Ministry of Healthcare of Ukraine
Poltava State Medical University

Department of Biological and Bioorganic Chemistry

SYLLABUS
BIOLOGICAL AND BIOORGANIC CHEMISTRY

Compulsory discipline

level of higher education	the second (master's) level of higher education
field of knowledge	22 «Healthcare»
specialty	222 «Medicine»
academic qualification	Master of Medicine
professional qualification	Doctor
educational and professional program	«Medicine»
mode of study	full-time
course(s) and semester(s) of study of the discipline	I course, II semester, II course, III-IV semesters

Poltava – 2023

THE INFORMATION ABOUT TEACHERS WHO TEACH THE EDUCATIONAL DISCIPLINE

Surname, name, of teachers, academic degree, academic rank	Bilets Maryna Volodymyrivna, PhD, Assoc. Prof., PhD Khmil Dmutro Oleksandrovych, PhD, Kotvytska Alina Anatoliyivna, Tykhonovych Kseniia Volodymyrivna
Teachers profile	https://en.pdmu.edu.ua/education/departments/bio-him
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Department page on the PSMU website	https://en.pdmu.edu.ua/education/departments/bio-him

BASIC CHARACTERISTICS OF EDUCATIONAL DISCIPLINE

The scope of the academic discipline (module)

The number of credits / hours– 9.0 / 270, of which:

Lectures (hours) - 32

Practical (hours) - 112

Self-preparatory work (hours). - 126

Type of control Exam

The policy of the academic discipline

The policy of the discipline "Biological and Bioorganic Chemistry" is determined by a system of requirements to which lecturers of the department pay attention to the recipients for higher education when studying the discipline and is based on the principles of academic integrity. First of all, these are the requirements for the rules of conduct: attending classes without delay, turning off the phones during the class, as this distracts from the learning process and does not allow to objectively assess the recipient. The recipients for higher education should prepare for practical classes in advance, during the class they should take an active part in the discussion of the topic, using the acquired knowledge. Much attention is paid to the inadmissibility of the use of additional sources of information during practical classes, final module control or semester exam. Timely attendance of classes without passes is the key to successful mastering of material on biological and bioorganic chemistry.

When organizing the educational process at the Department of Biological and Bioorganic Chemistry, lecturers and students act in accordance with:

Regulation on the organization of the educational process at Poltava State Medical University.

Regulation on the academic integrity of recipients of higher education and employees of Poltava State Medical University.

Regulation on the organization and methods for assessment of educational activities of higher education recipients at Poltava State Medical University.

Regulation on the organization of self-directed work of students at Poltava State Medical University.

Regulation on the appeal claim for the results of final control of academic performance for recipients of higher education.

The procedure of the re-crediting academic disciplines, determining of academic difference, and the procedure for passing academic difference in PSMU are defined in the “Regulations on the procedure of re-crediting academic disciplines and determining of the academic difference in Poltava State Medical University”.

Regulations on non-formal and informal education of participants in the educational process of the Poltava State Medical University.

The above documents can be found on the academic office:

REGULATORY DOCUMENTS
(https://www.pdmu.edu.ua/n-process/department-npr/normativni-dokumenti)

Description of the discipline (abstract):

The discipline of "Biological and bioorganic chemistry" is taught for first and second year students for three semesters. We study the chemical nature of the substances that make up the human body, the metabolism of these substances, the reality of these transformations with the activity of the body and tissues, the mechanisms of regulation of these processes in normal and pathological conditions. The discipline includes sections: static biochemistry (chemical composition of substances), dynamic (metabolism and its regulation), dynamic biochemistry (features of the transformation of substances in different tissues and organs).

