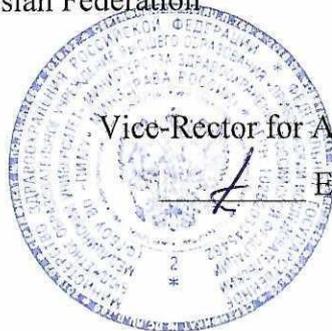


Federal State Budgetary Educational Institution of Higher Education  
"Privolzhsky Research Medical University"  
Ministry of Health of the Russian Federation



APPROVED

Vice-Rector for Academic Affairs

E.S. Bogomolova

31 August 2021

## WORKING PROGRAM

Name of the academic discipline: **BIOCHEMISTRY**

Specialty: **31.05.01 GENERAL MEDICINE**  
(code, name)

Qualification: **GENERAL PRACTITIONER**

Department: **BIOCHEMISTRY**

Mode of study: **FULL-TIME**

Labor intensity of the academic discipline: **72 academic hours**

Nizhny Novgorod  
2021

The working program has been developed in accordance with the Federal State Educational Standard for the specialty 31.05.01 GENERAL MEDICINE approved by Order of the Ministry of Education and Science of the Russian Federation No. 988 dated August 12, 2020.

**Developers of the working program:**

Erlykina E.I., Doctor of Biological Sciences, Professor, Head of the Department of Biochemistry named after G.Ya.Gorodisskaya.

Kopytova T.V., Doctor of Biological Sciences, Professor of the Department of Biochemistry named after G.Ya.Gorodisskaya.

The program was reviewed and approved at the department meeting (protocol No. 7 from 15.04.2021).

Head of the Department,

Doctor of Biological Sciences, Professor,  (Erlykina E.I.)  
(signature)

AGREED

Deputy Head of EMA ph.d. of biology  Lovtsova L.V.  
(signature)

15.04.2021.

**1. The purpose and objectives of mastering the academic discipline biochemistry** (hereinafter – the discipline):

1.1. The purpose of mastering the discipline:

**The purpose of mastering the discipline:** participation in forming the relevant competencies UC-1, GPC-5 and GPC-10.

1.2. Tasks of the discipline:

to form knowledge about the basic patterns of metabolic processes that determine the state of human health and adaptation at the molecular, cellular and organ levels of the whole organism, to apply the knowledge gained in solving clinical problems.

1.3. Requirements to the deliverables of mastering the discipline:

**As a result of completing the discipline, the student should:**

**Know:**

- the structure and properties of the main classes of biologically important compounds, the main metabolic pathways of their transformation, the role of hereditary factors in the development of diseases,

- the chemical and biological essence of the processes occurring in the living human body at the molecular and cellular levels, their changes under the influence of negative factors,

- basic principles of biochemical processes of human activity in their integrity and interrelation.

**Be able to:**

- use the basics of biochemical knowledge about the composition and metabolism of organs and tissues to analyze their functions at the molecular level and the state of the body as a whole,

- analyze the state of the human body using knowledge about the biochemical processes underlying its activities; interpret the results of the most common methods of laboratory diagnostics, receive information in global computer networks,

- determine the state of the human body, based on the interpretation of biochemical studies, identify the signs of pathological processes,

- navigate in educational, scientific, regulatory and reference literature, in information resources.

**Possess:**

- the ability to think abstractly, analyze, synthesize the information received,

- basic information transformation technologies, medical and functional conceptual apparatus,

- methods of forming a healthy lifestyle of a person, using knowledge about the molecular mechanisms underlying the processes of vital activity,

- analytical skills with information obtained from various sources.

**2. Position of the academic discipline in the structure of the General Educational Program of Higher Education (GEP HE) of the organization.**

**2.1.** The discipline biochemistry refers to the core part of Block 1 of GEP HE (Academic discipline index).

The discipline is taught in the third and the fourth semester/2<sup>nd</sup> year of study.

**2.2. The following knowledge, skills and abilities formed by previous academic disciplines are required for mastering the discipline:**

1. biology,

2. physics,
3. medical informatics,
4. chemistry,
5. histology,
6. cytology and embryology,
7. normal anatomy,
8. normal physiology.

**2.3. Mastering the discipline is required for forming the following knowledge, skills and abilities for subsequent academic disciplines:**

1. pathophysiology,
2. clinical pathophysiology;
3. pharmacology;
4. microbiology,
5. virology;
6. immunology.

