms and concepts; partially possesses practical skills; made significant mistakes in answers or did not give answers to the theoretical question and situational task at all; demonstrates a lack of systematic knowledge and does not understand the connection with professionally-oriented disciplines and the future activities of a doctor.

Distribution of points received by a higher education applicant for the exam:

Traditional assessment	Audience or LIKAR_NMU (https://likar.nmu.kyiv.ua/)					General mark for the exam
	Test control	Terms and concepts	Practical skills	Theoretical question	Situational task	
«5»	27-30	15-18	15-18	21-26	22-28	100-120
«4»	22-26.5	12-15	12-15	16-21	17-22	79-99.5
«3»	18-21.5	10-12	10-12	13-16	14-17	65-78.5
«2»	0	0	0	0	0	0

When assigning grades for the discipline, the number of points accumulated by the applicant for higher education for current studies (maximum 80) and the result of passing the exam (maximum 120) are taken into account.

Distribution of points received by a higher education applicant for the discipline:

Number of classes	Ongoing assessment and independent work				*IP	Sum of points for current training	Sum of points for Exam	Sum of points per discipline
	«5»	«4»	«3»	«2»				

45	1,7	1,4	1,1	0	3,5	0-80	0-120	0-200
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***IP** - participation in research and registration of scientific results in the form of publications, speeches at conferences, obtaining prizes at the University and All-Ukrainian Olympiad in the discipline "Medical Biochemistry". The corresponding score is counted towards the results of the current control. The absolute winner who held the 1st place at the University and All-Ukrainian Olympiad in the discipline "Medical Biochemistry" receives an automatic enrollment of 120 points (equivalent to the highest grade in the exam). The grade in the discipline must be at least 111 points and not more than 200 points.

Correspondence of scales of assessment of the quality of assimilation of educational material.

National scale score	Score in points	ECTS score	Explanation
«5» Perfectly	170-200	A	Excellent (excellent performance with only a small number of errors).
«4» Well	155-169	B	Very good (above average with a few bugs).
	140-154	C	Good (in general, correct execution with a certain number of significant errors).
«3» Satisfactory	125-139	D	Satisfactory (not bad, but with a significant number of drawbacks).
	111-124	E	Enough (performance meets the minimum criteria).
«2» Disappointing	60-110	FX	Unsatisfactory (with the possibility of reassembly).
	1-59	F	Unsatisfactory (with the obligatory re-study of the discipline).

Question to the exam

Gene expression.

1. Structure and biological significance of DNA and RNA. Types of RNA.
2. General scheme of DNA replication. The biological significance of replication.
3. Stages of DNA replication (initiation, elongation, termination), enzymes and their role in DNA replication of prokaryotes and eukaryotes.
4. General scheme of RNA transcription. Biological significance of transcription.
5. RNA transcription steps (initiation, elongation, termination), enzymes, and their role in RNA transcription. Post-transcriptional modification (processing) of RNA.

6. Genetic Code: definition, properties, biological significance.
7. General scheme of protein translation. Protein-synthesizing system: localization, components, their characteristics.
8. Stages of protein translation (initiation, elongation, termination), enzymes and their role in protein translation.
9. Post-translational modification of polypeptides: chemical modification, limited proteolysis, protein folding.

Enzymes and coenzymes. Regulation of metabolism.

1. Enzymes: definition; Structure and properties of enzymes.
2. Classification and nomenclature of enzymes, characteristics of individual classes of enzymes.
3. Isoenzyme forms of enzymes, diagnostic value of isoenzymes.
4. Mechanisms of action of enzymes.
5. Dependence of catalysis rate on substrate concentration, pH, and temperature.
6. Enzyme activators and inhibitors: Examples and mechanisms of action.
7. Types of enzyme inhibition: reverse (competitive, non-competitive) and irreversible inhibition.
8. Regulation of enzymatic processes.
9. Fat-soluble vitamins. Role in the life of the human body.
10. Water-soluble vitamins: coenzyme forms and their participation in biochemical reactions.

Basic patterns of metabolism. Tricarboxylic acid cycle.

1. Metabolism – general patterns of catabolic and anabolic processes. Common stages of intracellular catabolism of biomolecules: proteins, carbohydrates, lipids.
2. Tricarboxylic acid cycle. Localization, scheme of enzymatic reactions, importance in metabolism.
3. Tissue respiration (components of the mitochondrial respiratory chain and their characteristics).
4. Mechanisms of oxidative phosphorylation. The mechanism of ATP formation is the chemiosmotic theory of ATP synthesis.
5. Tissue respiration and oxidative phosphorylation disconnectors.
6. Inhibitors of electron transport and oxidative phosphorylation in mitochondria.

Hormonal regulation of metabolism and biological functions of the cell.

1. Hormones, Chemical Nature, and Biological Role.
2. Molecular-cellular mechanisms of action of hormones of protein-peptide nature.
3. Molecular and cellular mechanisms of action of steroid hormones.
4. Molecular-cellular mechanisms of action of thyroid hormones.
5. Molecular mechanisms of action and biological role of eicosanoids.