Pre-requisites and post-requisites of an academic discipline (interdisciplinary links)

Biological and bioorganic chemistry as academic discipline:

Pre-requisites: is based on the study by the recipients for higher education of Latin and medical terminology, human anatomy, histology, cytology and embryology, medical chemistry;

Post-requisites: a) lays the foundations for the recipients for higher education to study pathophysiology, pharmacology, propaedeutics of clinical disciplines, which involves the integration of teaching with these disciplines and the formation of skills to apply knowledge of biological and bioorganic chemistry, especially biochemical processes that take place in healthy and sick people and professional activities;

b) lays the foundations for clinical diagnosis of the most common diseases, monitoring the course of the disease, monitoring the effectiveness of drugs and measures aimed at preventing pathological processes.

The aim and tasks of the biological and bioorganic chemistry:

The aim of studying the academic discipline biological and bioorganic chemistry is: interpretation of the results of biochemical tests and changes, biochemical and enzymatic indices used for diagnosis of human diseases; to analyze biochemical processes of metabolism and its regulation in ensuring the functioning of organs and systems of the human body.

The ultimate goal is to learn practical skills.

The main tasks of studying the discipline "Biological chemistry" are: mastering the skills to study biochemical components in biological fluids and to analyze the results of biochemical investigations and changes in biochemical, in particular, enzymatic parameters used to diagnose the most common human diseases.

Competences and learning outcomes in accordance with the academic and professional program, the formation of which is facilitated by the discipline (integral, general, special)

According to the requirements of the Educational Professional Programe, the discipline provides the recipients for higher education with the acquisition of competencies:

- *integrated:*

The ability to solve complex problems, including those of a research and innovation nature in the field of medicine. Ability to continue learning with a high degree of autonomy.

- *general:*

• Ability to abstract thinking, analysis and synthesis, the ability to learn and master modern knowledge.

• Ability to learn and master modern knowledge.

• Ability to apply knowledge in practical situations.

• Knowledge and understanding of the subject area and understanding of professional activity.

• Ability to work in a team.

• Ability to interpersonal interaction.

• Ability to use information and communication technologies.

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

- *special (professional, subject):*

• Ability to determine the required list of laboratory and instrumental examinations and evaluate their results.

• Ability to determine the nature of nutrition in the treatment of diseases.

• Ability to determine the principles and nature of treatment and prevention of diseases.

• Ability to diagnose emergency conditions.

• Ability to manage healthcare workflows that are complex, unpredictable and require new strategic approaches.

• Observance of professional and academic integrity, bearing responsibility for the reliability of the obtained scientific results.

Program learning outcomes:

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

• Understanding and knowledge of fundamental and clinical biomedical sciences, at a level sufficient for solving professional tasks in the field of health care.

• Specialized conceptual knowledge, which includes scientific achievements in the field of health care and is the basis for conducting research, critical understanding of problems in the field of medicine and related interdisciplinary problems.

• Assign and analyze additional (mandatory and optional) examination methods (laboratory, functional and/or instrumental) of patients with diseases of organs and body systems for differential diagnosis of diseases.

• Search for the necessary information in the professional literature and databases of other sources, analyze, evaluate and apply this information.
• Clearly and unequivocally communicate own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists.

As a result of studying the discipline the student must know:

- The structure of bioorganic compounds and the functions they perform in the human body.
- The reactivity of the basic classes of biomolecules, which ensures their functional properties and metabolic transformations in the organism.
- General biochemical mechanisms of the occurrence of pathological processes in the human body.
- Features of diagnosis of the physiological state of the organism and the development of pathological processes on the basis of laboratory tests.
- Relationship of the structural features and transformations of bioorganic compounds as the basis of their pharmacological action as a medicinal product.
- Basic mechanisms of biochemical action and principles of the use of different classes of pharmacological agents.
- Biochemical and molecular basis of physiological functions of cells, organs and systems of the human body.
- Functioning of enzymatic processes occurring in membranes and organelles for the integration of metabolism in individual cells.
- Norms and changes in biochemical and enzymatic parameters used to diagnose the most common human diseases.
- Significance of biochemical processes of metabolism and its regulation in ensuring the functioning of organs, systems and the integral organism of a person.

