

MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
Educational Institution
BELARUSIAN STATE MEDICAL UNIVERSITY

**Контрольный
экземпляр**

APPROVED



by Vice-rector for academic work
Yu.A.Sokolov

15.11.2023

Reg. # UD-091-012/2324/edu.

BIOLOGICAL CHEMISTRY

**Curriculum of educational institution
in the academic discipline for the specialty:**

7-07-0911-03 «Dentistry»

Curriculum is based on the educational program «Biological Chemistry», approved 15.11.2023, registration # UD-091-012/2324/edu; on the educational plan in the specialty 7-07-0911-03 «Dentistry», approved 17.05.2023, registration # 7-07-0911-03/2324/mf.

COMPILERS:

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RECOMMENDED FOR APPROVAL:

by the Department of Biological Chemistry of the educational institution «Belarusian State Medical University»
(protocol # 1 of 31.08.2023);

by the Scientific and Methodological Council of the educational institution «Belarusian State Medical University»
(protocol # 11 of 15.11.2023)

EXPLANATORY NOTE

«Biological Chemistry» is the educational discipline of the module «Medical and Biological Module # 1», which contains systematized scientific knowledge and techniques in the field of medical biochemistry, studying the molecular basis of normal life processes in human and the possible causes and effects of metabolic disturbances.

The aim of the discipline «Biological Chemistry» is the formation of basic professional competencies about the molecular basis of normal physiological functions in human in terms of ontogenesis; molecular basis of the pathological processes, their prevention and treatment; biochemical methods of diagnosing and monitoring of human health status.

The objectives of the discipline «Biological Chemistry» are to form students' scientific knowledge about:

- basic principles of the molecular organization of the cell, tissue, organism;
- basic laws of metabolic processes, metabolic regulation and its interaction with the functional activity in a living system;
- pathogenetic mechanisms of pathological processes, subject to the main types of heritable metabolic defects;
- research techniques;
- basic principles of clinical and laboratory technologies;
- molecular basis of organs of the oral cavity functioning;
- skills and abilities necessary for using the results of biochemical analyses for the health assessment; interpretation of the results of laboratory and instrumental methods of analysis.

The knowledge, skills, and abilities acquired during the study of the academic discipline «Biological Chemistry» are necessary for successful mastering of the following academic disciplines: «Pharmacology», «Preventive Dentistry».

Studying the educational discipline «Biological Chemistry» should ensure the formation of students' basic professional competency:

BPC. Use knowledge about the molecular basis of vital activity processes in the human body in normal and pathological conditions, apply the principles of biochemical methods for diagnosing diseases, the main methods of biochemical research.

As a result of studying the discipline «Biological Chemistry» the student should

know:

- the essence of biochemical processes occurring in the human body in normal and pathological conditions;
- metabolic pathways and their regulation;
- basic methods for studying metabolic processes: protein metabolism, lipid metabolism, carbohydrate metabolism, hormones, enzymes, system of hemostasis, and others;

be able to:

use unified methods for the analysis of biological fluids (blood, urine, saliva, gastric juice) and bone tissue;

work with equipment used in biochemical laboratories (photoelectric colorimeters, centrifuges, thermostats);

use automatic pipettes, dispensers and other labor saving tools;

analyze the results of biochemical research;

master:

methods of qualitative and quantitative analysis of nucleic acids, proteins, lipids, carbohydrates, vitamins and hormones in biological material;

knowledge of the basic molecular processes that ensure the vital activity and functioning of the human body, including the organs of the oral cavity.

Total number of hours for the study of the discipline is 206 academic hours. Classroom hours according to the types of studies: lectures - 32 hours, laboratory classes – 87 hours), student independent work (self-study) - 87 hours.

Intermediate assessment is carried out according to the syllabus of the specialty in the form of a credit (2 semester) and examination (3 semester).

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	semester	Number of academic hours					Form of intermediate assessment
		total	in-class	including		out-of-class self-studies	
				lectures	laboratory classes		
7-07-0911-03 «Dentistry»	2	98	65	14	51	33	credit
	3	108	54	18	36	54	examination

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	laboratory
1. Introduction to the discipline «Biological Chemistry». Enzymes	2,66	9
1.1. Introduction to the discipline «Biological Chemistry». Structure and properties of proteins	-	3
1.2. Enzymes: structure, properties and mechanism of action	1,33	3
1.3. Regulation of enzyme action	1,33	3
2. Introduction to metabolism. Biological oxidation. Central metabolic pathways	2,66	9
2.1. Introduction to metabolism and energy exchange. Central pathways of metabolism	1,33	3
2.2. Biological oxidation	1,33	6
3. Carbohydrates metabolism and functions	3,99	12
3.1. Carbohydrates. The main pathways of glucose metabolism. Glycogen metabolism	1,33	3
3.2. Dichotomous breakdown of glucose. Gluconeogenesis	1,33	3
3.3. Secondary pathways of glucose metabolism. Regulation of carbohydrate metabolism	1,33	6
4. Lipids metabolism and functions	3,99	12
4.1. Lipid classification. Digestion and absorption	1,33	3
4.2. Cholesterol metabolism. Transport of exogenous and endogenous lipids. Disorders of lipid metabolism	1,33	3
4.3. Intracellular metabolism of fatty acids. Ketone bodies. Eicosanoids and their role in the regulation of metabolism and physiological functions	1,33	6
5. Simple protein and amino acid metabolism	2,66	8
5.1. Protein digestion. Role of proteolysis. Pathways of amino acid utilization in cells	1,33	2
5.2. Intracellular metabolism of amino acids. Synthesis of amino acids	-	2
5.3. Ammonia detoxification	1,33	4
6. Nucleoprotein metabolism. Structure and synthesis of nucleic acids. Protein biosynthesis. Methods of molecular biology	3,99	4
6.1. Structure and metabolism of nucleoproteins	1,33	2
6.2. Biosynthesis of nucleic acids and proteins. Techniques of molecular biology	2,66	2
7. Regulation of metabolism. Biochemistry of hormones	3,99	8

Section (topic) name	Number of class hours	
	lectures	laboratory
7.1. Principal mechanisms of metabolism regulation. Mechanism of hormone action	1,33	2
7.2. Structure, metabolism and influence of major hormones on metabolism	2,66	6
8. Biochemistry of organs and tissues	5,32	19
8.1. Biochemistry of the blood	1,33	9
8.2. Biochemistry of the liver	1,33	4
8.3. Biochemistry of the connective tissues and teeth	1,33	2
8.4. Biochemistry of the oral fluid	1,33	4
9. Biochemistry of nutrition	2,66	6
9.1. Essential nutritive factors and their role in development of oral cavity organs	1,33	4
9.2. Water and mineral salts. Calcium and phosphorus metabolism. Microelements	1,33	2
Total hours	32	87

CONTENT OF THE EDUCATIONAL MATERIAL

1. Introduction to the discipline «Biological Chemistry». Enzymes

1.1. Introduction to the discipline «Biological Chemistry». Structure and properties of proteins

The development of biochemistry, major stages. Position of biochemistry in medical education and dentistry. Major categories and areas in biochemistry. Objects in biochemical research.