Carbohydrate metabolism and its regulation.

1. Digestion of carbohydrates and absorption of their hydrolysis products. The role of cellulose and other dietary fibers in digestion.
2. Metabolic pathways of fructose conversion, biological significance, hereditary enzymopathies.
3. Metabolic pathways of galactose conversion, biological significance, hereditary enzymopathies.
4. Oxidation of glucose under anaerobic conditions, general characteristics of the process. Reaction diagram and regulatory enzymes.
5. Stages of aerobic oxidation of glucose. Enzymes, coenzymes.
6. Comparative characteristics of bioenergetics of aerobic and anaerobic oxidation of glucose, Pasteur effect.
7. Glycogen: structure, biological significance, synthesis and breakdown in the liver, hormonal regulation of metabolism.
8. Glycogenoses and aglycogenesis, their general characteristics.
9. The role of adrenaline, glucagon, and insulin in hormonal regulation of glycogen metabolism in muscles and liver.
10. Gluconeogenesis: substrates, enzymes and biological significance of the process. Glucose-lactate (Cory cycle) and glucose-alanine cycles.
11. Pentose phosphate pathway of glucose oxidation: process diagram and biological significance.
12. Blood glucose (glucosemia): normoglycemia, hypo- and hyperglycemia, glucosuria. Pathologies of carbohydrate metabolism (diabetes mellitus). Hormonal regulation of blood glucose concentration and metabolism.

Lipid metabolism and its regulation.

1. Digestion of dietary lipids and absorption of their hydrolysis products. The role of bile acids. Steatorrhea.
2. Intracellular lipolysis and its hormonal regulation.
3. β -oxidation of fatty acids and glycerol in tissues (enzymes, coenzymes, biological significance, energy value).
4. Neurohumoral regulation of lipolysis involving adrenaline, glucagon, and insulin.
5. Fatty Acid Synthesis: Localization and Biological Significance. The role of biotin.
6. Synthesis of triacylglycerols: localization and biological significance.
7. Synthesis of phospholipids: localization and biological significance. Lipotropic factors.
8. Sphingolipids: classification, biological significance. Sphingolipidoses.
9. Biosynthesis of ketone bodies: localization and biological significance.
10. Metabolism of ketone bodies under conditions of starvation and diabetes mellitus.
11. Cholesterol biosynthesis: process diagram, regulation of cholesterol synthesis.
12. Pathways of cholesterol biotransformation: esterification, formation of bile

acids, steroid hormones, vitamin D3.

13. Main classes of plasma lipoproteins and their characteristics. Hyperlipoproteinemia.

14. Pathologies of lipid metabolism: atherosclerosis, obesity, diabetes mellitus.

Metabolism of amino acids. Enzymopathies of amino acid metabolism.

1. Digestion of proteins and absorption of their hydrolysis products. Characterization of proteolytic enzymes and their activation.

2. Impaired digestion of proteins, formation, and neutralization of toxic products. Animal indican and its diagnostic value.

3. Amino acid pool. Ways to use amino acids in the body. Glucogenic and ketogenic amino acids. Deamination of free L-amino acids in tissues.

4. Transamination of amino acids: reactions and their biochemical significance, mechanism.

5. Decarboxylation of L-amino acids in the human body. Biological significance of the products formed. Oxidation of biogenic amines.

6. Formation of ammonia, mechanism of its toxic action and methods of neutralization in the body. Transport forms of ammonia.

7. Urea biosynthesis: scheme of biosynthesis, enzymopathies of the ornithine cycle. Hyperammonemia.

8. Biosynthesis of creatine and creatine phosphate and their biological importance.

9. Glutathione: biosynthesis and its biological functions.

10. Specialized pathways for the metabolism of cyclic amino acids – phenylalanine and tyrosine. Hereditary enzymopathies of amino acid metabolism. Phenylketonuria, albinism, alcaptonuria.

11. Sulfur-containing amino acids. Methionine, its biological importance. S-adenosylmethionine.

12. Metabolism of branched-chain amino acids (valine, leucine, isoleucine). Leucinosis.

13. Metabolism of the cyclic amino acid tryptophan and its hereditary enzymopathies.

Metabolism of nucleoproteins.

1. Digestion of nucleoproteins and absorption of end products of their metabolism.

2. Metabolism of purine nucleotides. Disorders of the biosynthesis and breakdown of purine nucleotides (Lesch-Nyhan syndrome, gout).

3. Metabolism of pyrimidine nucleotides (reaction diagram). Regulation of synthesis, breakdown of pyrimidine nucleotides. Impaired biosynthesis and breakdown of pyrimidine nucleotides (orotaciduria).

4. Regulation of deoxyribonucleotide biosynthesis (formation of thymidyl nucleotides). Inhibitors of dTMP biosynthesis as antitumor agents.

Functional Biochemistry.

Blood biochemistry.