**3. Deliverables of mastering the academic discipline and metrics of competence acquisition**

Mastering the discipline aims at acquiring the following universal (UC) or/and general professional (GPC) or/and professional (PC) competencies

№	Competence code	The content of the competence (or its part)	Code and name of the competence acquisition metric	As a result of mastering the discipline, the students should:		
				know	be able to	possess
1.	UC-1	Able to carry out critical analysis of problem situations based on a systematic approach, develop an action strategy	Knows: methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis Able to: gain new knowledge based on analysis, synthesis, etc.; collect data on complex scientific problems related to the professional field; search for information and solutions based on action, experiment and experience Has practical experience: researching the problem of professional activity using analysis, synthesis and other	the basic principles of biochemical processes of human activity in their integrity and interrelation	use the basics of biochemical knowledge about the composition and metabolism of organs and tissues to analyze their functions at the molecular level and the state of the body as a whole	ability to think abstractly, analyze, synthesize the information received

			methods of intellectual activity; developing an action strategy to solve professional problems			
2.	GPC-5	Able to assess morphofunctional, physiological conditions and pathological processes in the human body to solve professional problems	Knows: anatomy, histology, embryology, topographic anatomy, physiology, pathological anatomy and physiology of human organs and systems Able to: evaluate the basic morphological and functional data, physiological conditions and pathological processes in the human body Has practical experience in: assessment of basic morphological and functional data, physiological conditions and pathological processes in the human body when solving professional problems	the structure and properties of the main classes of biologically important compounds, the main metabolic pathways of their transformation, the role of hereditary factors in the development of diseases	determine the state of the human body, to identify signs of pathological processes, based on the interpretation of biochemical studies	basic technologies for performing biochemical analyses in clinical settings and "at the patient's bedside"  transformation of information by a medico-functional conceptual apparatus
3.	GPC-10	Able to understand the principles of modern information technologies and use them to solve the tasks of professional activity	Knows: the capabilities of reference information systems and professional databases; methods of information retrieval, information and communication technologies; modern medical and biological	medical and biological terminology, basic information and information and communication technologies	Analyze the state of the human body using knowledge about the biochemical processes underlying its activity; interpret the results	Methods of evaluation of laboratory studies using mathematical calculations and comparisons.

			<p>terminology; fundamentals of information security in professional activities</p> <p>Able to: apply modern information and communication technologies to solve the tasks of professional activity; carry out an effective search for information necessary to solve the tasks of professional activity using reference systems and professional databases; use modern medical and biological terminology; master and apply modern information and communication technologies in professional activity, taking into account the basic requirements of information security</p> <p>Has practical experience in the use of modern information and bibliographic resources, the use of special software and automated information systems to solve standard tasks of professional activity, taking into account the basic requirements of information security</p>	<p>es, bibliographic resources</p>	<p>of the most common methods of laboratory diagnostics, obtain information using information technologies and bibliographic resources</p>	
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**4. Sections of the academic discipline and competencies that are formed when mastering them**

№	Competence code	Section name of the discipline	The content of the section in teaching units
1	UC-1, GPC-5, GPC-10	Structure, properties and functions of proteins	Structural organization, physico-chemical properties and functions of proteins. The role of proteomics in the assessment of pathological conditions.
2	UC-1, GPC-5, GPC-10	Enzymes.	Structure and properties of enzymes. Mechanisms of regulation of enzyme activity.
3	UC-1, GPC-5, GPC-10	Introduction to metabolism. Biological oxidation.	Exchange with the environment. Metabolism: anabolic, anabolic and amphibolic reactions. Specific and general pathways of catabolism. The concept of biological oxidation. The Krebs cycle, its connection with the respiratory chain. The structure and functions of the electron transfer chain, the mechanism of oxidative phosphorylation.
4	UC-1, GPC-5, GPC-10	Protein and amino acid metabolism	Nutritional value of proteins. Digestion of food proteins. Transport of amino acids into the cell. Common pathways of amino acid catabolism. Ammonia neutralization and transport. Ornithine cycle of urea synthesis. Hyperammonemia. The exchange of individual amino acids.
5	UC-1, GPC-5, GPC-10	Nucleotide metabolism	Metabolism of purine and pyrimidine nucleotides. Synthesis of deoxyribonucleotides.
6	UC-1, GPC-5, GPC-10	Hormones	Signal transmission to the cell. Membrane receptors. Formation of secondary messengers. Metabolic changes in response to signaling molecules. Intracellular signal transmission. Hormonal regulation as a mechanism of intercellular and inter-organ coordination of metabolism.
7	UC-1, GPC-5, GPC-10	Carbohydrate metabolism	The structure of the main mono-, oligo- and polysaccharides. Digestion of food carbohydrates. Indigestible carbohydrates. Common pathways of glucose metabolism in the cell. Synthesis and breakdown of glycogen, regulation. Glycolysis. Key reactions of gluconeogenesis. Reactions of the pentose phosphate pathway of glucose conversion. Formation of reducing equivalents and ribose. Regulation of blood glucose levels.
8	UC-1, GPC-5, GPC-10	Lipid metabolism	Digestion of food lipids. The metabolism of fatty acids. Eicosanoids. Synthesis and utilization of ketone bodies. Metabolism of triacylglycerols and glycerophospholipids, regulation. Cholesterol metabolism. Lipid composition of biological membranes and their properties. Mechanisms of transfer of substances through membranes. Lipid peroxidation.
9	UC-1, GPC-5, GPC-10	Biochemistry of connective tissue.	Biochemistry of the intercellular matrix. The structure of collagen. Collagen synthesis, posttranslational processing, the role of ascorbic acid. Violations of the synthesis of collagen proteins in humans. Elastin. Synthesis and breakdown of elastin. Changes in the structure of elastin in pathological processes. Proteoglycans and glycosaminoglycans. Mucopolysaccharidoses. Catabolism of intercellular matrix proteins.
10	UC-1, GPC-5, GPC-10	Biochemistry of muscle tissue	Proteins of myofibrils, molecular structure: myosin, actin, actomyosin, tropomyosin, troponin. Biochemical mechanisms of muscle contraction and relaxation. Peculiarities of energy metabolism in muscles; creatine phosphate. Creatinuria. Features of myocardial metabolism
11	UC-1, GPC-5, GPC-10	Biochemistry of the liver	Liver functions. The breakdown of hemoglobin in tissues: the formation of bilirubin, its further transformations; the fate of bile pigments. Endogenous and foreign toxic substances. Neutralizing liver function. Microsomal and non-microsomal oxidation. Conjugation reactions.

