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Acting vice-Rector for Academic Affairs,
Professor K.M. Ragimov

01 July 2023.



WORKING PROGRAMM

on "BIOCHEMISTRY"

Discipline index – B1.O.22.

Specialty - 31.05.01 « General Medicine »

Level of higher education – specialty

Graduate qualifications – medical doctor

Faculty - Medical

The department - General and biological chemistry

Form of training - full-time

Course – 2

Semester – 3, 4

Total labor input (in credit units / hours) – 7/252

lectures - 44 hours

practical classes - 88 hours

laboratory classes -20 hours

independent work –64 hours


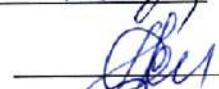

exam - 4 semester - 36 hours

The work program of the discipline "Biochemistry" is developed on the basis of the workplan of BPEP HE in the specialty 05.31.01. "General Medicine" (higher education level - specialty), approved by the Academic Council of the Federal State Budget Educational Institution of Higher Medical Education of the Dagestan State Medical University of the Health Ministry of the Russian Federation, Minutes No. 1 dated 08/29/2019, in accordance with the Federal State Educational Standards of Higher Education in the direction of preparation 05.31.01. "General Medicine" (higher education level – specialty), approved by order No. 95 of the Education and Science Ministry of the Russian Federation dated 12.08.2020.

The work program of the discipline was approved at a meeting of the Department of General and Biological Chemistry from 23.05.2023 Protocol No. 8.

Head of Department  prof. Nagiev E.R.

Work program agreed:

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2. The Head of ED and CCE  A.M. Karimova
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CONTENT

1.	PURPOSE AND OBJECTIVES OF DISCIPLINE MASTERTING	
2.	LIST OF PLANNED TRAINING RESULTS	
3.	PLACE OF EDUCATIONAL DISCIPLINE IN THE STRUCTURE OF THE EDUCATIONAL PROGRAM	
4.	THECOMPLEXITY EDUCATIONAL DISCIPLINE AND TYPERS OF CONTACT WORK	
5.	STRUCTURE AND CONTENT OF EDUCATIONAL DISCIPLINE	
5.1.	SECTIONS OF EDUCATIONAL DISCIPLINE AND COMPETENCE WHICH SHOULD BE MASTERED AT THEIR STUDY	
5.2.	SECTIONS OF DISCIPLINE, TYPES OF EDUCATIONAL ACTIVITIES AND FORMS OF CURRENT CONTROL	
5.3.	TITLE OF LECTURES WITH INDICATION OF NUMBER OF HOURS	
5.4.	MES IN PRACTICE LESSONS WITH INDICATION OF NUMBER OF HOURS	
5.5.	LABORATORY WORKSHOP	
5.6.	INDEPENDENT WORK OF A STUDENT IN DISCIPLINE	
6.	LIST OF BASIC AND ADDITIONAL LITERATURE NECESSARY FOR THE DEVELOPMENT OF DISCIPLINE	
7.	LIST OF RESOURCES OF THE INTERNET INFORMATION AND TELECOMMUNICATION NETWORK	
8.	EDUCATIONAL TECHNOLOGIES	
9.	MATERIAL AND TECHNICAL SUPPORT	
10.	HUMAN RESOURCES	
11.	ASSESSMENT FUND FOR CURRENT MONITORING AND INTERMEDIATE ASSESSMENT	
12.	WORK PROGRAM REGISTRATION SHEET	
13.	APPENDIX: AF	

1. PURPOSE AND OBJECTIVES OF DISCIPLINE MASTERTING

PURPOSE – to form knowledge about the **molecular mechanisms** of the physiological functions of the human body and their disorders in pathological conditions, about the basic laws of metabolic processes that determine the state of health and human adaptation to changes in the conditions of the external and internal environment; substantiate biochemical mechanisms for the prevention and treatment of diseases, and biochemical methods for diagnosing diseases and monitoring the effectiveness of treatment.

OBJECTIVES:

- To study the chemical structure of organic substances and their metabolism in a healthy person;
- familiarization of students with the structure, properties and functions of basic biomolecules.
- to study of the pathways of the metabolism of nucleic acids, proteins, carbohydrates and lipids and their relationships.
- to study of the stages of energy metabolism, methods of storage and consumption of metabolic fuel by cells.
- formation of ideas about the basic principles of regulation and their mechanisms.
- to show by examples the pathogenesis of diseases as a result of damage to biochemical mechanisms;
- to teach students the biochemical diagnosis of diseases of the digestive, cardiovascular and excretory systems of the body;
- to teach students to work with literature, that is, find and understand information on biochemistry when it becomes necessary, and use this information to solve medical problems.

2. LIST OF PLANNED STUDY RESULTS

Competencies formed in the process of studying a discipline:

Category (group) of general profession	Code and name of general professional competence	Code and name of the achievement indicator of general professional competence
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al competencies		
	GPC -5. One is able to assess morphofunctional, physiological conditions and pathological processes in the human body to solve professional problems.	
		ID-1 GPC-5 To know functional systems, their regulation and self-regulation under the influence of environmental factors in normal and pathological processes To be able to evaluate the results of clinical, laboratory and functional diagnostics in solving professional problems. To possess algorithm of laboratory and functional diagnostics in solving professional problems,
		ID -2 GPC-5 One can: interpret the data of the main physical-chemical, mathematical and natural-science research methods in solving professional problems To know: the chemical and biological essence of the processes occurring in a living organism at the molecular and cellular levels; structure and biochemical properties of the main classes of biologically important compounds, the main metabolic pathways of their transformations; the role of cell membranes and their transport systems in metabolism in the body; To be able: to evaluate and interpret the results of the most common laboratory diagnostic methods to identify pathological processes; - substantiate the nature of the pathological process and its clinical manifestations, the principles of pathogenic therapy of the most common diseases. To possess the ability to assess physiological conditions and pathological processes in the human body based on the results of a laboratory examination in solving professional problems.

3. PLACE OF EDUCATIONAL DISCIPLINE IN THE STRUCTURE OF OOP:

The discipline "Biochemistry" refers to the base part of block 1 of discipline B1. 0. 23. in the specialty 05.31.01. "General Medicine."

The basic knowledge necessary to study the discipline is formed:

- through the study of the following disciplines - biology, chemistry; anatomy; histology, embryology, cytology; normal physiology.

The discipline "Biochemistry" is the previous one for the study of disciplines:

- pathophysiology;
- pharmacology;
- microbiology, virology;

- immunology;
- professional disciplines.

To study the discipline "Biological chemistry" the following knowledge, skills and abilities formed by previous disciplines are required.

Bioorganic chemistry:

- **Knowledge** – To know the structure of the most important organic compounds that make up human organs and tissues (in particular, DNA, RNA, proteins, etc.);
- **Skills** - To be able to write the formulas that make up the components of the human body's macromolecules (amino acids, nucleotides, etc.), indicate what chemical bonds they connect to each other;
- **Attainments** - theoretical skills explaining the development mechanisms of some pathological processes.

Biology:

- **Knowledge** – To know the functions of the most important organic compounds that make up human organs and tissues (in particular, DNA, RNA, proteins, etc.);
- **Skills** - To be able to analyze the possible connections between the origin of life on Earth and the structure and functions of proteins and nucleic acids;
- **Attainments** - theoretical skills explaining the mechanisms of development of some pathological processes in a living organism.