Medical biochemistry. Role of biochemistry in understanding of human and environment interrelations. Role of biochemical research in understanding of pathological processes in oral cavity.

Discovery of amino acids, peptide theory of structure. Protein classification according to their functions, molecular shape, constitution complexity.

The levels of protein molecule organization. Physical and chemical properties of proteins and protein solutions.

1.2. Enzymes: structure, properties and mechanism of action

History of enzymes discovery and investigation. Enzyme classification and nomenclature. Properties of enzymes. Active site of enzymes and its function.

Single- and two-component enzymes. Coenzymes, classification. Coenzyme function of water-soluble vitamins. Variety of metalloenzymes involved in the metabolism of collagen and other connective tissue proteins.

Enzyme-substrate interaction. Influence of conformational changes on enzyme activity, denaturation. Properties of enzymes. Dependence of the velocity of enzyme-catalyzed reaction on temperature, pH, substrate and enzyme concentrations.

1.3. Regulation of enzyme action

Mechanisms of enzyme activity regulation: competitive inhibition, allosteric enzymes, regulation of enzyme structure by covalent modification. Role of enzyme cooperative conformational changes in mechanisms of reaction catalysis. Natural and artificial inhibitors of enzyme activity.

Enzyme composition in different organs and tissues. Organo-specific enzymes, origin of the plasmatic and salivary enzymes. Determination of enzyme activity in blood and saliva for diagnosis.

Multiple forms of the enzymes. Isoenzymes.

Enzymes as analytical reagents in laboratory studies, immobilized enzymes. Enzymes as medicines. The use of enzymes and their inhibitors in dentistry.

2. Introduction to metabolism. Biological oxidation. Central metabolic pathways

2.1. Introduction to metabolism and energy exchange. Central pathways of metabolism

The concept of metabolism, metabolic pathways. Forms of metabolic pathways. Methods of metabolism study at the level of the whole organism, organs, tissue sections, cell cultures. Tissue homogenates, fractionation of homogenates, subcellular structures. Isolation of metabolites and enzymes, determination of substrate transformation sequence.

Interrelations between anabolism and catabolism. The diagram of the main substances (carbohydrates, lipids, proteins) catabolism. The concept of specific and central metabolic pathways.

Oxidative decarboxylation of pyruvate, sequence of reactions, characteristics of enzymes and coenzymes. The concept of multienzyme complex. Role of coenzymes.

Tricarboxylic acid cycle (TCA, citric acid cycle) as the last step of acetyl fragments catabolism, which are formed during breakdown of carbohydrates, lipids and amino acids. Sequence of TCA cycle reactions and key enzymes. Functions of the citric acid in the cell: catabolic, anabolic, hydrogen-donor. Energy yield of TCA cycle. Structural and functional connection of the process with the mitochondrial electron transport chain. Anaplerotic reactions.

2.2. Biological oxidation

Biological oxidation (tissue respiration) as a complex of redox processes carried out with the involvement of oxygen. Mitochondrial oxidation system (respiratory chain) as the main way of oxygen utilization in cells.

Components of the respiratory chain. Coenzyme functions of vitamins PP and B₂. Respiratory chain as a multi-link system of transport of two protons and two electrons from an oxidized substrate to oxygen with the formation of water molecule. Polyzyme complexes of mitochondria.

Coupling the energy release of in the respiratory chain with its use for the biosynthesis of adenosine triphosphate (ATP) (oxidative phosphorylation). R/O coefficient as an indicator of the effectiveness of this coupling. Chemiosmotic theory of coupling. Inhibitors and uncouplers of tissue respiration and oxidative phosphorylation processes. Energy consumers of ATP (and other high-energy compounds): biosynthetic processes, active transport through membranes, mechanical

(muscular) movement.

Non-mitochondrial oxidation as a minor pathway of biological oxidation, providing the incorporation of oxygen into the molecule of the oxidized substrate. Mechanisms of oxygenase oxidation. Monooxygenases (hydroxylases) and dioxygenases, their most important substrates. Hydroxylation of proline and lysine in collagen and elastin precursor molecules; participation of vitamin C. Hydroxylation of steroids in the biosynthesis of steroid hormones. Oxidases, their substrates and biological roles. Formation of hydrogen peroxide.

3. Carbohydrates metabolism and functions

3.1. Carbohydrates. The main pathways of glucose metabolism. Glycogen metabolism

Carbohydrates and their classification. Structure and functions of carbohydrates in living organisms.

Dietary carbohydrates as the main source of energy for the vital activity in human body. Pathways of monosaccharides metabolism after their absorption in the intestines. Liver and muscles as the main sites of carbohydrates storage. Physiological concentrations of glucose in human blood and methods for its determination.

Central metabolic pathways of carbohydrate metabolism: glycogen biosynthesis; pentose phosphate pathway (hexose monophosphate shunt, apotomic oxidation); dichotomous oxidation of glucose (hexose bisphosphate pathway); uronic acid pathway. Hexokinase as the key enzyme that limits the total rate of all glucose metabolism pathways. The role of glucokinase in the liver. Irreversibility of the hexokinase reaction and a bypass reverse reaction.

Properties and distribution of glycogen as a reserve polysaccharide. Biosynthesis of glycogen. Glycogen synthase as a secondary control point in the glycogen biosynthesis; mechanisms of its allosteric regulation. Mobilization of glycogen. Allosteric properties of glycogen phosphorylase. The role of insulin, glucagon and epinephrine in the regulation of glycogen storage and mobilization.

3.2. Dichotomous breakdown of glucose. Gluconeogenesis

The dichotomy is the predominant pathway of glucose catabolism. General characteristics of dichotomy stages under anaerobic conditions. Glycolysis, alcoholic fermentation. Location in the cell and the reactions of glycolysis and alcoholic fermentation. Glycolytic oxidoreduction as a mechanism that enables the breakdown of glucose (or glycogen) to lactate without oxygen participation. Reversibility and energy yield of glycolysis. Anaerobic glycolysis as the only source of ATP synthesis in red blood cells.