12	UC-1, GPC-5, GPC-10	Biochemistry of nervous tissue	Chemical composition of nervous tissue. Energy metabolism in the nervous tissue. Mediators: acetylcholine, catecholamines, serotonin, gamma-aminobutyric acid, glutamic acid, glycine, histamine. Violation of the metabolism of biogenic amines in mental diseases.
13	UC-1, GPC-5, GPC-10	Biochemistry of blood and urine	Blood and its functions. Blood proteins. Methods of quantitative determination of proteins and protein fractions, changes in the protein composition of blood in some pathological conditions. Clinical significance of the blood test. Clinical significance of the determination of urea, creatinine. Iron metabolism. Disorders of heme synthesis. Porphyria. Anemia. Blood enzymes, their diagnostic significance. Primary urine. Characteristics of urine components in normal and pathological conditions. Chemical components of urine: protein, non-protein nitrogenous substances, urea, uric acid, ammonium salts, creatine and creatinine, hippuric acid, indican, lactic and pyruvic acids, mineral salts. The concept of urine clearance. Proteinuria. Glycosuria. Ketonuria. Bilirubinuria. Urobilin bodies. Hematuria, hemoglobinuria. Crystal structures of urinary sediment

### 5. Volume of the academic discipline and types of academic work

Type of educational work	Labor intensity		Labor intensity (AH) in semesters			
	volume in credit units (CU)	volume in academic hours (AH)	Semester 3	Semester 4		
Classroom work, including		133	73	60		
Lectures (L)	0,78	28	18	10		
Laboratory practicum (LP)*	2,91	105	55	50		
Practicals (P)						
Seminars (S)						
Student's individual work (SIW)	2,30	83	45	38		
Mid-term assessment						
credit/exam ( <i>specify the type</i> )	1	36				
<b>TOTAL LABOR INTENSITY</b>	<b>7</b>	<b>252</b>	<b>118</b>	<b>98</b>		

### 6. Content of the academic discipline

#### 6.1. Sections of the discipline and types of academic work

№	Name of the section of the academic discipline	Types of academic work* (in AH)					
		L	LP	P	S	SIW	total
1	Structure, properties and functions of proteins. Enzymes.	3	19			14	36
2	Introduction to metabolism. Biological oxidation	3	12			4	19
3	Hormones	2	5			6	13
4	Protein and amino acid metabolism	4	10			17	31
5	Nucleotide metabolism	2	2			11	15
6	Carbohydrate metabolism	4	15			7	26
7	Lipid metabolism	6	20			7	33
8	Biochemistry of connective tissue. Biochemistry of muscle tissue.	2	5+7			5	12
9	Biochemistry of the liver.	2	5			4	11
10	Biochemistry of the nervous system.					9	9

11	Biochemistry of blood and urine		5			6	11
	TOTAL						252

\* - L – lectures; LP – laboratory practicum; P – practicals; S – seminars; SIW – student's individual work.