Sections of the discipline "Biochemistry"

№	Name of sections
1	The structure and function of proteins. Enzymes
2	Vitamins and hormones
3	Bioenergy and biooxidation
4	Carbohydrate metabolism.
5	Lipid metabolism.
6	The metabolism of simple and complex proteins.
7	Regulation of metabolism. Biochemistry of individual organs and tissues..
8	The biosynthesis of nucleic acids and proteins. The basics of molecular genetics..

The list of disciplines, which mastering by students is necessary for the study of biological chemistry.

№	Discipline	Sections
2.	Bioorganic chemistry	The structure and reactivity of carbohydrates, lipids, peptides and proteins, nucleic acids. General idea of biologically active substances; chemistry of some vitamins and hormones
3.	Physiology	"Cell Physiology"; "Physiology of metabolism"; "Physiology of digestion"; "Endocrine glands"; "Blood"; "Physiology of water-salt metabolism"
4.		

	Physiology	"The structure of cell organization, chemistry, functions of organelles of the cell"; "Levels of organization of living matter"; "Assimilation and dissimilation, their unity and opposite. Features of the structure of proteins. " "The concept of genetic material and its properties. The molecular basis of heredity. The problems of genetic engineering, the concept of hereditary diseases. "
5.	Physics	Biomechanics "(centrifugation, its use in the practice of biomedical research." Oscillations and waves. Acoustics "(action of ultrasound on matter." Thermodynamics of biological systems "(The body as an open system. Energy balance. Forms of energy in a living cell. Calorimeter.) Optics. " "(Concentration colorimetry. Colorimetry)." Bioelectric potentials "Membrane potential and its ionic nature.
6.	Anatomy	«Organogenesis "Age-related anatomy" "Comparative anatomy" "Achievements of anatomy in the development of the doctrine of man"

3. THE CAPACITY OF EDUCATIONAL DISCIPLINE AND TYPES OF CONTACT WORK

The total complexity of the discipline is 7 credits.

Type of study	Total hours	Number of hours per semester		
		3	4	
Classwork lessons (total), including:	152	100	52	
Lectures (L)	44	28	16	
Practical classes (PC)	88	60	28	
Laboratory classes (LC)	20	12	8	
Student's self-study (SSS) (total)	64	44	20	
Type of intermediate certification (test, exam)	36		36	
Total labor input	hours.	252	144	108
	credit unit	7	4	3

5. STRUCTURE AND CONTENT OF EDUCATIONAL DISCIPLINE

5.1 Sections of academic discipline and competencies that should be mastered in their study

№	Section Content	The name of the discipline section	Controlled competencies
1.	Biological functions of proteins. Amino acids as structural elements of a protein molecule. Structural organization of proteins. Physico-chemical properties of proteins. Reversible and irreversible protein precipitation reactions.	The physiological role and biological functions of proteins. The primary structure of proteins and its informational role. Secondary and tertiary structures of proteins. Protein conformation: formation stages, features of the influence of environmental conditions. Conformational lability of proteins. Features of the quaternary structure of the protein. The structure and functions of oligomeric proteins on the example of hemoglobin in comparison with myoglobin. The molecular weight of proteins. Size and shape of protein molecules. Globular and fibrillar proteins. Physico-chemical properties of the protein: solubility, ionization, hydration, precipitation of proteins from solutions. Protein denaturation, reversibility of denaturation. Factors causing denaturation. Protein precipitation reactions.	GPC -5
2	Classification of proteins. Simple and complex proteins. Chromoproteins. Hemoglobin, chemical nature, structure, role	Classification of proteins. Simple proteins - albumin, globulin, protamine, histone, structure and biological role. Complex proteins, their representatives. Phosphoproteins, nucleoproteins, Chromoproteins, their representatives. Hemoglobin, chemical nature, structure, role. Derivatives of hemoglobin. Hemoglobinopathies.	GPC -5

3.	<p>General characteristics and properties of enzymes. The chemical nature of enzymes.</p> <p>The structure of enzymes.</p> <p>The mechanism of action of enzymes. Features of enzymatic catalysis.</p>	<p>General characteristics and basic properties of enzymes. Evidence of the protein nature of enzymes. The specificity of the action of enzymes. Types of specificity. Organ-specific enzymes. Isoenzymes, determination of the isoenzyme spectrum of enzymes in the clinic.</p> <p>Enzymes as simple and complex proteins. Cofactors: prosthetic groups of enzymes, coenzymes, metal ions. Cofactors of enzymes, characteristics of the main coenzymes and their functions. The mechanism of action of enzymes. Enzyme-substrate complexes and the mechanism of their formation. The main parameters characterizing the dependence of the rate of the enzymatic reaction on the concentration of the substrate. Active and allosteric enzyme centers.</p>	GPC -5
4.	<p>Factors affecting enzyme activity.</p> <p>Regulation of enzyme activity. Classification of enzymes. Medical Qing Enzymology. Medicines are enzyme inhibitors. The use of enzymes in medicine</p>	<p>tivators and inhibitors of enzymes. Types of inhibition. Regulation of enzyme activity.</p> <p>zyme inhibitors and their use as therapeutic agents. Classification and nomenclature of enzymes. Brief description of individual classes of enzymes. The concept of enzymopathies. Enzymes are medicines. Principles of enzyme diagnostics and enzyme therapy</p>	GPC -5
5.	<p>Some issues of nutritional biochemistry. Vitamins, hypovitaminosis and vitamin deficiency. Vitamin classification. Fat-soluble vitamins A, D, E, K. Ascorbic acid - vitamin C, biolol.</p> <p>Characterization of water soluble vitamins. Coenzyme role of vitamins</p>	<p>Introduction to metabolism. Biochemistry of nutrition. Ideas about interchangeable and irreplaceable components of food. The biological role of vitamins. Hypo-, hyper- and vitamin deficiencies. Anti-vitamins. Vitamin classification. Fat-soluble vitamins A, D, E, K, bio-role. Ascorbic acid is vitamin C. The role of vitamin C in collagen synthesis. The mechanism of development of scurvy (scorbut).</p> <p>The biological role of water-soluble vitamins B1, B2, B6, B12, PP, P (rutin), N (biotin). Pantothenic and folic acid. Coenzyme role of water soluble vitamins. The participation of vitamins in the metabolism. Hypovitaminosis associated with a lack of water-soluble vitamins. The biological role of vitamin-like substances</p>	GPC -5
6.	<p>General characteristics of hormones. The mechanisms of action of hormones.</p> <p>Hormones of the hypothalamus, pituitary,</p>	<p>The mechanism of action of steroid and protein hormones. Membrane-intracellular and cytosolic mechanisms of hormone action. cAMP - as an intermediary between hormones and intracellular regulatory mechanisms. The role of adenylate cyclase and phosphodiesterase, protein kinases. Ca²⁺</p>	GPC -5