Aerobic glucose oxidation. The main steps. Phosphofructokinase as a secondary control point of the dichotomy, its allosteric properties. Oxidative decarboxylation of pyruvic acid and TCA as stages of aerobic glucose oxidation. Role of mitochondrial respiratory chain enzymes in glucose oxidation.

Bypass reverse pathways for irreversible steps of the cytoplasmic stage of the dichotomy. Gluconeogenesis as a way to synthesize carbohydrates from other substances (amino acid metabolites, glycerol). Pyruvate carboxylase: key role in gluconeogenesis, activation by acetyl-CoA molecules. The summary reaction of the

glucose biosynthesis from pyruvate and energy requirement.

3.3. Secondary pathways of glucose metabolism. Regulation of carbohydrate metabolism

Pentose phosphate pathway, its location in the cell. Chemistry of the oxidative stage, its limiting and regulatory steps; role as a source of the reduced form of nicotinamide adenine dinucleotide phosphate (NADP). General diagram of the non-oxidative part of the path; its reversibility, role in maintaining the balance between the formation and utilization of various monosaccharides. Glyceraldehyde phosphate as one of the junction points of different metabolic pathways. Proportion of the pentose phosphate pathway in the total utilization of glucose by cells of different types; mechanisms of its autonomic self-regulation. The functional role of the pathway in the cells of adipose tissue, liver, adrenal cortex and gonads, in red blood cells.

Uronic acid pathway, the main reactions, biological role, connection with pentose phosphate pathway and other pathways of glucose metabolism.

Autonomic self-regulation of carbohydrate metabolism. The energy charge of the cell as the most important factor in self-regulation of the intensity of breakdown (utilization) of carbohydrates. The direction of the processes during intensive muscular work, at rest, in excessive carbohydrate nutrition against the background of a sedentary lifestyle.

The role of vitamin B₁ in carbohydrate metabolism.

Hormonal regulation of carbohydrate metabolism. The predominant role of insulin; primary mechanisms of its action; stimulation of glucose uptake by the cells and hypoglycemic effect.

Hormones that increase blood glucose level: hormones of indirect effect (thyroxine, thyrotropin, corticotropin, somatotropin) and direct effect (epinephrine, glucagon, glucocorticosteroids) on carbohydrate metabolism. Molecular mechanisms of action of these hormones. Antagonism and synergism with insulin. Metabolic effects of glucagon and adrenaline mediated by the adenylate cyclase system in the liver and in muscle tissue.

Quantitative determination of glucose in blood and urine.

Features of carbohydrates utilization by oral bacteria. Synthesis of glycogen and extracellular polysaccharides (dextran, levan), the role of these processes. The metabolism of sucrose in bacteria, the relationship with changes of the pH of the oral fluid and the caries development.

4. Lipid metabolism and functions

4.1. Lipid classification. Digestion and absorption

The concept of lipids, their classification. Structure and functions of simple and complex lipids. Phospholipids and glycolipids.

Lipid digestion: emulsification, enzymatic hydrolysis, micelle formation. Role of bile acids. Disorders of digestion and absorption.

Lipids re-synthesis in enterocytes.

Chylomicron as a transport form of exogenous lipids.

4.2. Cholesterol metabolism. Transport of exogenous and endogenous lipids. Disorders of lipid metabolism

The biological role of cholesterol. Synthesis of cholesterol. Regulation of cholesterol synthesis. Excretion of cholesterol out of the human body.

Lipid synthesis in the liver. Catabolism of triacylglycerols in transport forms. Lipoprotein lipase and its role.

Transport of cholesterol in blood, the role of VLDL, low density lipoproteins and high density lipoproteins in the mechanisms of cholesterol transport in the human body. Conversion of cholesterol into bile acids. Hypercholesterolemia and its causes. Cholelithiasis. Biochemical basis for the treatment and prevention of hypercholesterolemia and atherosclerosis.

4.3. Intracellular metabolism of fatty acids. Ketone bodies. Eicosanoids and their role in the regulation of metabolism and physiological functions

Mechanisms of fatty acid activation. Fatty acid transport to mitochondria, role of carnitine. β -Oxidation of fatty acids – specific fatty acid catabolic pathway. Enzymes of β -oxidation. Connection of β -oxidation with tissue respiration enzymes, energy yield of fatty acid β -oxidation.

The ways of active acetic acid utilization. Biosynthesis of fatty acids. Structural features of fatty acid synthase. The role of glucose metabolism pathways in the synthesis of fatty acids. Polyunsaturated fatty acids as essential nutritional factors.

Ketone bodies as an energy material alternative to glucose. Formation of β -hydroxy- β -methylglutaryl-CoA during their biosynthesis in liver mitochondria. The mechanism of ketone bodies utilization in other tissues. Methods for determination of ketone bodies in blood and urine. Ketonemia and ketonuria in healthy people and in diabetes mellitus.

Storage and mobilization of fats in adipose tissue: role, mechanism, hormonal regulation. Transport of fatty acids in the blood. Disturbances of storage and mobilization of fats in obesity.

Metabolism of arachidonic acid. Biosynthesis of eicosanoids (prostaglandins, prostacyclins, leukotrienes, thromboxanes) and their biological role.

5. Simple protein and amino acid metabolism

5.1. Protein digestion. Role of proteolysis. Pathways of amino acid utilization in cells

General characteristics and classification of proteolytic enzymes. Substrate specificity of proteinases. Low specific proteinases, their role in extracellular (digestion) and intracellular proteolysis. The role of lysosomes. Total proteolysis, its general biological significance. Mechanisms of protection against excessive proteolysis: spatial separation (compartmentation); biosynthesis of proteins in the form of precursors; post synthetic covalent modification of proteins (glycosylation, amination, acetylation, etc.); proteinase inhibitors.

Highly specific proteinases. Partial proteolysis, its biological significance. The role of highly specific intracellular proteinases in post synthetic protein maturation, processing of collagen and elastin precursors. Extracellular highly specific proteinases. Substrate selectivity of proteases as a factor in the formation of extracellular proteolytic systems.

The role of partial proteolysis in the molecular basis of the nervous system functioning: endorphins, enkephalins and other functionally active peptides.

Proteinases of the gastrointestinal tract. Absorption of amino acids. Putrefaction of proteins in the intestines.

Amino acid pool of the cell and ways of its utilization.

5.2. Intracellular metabolism of amino acids. Synthesis of amino acids

Mechanisms of amino acid catabolism. Transamination, aminotransferases. Tissue and intracellular specificity of transaminases and its significance.