## 6.2. Thematic schedule of educational work types:

### 6.2.1 Thematic schedule of lectures

№	Name of lecture topics	Volume in AH	
		semester 3	semester 4
1	Introduction to biochemistry. Structure and properties of proteins	1	
2	Structural organization and properties of enzymes. Fundamentals of enzymatic kinetics	2	
3	Energy metabolism. The general catabolic pathway. The Krebs cycle.	1	
4	Mitochondrial electron transfer chain. Oxidative phosphorylation. Regulation. Hypoenergetic states. The concept of mitochondrial diseases.	2	
5	Amino acid metabolism. Common pathways of amino acid catabolism	2	
6	Metabolism of individual amino acids. Final products of nitrogen metabolism	2	
7	Nucleotide metabolism	2	
8	Biochemistry of hormones. Mechanisms of hormonal signal transmission.	2	
9	Biochemistry of carbohydrates. Glycogen metabolism. The concept of glycogenoses.	2	
10	Glucose metabolism. Regulation of carbohydrate metabolism	2	
11	Lipid metabolism. Digestion and absorption of lipids. Transport of lipids. Dyslipoproteinemia		2
12	Lipid catabolism. Synthesis and oxidation of ketone bodies. Ketonemia, ketonuria		2
13	Lipid anabolism. Metabolism of membranes. Lipid peroxidation.		2
14	Biochemistry of connective and muscle tissue		2
15	Biochemistry of the liver		2
	TOTAL (total – 28 AH)	18	<b>10</b>

### 6.2.2. The thematic plan of laboratory practicums (if this type of classes is stipulated in the curriculum)

№	Name of laboratory practicums	Volume in AH	
		semester 3	semester 4
1	1. Structure and properties of amino acids and proteins Investigation of amino acid composition and structural organization of protein molecules;	20	

	<p>properties of proteins and methods of their research in the medical practice.</p> <p>2. Properties of proteins. Mutant proteins. Pathology of protein folding. Molecular and conformational diseases.</p> <p>The study of the physicochemical properties of proteins; the place and role of holding processes in the formation of protein structure; characteristics of molecular and conformational diseases. The interaction of proteins with ligands as the basis of some approaches to the treatment of diseases.</p> <p>3. The structure of enzymes. Vitamins as participants in enzymatic reactions. The specificity of the action of enzymes. Congenital and acquired enzymopathies. Enzyme diagnostics.</p> <p>Formation of knowledge about enzymes, their structure, classification, biological functions, methods of measuring their activity in the medical practice. The application of knowledge about vitamins as cofactors of enzymes in the medical practice.</p> <p>4. Regulation of enzyme activity. Enzyme inhibitors as drugs: the application of enzymes in medicine.</p> <p>Study of the kinetics of enzymatic reactions, types of regulation of enzyme activity for use in the medical practice.</p>		
2	<p>1. Energy metabolism. Tricarboxylic acid cycle. Violations of energy metabolism</p> <p>2. Exchange with the environment. Digestion of basic nutrients (fats, proteins and carbohydrates). Metabolism: anabolic, anabolic and amphibolic reactions. Specific and general pathways of catabolism. Oxidative decarboxylation of pyruvic acid: the structure of the pyruvate dehydrogenase complex (enzymes and coenzymes). Citric acid cycle (Krebs cycle).</p> <p>2. Biological oxidation. Oxidative phosphorylation. Mitochondrial diseases.</p> <p>Organization of the mitochondrial respiratory chain, multi-enzyme complexes, electron carriers. Oxidative phosphorylation. Regulation. Hypoenergetic states. The concept of mitochondrial diseases.</p>	12	
3	<p>1. Protein digestion. Diagnostic value of biochemical analysis of gastric contents</p> <p>General characteristics of protein metabolism. The biological value of proteins. Nitrogen balance. Protein digestion. Violations of the processes of digestion and absorption of proteins. Diagnostic value of gastric juice. Protein rotting.</p> <p>2. Interstitial transformations of amino acids. Hereditary disorders of amino acid metabolism. Common pathways of amino acid catabolism. Glycogenic and ketogenic amino acids. Metabolism of individual amino acids: phenylalanine, tyrosine, arginine. Disorders of amino acid metabolism, their</p>	16	