	thyroid and parathyroid glands.	+, cGMP as secondary intermediaries. Guanylate cyclase, the role of nitric oxide NO in the formation of cGMP. Characterization of the hormones of the hypothalamus, pituitary, thyroid and parathyroid glands.	
7.	Hormones of the brain and adrenal cortex. Hormones of the pancreas and gonads.	Chemical structure, biological effect and participation in the metabolism of hormones of the cortical and brain layer of the adrenal glands; hormones of the pancreas and gonads. The development of pathological conditions with hypo- and hyperfunction of these endocrine glands. Prostaglandins and their derivatives. - biological role and effect on metabolism.	GPC -5
8.	Bioenergy General patterns of metabolism. The formation and storage of energy in the cell. Macroergic compounds.	General patterns of metabolism in a living organism. The main stages of the catabolism of substances and their relationships. Representations of specific and general ways of catabolism. The catabolism of nutrients (carbohydrates, fats, proteins) is the main source of energy necessary for vital processes. Energy-rich compounds as universal energy keepers in biological objects. Structural features and properties of macroergic compounds. Endergonic and exergonic reactions in a living cell; macroergic compounds. ADP-ATP cycle. ATP and its analogues. Creatine phosphate and its role in bioenergy.	GPC -5
9.	Biooxidation Modern representations of biological oxidation. Mitochondrial electron transfer chain. Oxidative phosphorylation.	Features of oxidative processes in living tissues. Structures suitable for dehydrogenation. Dehydrogenation of substrates and oxidation of hydrogen to form water (tissue respiration) as an energy source for ATP synthesis. Thermoregulatory function of tissue respiration. Regulation of tissue respiration intensity by endogenous and exogenous substances. The structure of the main respiratory chain. The role of NAD, NADP, FAD and FMN. Coenzyme Q and cytochromes. Biological oxidation and oxidative phosphorylation. P / O phosphorylation coefficient. Chemiosmotic theory of oxidative phosphorylation. Dissociation of oxidation and phosphorylation. Free breathing. Conjugation and uncoupling factors. Respiratory control. Substrate phosphorylation. Microsomal oxidation is a biological role.	GPC -5

10.	<p>Assimilation of dietary carbohydrates. Glycogen exchange. Regulation of the synthesis and breakdown of glycogen</p> <p>Glucose catabolism.</p>	<p>Essential carbohydrate foods. Digestion. Glucose as a major metabolite of carbohydrate metabolism. The mechanism of transmembrane transfer of glucose and other monosaccharides to cells. Glycogen is a backup form of glucose. The structure, properties and distribution of glycogen. Glycogen biosynthesis and breakdown (mobilization) are processes that maintain a constant glucose level in the blood. Differences in glycogen mobilization in the liver and muscles. Regulation of the synthesis and breakdown of glycogen by hormones.</p> <p>Aerobic breakdown is the main pathway for glucose catabolism in humans. Aerobic glycolysis as a glucose-specific pathway of catabolism. Energy effect of aerobic glycolysis and aerobic breakdown of glucose. Anaerobic decomposition (anaerobic glycolysis). The difference between the final proton acceptors during aerobic and anaerobic glycolysis. Regeneration of NAD + as a reaction that ensures the continuous course of the glycolytic process in tissues with a limited supply of oxygen or the absence of mitochondria in the cells. Regulation of glucose catabolism.</p>	GPC -5
11	<p>The final stage of the catabolism of nutrients. The tricarboxylic acid cycle.</p>	<p>The specific and general path of catabolism. Oxidative decarboxylation of pyruvic acid. Pyruvate dehydrogenase complex. The tricarboxylic acid cycle is the main source of tissue respiration substrates. The relationship of reactions of the common pathway of catabolism and CPE. Energy balance of aerobic glucose oxidation. Mechanisms of regulation of the general pathway of catabolism. Hypoenergetic conditions.</p>	GPC -5
12.	<p>Glucose synthesis (gluconeogenesis). The pentose phosphate pathway for glucose conversion. Regulation of blood glucose is normal, hyperhypoglucosemia in pathological conditions.</p>	<p>Glucose biosynthesis (gluconeogenesis) from non-carbohydrate substances. Substrates of gluconeogenesis in various physiological conditions: during fasting and during physical exertion. Routes of exchange of lactate (measles cycle). Regulation of glycolysis and gluconeogenesis. The role of insulin and glucagon. The importance of glycolysis in the liver for fat synthesis. Regulation of blood glucose in various physiological conditions of the body. The pentose phosphate pathway for glucose conversion. Distribution and physiological significance of the process.</p>	GPC -5

3.	<p>Assimilation of food lipids. Lipid transport by chylomicrons. Fat mobilization, β-oxidation of fatty acids. Metabolism of ketone bodies. Biosynthesis and functions of eicosanoids</p>	<p>The structure and functions of human tissue lipids, essential fatty acids. Digestion, absorption and transport of blood fats and possible violations of these processes: steatorrhea, hyperchilomicronemia. The function of lipoprotein lipase. Mobilization of fat in adipose tissue. The role of insulin, glucagon, adrenaline in the regulation of fat metabolism. β – oxidation of fatty acids, its regulation. The biosynthesis and oxidation of ketone bodies. The role of fatty acids and ketone bodies as sources of energy during physical work, fasting, diabetes. Eicosanoids, biological effects. The use in dentistry of drugs that suppress the synthesis of eicosanoids.</p>	GPC -5
	The biosynthesis of fatty acids and fats. Hormonal regulation.	<p>Stages of fatty acid biosynthesis, synthesis of fats from carbohydrates in the liver, packaging in VLDL and transport. Deposition of fat in adipose tissue. The role of insulin in the regulation of fatty acid and fat synthesis.</p>	GPC -5
14	<p>Cholesterol metabolism, regulation of the process. Biosynthesis and function of bile acids. Hypercholesterolemia. Cell structure membranes and their role in metabolism and energy. The role of membranes in transmembrane signaling. Lipid peroxidation and antioxidant systems.</p>	<p>The functions of cholesterol, the stages of its biosynthesis and regulation. The role of lipoproteins in cholesterol transport. Synthesis and conjugation of bile acids, enterohepatic circulation. Hypercholesterolemia, biochemical basis for the development of atherosclerosis and its treatment. The role of ω-3 acids in the prevention of atherosclerosis complications. Gallstone disease and principles of its treatment. The main cell membranes and their functions. The lipid composition of the membranes is phospholipids, glycolipids, cholesterol. Mechanisms for the transfer of substances through membranes. The main components and stages of transmembrane signaling of hormones, mediators, cytokines, eicosanoids. Lipid peroxidation (LPO) and its mechanism. Membrane damage due to LPO activation. The mechanism of protection against the toxic effects of oxygen: superoxide dismutase, catalase, glutathione peroxidase ..</p>	GPC -5
15	<p>Nitrogen balance. Digestion and absorption of proteins in the gastrointestinal tract. Decay of proteins in the intestines. Paired connections.</p>	<p>Digestion of proteins, absorption of amino acids. Peptidases of the stomach and pancreas. Essential and essential amino acids. Diagnostic value of biochemical analysis of gastric and duodenal juice. Decay of proteins in the intestines. The role of the liver in the neutralization of toxic substances and the formation of paired compounds.</p>	GPC -5
	<p>Common pathways of amino acid catabolism. Trans and deamination as an</p>	<p>The role of pyridoxalphosphate in the metabolism of amino acids. Transamination and deamination of amino acids. The biological significance of these</p>	GPC -5

intermediate exchange of amino acids.	processes. Oxidative deamination is the main type of deamination in human tissues. Glutamate dehydrogenase. The clinical significance of serum transaminases. Indirect zeamination of amino acids.	
The exchange of individual amino acids. The formation and inactivation of biogenic amines. Methionine and its participation in transmethylation processes. Inherited disorders of amino acid metabolism. Education, causes of toxicity and neutralization of ammonia. Urea synthesis Hyperammonemia.	Decarboxylation of amino acids and the formation of biogenic amines. Exchange of serine and glycine. The role of H4 folate. The mechanism of action of sulfa drugs. Methionine and transmethylation reactions. The synthesis of creatine and its importance for providing energy to muscle work. The exchange of phenylalanine and tyrosine in different tissues. Synthesis of catecholamines and their biological role. The final products of nitrogen metabolism are ammonium salts and urea. The role of glutamine and alanine in the neutralization and transport of ammonia. Urea synthesis in the liver. Violations of the synthesis and elimination of urea, as the main cause of different types of hyperammonemia. Use of nitrogen-free amino acid residues	GPC -5