Integrative final results of program of training, the formation of which is favored by the educational discipline:
the student should **be able to:**

- To analyze the correspondence between the structure of bioorganic compounds and physiological functions they perform in the organism.
- Interpret features of the physiological state of the organism and the development of pathological processes based on laboratory tests.
- To analyze the reactivity of carbohydrates, lipids, amino acids, ensuring their functional properties and metabolic transformations in the organism.
- To interpret the structural features and transformations of bioorganic compounds as the basis of their pharmacological action as medicines.
- Interpret biochemical mechanisms of pathological processes in the human body and the principles of their correction.
- Explain the basic biochemical mechanisms of action and principle of the use of different classes of drugs.
- Explain the biochemical and molecular basis of physiological functions of cells, organs and systems of the human body.
- To analyze the functioning of enzymatic processes in membranes and organelles for the integration of metabolism in individual cells.
- To classify the results of biochemical studies and changes of biochemical and enzymatic parameters that are used to diagnose the most common human diseases.
- To interpret the significance of the biochemical processes of metabolism and its regulation in ensuring the functioning of the organs, systems and integrated human body.

Thematical plan of lectures

Item No.	Names of topics	Number of hours
Module 1. Biological and Bioorganic Chemistry		
Content module 1 Biologically important classes of bioorganic compounds. Biopolymers and their structural components		
1	**Bioorganic chemistry as a science. Classification, structure and reaction reaction ability of bioorganic substances.** General characteristics of chemical reactions of bioorganic compounds. Classification of reactions according to direction and result. Classification of reactions according to mechanism. Nucleophiles and electrophiles. The radical substitution of a saturated carbon atom (SR). Electrophilic attachment to unsaturated compounds (AE). Electrophilic substitution in aromatic compounds. The effect of substituents on the reactivity of arenes (SE). Nucleophilic substitution of a saturated carbon atom (SN).	2
2	**α-Amino acids, peptides, proteins.** Classification of amino acids by the structure of the carbon chain, the ability to synthesis in the body and the polarity of the radical. General properties of amino acids. Proteins as biopolymers. Methods for combining α-amino acids in protein molecules. The bonds forming the primary, secondary, tertiary and quaternary structures. Globular and fibrillar proteins. Studying the levels of structural organization of protein molecules.	2
3	**Classification, structure and chemical properties of carbohydrates.** Classification of carbohydrates. Isomerism. Tautomeric forms of monosaccharides. Mutarotation. Chemical reactions of monosaccharides with the participation of the carbonyl group: redox reactions (qualitative for the detection of the aldehyde group). Classification of disaccharides by their ability to redox reactions. Two types of bonds between monosaccharide residues and their effect on the reactivity of disaccharides. The structure, properties and role in the structure formation of polysaccharides, maltose and celobiosis, their tautomeric forms. Homopolysaccharides as polyglycosides.	2
4	**Heterocyclic compounds. Structure, properties and bo biological role of nucleic acids.** Classification of heterocycles by cycle size, quantity and quality of heteroatoms. Five-membered heterocycles with one and two heteroatoms and their derivatives. Benzopyrol (indole) as a component of tryptophan and its conversion products - biologically active compounds (tryptamine, serotonin) and toxic substances (skatol, indole) and the products of their neutralization. The formation of pyrazole derivatives as drugs. Six-membered heterocycles with one and two hetero atoms are the basis of biologically important compounds and nitrogen bases.	2
Content module 2. General principles of metabolism. Carbohydrate, lipid and amino acid metabolism and its regulation.		
1	**Bioenergetics: general pathways of carbohydrate, lipid and amino acid metabolism. Tricarboxylic acid cycle. Biological oxidation and oxidative phosphorylation.** Pathways of ATP synthesis in cells: substrate and oxidative phosphorylation. The formation of ATP in cells by anaerobic and aerobic conditions. The benefits of aerobic oxidation of compounds. Biological oxidation reactions: types of reactions (dehydrogenase, oxidase, oxygenase) and their biological significance. Tissue breathing. Molecular complexes of the inner membranes of mitochondria: NADH-coenzyme Q-reductase; Q-reductase succinate coenzyme; coenzyme Q-cytochrome c-reductase; cytochrome c oxidase. Ways to incorporate reducing equivalents into the mitochondrial respiratory chain.	2