	<p>diagnosis. Nitric oxide, mechanism of action, physiological effect.</p> <p>3. End products of protein metabolism. Violations of the synthesis and excretion of urea. Temporary and final neutralization of ammonia. Toxicity of ammonia. Hyperammonemia. Residual nitrogen. Azotemia.</p>		
4	<p>1. Nucleic acids. Nucleotide metabolism. The idea of biosynthesis and catabolism of purine and pyrimidine nucleotides. The role of the PRPP.. Regulation of the synthesis of purine and pyrimidine nucleotides. Metabolic disorders of purines (gout, Lesh-Nihan syndrome) and pyrimidines. Synthesis of deoxyribonucleotides. The use of deoxyribonucleotide synthesis inhibitors in cancer chemotherapy.</p> <p>2. Protein synthesis. Fundamentals of genomics and proteomics. Principles of gene therapy. Study of the structure and processes of nucleic acid metabolism, their role in the transmission and realization of genetic information; regulation of matrix biosynthesis processes in the cell, the effect of antibiotics on them.</p>	2	
5	<p>Hormones: The main mechanisms of metabolic regulation. General characteristics of hormones. Classification of hormones, synthesis and degradation of hormones, regulation. Characteristics of the receptors. Mechanisms of hormonal action: membrane, intracellular. The application of hormones in medicine.</p>	5	
6	<p>1. Digestion of carbohydrates. The body's reserve carbohydrates. Glycogen. The structure of the main mono-, oligo- and polysaccharides. Common pathways of glucose metabolism in the cell. Synthesis and breakdown of glycogen, regulation. Glycogenoses.</p> <p>2. Glucose catabolism. Glycolysis. The pentose phosphate pathway of glucose oxidation. Glycolysis: a sequence of reactions. Glycolytic oxidoreduction. Substrate level phosphorylation. Key reactions of gluconeogenesis. Reactions of the pentose phosphate pathway of glucose conversion. Gluconeogenesis. Regulation of carbohydrate metabolism. Regulation of blood glucose levels.</p>		15
7	<p>1. The most important lipids of the body. Digestion of lipids. Transport of lipids. Atherogenic lipoproteins. The main lipids of the body, structure, functions. Digestion, absorption of lipids. Lipid resynthesis in the intestinal wall. Transport of lipids. Lipoproteins: structure, metabolism, functions. Dyslipoproteinemia.</p>		20
8	<p>1. Biochemistry of connective tissue. Biochemistry of muscle tissue. Chemical composition of</p>		5

	connective tissue. Characteristics of collagen, elastin, glycosaminoglycans: features of amino acid composition, primary and spatial structure, polymorphism, functions, biosynthesis. Changes in connective tissue during aging, collagenosis, wound healing. Oxyprolinuria in collagenopathies. 2.The most important proteins of myofibrils: myosin, actin, actomyosin. Tropomyosin. Troponin. The molecular structure of myofibrils. Biochemical mechanisms of muscle contraction and relaxation. The peculiarities of energy metabolism in muscles, creatine phosphate. Features of metabolism in the heart muscle.		
9	Liver biochemistry of liver. bile pigments metabolism. Biotransformation of xenobiotics Liver function. Antitoxic liver function. Endogenous and exogenous toxic substances. Metabolism of foreign substances: microsomal oxidation reactions and conjugation reactions. Alcohol neutralization as a way of non-microsomal oxidation. bile pigments metabolism. The breakdown of hemoglobin. Bilirubin synthesis and decay. Direct and indirect bilirubin. Violation of bilirubin metabolism. Jaundice: hemolytic, obstructive, hepatic. Diagnostic value of determination of bilirubin and other bile pigments in blood and urine.		5
10	Biochemistry of blood and urine Blood and its functions. Blood proteins. Clinical significance of protein fractionation and determination of metabolites in blood serum. Iron metabolism. Disorders of heme synthesis – porphyria . Anemia. Blood enzymes, their diagnostic significance. Primary urine. Characteristics of urine components in normal and pathological conditions. Clinical significance of the analysis of physical properties, chemical components, cellular elements of urine and crystal structures of urinary sediment.		5
	<b>TOTAL (total - AH) 105</b>		

6.2.3. Thematic plan of practicals: not provided.

№	Name of the topics of practicals	Volume in AH	
		semester	semester
	<b>TOTAL (total - AH)</b>		

6.2.4. Thematic plan of seminars (if this type of classes is stipulated in the curriculum): not provided

№	Name of seminar topics	Volume in AH

		semester	semester
	TOTAL (total - AH)		