Direct and indirect deamination of amino acids. The biological role of deamination. The central role of glutamic acid in amino acid metabolism.

Chemistry of decarboxylation and the most important decarboxylases of amino acids, the spectrum of their substrate specificity and irreversibility of action. The role of vitamin B₆. Biogenic amines: mediator and other functions. Inactivation of amines with the participation of amine oxidases. Spatial separation of decarboxylases and amine oxidases.

The ways of nitrogen-free amino acid residue utilization: the synthesis of new amino acids, the formation of glucose (glucogenic amino acids), the formation of ketone bodies (ketogenic amino acids), direct oxidation, conversion into lipids in case of protein nutrition disorders.

5.3. Ammonia detoxification

The main sources of ammonia in the human body. Ways of temporary and final detoxification of ammonia. Synthesis of urea in the liver, mitochondrial and cytosolic steps of the process. Reactions of transamination and aspartate regeneration as a mechanism of coupling of the urea cycle, cycle of indirect deamination and tricarboxylic acid cycle. Glucose-alanine cycle, its role in the transport of ammonia in blood. Formation of asparagine and glutamine. The role of glutamine in maintaining the acid-base balance of the human body. Daily excretion of urea and ammonia with urine.

Other nitrogen-containing non-protein compounds of blood plasma, the importance of determination of their content.

6. Nucleoproteins metabolism. Structure and synthesis of nucleic acids. Protein biosynthesis. Methods of molecular biology

6.1. Structure and metabolism of nucleoproteins

History of nucleoprotein discovery. Nucleic acids, differences between deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Features of nucleic acids primary structure. Bond between nucleotides.

Secondary structure of nucleic acids: features of DNA and RNA secondary structure, types of bonds stabilizing secondary structure.

Tertiary structure, role of proteins in organization of nucleic acid spatial structure. Methods for studying the structure of nucleic acids. Ribosome structure. Polyribosomes. Informosome and messenger RNA, transfer RNA, structure and functions. Chromosome structure.

Nucleic acid degradation. Nucleases in gastro-intestinal tract. Degradation of purine nucleotides, xanthine oxidase. Uric acid as the end product of purine catabolism in primates. Degradation of pyrimidine nucleotides, end products.

Pathways for the synthesis of nucleotides (salvage pathways and *de novo*). Synthesis of purine nucleotides. Substrates, key enzymes and regulation of purine nucleotide synthesis. Synthesis of pyrimidine nucleotides: substrates and enzymes of synthesis. Disorders of nucleotide metabolism.

6.2. Biosynthesis of nucleic acids and proteins. Techniques of molecular biology

Synthesis of DNA: substrates, enzymes, conditions of synthesis. Replication as a way of the information transfer from matrix to the reaction product. Mechanisms of the replication regulation. Reverse transcription, its biological role.

Biosynthesis of RNA (transcription): substrates, enzymes, conditions of transcription. Transcription as a way of the information transfer from DNA to RNA. Biosynthesis of ribosomal, transfer and messenger RNA. Mechanisms of transcription regulation.

Protein biosynthesis. Genetic (amino acid, nucleotide) code and its properties. Adaptor role of transfer RNA. Recognition. Mechanisms and stages of translation. Regulation of translation. Universality of genetic code and protein biosynthesis mechanism. Antibiotics – inhibitors of protein and nucleic acid synthesis.

Post-translational modification of proteins, types, role in the synthesis of collagen and elastin, secreted proteins of the oral fluid.

Polymerase chain reaction as the method of molecular biology: steps and application. Cloning, genetic engineering.

7. Regulation of metabolism. Biochemistry of hormones

7.1. Principal mechanisms of metabolism regulation. Mechanism of hormone action

Regulation of metabolic processes by changing of enzymes' activity (activation, inhibition), changing enzymes' amount (induction and repression of synthesis, enzyme degradation rate), changing plasma membrane permeability.

Hormonal regulation as a way of intercellular and inter-organ coordination of metabolism. Target cells and cellular hormonal receptors.

Hormones classification by the chemical structure, place of synthesis, mechanism of action. Mechanism of action of protein, peptide and amino acid hormones.

Messengers of hormonal action on a cell: cyclic purine nucleotides, calcium ions, products of phosphatidylinositol hydrolysis. Protein kinases, role in mechanisms of enzyme activity modulation.

Mechanism of action of steroid hormones. Intracellular receptors. Influence on protein biosynthesis.

7.2. Structure, metabolism and influence of major hormones on metabolism

Hormones affecting the metabolism of mineralized tissues. Disorders of the function of the endocrine glands: hyper- and hypoproduction of hormones, general principles of treatment.

8. Biochemistry of organs and tissues

8.1. Biochemistry of the blood

Formed elements of blood. Varieties and derivatives of hemoglobin. Transport

of oxygen and carbon dioxide in the blood. Mechanism of saturation of hemoglobin with oxygen and carbon monoxide. Hypoxia.

Blood plasma and blood serum. Blood plasma proteins. Classification according to the functions of blood proteins: transport proteins, proteins of the complement system, kinin system, coagulation, fibrinolysis, immunoglobulins, proteins – inhibitors of proteolysis. Plasma proteins as the source of amino acids during starvation.

Blood clotting. Primary and secondary hemostasis. The role of platelets in hemostasis. Intrinsic and extrinsic pathways of coagulation. Cascade mechanism of activation of enzymes involved in blood coagulation. The role of vitamin K in blood clotting. Anticoagulant systems. Hemophilia and thrombosis.

The value of a routine blood chemistry in characterizing the state of human health.

8.2. Biochemistry of the liver

Role of the liver in carbohydrate, lipid, amino acid metabolism. Synthesis of plasma proteins in the liver.

Reactions of substances detoxification in the liver. Role of microsomal oxidation in detoxification processes. Active glucuronic and sulfuric acids in detoxification processes. Detoxification of putrefaction products coming from the intestines.

Role of the liver in heme metabolism. Reactions of heme synthesis, substrates, enzymes. Reactions of heme degradation, direct and indirect bilirubin. Disorders of bilirubin metabolism.

8.3. Biochemistry of the connective tissues and teeth

Cells of the connective tissue, characteristics of metabolism. Chemical composition of intercellular substance. Proteins of connective tissues. Collagen as a glycoprotein: structural variability, covalent nature of the connection of the carbohydrate component with the protein. Isocollagens, their general characteristics. Features of the synthesis and breakdown of collagen. Non-collagen proteins of connective tissues: elastin, features of synthesis and breakdown, role in the human body. Adhesive proteins: structural features.

Proteoglycans, mucoproteins, glycoproteins: structural features of their carbohydrate fragments.