	Oxidative phosphorylation. ATP synthetases of mitochondria, structure and principles of function. FO and F1 subunits of ATP synthetase, their functional significance. The theory of oxidative phosphorylation is a chemoosmotic theory - the molecular mechanism of ATP generation in the process of biological oxidation. Electrochemical gradient of protons (ΔμH +). Electron transport inhibitors (rotenone, amital, antimycin A, cyanides, carbon monoxide) and oxidative phosphorylation disconnectors (2,4-dinitrophenol, thyroid hormones, free fatty acids), their bio-medical significance. Violation of ATP synthesis under conditions of exposure to the human body of pathogenic factors of chemical, biological and physical origin.	
2	**Carbohydrate metabolism.** Anaerobic glucose oxidation - glycolysis: enzymatic glycolysis reactions, energy, regulation. Stages of glucose aerobic oxidation, oxidative decarboxylation of pyruvate, Multienzyme pyruvate dehydrogenase complex - features of functioning with the participation of three enzymes and five coenzymes. Comparative characteristics of bioenergy of aerobic and anaerobic oxidation of glucose. Pentose phosphate pathway (PFS) glucose oxidation scheme, biological significance, features of functioning in various tissues. The metabolic pathway and enzymatic reactions of the conversion of fructose in the human body. Glucose biosynthesis - gluconeogenesis: physiological significance, enzymatic reactions, regulatory enzymes. Glycogen breakdown and biosynthesis: enzymatic reactions of glycogenesis and glycogenolysis; cascade mechanisms of cAMP-dependent regulation of glycogen phosphorylase and glycogen synthase activities. Hormonal regulation of glycogen metabolism in muscles and liver. Hormones - regulators of glucose metabolism (glucagon, adrenaline, glucocorticoids, growth hormone, insulin - effects and mechanisms of influence on glucose levels).	2
3	**Lipid metabolism.** Pathways of lipid metabolism. Adipocytes of adipose tissue and their role in lipid metabolism and bioenergy processes in the body. The catabolism of triacylglycerols: reactions; mechanisms of regulation of triglyceride lipase activity. Neurohumoral regulation of lipolysis with the participation of adrenaline, norepinephrine, glucagon, insulin. The biosynthesis of triacylglycerols. Cholesterol biosynthesis: metabolic precursors; reaction. Regulation of cholesterol synthesis. Ways of biotransformation of cholesterol: esterification; the formation of bile acids, steroid hormones, vitamin D3; excretion of cholesterol from the body. The role of cytochrome P-450 in the biotransformation of physiologically active steroids. Pathologies of lipid metabolism. Atherosclerosis: development mechanisms, the role of genetic factors. Atherosclerosis as an autoimmune process.	2
4	**Amino acid metabolism.** Pathways of formation and maintenance of a pool of free amino acids in the human body. General pathways of free amino acids metabolism. Pathways of formation of ammonia. Ammonia toxicity and mechanisms of its neutralization. Circulatory transport of ammonia (glutamine, alanine). Urea biosynthesis: enzymatic reactions, genetic defects of urea synthesis enzymes (enzymes).	2
Content module 3. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions		
1	**Hormones: biochemical and molecular-biological mechanisms of hormone action; protein and peptide hormones.** Hormones and other bioregulators in the system of intercellular integration of the functions of the human body, their chemical nature, classes of hormones: protein-peptide hormones; hormones - derivatives of amino acids; steroid hormones; bioregulators are derivatives of arachidonic acid. Synthesis and secretion of hormones. Cyclicity of hormonal secretion in the human body. Circulatory transport of hormones. Targets of hormonal action; types of cell responses to hormones. Hormone receptors: membrane (ionotropic, metabotropic) and cytosolic receptors. Biochemical systems of intracellular transduction of hormonal signals.	2
2	**Lipid hormones.** Chemical nature and action mechanism of steroid hormones on the target cell. Action mechanism of glucocorticoids and mineralcorticoids in metabolism. Hyper- and hypofunction of adrenal cortex. Sex hormones. Hormones of adrenal cortex in stress reactions. Methods of biochemical diagnostics of functioning of adrenal cortex and sex glands. Precursors of eicosanoid formation.	