16	<p>The exchange of complex proteins.</p> <p>Transformation of nucleoproteins.</p> <p>Biosynthesis of DNA and RNA. Repair errors and DNA damage.</p> <p>Protein biosynthesis - translation. Inhibitors of matrix biosynthesis.</p> <p>Mechanisms of genetic variation and protein polymorphism.</p> <p>Regulation of protein synthesis. Molecular mutations.</p>	<p>The breakdown of nucleoproteins and nucleic acids.</p> <p>Ways of synthesis of purine and pyrimidine nucleotides, enzymes, regulation. Catabolism of purine and pyrimidine nucleotides. Pathology of purine nucleotide metabolism: gout. The structure and functions of nucleic acids. Features of the structure of DNA. DNA replication. The structure and functions of DNA and various types of RNA.</p> <p>DNA synthesis, providing the transmission of genetic traits from generation to generation. The association of replication with the cell cycle. DNA repair is the basis of genome stability.</p> <p>Biological code as a way of translating a four-digit nucleotide record into an amino acid sequence.</p> <p>Protein synthesizing system. The sequence of events during the formation of the polypeptide chain on the ribosome. Amino Acid Activation. Broadcast and its mechanism. Stages of protein synthesis. Initiation, Elongation and Termination of Protein Synthesis. Postsynthetic changes and the formation of functionally active proteins.</p> <p>Regulation of protein biosynthesis. The concept of operon and regulation at the transcription level. Induction and its mechanisms. Post-translational modifications of proteins. Inhibitors of matrix syntheses. Molecular mutations and recombinations as a source of genetic variation. Inherited diseases. The use of DNA technology in medicine.</p> <p>Polymerase chain reaction and PCR diagnostics.</p>	GPC -5
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17	<p>Changes in hormonal status and metabolism during fasting and diabetes. Hormonal regulation of water-salt metabolism and calcium metabolism.</p>	<p>Regulation of energy metabolism, the role of insulin and contrainsular hormones in providing homeostasis. The role of insulin and glucagon in the regulation of energy metabolism in the postabsorption period and during fasting. Changes in hormonal status and metabolism in diabetes. Diabetic coma. The pathogenesis of late complications of diabetes mellitus (macro- and microangiopathies, nephropathy, retinopathy, cataracts, caries, periodontal disease). Regulation of water-salt metabolism. The structure and functions of aldosterone, vasopressin, atrial natriuretic factor (PNF). The renin-angiotensin-aldosterone system. Biochemical mechanisms of the occurrence of renal hypertension, edema, xerostomia. The role of hormones in the regulation of calcium and phosphate metabolism (parathyroid hormone, calcitonin and calcitriol). The structure, biosynthesis and mechanism of action of calcitriol. Causes and manifestations of rickets, hypo- and hyperparathyroidism</p>	<i>GPC -5</i>
18	<p>The chemical composition of the blood. Proteins of blood plasma. Red blood cell metabolism. Blood enzymes. Buffer systems. Organic and inorganic components of the blood. Hem metabolism and the formation of bile pigments. Jaundice Biochemistry of connective tissue. Collagen, elastin, proteoglycans, their role.</p>	<p>The chemical composition of the blood. Proteins of blood plasma. Albumins, globulins, fibrinogen. Proteins of the acute phase, their determination for the purpose of diagnosis. Features of the structure of red blood cells. Glucose metabolism and neutralization of reactive oxygen species in red blood cells. Hemoglobinopathies. Enzymes of blood plasma, their definition for the diagnosis of various diseases. Non-protein nitrogenous components of the blood. Nitrogen-free organic components of the blood. Azotemia. Inorganic components of the blood. Blood buffer systems and acid-base balance. The structure and biosynthesis of heme, regulation. Disorders of heme biosynthesis - porphyria. Iron metabolism: absorption, transport, entry into cells. Violations of iron metabolism. Hem catabolism. Bilirubin metabolism. Jaundice and their differential diagnosis. Hereditary metabolic disorders of bilirubin. Features of the synthesis of intracellular and extracellular post-translational modifications of the proteins of the intercellular matrix. The structure and functions of glycosaminoglycans. Hereditary and acquired disorders of protein metabolism of connective tissue. Non-collagenous bone proteins: osteonectin, osteocalcin, osteopontin; features of their structure and metabolism. Changes in connective tissue with</p>	<i>GPC -5</i>

aging.

5.1. Sections of the discipline and labor intensity by types of educational work

Section №	Name of the discipline section	Types of educational work, hour.					Total hour.
		classwork				extracurricular	
		L	PC		LC		*SSS
1.	The structure and functions of proteins Enzymes.	6	16		4	8	34
2.	vitamins Hormones	8	20		4	18	50
3	Bioenergetics. Biooxidation	6	10		2	8	26
4	Carbohydrate metabolism	8	14		2	10	34
	TOTAL for the 3 semester	28	60		12	44	144
5	lipid metabolism. The structure of biological membranes. Lipid peroxidation and antioxidant systems.	4	8		2	4	18
6	Metabolism of simple and complex proteins. Amino acid metabolism.	4	6		2	6	18
7	Biosynthesis of nucleic acids and proteins (matrix syntheses).	4	6		2	4	16
8	The regulation of metabolism. Biochemistry of individual organs and tissues (Biochemistry of the liver, blood, urine, connective tissue).	4	8		2	6	20

	TOTAL for the 4 semester	16	28	8	20	72
	TOTAL FOR THE YEAR	44	88	20	64	216

5.3 Thematic plan of lectures

n/ №	Section of discipline	Thematics of lectures	3 term	4 term
1	Proteins and enzymes	<p>Lecture №1 Structural organization of proteins. Features of the functioning of oligomeric proteins.</p> <p>Lecture №2 Physico-Chemical Properties of Proteins</p> <p>Lecture №3 Features of enzymatic catalysis. Regulation of enzyme activity. The role of vitamins enzyme inhibitors. The use of enzymes in medicine</p>	2 2 2	
2	Vitamins and Hormones	<p>Lecture №4 Water soluble and fat soluble vitamins.</p> <p>Lecture №5 Coenzyme form of vitamins.</p> <p>Lecture №6 Hormones, mechanism of action, structure.</p> <p>Lecture №7 Hormones of the hypothalamus, pituitary gland, pancreas, adrenal glands.</p>	2 2 2	
3	Bioenergy and biooxidation	<p>Lecture №8 Common pathway of catabolism.</p> <p>Lecture №9 tissue respiration. Mitochondrial electron transport chain.</p> <p>Lecture №10 Oxidative phosphorylation of ADP. Mitchell's chemiosmotic theory</p>	2 2	
4	Carbohydrate metabolism.	<p>Lecture №11 Assimilation of dietary carbohydrates. Synthesis and mobilization of glycogen, regulation of processes.</p> <p>Lecture №12 Aerobic and anaerobic glycolysis. Energy effect of processes.</p> <p>Lecture №13 Oxidative decarboxylation of pyruvate and tricarboxylic acid cycle.</p> <p>Lecture №14 Gluconeogenesis is the synthesis of glucose from non-carbohydrate substances. Hormonal regulation of the process</p>	2 2	
		TOTAL	28 h	
5	lipid metabolism	<p>Lecture №15 Assimilation of dietary lipids. Transport of lipids by chylomicrons. Biosynthesis of fatty acids and fats. Hormonal regulation.</p> <p>Lecture №16 TAG mobilization. Process regulation. B-oxidation. Exchange of ketone bodies. Eicosanoids. cholesterol exchange. Hypercholesterolemia. Synthesis of bile acids. biological membranes. lipid peroxidation.</p>		2 2
6	Protein metabolism	<p>Lecture №17 Digestion of proteins. Replaceable and irreplaceable amino acids. Trans- and deamination of amino acids.</p> <p>Lecture №18 Neutralization of ammonia in tissues. ornithine cycle. Synthesis of non-essential amino acids. Exchange of individual amino acids.</p>		2 2
7	Biosynthesis of	Lecture №19 The structure of nucleic acids. Synthesis of		2