The functional role of connective tissue phosphoproteins, their participation in processes of mineralization.

Connective tissue changes with aging. Influence of nutrition on connective tissue metabolism.

Biochemistry of bone tissue. Bone proteins: structural, calcium-binding, osteo-inductive, osteogenesis inhibitors. Features of the amino acid composition. The role of proteins in the processes of osteogenesis. Mechanisms of bone tissue mineralization. Regulation of the processes of bone tissue mineralization and demineralization.

Enamel. Features of the enamel development. Immature enamel. Enamel proteins, features of their structure. Enamel minerals. Enamel apatite. Influence of the environment and nutritional factors on the processes of enamel mineralization and

demineralization. Chemical bases of development of caries. Risk factors of caries development and ways of prophylaxis.

Dentine. Chemical composition. Dentin collagen. Proteoglycans. The structure of the mineral component of dentin. The concept of secondary dentin.

Cement. Chemical composition. Cement collagen. Proteoglycans, other organic cement molecules. The structure of the mineral component of cement.

Pulp of the tooth. Features of the chemical composition. The role of the pulp.

Cuticle, enamel pellicle, dental plaque, tartar: chemical composition, mechanisms of formation. The role of microorganisms and products of their metabolism in the oral cavity.

8.4. Biochemistry of the oral fluid

Oral fluid: mechanism of formation and chemical composition. Proteins, enzymes, carbohydrates of the oral fluid. Saliva. Features of the chemical composition of the saliva of individual salivary glands. The role of saliva. Regulation of salivary secretion.

Gingival fluid: chemical composition. The role of gingival fluid in normal and pathological conditions. The role of leukocytes in the oral cavity.

Dental fluid: features of the chemical composition of the enamel fluid, participation in enamel remineralization. Fluid of dentinal tubules: chemical composition, participation in the «trophism» of the tooth.

9. Biochemistry of nutrition

9.1. Essential nutritive factors and their role in development of oral cavity organs

Requirement of proteins. Nitrogen balance. Total urine nitrogen as a criterion for the protein metabolism. «Wear factor» and the physiological minimum of protein in the diet. Qualitative composition of dietary proteins. Essential and non-essential amino acids, their daily requirement. Exogenous and endogenous amino acids pools. The rate of renewal of individual body proteins. Dietary proteins and tooth development. Dietary lipids. Requirements for the lipid composition of dietary products. Carbohydrates as constituents of food. Essential nutritional factors.

The role of nutrition in the physiology and pathology of the oral cavity. Parenteral nutrition in dentistry.

Vitamins: classification. Water-soluble and fat-soluble vitamins, features of the mechanisms of action, participation in metabolic processes. Causes of vitamin deficiency: exogenous and endogenous deficiency and avitaminose. Hypervitaminosis and their causes. Daily requirement for vitamins. The content of vitamins in dietary sources. Influence of vitamins on metabolism in tissues of teeth and oral cavity. Vitamins as medicinal drugs in dentistry.

9.2. Water and mineral salts. Calcium and phosphorus metabolism. Microelements

Water and minerals as components of nutrition. Classification of minerals. Ways of entry of minerals into the human body, mechanisms of absorption. Functions of minerals. Electrolyte composition of biological fluids.

Mechanisms of regulation of volume, electrolyte composition and pH of human body fluids. The role of the kidneys, gastrointestinal tract, skin, lungs in the

regulation of water-salt balance. Conditions and mechanisms for the occurrence of acidosis, alkalosis, dehydration and edema.

Calcium and phosphorus requirement, mechanisms of absorption, distribution in the human body. Apatites: mechanisms of formation. The structure of hydroxyapatite crystals, the role of the environment surrounding the crystals on the mechanism of crystal formation. Isoionic and isomorphous substitution. Carbonate, strontium, plumbeous apatites. The role of fluorine in the formation of apatite crystals. Biological fluids as an example of a supersaturated solution of calcium and phosphorus. The role of the seed in the formation of hydroxyapatite crystals. Epitaxis. Plasma calcium. Regulation of calcium and phosphorus level in the blood. Hormones of the parathyroid and thyroid glands. Vitamin D and its active forms.

Microelements: biological role of iron, copper, cobalt, iodine, zinc, magnesium. Fluorine metabolism in the human body.

ACADEMIC DISCIPLINE CURRICULAR CHART

Section, topic #	Section (topic) name	number of hours			Self-studies	Form of control
		lectures		laboratory		
2 semester						
1.	Introduction to the discipline «Biological Chemistry». Enzymes	2,66	9	5		
1.1.	<i>Introduction to the discipline «Biological Chemistry». Structure and properties of proteins</i> Introduction to biochemistry. The structure of proteins. Physical and chemical properties of proteins Lab. work: Mechanisms of protein sedimentation	-	3	1		interviews, written accounts of laboratory work, electronic test
1.2.	<i>Enzymes: structure, properties and mechanism of action</i> Introduction to enzymology Enzymes. Classification, structure, properties. Lab. work: The effect of various factors on the rate of enzyme-catalyzed reactions	1,33	3	2		interviews, written accounts of laboratory work, electronic test
1.3.	<i>Regulation of enzyme action</i> Enzymology (continuation) Regulation of enzyme action Lab. work: Determination of enzyme activity	1,33	3	2		interviews, written accounts of laboratory work, electronic test
2.	Introduction to metabolism. Biological oxidation. Central metabolic pathways	2,66	9	7		
2.1.	<i>Introduction to metabolism and energy exchange. Central pathways of metabolism</i> Introduction to metabolism and energy exchange. Central pathway	1,33	3	2		
		1,33	-	-		