	Prostanoids, thromboxanes and leukotrienes, examples of structure of prostaglandins. Arachidonic acid – the precursor of eicosanoid synthesis (role of phospholipase A_2). Role of prostaglandin synthase complex in synthesis of prostaglandins and thromboxanes. Types of leukotrienes. Biosynthesis of leukotrienes (5-HPETE – leukotrienes). Biological role of prostaglandins. Biological role of thromboxanes. Biological role of leukotrienes (role of slowly reacting substance in genesis of allergies). Eicosanoids as central mediators of inflammation (chemoattractors, vasodilators, stimulators of exudation, migrations and degranulation of leukocytes and phagocytosis). Clinical application of eicosanoids. NSAIDs blockade cyclooxygenase and its consequences.	
3	**Biochemistry of blood. Respiration function of erythrocytes.** Physiological and biochemical functions of blood. Respiratory function of red blood cells. Hemoglobin: structure, properties, mechanisms of participation in the transport of oxygen and carbon dioxide. Variants of human hemoglobins; molecular disorders in the structure of hemoglobins (hemoglobinoses) - hemoglobinopathies, thalassemias. The acid-base balance of the human body. Mechanisms of regulation and maintenance of the acid-base balance: blood buffer systems, lung and kidney function.	2
4	**Biochemical principles of realization of immune processes. Immunodeficiency conditions.** General characteristics of the immune system; cellular and biochemical components. Immunoglobulins: structure, biological functions, mechanisms of regulation of the synthesis of immunoglobulins. Biochemical characteristics of individual classes of human immunoglobulins. Mediators and hormones of the immune system; cytokines (interleukins, interferons, protein-peptide factors of growth regulation and cell proliferation). Biochemical components of the human complement system; classic and alternative (properdine) activation mechanisms. Biochemical mechanisms of immunodeficiency states: primary (hereditary) and secondary immunodeficiencies; acquired immune deficiency syndrome.	2
5	**Biochemical functions of the liver. Biochemistry of jaundices. Biotransformation of foreign compounds in the liver.** Homeostatic role of the liver in the metabolism. Biochemical functions of hepatocytes. Carbohydrate, lipid-regulating, protein, urea-educational, pigment, bile-forming liver functions. The biochemical composition of bile. The role of the liver in the exchange of bile pigments. Hemoglobin catabolism: rupture of the tetra-pyrrole heme ring, decomposition of verdoglobin, conversion of biliverdin to bilirubin, formation of bilirubin-diglucuronide, excretion into bile. Pathobiochemistry of jaundice; hemolytic, parenchymal, obstructive.	2
6	**Biochemical functions of the kidney. Biochemistry of urine and urine formation. Patobiochemistry of urine.** Water-salt metabolism in the body. Intracellular and extracellular fluid spaces, their chemical composition. The role of the kidneys in the regulation of electrolyte balance and pH of body fluids. Biochemical mechanisms of urine production. Hormonal mechanisms of regulation of water-salt metabolism and renal function; antidiuretic hormone; aldosterone. Pathobiochemistry of the kidneys and water-salt metabolism. The biochemical composition of human urine in the conditions of pathological processes.	2
7	**Biochemistry of the connective and bone tissues. Factors of osteoporosis risk.** General characteristics of the morphology and biochemical composition of connective tissue. The biochemical structure of the intercellular substance of loose fibrous connective tissue fibers (collagenic, reticular, elastic) is the main amorphous substance. Proteins of connective tissue fibers collagen, elastin, glycoproteins and proteoglycans. Collagen biosynthesis and the formation of fibrillar structures. Complex carbohydrates of the main amorphous matrix of connective tissue are glycosine minoglycans (mucopolysaccharides). Pathobiochemistry of connective tissue. Biochemical mechanisms of development of mucopolysaccharidoses and collagenoses, their clinical and biochemical diagnostics.	2
8	**Biochemistry of the nervous tissue.** Features of the biochemical composition and metabolism of nerve tissue. The chemical composition of the brain, neurospecific proteins and lipids (gangliosides, cebroside, cholesterol). Features of the amino acid composition of the brain the role of the glutamic acid system. Energy	2