	proteins	DNA, RNA, repair Lecture №20 Protein biosynthesis. Inhibitors of matrix biosynthesis. Mechanisms of genetic variability and protein polymorphism. DNA technologies in medicine.		2
8	Regulation of metabolism. Biochemistry of individual organs and tissues (Biochemistry of the liver, blood, urine, connective tissue).	Lecture №21 Hormonal regulation of water-salt metabolism. Biochemistry of the liver. Inactivation of foreign substances in the body. Metabolism of erythrocytes, heme and formation of pigments.		2
		Lecture №22 Biochemistry of connective and bone tissue. Regulation of the process by hormones and vitamins. Collagen, elastin, proteoglycans, their role.		2
		TOTAL		16h

TOTAL:44h

5.4. Thematic plan of practical classes

№ section	disciplines section	Topics of practical classes	Forms of current control *	Number of hours per semester	
				№3	№4
1.	<i>Proteins and enzymes</i>	PC1 Structural organization of proteins. Amino acids as structural components of proteins.	T,I	2	
		PC.2 Physico-chemical properties of proteins.	T,I	2	
		PC.3 Features of the functioning of oligomeric proteins. Hemoglobin. Its structure and role.	T,I	2	
		PC.4 Features of enzymatic catalysis. Enzyme specificity.	T,I	2	
		PC.5 Factors affecting the activity of enzymes. Regulation of enzyme activity.	T,I	2	
		PC.6 Classification of enzymes.	T,I	2	
		PC.7 Enzymology. Medicines are enzyme inhibitors. The use of enzymes in medicine	T,I	2	
		PC. 8 Colloquium on topics: «Proteins and enzymes»	T, ST	2	
2.	<i>Vitamins and</i>	PC.9 Some questions of nutritional	T,I	2	

	<i>hormones</i>	biochemistry.			
		PC10. Fat-soluble vitamins A, D, E, K. Ascorbic acid - vitamin C, biolol.	T,I	2	
		PC.10 Vitamins, hypovitaminosis and beriberi. Classification of vitamins.	T,I	2	
		PC.11 Water-soluble vitamins, their coenzymatic role. Hypervitaminosis and hypovitaminosis.	T,I	2	
		PC.12 Hormones. general characteristics	T,I	2	
		П3.13 Hormones of the hypothalamus and pituitary gland	T,I		
		PC.14 Hormones. Adenylate cyclase and cytosolic mechanisms of action of hormones.	T,I	2	
		PC 15 Hormones of the pancreas. Action of insulin.	T,I. S.	2	
		PC.16 Hormones of a steroid nature, their mechanism of action.	T,I	2	
		PC.17 Glucocorticoids	T,I	2	
		PC.18 Colloquium on topics: «Vitamins and hormones»	T. ST.	2	
3	Bioenergy biooxidation	PC.19 General path of catabolism.	T,I	2	
		PC.20 Bioenergy and biooxidation	T,I	2	
		PC.21 Mitochondrial electron transport chain. tissue respiration.	T,I	2	

		PC.22 Oxidative phosphorylation of ADP. Mitchell's chemiosmotic theory.	T,I	2	
		PC.23 Colloquium. Bioenergy and biooxidation	T. ST.	2	
4	Carbohydrate metabolism	PC.24. The main carbohydrates in food. Digestion. Biosynthesis and decay (mobilization). Regulation of glycogen synthesis and breakdown by hormones.	T,I	2	
		PC.25 Aerobic and anaerobic breakdown of glucose. Glycolysis. Lactic acid formation.	T,I	2	
		PC. 26 Oxidative decarboxylation of pyruvic acid. Tricarboxylic acid cycle.	T,I	2	
		PC.27. Pentose phosphate pathway for glucose oxidation	T,I	2	
		PC.28. Carbohydrate metabolism.	T,I	2	
		PC.29. Solution of situational problems on the topic Carbohydrate metabolism	T,I	2	
		PC.30 Colloquium on the topic Carbohydrate metabolism	T. ST.	2	
		TOTAL:		60 h	
5	Lipid metabolism	PC.31. Assimilation of dietary lipids. Transport of lipids by chylomicrons.	T,I		2
		PC.32. TAG mobilization. Process regulation. B-oxidation. Exchange of ketone bodies. Eicosanoids. Biosynthesis of fatty acids and fats. Hormonal regulation.	T,I		2
		PC.33. cholesterol exchange. Hypercholesterolemia. Synthesis of bile acids. biological membranes. lipid peroxidation	T,I		2
		PC.34. Colloquium on topics: «Lipid metabolism»	T. ST		2
6	Protein	PC.35. Digestion of proteins. Trans- and			2

metabolism		deamination of amino acids. Exchange of individual amino acids. Neutralization of ammonia in tissues. ornithine cycle.			
		PC.36 Metabolism of complex proteins. Heme metabolism and pigment formation. Neutralization of bilirubin.	T.		2
		PC.37. Colloquium on topics: «Protein metabolism»»	T.		2
7	Biosynthesis of proteins	П3.38 Structure of nucleic acids Synthesis of DNA. Replication, repair. Transcription, Operon theory, regulation of RNA synthesis at the level of transcription	T.		2
		PC.39. protein biosynthesis. Inhibitors of matrix biosynthesis. Mechanisms of genetic variability and protein polymorphism. DNA technologies in medicine. PCR diagnostics	T.		2
		PC.40. Colloquium on the topic «Structure and functions of proteins, nucleic acids, matrix biosynthesis»	T. ST.		2
8	Regulation of metabolism Liver biochemistry.	PC.41. Hormonal regulation of carbohydrate, lipid and amino acid metabolism, regulation of water-salt metabolism. Calcium and phosphate metabolism.	T,I		2
		PC.41. Biochemistry of the liver. Inactivation of foreign substances in the body. Biochemistry of urine. Biochemistry of blood.	T,I		2
		PC.41. Biochemistry of connective and bone tissue. Regulation of the process by hormones and vitamins. Collagen, elastin, proteoglycans, their role.	T,I		2
		PC.41. Colloquium on topics: «Biochemistry of the liver, blood, connective tissue, urine biochemistry	T, ST		2
		TOTAL		28h.	