	of catabolism: Krebs cycle								
	Introduction to metabolism. Central metabolic pathway – the Krebs citric acid cycle								interviews, written accounts of laboratory work, electronic test
	Lab. work: Evaluation of TCA cycle functioning	-	3	2	3				
2.2.	<i>Biological oxidation</i>	1,33	6	5					
	Biological oxidation. Tissue respiration. Oxidative phosphorylation	1,33	-	-					
	Biological oxidation. Pathways of oxygen utilization by cells. Oxidative phosphorylation.		3	2					interviews, written accounts of laboratory work, electronic test
	Lab. work: Studying of oxidative phosphorylation								
	Colloquium «Enzymes, introduction to metabolism. Central metabolic pathway, biological oxidation. Oxidative phosphorylation»	-	3	3					colloquium, control questioning
3.	Carbohydrates metabolism and functions	3,99	12	6					
3.1.	<i>Carbohydrates. The main pathways of glucose metabolism. Glycogen metabolism</i>	1,33	3	2					
	Carbohydrate metabolism. Glycogen metabolism. Anaerobic glucose oxidation	1,33	-	-					
	Digestion of carbohydrates. Metabolism of glycogen. Glycolysis		3	2					interviews, written accounts of laboratory work, electronic test
	Lab. work: Detection of alcoholic fermentation products	-	3	2					
3.2.	<i>Dichotomous breakdown of glucose. Gluconeogenesis</i>	1,33	3	2					
	Carbohydrate metabolism. Aerobic glucose oxidation	1,33	-	-					
	Gluconeogenesis								
	Metabolic pathways of pyruvate. Gluconeogenesis. Aerobic oxidation of glucose to final products (CO ₂ and H ₂ O)	-	3	2					interviews, written accounts of laboratory work, electronic test
	Lab. work: Determination of pyruvate in the urine								
3.3.	<i>Secondary pathways of glucose metabolism. Effect of hormones on the blood glucose level. Features of carbohydrate utilization by oral microflora</i>	1,33	6	2					
	Carbohydrate metabolism. Pentose phosphate pathway and uronic acid pathway	1,33	-	-					

	Secondary pathways of glucose metabolism. Effect of hormones on the blood glucose level. Features of carbohydrate utilization by oral microflora Lab. work: Effect of hormones on blood glucose level Colloquium «Carbohydrates metabolism»	-	3	2	interviews, written accounts of laboratory work, electronic test
		3,99	12	9	colloquium, control questioning
4.	Lipids metabolism and functions	1,33	3	2	
4.1.	<i>Lipids classification. Lipids digestion and absorption</i> Lipid metabolism. Lipids digestion and absorption. Transport of exogenous lipids.	1,33	-	-	
	Lipid metabolism. Digestion and re-synthesis. Transport of exogenous lipids Lab. work: Evaluation of lipase activity	-	3	2	interviews, written accounts of laboratory work, electronic test
4.2.	<i>Cholesterol metabolism. Transport of exogenous and endogenous lipids. Disorders of lipid metabolism</i> Transport of endogenous lipids. Mechanisms of atherosclerosis development	1,33	3	2	
	Lipids blood transport. Metabolism of cholesterol. Depositing and mobilization of lipids. Lab. work: Determination of plasma β -lipoproteins	1,33	-	-	interviews, written accounts of laboratory work, electronic test
4.3.	<i>Intracellular metabolism of fatty acids. Ketone bodies. Eicosanoids and their role in the regulation of metabolism and physiological functions</i> Intracellular metabolism of fatty acids. Ketosis	1,33	6	5	
	Fatty acids metabolism. Metabolism of ketone bodies. Determination of total cholesterol concentration in serum Lab. work: Determination of cholesterol in serum Colloquium «Lipid metabolism»	-	3	2	interviews, written accounts of laboratory work, electronic test
8.	Biochemistry of organs and tissues	1,33	9	6	colloquium, control questioning
8.1	<i>Biochemistry of blood</i> Biochemistry of blood. System of hemostasis	1,33	9	6	
	Physical and chemical properties of the blood. Hemoglobins Lab. work: Studying of serum buffer properties. Determination of	1,33	-	-	interviews, written accounts of laboratory work, electronic test
		-	3	1	

	chlorides in serum								interviews, written accounts of laboratory work, electronic test
	Blood plasma proteins. Blood clotting system Lab. work: Determination of calcium in plasma	-	3	1					Credit, accounts of laboratory work with oral defense, electronic test
	Final lesson «Introduction to the discipline «Biological chemistry», «Enzymes», «Introduction to metabolism. Biological oxidation. Central metabolic pathways», «Carbohydrate metabolism and functions», «Lipid metabolism and functions»	-	3	4					
3 semester									
5.	Simple protein and amino acid metabolism	2,66	8	12					
5.1.	<i>Protein digestion. Role of proteolysis. Pathways of amino acid utilization in cells</i>	1,33	2	3					
	Protein metabolism. Intracellular metabolism of amino acids	1,33	-	-					interviews, written accounts of laboratory work, electronic test
	Digestion and absorption of proteins. Lab. work: Analysis of gastric juice	-	2	3					interviews, written accounts of laboratory work, electronic test
5.2.	<i>Intracellular metabolism of amino acids. Amino acid synthesis</i>	-	2	3					
	Intracellular amino acid metabolism. Lab. work: Determination of amino transferase activity in blood serum	-	2	3					interviews, written accounts of laboratory work, electronic test
5.3	<i>Detoxification of ammonia</i>	1,33	4	6					
	Protein metabolism. Detoxification of ammonia Detoxification of ammonia Lab. work: Determination of nonprotein nitrogen in blood and urea in urine	1,33	-	-					interviews, written accounts of laboratory work, electronic test
	Colloquium «Colloquium: «Metabolism of simple proteins», «Blood Biochemistry»	-	2	3					colloquium, control questioning
6.	Nucleoproteins metabolism. Structure and synthesis of nucleic acids. Protein biosynthesis. Methods of molecular biology	3,99	4	6					
6.1.	<i>Structure and metabolism of nucleoproteins</i>	1,33	2	3					
	Metabolism of nucleic acids	1,33	-	-					
	Nucleoproteins chemistry and metabolism Lab. work: Determination of uric acid in urine	-	2	3					interviews, written accounts of laboratory work, electronic test

6.2.	<i>Biosynthesis of nucleic acids and proteins. Modern techniques of molecular biology</i>	2,66	2	3	
	Matrix biosyntheses.	1,33	-	-	
	Modern techniques of molecular biology	1,33	-	-	
	Matrix biosyntheses (synthesis of DNA, RNA, proteins)	-	2	3	interviews, electronic test
7.	Regulation of metabolism. Biochemistry of hormones	3,99	8	12	
7.1.	<i>Principal mechanisms of metabolism regulation. Mechanism of hormone action</i>	1,33	2	3	
	Introduction to endocrinology	1,33	-	-	
	Hormones, general characteristic and peculiarities of biological action	-	2	3	interviews, electronic test
7.2.	<i>Structure, metabolism and influence of major hormones on metabolism</i>	2,66	6	9	
	Biochemistry of hormones	1,33	-	-	
	Biochemistry of hormones (continuation)	1,33	-	-	
	Biochemistry of hormones. Hypothalamic hormones. Pituitary hormones. Hormones of adrenal cortex. Thyroid hormones. Sex hormones	-	2	3	interviews, written accounts of laboratory work, electronic test
	Lab. work: Qualitative reactions for hormones				
	Biochemistry of hormones. Hormones regulated glucose blood level. Diabetes mellitus.	-	2	3	interviews, written accounts of laboratory work, electronic test
	Lab. work: Glucose tolerance test				
	Colloquium Colloquium: «Nucleoproteins metabolism», «Synthesis of DNA, RNA and proteins», «Hormones»	-	2	3	colloquium, control questioning.
9.	Biochemistry of nutrition	2,66	6	9	
9.1.	<i>Essential nutritive factors and their role in development of oral cavity organs</i>	1,33	4	6	
	Biochemistry of nutrition. Role of proteins, fats, carbohydrates, vitamins. Water-soluble vitamins	-	2	3	interviews, written accounts of laboratory work, electronic test
	Lab. work: Determination of vitamin C in urine				
	Biochemistry of nutrition. Vitamins	1,33	-	-	