#### 6.2.5. Types and topics of student's individual work (SIW)

№	Types and topics of SIW	Volume in AH	
1	<p><b>Structure, properties and functions of proteins Enzymes.</b> Preparation for practical classes, knowledge-based monitoring and tests. Preparation of essays on the following topics:</p> <ul style="list-style-type: none"> <li>- Prions and prion diseases.</li> <li>- The role of proteomics in the assessment of pathological conditions.</li> <li>- Enzyme specificity and its application in medicine.</li> <li>- Hypovitaminosis and vitamin deficiency.</li> <li>- Hereditary enzymopathies.</li> </ul>	semester 3 13	semester 4
2	<p><b>Introduction to metabolism. Biological oxidation.</b> Preparation for practical classes, knowledge-based monitoring and tests. Preparation of essays on the following topics:</p> <ul style="list-style-type: none"> <li>- biochemical bases of the use of medicines based on vitamins of group B and succinic acid.</li> </ul> <p>Biochemistry of hypoenergetic states. Mitchell's chemiosmotic theory. Formation and use of electrochemical potential. Mitochondrial diseases. The role of mitochondria in the development of programmed cell death and apoptosis.</p>	6	
3	<p><b>Hormones.</b> Preparation for practical classes, knowledge-based monitoring and tests. Preparation of essays on the following topics:</p> <ul style="list-style-type: none"> <li>- Target cells and cellular hormone receptors.</li> <li>- Insulin. Mechanisms of hormonal signal transmission to the cell.</li> <li>- Structure, synthesis and metabolism of iodothyronines.</li> <li>- Eicosanoids as regulators of cellular functions, auto- and paracrine mechanism of regulatory effect.</li> </ul>	6	
4	<p><b>Protein and amino acid metabolism.</b> Preparation for practical classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics:</p> <ul style="list-style-type: none"> <li>- the significance of determining the acidity of gastric juice for the diagnosis of gastrointestinal diseases.</li> <li>- Metabolism of serine and threonine.</li> <li>- Metabolism of sulfur-containing amino acids.</li> <li>- nitric oxide as the discovery of the 20th century.</li> <li>- Enzymopathies of amino acid metabolism.</li> </ul>	12	
5	<p><b>Nucleotide metabolism.</b> Preparation for practical</p>	8	

	<p>classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics: -Enzymopathy of purine reutilization. Gout. Lesh-Nihan syndrome. -Application of DNA technologies in medicine.</p>		
6	<p><b>Carbohydrate metabolism.</b> Preparation for practical classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics: - Disorders of digestion and absorption of carbohydrates. - glucose transporters. -Hyperglycemia and hypoglycemia. -Glycation of proteins. - The relationship of glycolysis and gluconeogenesis.</p>		7
7	<p><b>Lipid metabolism.</b> Preparation for practical classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics: - essential fatty acids and phospholipids. -bile acids: formation and their role in the digestion of lipids. -the relationship of carbohydrate and lipid metabolism. - Hypercholesterolemia and hyperlipoproteinemia as risk factors for atherosclerosis.</p>		7
8 9	<p><b>Biochemistry of connective tissue. Biochemistry of muscle tissue.</b> Preparation for practical classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics: - age-related changes in the metabolism of connective tissue. - Biochemical changes in muscular dystrophy and muscle denervation. -biochemical features of myocardial metabolism.</p>		4
10	<p><b>Biochemistry of liver.</b> Preparation for practical classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics:  - Microsomal and non-microsomal oxidation. - The significance of the liver in the metabolism of drugs. - Methods of investigation of antitoxic liver function.</p>		4
11	<p><b>Biochemistry of nervous system.</b> Preparation for practical classes, knowledge-based monitoring, and tests. Preparation of essays on the following topics: - The peptide continuum of the brain. Delta-sleep-inducing peptide as the regulator of brain metabolism - Violation of the metabolism of biogenic amines in neuropsychiatric diseases. -Modern concept of neuroplasticity.</p>		9
12	<p><b>Biochemistry of blood and urine.</b> Preparation for practical classes, knowledge-based monitoring, and</p>		6

	tests. Preparation of essays on the following topics: - acute phase proteins as the markers of inflammation - modern methods for the determination of enzymes in blood serum - hormonal regulation of kidney functions - modern methods of dry chemistry in laboratory diagnostics		
	<b>TOTAL (total - AH) 83</b>		

### 7. Types of assessment formats for ongoing monitoring and mid-term assessment

№	Semester No.	Types of control	Name of section of academic discipline	Competence codes	Assessment formats			
					types	number of test questions	number of test task options	
1.	3	Current monitoring	Control of mastering the topic	Structure and functions of proteins and amino acids. Enzymes	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Structure and functions of proteins and amino acids. Enzymes	UC-1, GPC-5, GPC-10	Medical cases Control work	1 1	8-16 10-15
1	3	Current monitoring	Control of mastering the topic	Common pathways of catabolism. Biological oxidation.	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Common pathways of catabolism. Biological oxidation.	UC-1, GPC-5, GPC-10	Medical cases Control work	2 1	10-15 23
1	3	Current monitoring	Control of mastering the topic	Protein and amino acid metabolism	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Protein and amino acid metabolism	UC-1, GPC-5, GPC-10	Medical cases Control work Essays	1 2 1	10-15 38 4-6
1	3	Current monitoring	Control of mastering the topic	Nucleotide metabolism	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random