TOTAL: 88 h**5.5. Laboratory studies**

№	Disciplines дисциплины	Name of laboratory classes	Forms of current control*	Number of hours per semester	
				№3	№4
1.	<i>Proteins and enzymes</i>	LC. 1 Protein precipitation reactions. Qualitative reactions to proteins. Benzidine test for hemoglobin.	Pr,S	2	
		LC. 2 Influence of activators and inhibitors on the activity of salivary enzymes.	Pr	2	
2.	<i>Vitamins and</i>	LC. 3 Quantitative determination of vitamin	Pr	2	

	<i>hormones</i>	C LC. 4 Quantification of rutin in tea. Qualitative reaction to vitamin B ₂ .			
3.	Bioenergetics. Biooxidation.	LC. 5 Quantification of ATP Determination of catalase activity	Pr	2	
4	Carbohydrate metabolism	LC. 6 Determination of salivary amylase activity	Pr,I	2	
		TOTAL:		12h.	
5	Lipid metabolism	LC. 1 Determination of lipase activity Qualitative and quantitative determination of acetone	Pr,I		2
		LC 2 Quantification of cholesterol	Pr,I		2
6	Protein metabolism	LC. 3 Analysis of gastric juice. Determination of pathological constituents of gastric juice. Determination of alanine aminotransferase activity	Pr,I		2
7	Regulation of metabolism Liver biochemistry.	LC. 4. Determination of phenylpyruvic acid in urine Determination of total blood serum protein by the biuret method	Pr,I		2
		TOTAL			8h
		TOTAL	20h		

5.6. Educational and methodological support for independent work in the discipline

5.6.1. Independent work of the student in the discipline

№ п/п	Disciplines section	Name of works	Labor intensity (hour)	Forms of control
1.	Proteins and enzymes	The structure and functions of oligomeric proteins on the example of hemoglobin in comparison with myoglobin.	2	I
		Hemoglobinopathies, prevalence in the Republic of Dagestan.	2	P
		Regulation of enzyme activity.	2	I
		Enzyme inhibitors and their use as therapeutic drugs.	2	P
2.	Vitamins and hormones	Ideas about replaceable and irreplaceable components of food.	6	I
		Genetically modified foods in nutrition.	4	P

3.	Bioenergy	Prostaglandins and their derivatives, biological role and influence on metabolism.	4	ST
		Hormonal regulation of metabolism. Insulin and glucagon as antagonists. Role in the development of pathology.	4	T
		Tissue respiration inhibitors	4	P
		Vitamins - precursors of tissue respiration coenzymes.	4	P
4	Carbohydrate metabolism	Carbohydrates metabolism disorders	2	P
		Tricarboxylic acid cycle multimedia presentation	4	I
		glycolysis	4	P
			44 h.	
5	Lipid metabolism	lipid metabolism disorder	2	P
		Hypercholesterolemia multimedia presentation	2	I
		Violation of bilirubin metabolism multimedia presentation	2	I
6	Protein metabolism	Gout: causes, symptoms, treatment	2	P
		Phenylketonuria: causes, symptoms, treatment multimedia presentation	2	I
7	Biosynthesis of nucleic acids	Genetic diseases	4	P
		Hereditary and acquired metabolic disorders of connective tissue proteins.	4	P
8	Biochemistry of connective tissue	Changes in connective tissue during aging and collagenoses.	2	P
			20 h.	
	<i>Exam preparation *</i>	<i>Repetition and consolidation of the studied material (work with lecture material, educational literature); wording of questions; pre-examination individual and group consultations with the teacher.</i>	24	
TOTAL :			64 h.	

5.6.2. Guidelines for students on mastering the discipline

APPENDIX to the WP

VI. EVALUATION TOOLS FOR CURRENT CONTROL OF PROGRESS AND INTERIM CERTIFICATION ON THE RESULTS OF MASTERING THE DISCIPLINE

6.1. The list of competencies indicating the stages of their formation in the process of mastering the work program of the discipline

№ Discipline section	discipline section name (module)	Controlled competency code (or part of it)	Forms of control
1	2	3	4
1.	Proteins and enzymes	GPC-5	I,T, <i>ST, P,Pr</i>
2.	Vitamins and hormones	GPC-5	I,T, <i>ST, P,Pr</i>
3	Биоокисление Bioenergy	GPC-5	I,T, <i>ST, P,Pr</i>
4	Carbohydrate metabolism	GPC-5	I,T, <i>ST, P,Pr</i>
5	Lipid metabolism	GPC-5	I,T, <i>ST, P,Pr</i>
6	Protein metabolism	GPC-5	I,T, <i>ST, P,Pr</i>
7	Protein biosynthesis	GPC-5	I,T, <i>ST, P</i>
8	regulation of metabolism. Biochemistry of individual organs and tissues (liver, blood, urine, connective tissue).	GPC-5	I,T, <i>ST, P,Pr</i>

6.2. Criteria for evaluating the results of mastering the discipline

Assessment Metrics	Критерии оценивания			
	«unsatisfactory» (minimum level not reached)	«satisfactory» (minimum level)	«good» (average level)	«excellent» (high level)
Competency code	GPC-5			
To know	The student does not know the main provisions in the studied material of the discipline. Does not know the structure and biochemical properties of the main classes of biologically important compounds, the main metabolic pathways for their transformation; mechanisms of transmission and implementation of genetic information	The student has mastered the main content of the material of the discipline, but has gaps in the assimilation of the material that do not prevent further assimilation of the educational material. Has unsystematized knowledge of biologically important metabolic pathways in biochemistry;	The student is able to independently highlight the main provisions in the studied material. Knows the main aspects of the most important biochemical processes and various types of homeostasis in the body; chemical and biological essence of the processes occurring in a living organism at the molecular and cellular levels.	The student independently singles out the main provisions in the studied material and is able to give a brief description of the main ideas of the studied material of the discipline. Shows deep knowledge and understanding in predicting the possibility of developing pathologies, using knowledge about the biochemical mechanisms of their

	during the synthesis of DNA, RNA, proteins;			development
To be able to	The student does not know how to use illustrations, diagrams as auxiliary material, does not know how to search and draw generalized conclusions	Student has difficulty writing metabolic charts.	The student is able to explain the consequences of violations of biochemical processes in the body	The student is able to consistently explain the physiological nature of the processes, as well as explain the cause of the pathologies of HD processes.
To possess	The student does not have the skills of independent work with educational scientific and reference literature.	The student has little knowledge of static biochemistry The student basically owns the skill of using visual material.	The student has knowledge of everything studied program material, the material sets out consistently allows for minor errors and shortcomings in the reproduction of the studied material.	The student independently selects the main position in the studied material and is able to give a brief description of the main ideas of the studied material. The student shows a deep and complete knowledge of the entire volume of the discipline being studied.

6.3. Evaluation tools for monitoring progress

STUDENT'S INTERVIEW ON CONTROL QUESTIONS

Topic of the lesson: General characteristics and properties of enzymes. The chemical nature of enzymes. The structure of enzymes. The mechanism of action of enzymes. Features of enzymatic catalysis

Controlled Competency Codes: GPC-5

1. General characteristics and basic properties of enzymes.
2. Evidence of the protein nature of enzymes.
3. The specificity of the action of enzymes.
4. Types of specificity.
5. Organ-specific enzymes.
6. Isoenzymes, determination of the isoenzyme spectrum of enzymes in the clinic.

✓ **Criteria for assessing the current control of progress**

✓ «Excellent»:

- ✓ The student has a deep knowledge of the educational material on the topic of the practical lesson, formulated a complete and correct answer to the questions of the topic of the lesson, in compliance with the logic of the presentation of the material, shows the assimilation of the relationship of the main concepts used in the work, was able to answer all clarifying and additional questions. The student demonstrates knowledge of theoretical and practical material on the topic of the lesson.