	Biochemistry of nutrition. Fat-soluble vitamins Lab. work: Qualitative reactions for vitamins A, E, K	-	2	3	interviews, written accounts of laboratory work, electronic test
9.2	<i>Water and mineral salts. Calcium and phosphorus metabolism. Microelements</i>	1,33	2	3	
	Biochemistry of nutrition. Water and mineral metabolism	1,33	-	-	
	Biochemistry of nutrition. Mineral substances. Regulation of water-electrolyte balance. Lab. work: Determination of potassium content in serum	-	2	3	interviews, written accounts of laboratory work, electronic test
8.	Biochemistry of organs and tissues	3,99	10	15	
8.3.	<i>Biochemistry of the connective tissues and teeth</i>	1,33	2	3	
	Biochemistry of the connective tissues and teeth	1,33	-	-	
	Connective tissue proteins	-	2	3	interviews, electronic test
8.4	<i>Biochemistry of the oral fluid</i>	1,33	4	4	
	Biochemistry of the oral fluid	1,33	-	-	
	Biochemistry of the oral cavity and oral fluid Lab. work: Determination of pH of the saliva. Detection of mineral components in bone. Determination of chlorides in the saliva	-	2	2	interviews, written accounts of laboratory work, electronic test
	Colloquium «Biochemistry of nutrition», «Connective tissue proteins», «Biochemistry of teeth and oral cavity fluids»	-	2	2	colloquium, control questioning
8.2.	<i>Biochemistry of the liver</i>	1,33	4	8	
	Biochemistry of the liver	1,33	-	-	
	Biochemistry of the liver Lab. work: Determination of total bilirubin in serum	-	2	4	interviews, written accounts of laboratory work, electronic test
	Final class «Simple protein and amino acid metabolism», «Biochemistry of blood», «Nucleoproteins metabolism. Structure and synthesis of nucleic acids. Protein biosynthesis. Methods of molecular biology», «Regulation of metabolism. Biochemistry of hormones», «Biochemistry of nutrition», «Biochemistry of organs and tissues»	-	2	4	Interviews, electronic testing, accounts of laboratory work with oral defense Examination
	Total hours	32	87	87	

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic:

1. Textbook Biological Chemistry. Lecture notes / A. D. Taganovich, I. L. Kotovich, A. V. Kolb, N. N. Kovganko, T. Yu. Prinkova – Minsk : BSMU, 2017. – 162 p.

2. Gubsky, Yu. Biological Chemistry : textbook/ ed. Yu. Gubsky. – Vinnitsia : Nova Knyha, 2017. – 488 p.

Additional:

3. Lehninger Principles of Biochemistry/ David L. Nelson, Michael M. Cox: Forceman and Company, New York, 2013. – 1189 p.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF SUPERVISED STUDENT INDEPENDENT WORK IN THE ACADEMIC DISCIPLINE

Main forms of supervised student independent work:

preparation for lectures and laboratory classes;

preparation for colloquia, tests and exam in the academic discipline;

research practice and creative tasks;

preparation of thematic reports, abstracts, presentations;

taking notes of original sources;

the study of topics that are not included in lectures and laboratory classes:

«Biochemistry of the nervous system», «Biochemistry of muscles».

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:

1. Oral form:

colloquiums

interviews;

examination.

2. Written form:

colloquiums;

control questioning;

written accounts of laboratory work.

3. Oral-written form:

accounts of laboratory work with oral defense;

credit.

4. Technical form:

electronic tests

LIST OF AVAILABLE TEACHING METHODS

Traditional method (lecture, laboratory practicals);
 Active (interactive) methods:
 Problem-Based Learning (PBL);
 Case-Based Learning (CBL);

LIST OF PRACTICAL SKILLS

List of practical skills	Practical skills control form
1. Determination of amylase activity in oral fluid. 2. Quantitative determination of calcium, potassium, sodium in oral fluid. 3. Determination of gastric juice acidity. 4. Qualitative and quantitative determination of pathological components in urine: ketone bodies, glucose, protein, blood. 5. Quantitative determination of biological substances in blood and urine: protein, glucose, cholesterol, lipoproteins, urea, bilirubin, vitamin C.	Laboratory work

LIST OF EQUIPMENT USED

Centrifuge, thermostat, photoelectric colorimeter, fume hood, laboratory ware, automatic pipettes, pipette-holders.

LIST OF LECTURES

2 semester

1. Introduction to enzymology.
2. Enzymology (continuation).
3. Introduction to metabolism and energy exchange. Central pathway of catabolism: Krebs cycle.
4. Biological oxidation. Tissue respiration. Oxidative phosphorylation.
5. Carbohydrate metabolism. Glycogen metabolism. Anaerobic glucose oxidation.
6. Carbohydrate metabolism. Aerobic glucose oxidation. Gluconeogenesis.
7. Carbohydrate metabolism. Pentose phosphate pathway and uronic acid pathway.
8. Lipid metabolism. Lipids digestion and absorption. Transport of exogenous lipids.
9. Transport of endogenous lipids. Mechanisms of atherosclerosis development.
10. Intracellular metabolism of fatty acids. Ketosis.
11. Biochemistry of blood. System of hemostasis.

3 semester

1. Protein metabolism. Intracellular amino acid metabolism.
2. Protein metabolism. Detoxification of ammonia.
3. Metabolism of nucleic acids.
4. Matrix biosynthesis.
5. Modern techniques of molecular biology.
6. Introduction to endocrinology.
7. Biochemistry of hormones.
8. Biochemistry of hormones (continuation).
9. Biochemistry of nutrition. Vitamins.
10. Biochemistry of nutrition. Water and mineral metabolism.
11. Biochemistry of the connective tissues and teeth.
12. Biochemistry of the oral fluid.
13. Biochemistry of the liver.