1. Blood functions. Biochemical composition of blood. Characterization of the main protein fractions of blood plasma (albumin, globulins, and fibrinogen).
2. Biological role of plasma proteins. Proteinemia.
3. Immunoglobulins: biochemical characterization of selected classes of human immunoglobulins.
4. Acute phase proteins (C-reactive protein, interleukins, interferons).
5. Respiratory function of the erythrocyte.
6. Glucose metabolism in the erythrocyte. The role of glutathione peroxidase.
7. Normal and pathological forms of hemoglobin.
8. Non-protein nitrogen-containing substances of the blood in normal and pathological conditions. Azotemia.
9. Plasma enzymes are used in enzyme diagnostics.
10. Kallikrein-kinin and renin-angiotensin blood systems.
11. The blood coagulation system and the fibrinolytic blood system.
12. Complement system: biochemical components of the human complement

Liver biochemistry.

1. Biochemical functions of the liver. The role of the liver in carbohydrate, protein, and lipid metabolism.
2. Biochemical mechanisms of ethanol neutralization.
3. Microsomal xenobiotic neutralization systems.
4. Heme synthesis: localization, regulation and biological significance. Porphyrria.
5. Heme catabolism: localization and biological significance. Jaundice.

Biochemistry of the kidneys.

1. Mechanism of formation and biochemical composition of primary and secondary urine.
2. Metabolic processes in the kidneys.
3. Physicochemical properties of urine.
4. Normal and pathological components of urine.

Biochemistry of the nervous system, muscle, and connective tissues.

1. Biochemistry of nervous tissue: features of biochemical composition and metabolism.
2. Formation and neutralization of ammonia in brain cells.
3. Biochemical mechanisms of nerve impulse transmission.
4. Neurotransmitters and neuropeptides: mechanism of action and biological effect.
5. Biochemistry of muscle tissue. Energy supply of muscle contraction.
6. Creatine, creatine phosphate, creatinine: localization, synthesis, biological significance. Myopathies.
7. Regulation of glycogen metabolism in muscle tissue.
8. Features of metabolism in the heart muscle.
9. The role of Ca^{2+} in muscle contraction.
10. Synthesis and biochemical composition of collagen and elastin. Biochemical

indicators of the state of connective tissue (collagenoses, mucopolysaccharidoses).

Practical skills to the exam

1. Detection of peptides in solution.
2. Protein precipitation reactions.
3. Trommer's test to prove the presence of hydroxyl groups in the glucose molecule.
4. Detection of pancreatic hormone (insulin) in the test solution by reaction with nitric acid.
5. Detection of lactic acid (lactate) by Uffelmann's reaction in muscle tissue.
6. Quantitative determination of pyruvic acid in a model urine solution.
7. Determination of cholesterol in a model blood serum solution.
8. Perform a qualitative reaction to phenylpyruvic acid in the experiment.
9. Perform a reaction to pancreatic hormone (insulin) with nitric acid.
10. Determination of water-containing hormones (thyroxine, T3 and T4) in biological fluids.
11. Detection of vitamin K. Reaction with alkaline cysteine solution.
12. Detection of glycogen in hydrolysates of liver samples under normal diet and in a state of starvation.
13. Determination of indican in urine (Obermeyer test).
14. Determination of total bilirubin in blood plasma by Bokalchuk method.
15. Determination of hemin group of hemoglobin by benzidine test.
16. Conducting a comparative analysis for the detection of proteins in different samples of model urine solutions using the precipitation reaction with sulfosalicylic acid.
17. Determination of creatinine in urine by the Jaffe method

12. Course policy: mandatory adherence to academic integrity by students, namely:

- independent performance of all types of work, tasks, forms of control provided for by the work program of this academic discipline;
- references to sources of information in case of using ideas, developments, statements, information;
- compliance with the norms of legislation on copyright and related rights;
- providing reliable information about the results of their own educational

(scientific, creative) activities, using research methods and sources of information.

13. Methodological support

- work program of the academic discipline;
- syllabus of the academic discipline;
- textbooks, manuals in accordance with the list of references;
- multimedia lectures;
- methodological recommendations for practical classes;
- methodological recommendations for independent work of the applicant;
- Electronic version:

<https://nmuofficial.com/zagalni-vidomosti/kafedri/department-bioorganic-biological-chemistry/informatsiya-dlya-studentiv-5/>
<https://likar.nmu.kyiv.ua/>

- workbooks;
- electronic bank of test tasks STEP 1 for current and final control of applicants' performance;
- cases of situational tasks and clinical situations for current and final control of the success of applicants with examples of solution.

14. Recommended Reading

Main

1. Biological Chemistry : textbook / Yu. I. Gubskiy ; Bogomolets National Medical University. - 3rd ed. - Vinnytsia : Nova Knyha, 2020. -488 p.

Additional

1. Kaplan medikal USMLE Step 1 Lecture Notes 2020: biochemistry and Medical Genetics / ed. S.Turco. - New York: Kaplan Medical, 2020. - 403 p.

Electronic resources

- <https://nmuofficial.com/zagalni-vidomosti/kafedri/department-bioorganic-biological-chemistry/informatsiya-dlya-studentiv-5/>
- <https://likar.nmu.kyiv.ua/>