								sampling)
			Monitoring the student's individual work	Nucleotide metabolism	UC-1, GPC-5, GPC-10	Medical cases Control work	1 1	10-15 22
1	3	Current monitoring	Control of mastering the topic	Hormones	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Hormones	UC-1, GPC-5, GPC-10	Interview Medical cases Essays	2 1 1	18-20 25 2-6
1	4	Current monitoring	Control of mastering the topic	Carbohydrate metabolism	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Carbohydrate metabolism	UC-1, GPC-5, GPC-10	Interview Control work Medical cases	1 2 1	5-8 18-20 34
1	4	Current monitoring	Control of mastering the topic	Lipid metabolism	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Lipid metabolism	UC-1, GPC-5, GPC-10	Interactive lesson Control work Medical cases Essays	1 2 1 1	10-15 39 6-8
1	4	Current monitoring	Control of mastering the topic	Biochemistry of connective tissue Biochemistry of muscle tissue	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Biochemistry of connective tissue Biochemistry	UC-1, GPC-5, GPC-10	Interview Control work	1 1	10-15 15

				of muscle tissue		Medical cases	1	17
1	4	Current monitoring	Control of mastering the topic	Biochemistry of the liver	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Biochemistry of the liver	UC-1, GPC-5, GPC-10	Interview Control work Medical cases	1 2 1	10-15 15 17
1	4	Current monitoring	Control of mastering the topic	Biochemistry of nervous tissue	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Biochemistry of nervous tissue	UC-1, GPC-5, GPC-10	Interview Conference Medical cases	1 1 1	10 19
1	4	Current monitoring	Control of mastering the topic	Biochemistry of blood and urine	UC-1, GPC-5, GPC-10	Test assignments	10	testing (the variant is formed by random sampling)
			Monitoring the student's individual work	Biochemistry of blood and urine	UC-1, GPC-5, GPC-10	Interview Control work Medical cases	1 1 1	15 15-18 15
2.		Mid-term assessment	Exam/ Credit			Control work Medical cases	2 1	36 44

## 8. Educational, methodological and informational support for mastering the academic discipline (printed, electronic publications, the Internet and other network resources)

### 8.1. Key literature references

№	Name according to bibliographic requirements	Number of copies
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		at the department	in the library
1	Lippincott Illustrated Reviews: Biochemistry / E. E. Abali, S. D. Cline, D. S. Franklin, S. M. Viselli. - 8th ed. - Philadelphia : Wolters Kluwer, 2022. - XI, 625 p. : ill. - ISBN 978-1-975155-11-7.	1	60
2	Lieberman, M. Marks' basic medical biochemistry : a clinical approach / M. Lieberman, A. Peet. – 5th ed. – Philadelphia : Wolters Kluwer, 2018. – 2327 p. – ISBN 9781496324818. – URL: <a href="https://www.pdfdrive.com/marks-basic-medical-biochemistry-a-clinical-approach-5th-edition-d158491166.html">https://www.pdfdrive.com/marks-basic-medical-biochemistry-a-clinical-approach-5th-edition-d158491166.html</a>	1	N/A
3	Lieberman, M. Marks, Basic Medical Biochemistry: a clinical approach / M. Lieberman, A. D. Marks ; Lieberman, Michael ; Marks, Allan D. – 3 ed. – Philadelphia : Wolters Kluwer, 2009. – 1011 p. – ISBN 9781608313983.	1	1

### 8.2. Further reading

№	Name according to bibliographic requirements	Number of copies	
		at the department	in the library
1	Baynes, J. W. Medical biochemistry / J. W. Baynes, M. H. Dominiczak ; Baynes, John W. ; Dominiczak, Marek H. – 2nd ed. – Philadelphia ; Edinburgh ; London : Elsevier Mosby, 2005. – XII, 693 p. – ISBN 9780723433415.	0	1
2	Brownie, A. C. Medical biochemistry : a core text with self-assessment / A. C. Brownie, J. C. Kernohan ; Brownie Alexander C. ; Kernohan John C. – 2nd ed. – Edinburgh : Elsevier, 2005. – 319 с. : ил. мяг. – (Master medicine). – ISBN 0-443-10015-2.	0	1
3	Chatterjea, M. Textbook of medical biochemistry / M. Chatterjea, R. Shinde ; Chatterjea MN ; Shinde Rana. – 4th ed. – New Delhi : Jaypee Brothers Medical Publishers (P) LTD., 2000. – 775 с. : ил. мяг. – ISBN 81-7179-782-2.	0	1

### 8.3. Electronic educational resources for teaching academic subjects

#### 8.3.1. Internal Electronic Library System of the University (IELSU)

№	Name of the electronic resource	Brief description (content)	Access conditions	Number of users
1	Manual on biochemistry. Part 1 / A. A. Anashkina, O. V. Barinova, E. I. Erlykina [et al.] ; Nizhny Novgorod State Medical Academy. – N. Novgorod : Publishing House of NizhSMA, 2016.	The given workbook is designed according to the curriculum on biochemistry for the foreign students of general medicine of Medical Higher Educational Institutions. It is intended to save the student's time	Subscription	N/A