LIST OF LABORATORY (PRACTICAL) STUDIES**2 semester**

- Lesson 1. Introduction to biochemistry. The structure of proteins. Physical and chemical properties of proteins.
Lab. work: Mechanisms of protein sedimentation.
- Lesson 2. Enzymes. Classification, structure, properties.
Lab. work: The effect of various factors on the rate of enzyme-catalyzed reactions.
- Lesson 3. Regulation of enzyme activity.
Lab. work: Determination of enzyme activity.
- Lesson 4. Introduction to metabolism. Central metabolic pathway – the Krebs citric acid cycle.
Lab. work: Evaluation of TCA cycle functioning.
- Lesson 5. Biological oxidation. Pathways of oxygen utilization by cells. Oxidative phosphorylation.
Lab. work: Studying of oxidative phosphorylation.
- Lesson 6. Colloquium «Enzymes, introduction to metabolism. Central metabolic pathway, biological oxidation. Oxidative phosphorylation».
- Lesson 7. Digestion of carbohydrates. Metabolism of glycogen. Glycolysis.
Lab. work: Detection of alcoholic fermentation products.
- Lesson 8. Metabolic pathways of pyruvate. Gluconeogenesis. Aerobic oxidation of glucose to final products (CO_2 and H_2O).
Lab. work: Determination of pyruvate in the urine.
- Lesson 9. Secondary pathways of glucose metabolism. Effect of hormones on the blood glucose level. Features of carbohydrate utilization by oral microflora.
Lab. work: Effect of hormones on blood glucose level.
- Lesson 10. Colloquium «Carbohydrate metabolism».

Lesson 11. Lipid metabolism. Digestion and re-synthesis. Transport of exogenous lipids. Evaluation of lipase activity.

Lab. work: Evaluation of lipase activity.

Lesson 12. Lipids blood transport. Metabolism of cholesterol. Depositing and mobilization of lipids.

Lab. work: Determination of plasma β -lipoproteins.

Lesson 13. Fatty acids metabolism. Metabolism of ketone bodies. Determination of total cholesterol concentration in serum.

Lab. work: Determination of cholesterol in serum.

Lesson 14. Colloquium «Lipid metabolism».

Lesson 15. Physical and chemical properties of the blood. Hemoglobinoses.

Lab. work: Studying of serum buffer properties. Determination of chlorides in serum.

Lesson 16. Blood plasma proteins. Blood clotting system.

Lab. work: Determination of calcium in plasma.

Lesson 17. Final lesson «Introduction to the discipline «Biological chemistry», «Enzymes», «Introduction to metabolism. Biological oxidation. Central metabolic pathways», «Carbohydrate metabolism and functions», «Lipid metabolism and functions».

3 semester

Lesson 1. Digestion and absorption of proteins.

Lab. work: Analysis of gastric juice.

Lesson 2. Intracellular amino acid metabolism.

Lab. work: Determination of amino transferase activity in blood serum.

Lesson 3. Detoxification of ammonia.

Lab. work: Determination of nonprotein nitrogen in blood and urea in urine.

Lesson 4. Colloquium: «Metabolism of simple proteins», «Blood Biochemistry».

Lesson 5. Nucleoproteins chemistry and metabolism.

Lab. work: Determination of uric acid in urine.

Lesson 6. Matrix biosyntheses (synthesis of DNA, RNA, proteins).

Lesson 7. Hormones, general characteristic and peculiarities of biological action.

Lesson 8. Biochemistry of hormones. Hypothalamic hormones. Pituitary hormones.

Hormones of adrenal cortex. Thyroid hormones. Sex hormones.

Lab. work: Qualitative reactions for hormones.

Lesson 9. Biochemistry of hormones. Hormones regulated glucose blood level. Diabetes mellitus.

Lab. work: Glucose tolerance test.

Lesson 10. Colloquium: «Nucleoproteins metabolism», «Synthesis of DNA, RNA and proteins», «Hormones».

Lesson 11. Biochemistry of nutrition. Role of proteins, fats, carbohydrates, vitamins. Water-soluble vitamins.

Lab. work: Determination of vitamin C in urine.

Lesson 12. Biochemistry of nutrition. Fat-soluble vitamins.

Lab. work: Qualitative reactions for vitamins A, E, K.

Lesson 13. Biochemistry of nutrition. Mineral substances. Regulation of water-electrolyte balance.

Lab. work: Determination of potassium content in serum.

Lesson 14. Connective tissue proteins.

Lesson 15. Biochemistry of the oral cavity and oral fluid.

Lab. work: Determination of pH of the saliva. Detection of mineral components in bone. Determination of chlorides in the saliva.

Lesson 16. Colloquium: «Biochemistry of nutrition», «Connective tissue proteins», «Biochemistry of teeth and oral cavity fluids».

Lesson 17. Biochemistry of the liver.

Lab. work: Determination of total bilirubin in serum.

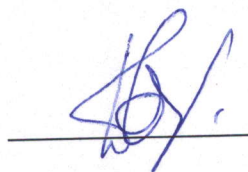
Lesson 18. Final class «Simple protein and amino acid metabolism», «Biochemistry of blood», «Nucleoproteins metabolism. Structure and synthesis of nucleic acids. Protein biosynthesis. Methods of molecular biology», «Regulation of metabolism. Biochemistry of hormones», «Biochemistry of nutrition», «Biochemistry of organs and tissues».

**PROTOCOL OF THE CURRICULUM APPROVAL
BY OTHER DEPARTMENTS**

Title of the discipline requiring approval	Department	Amendments to the curriculum in the academic discipline	Decision of the department, which designed the curriculum (date, protocol #)
1.Pharmacology	Pharmacology	No proposals and remarks	31.08.2023, protocol # 1
2.Preventive Dentistry	Pediatric Dentistry	No proposals and remarks	20.05.2022, protocol # 9

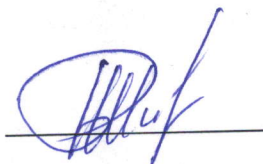
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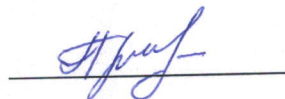
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Zh.A.Rutkovskaya

Associate Professor of the Department of Biological Chemistry of the Educational Institution «Belarusian State Medical University», PhD, Associate Professor



T.Yu.Prinkova

Curriculum content, composition and the accompanying documents comply with the established requirements.

Dean of the Medical Faculty for International Students of the educational institution «Belarusian State Medical University»



O.S.Ishutin

Methodologist of the educational institution «Belarusian State Medical University»



S.V.Zaturanova