✓ «Good»:

The student showed knowledge of the educational material, mastered the basic literature, was able to answer almost completely all the additional and clarifying questions asked. The student demonstrates knowledge of theoretical and practical material on the topic of the lesson, allowing

minor inaccuracies.

✓ «Satisfactory»:

- ✓ The student as a whole mastered the material of the practical lesson, answered not all clarifying and additional questions. The student finds it difficult to correctly assess the proposed task, gives an incomplete answer, requiring leading questions from the teacher.

✓ «Unsatisfactory»:

The student has significant gaps in the knowledge of the main educational material of the practical lesson, did not fully disclose the content of the questions, could not answer clarifying and additional questions.

TESTING

TOPIC: BIOCHEMISTRY OF ENZYMES

GPC -5

1. In disorders of what level of the structural organization of the enzyme, a molecular (genetic) disease can develop:

@ 1

2

3

4

domains

2. What level of organization of a protein molecule underlies the formation of enzyme specificity:

1

2

@ 3

@ 4

domains

3. At what level of the structural organization of a protein do its enzymatic properties begin to manifest?:

1

2

@ 3

@ 4

domains

5. The allosteric center of an enzyme is:

the sequence of amino acids in the polypeptide chain;

a unique combination of amino acid residues in the enzyme molecule involved in the act of catalysis;

@ section of the enzyme molecule, which serves to interact with the modifier (effector);

a combination of several types of subunits in different quantitative proportions

6. Attachment to the allosteric center of an effector enzyme causes:

@ change 3 (and 4) enzyme structure and active site configuration;

cleavage of peptide bonds;

change in the sequence of amino acids in the polypeptide chain;

hydrolytic cleavage of the polypeptide chain

7. The active site of an enzyme is:

amino acid sequence in a polypeptide chain:

@ a unique combination of amino acid residues in the enzyme molecule involved in the act of catalysis;

section of the enzyme molecule, which serves to interact with the modifier (effector);

a combination of several types of subunits in different quantitative proportions

8. Coenzyme (coenzyme) - what is it?

@ connection of small molecular weight, necessary for the action of the enzyme and loosely associated with it;

a protein consisting of several oligomeric subunits;

competitive inhibitor;

a low molecular weight compound whose interaction with an enzyme causes its inactivation;

9. The feedback regulation of enzyme activity is based on:

@ allosteric effect;

competitive inhibition;

pH;

change in the primary structure of the enzyme

10. The allosteric effect is based on:

@ conformational change;

cleavage of peptide bonds;

competitive inhibition;

increase in substrate concentration

Criteria for assessing the current control of progress (testing):

- «Excellentn»: 100-90%
- «Good»: 89-70%
- «Satisfactory»: 69-51%
- «Unsatisfactory»: <50%

6.4. Intermediate certification based on the results of mastering the discipline

6.4.1. Exam Semester 3

6.4.1. Interview

6.4.3. Example questions for preparing for the exam.

- Proteins and enzymes

1. Physiological role and biological functions of proteins. Amino acids. Structural organization of proteins.
2. Physico-chemical properties of proteins. Denaturation of proteins, reversibility of denaturation; factors that cause denaturation. Reversible and irreversible protein precipitation reactions
3. Classification of proteins. Simple proteins - albumins, globulins, histones.
4. Complex proteins, their representatives - nucleoproteins, chromoproteins. Hemoglobin, chemical nature, structure, role. Derivatives of hemoglobin. Hemoglobinopathies.

- Vitamins and hormones

2. Enzymopathology, molecular diseases, application of enzymes in medicine.
3. Enzymodiagnosics. Enzyme therapy. Immobilized enzymes. Understanding liposomes..
4. 20. Nutritional biochemistry. Replaceable and irreplaceable components of food. Hyper-, hypo- and avitaminosis.

Biooxidation Bioenergy

9. General patterns of metabolism in a living organism. The main stages of catabolism of substances and their relationship. Understanding Specific and General Pathways of Catabolism.

10. Energy-rich compounds as universal energy keepers in biological objects. Features of the structure and properties of macroergic compounds, ATP and its analogues.

Carbohydrate metabolism

- Basic animal carbohydrates, their biological role Digestion and absorption of carbohydrates in the gastrointestinal tract. Formulas of glucose, fructose, galactose.
- Biosynthesis and breakdown of glycogen, hormonal regulation of glycogen reservation and mobilization.
- Anaerobic breakdown of glucose (glycolysis). Glycogenolysis. Glycolytic oxidoreduction. Physiological significance of anaerobic oxidation. Be able to write all the reactions of glycolysis.
- Substrate phosphorylation during glycolysis. Energy balance of anaerobic glucose oxidation.

- Lipid metabolism

1. Biological significance and physiological role of lipids in the body. The most important lipids in human tissues. Classification of lipids. Reserve lipids (fats) and membrane lipids (complex lipids).
2. Digestion of lipids in the gastrointestinal tract. Features of digestion of fats. The role of bile. Bile acids in the process of digestion and absorption of lipids. Enzymes involved in the digestion of lipids.
3. Absorption of lipids. Resynthesis of lipids in the intestinal wall. Formation of chylomicrons and their characteristics.
4. Intracellular lipolysis. Fat depot lipases, mechanisms of their action and activation. Hormonal mechanisms of regulation of the activity of fat depot lipases. Physiological role of reservation and mobilization of fats in adipose tissue.

- Protein metabolism

1. Complete protein nutrition. nitrogen balance. Digestion of proteins in various parts of the gastrointestinal tract. The role of hydrochloric acid.
2. Replaceable and irreplaceable amino acids. Complete protein nutrition.
3. Proteinases - pepsin, trypsin, chymotrypsin. Proenzymes of proteinases and the mechanism of their transformation into active forms. Endopeptidases. Exopeptidases: carboxypeptidases, aminopeptidases, dipeptidases. Absorption of amino acids.

VI. Nucleic acid metabolism

10. History of discovery and study of nucleic acids. Functions of nucleic acids. Localization of nucleic acids in the cell.
11. Structural features of DNA (Crick-Watson model). Structural organization of DNA and RNA. DNA replication. Stages of DNA synthesis. DNA-dependent DNA polymerases. DNA-binding proteins and DNA-unwinding proteins. DNA damage repair.

Biochemistry of blood

Importance of blood for the body. The chemical composition of blood. Blood plasma proteins and their physiological role. Characterization of the main protein fractions - albumins, globulins, fibrinogen.

Biochemistry of urine.

- The chemical composition of the urine of a healthy person. a) organic substances of urine, sources of their formation. b) inorganic substances of urine, mineral components of urine. Hormonal regulation of diuresis.
- Changes in the properties and composition of urine in diseases. Pathological components of urine - glucose, protein, ketone bodies, blood, pigments. The diagnostic value of their determination.

Biochemistry of connective tissue.

- 6.4.4 1. Biochemistry of connective tissue. Features of the chemical composition.
 6.4.5 2. Collagen: features of the chemical composition, conformation.
 6.4.6 3. Elastin, structural features and functions. Glycosaminoglycans, their structure and properties: hyaluronic acid, chondroitinsulfuric acid, etc.