		and optimize their practical work.		
2	Glukhov, A. I. Biochemistry with exercises and tasks : монография / A. I. Glukhov, V. V. Garin ; Glukhov A. I. ; Garin V. V. – Москва : ГЭОТАР-Медиа, 2020. – 296 с. – ISBN 978-5-9704-5317-9.	The textbook written by the professors of the Biological Chemistry Department of the I.M. Sechenov First Moscow State Medical University (Sechenov University) approaches complicated modern scientific data about a molecular basis of the functioning of the organism in an intelligible form. This edition contains illustrative material, test tasks and situational problems in each of 14 sections. All the problems proposed for the individual solution have "guiding" questions that help students to solve them. Most of these tasks are based on the questions covered in the special course "Biochemistry of connective tissue. Biochemistry of mixed saliva". The textbook is intended for medical students who specialize in Dentistry, and can be also used for studying biochemistry by the students of other specialties.	Subscription	N\A

### 8.3.2. Electronic educational resources acquired by the University

№	Name of the electronic resource	Brief description (content)	Access conditions	Number of users
1	International scientometric database "Web of Science Core Collection"	Web of Science covers materials on natural, technical, social, and humanitarian sciences; takes into account the mutual citation of publications developed and provided by Thomson Reuters; has built-in capabilities for searching, analyzing, and managing bibliographic information.	Access is free from PRMU computers [Electronic resource] – Access to the resource at: <a href="http://apps.webofknowledge.com">http://apps.webofknowledge.com</a>	N\A

### 8.3.3 Open access resources

№	Name of the electronic resource	Brief description (content)	Access conditions
1	PubMed (National Library of Medicine)	PubMed is a free resource supporting the search and retrieval of biomedical and life sciences literature with the aim of improving health—both globally and personally. The PubMed database contains more than 35 million citations and abstracts of biomedical literature. It does not include full text journal articles; however, links to the full text are often present when available from other sources, such as the publisher's website or PubMed Central (PMC).	Available to the public online free.

## 9. Material and technical support for mastering an academic discipline

9.1. List of premises for classroom activities for the discipline

1. 7 specially equipped classrooms equipped with laboratory tables, fume hoods for seminars and practical classes in the study of the discipline

2. 2 specially equipped scientific laboratories for the implementation of research work of students

9.2. List of equipment for classroom activities for the discipline

1. water baths, photoelectrocolorimeters, laboratory centrifuges, thermostats, spectrophotometers, ionomers, urine analyzers, laboratory utensils, tripods, sets of appropriate reagents, laboratory animals (white rats), scalpels, blades, tweezers, Petri dishes, flasks, test tubes, reagent bottles; filter paper;

2. multimedia complexes for lectures (laptop, projector, screen), televisions, laptop with multimedia set-top box, computers, printers, scanners, educational boards.

9.3. A set of licensed and freely distributed software, including domestic production

Item no.	Software	number of licenses	Type of software	Manufacturer	Number in the unified register of Russian software	Contract No. and date
1	Wtware	100	Thin Client Operating System	Kovalev Andrey Alexandrovich	1960	2471/05-18 from 28.05.2018
2	MyOffice is Standard. A corporate user license for educational organizations, with no expiration date, with the right to receive updates for 1 year.	220	Office Application	LLC "NEW CLOUD TECHNOLOGIES"	283	without limitation, with the right to receive updates for 1 year.
3	LibreOffice		Office Application	The Document Foundation	Freely distributed software	

4	Windows 10 Education	700	Operating systems	Microsoft	Azure Dev Tools for Teaching Subscription	
5	Yandex. Browser		Browser	«Yandex»	3722	
6	Subscription to MS Office Pro for 170 PCs for FGBOU VO "PIMU" of the Ministry of Health of Russia	170	Office Application	Microsoft		23618/HN10030 LLC "Softline Trade" from 04.12.2020

**10. List of changes to the working program (to be filled out by the template)**

Federal State Budgetary Educational Institution of Higher Education  
 "Privolzhsky Research Medical University"  
 Ministry of Health of the Russian Federation  
 (FSBEI HE "PRMU" of the Ministry of Health of Russia)

Department of  
*Name of the department*

**CHANGE REGISTRATION SHEET**

working program for the academic discipline  
***NAME OF THE ACADEMIC DISCIPLINE***

Field of study / specialty / scientific specialty: \_\_\_\_\_  
 (code, name)

Training profile: \_\_\_\_\_  
 (name) - for master's degree programs

Mode of study: \_\_\_\_\_  
 full-time/mixed attendance mode/extramural

Position	Number and name of the program section	Contents of the changes made	Effective date of the changes	Contributor's signature
1				

Approved at the department meeting  
 Protocol No. \_\_\_\_\_ of \_\_\_\_\_ 20\_\_

Head of the Department

\_\_\_\_\_  
 department name, academic title

\_\_\_\_\_  
 signature

\_\_\_\_\_  
 print name