Exam card example.**FSBEI HE DSMU****Ministry of Health of Russia****Department of General and Biological Chemistry****Field - medical business**

BIOCHEMISTRY
EXAMINATION CARD № 1

1. Classification of proteins. Simple proteins - albumins, globulins, histones.
2. Regulation of enzyme activity, regulatory enzymes. Allosteric regulation of enzyme activity.
3. Specific pathways of amino acid metabolism
4. Write the reactions of anaerobic breakdown of glucose (glycolysis).

Approved at a meeting of the department, protocol dated 24.04. 2023 No.8

Head Department of General and Biological Chemistry

Professor

E.R. Nagiyev

Head of Academic Affairs Associate Professor

Z.M. Magomedova

FSBEI HE DSMU
Ministry of Health of Russia

Department of General and Biological Chemistry
Field - medical business

BIOCHEMISTRY
EXAMINATION CARD № 2

1. Biooxidation. Structures suitable for dehydrogenation.
2. Polyunsaturated fatty acids. The role of prostaglandins and their derivatives.
3. Glycosaminoglycans (hyaluronic acid, chondroitinsulfuric acid, heparin) and their role in the body.
4. Write the reactions of the tricarboxylic acid Krebs cycle.

Approved at a meeting of the department, protocol dated 24.04. 2024 No.8

Head Department of General and Biological Chemistry

Head Department of General and Biological Chemistry

Professor

E.R. Nagiyev

Head of Academic Affairs Associate Professor

Z.M. Magomedova

Assessment Metrics	Competency code GPC-5			
	«unsatisfactory» (minimum not reached)	«satisfactory» (minimum level)	«good» (average level)	«excellent» (high level)
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To be able	The student does not know how to use illustrations, diagrams as auxiliary material, does not know how to search and draw generalized conclusions	The student has difficulty writing metabolic diagrams.	The student is able to explain the consequences of violations of biochemical processes in the body	The student is able to consistently explain the physiological nature of the processes, as well as explain the cause of the pathologies of HD processes.
To possess	The student does not have the skills of independent work with educational scientific and reference literature.	The student has little knowledge of static biochemistry The student basically owns the skill of using visual material.	The student has knowledge of everything studied program material, the material is presented consistently, allows minor errors and shortcomings in the	The student independently selects the main position in the studied material and is able to give a brief description of the main ideas of the

			reproduction of the studied material.	studied material. The student shows a deep and complete knowledge of the entire volume of the studied discipline in part
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6. LIST OF BASIC AND ADDITIONAL LITERATURE NECESSARY FOR THE DEVELOPMENT OF DISCIPLINE

6.1. Main literature

Printed Sources:

№	Editions	The number of copies in the library
1	Principless of medical biochemistry: учебник «ОСНОВЫ БИОХИМИИ» для иностранных студентов лечебного факультета мед.вузов/ В.В. Давыдов, Е.Р. Грабовецкая; ISBN 978-5-906648-174.-М.: ЭКО-Вектор, 2016-552с.	100

Electronic sources:

1	EDS Medical University (Student Advisor) http://www.studmedlib.ru – access to all 2nd year students of the medical faculty of Dagestan State Medical University	
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6.2. additional literature

Printed Sources:

№	Editions	The number of copies in the library
1	Laboratory Manual on Biological Chemistry. for foreign students of Medical Department of Higher Education Institutions : tutorial / Baigildina A. A. , Davydov V. V. - Москва : ГЭОТАР-Медиа, 2019. - 304 с. - ISBN 978-5-9704-4971-4.	2
2	Biochemistry with exercises and tasks / ed. by Glukhov A. I. , Garin V. V. - Москва : ГЭОТАР-Медиа, 2020. - 296 с. - ISBN 978-5-9704-5317-9.	2
3	Biochemistry of the connective tissue. Biochemistry of mixed saliva. Tutorial Glukhov A., Usay L., Golenchenko V., Gubareva A. ГЭОТАР-Медиа. 2019 ISBN 978-5-9704-4972-1 128 с.	2

7. The list of resources of the information and telecommunication network "Internet":
sites

8. INFORMATION TECHNOLOGY

When studying the discipline, a common package of documents of Internet materials is used, which provide ample opportunities for improving university training of students. The standard features of

most programs are the implementation of the didactic principle of visualization in training; their use enables students to apply various methods to solve the educational problem.

Teaching methods using information technology.

The teaching methods using information technology used in the classroom "BIOCHEMISTRY" include:

- computer testing;
- demonstration of multimedia materials, including video films;
- A list of search engines (site moodle.dgmu.ru).
- A list of encyclopedic sites.

11. MATERIAL AND TECHNICAL SUPPORT

№ п/п	Address (location) buildings, structures facilities premises	Own or operational control, household management rent sublease, gratuitous use	Name of disciplines	Appointment equipped buildings, premises *, territories with indication of area (sq.m.)	Name of special rooms and premises for independent work	Equipment of special rooms and premises for self work	The list of licensed software. Requisites confirming the document
1	2	3	4	5	6	7	8
	44, Shamil avenue	Oper. control.	Biochemistry	<p>For educational and scientific educational process::</p> <p>Training laboratories No. 5-60 m2 each..</p> <p>Science Laboratory No. 4 - 60m2.</p> <p>Reactant's – 40 20m².</p> <p>Laboratory assistant – 30 m².</p> <p>Preparatory room– 20 m².</p>	training laboratories №5	<p>Amplifier Yamaha EMX 62, Speakers ASK SA-112, Acer Projector Roll wall screen (white, matte) Drager Luma 267 * 356</p> <p>Training tables, reagent kits and chemical glassware</p> <p>Training tables, fume hoods with water and electricity supply - 2 pcs, a cabinet for storing reagents - 2 pcs, chemical glassware.</p> <p>Chemical tables, fume hoods with reagent kits and chemical glassware.</p>	The list of software (Win HOME 10 Russian OLP (Sublicense agreement Tr000044429 dated 12/08/15); Kaspersky Edition Security for Business - Standard Russian Edition. 100-149 Node (License agreement No. 1081-2015 dated 10/14/2015); Office ProPlus 2013 RUS OLP NL Acdmc (Agreement No. ДП-026 dated 10.16.13), etc.)

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10. HUMAN RESOURCES

Information about the staffing necessary for the implementation of the educational process in the discipline

The total number of scientific and pedagogical workers who implement the discipline is 1 person.

The total number of bets held by scientific and pedagogical workers who implement the discipline is 0.75.

№	Full name of the teacher	Terms of attraction (full-time, internal part-time, external part-time, by agreement)	Current position, academic degree / academic title	The list of taught disciplines according to the curriculum	Education (which educational institution of vocational education graduated, year)	Level of education, name of the specialty in the diploma, name of the assigned qualification	The volume of the study load in the discipline (share rate)	Information on additional professional education, year		Work experience with an indication of the period of work and position
								By specialty	In pedagogy and psychology	
11	Magomedova Z.M.	full-time	Associate Professor Candidate of Chemistry	Biochemistry	DSU 1996	Specialty, chemistry, chemist	1,0	2012	2015	From 2010 to 2016 assistant, from 2017 to date, assistant professor

11. ASSESSMENT FUND FOR CURRENT MONITORING

(Appendix)

12. WORK PROGRAM SHEET

Changes to the work program are made on the basis of orders and instructions of the rector, as well as on the basis of decisions on improving the educational and methodological support of the discipline, approved at the appropriate level (decision of the academic council), CCMC and are recorded in the list of changes.

Work change registration sheet

Academic year	Date and number of notice of	Requisites protocol	Section, Division	Signature of recording change
20 - 20				
20 - 20				
20 - 20				
20 - 20				