	metabolism in the human brain, the importance of aerobic oxidation of glucose changes in physiological sleep and drug addiction. Neurotransmitters.	
	Total	**32**

Thematical plan of practical classes

Item no.	Names of topics	Number of hours
Content module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components		
1	**Classification, nomenclature and isomerism of bioorganic compounds. Nature of chemical bonds.** Acyclic, carbocyclic (alicyclic and aromatic) and heterocyclic compounds. Structure of their representatives. Classes of organic compounds and their respective functional groups. Priority of functional groups and their names. Common nomenclature International nomenclature. Radical-functional nomenclature. Structure isomerism. Stereoisomerism Configuration isomerism: optical, cis-trans and conformation isomers. Distribution of electrons on the atomic orbitals of the carbon atom. sp^3-hybridization of the carbon atom. sp^2- and sp-hybridization. σ- and π-bonds in organic compounds. Electronegativity of atoms. Distribution of electron density in organic molecules 1) inductive effect; 2)mesomeric effect	2
2	**Types of chemical reactions. Analysis of reaction ability of alkanes, arenes, alcohols, phenoles, amines.** The homological series of alkanes: names and molecular formulas. Chemical properties of alkanes. Radical substitution at the saturated carbon atom (S_R). Representatives of alkenes, alkadienes and alkynes. Their structure and chemical properties. Electrophilic substitution in unsaturated compounds (A_E). General characteristics of aromatic hydrocarbons, their electron structure and chemical properties. Electrophilic substitution in aromatic compounds (S_E). Effect of substitutients on the reactive ability of arenes. Structure of alcohols and phenols, their representatives, physical and chemical properties of the hydroxil compounds. Nucleophilic substitution at the saturated carbon atom (S_N). Polyatomic acyclic and cyclic alcohols Aliphatic and aromatic amines: representatives and their structure. Chemical properties of amines: reactions of amines as nucleophylic reagents. Aniline: its pharmacological and biological derivatives. The homological series of alkanes: names and molecular formulas. Chemical properties of alkanes. Radical substitution at the saturated carbon atom (S_R). Representatives of alkenes, alkadienes and alkynes. Their structure and chemical properties. Electrophilic substitution in unsaturated compounds (A_E). General characteristics of aromatic hydrocarbons, their electron structure and chemical properties. Electrophilic substitution in aromatic compounds (S_E). Effect of substitutients on the reactive ability of arenes. Structure of alcohols and phenols, their representatives, physical and chemical properties of the hydroxil compounds. Nucleophilic substitution at the saturated carbon atom (S_N). Polyatomic acyclic and cyclic alcohols Aliphatic and aromatic amines: representatives and their structure. Chemical properties of amines: reactions of amines as nucleophylic reagents.	2

	Aniline: its pharmacological and biological derivatives.	
3	**Analysis of chemical properties of aldehydes and ketones**. Explain the structure of the carbonyl group, write formulas and names of most abundant aldehydes and ketones. Try qualitative reactions: a) Fehling's with a water solution of formaldehyde; b) acetone with iodine solution in an alkaline media; c) precipitation of protein with formaline. Reactions of nuclephilic addition (A_N) of water, cyanides, alcohols and amines to aldehydes. The reaction of aldol condensation and its importance for elongation of hydrocarbon chains. Reactions of oxydation and reduction of aldehydes and ketones. Qualitative tests for the aldehyde group (Tollen's, Trommer's, Fehling's), their clinical importance. The reaction of disproportionation (dismutation, Cannizzaro's). Haloform reactions of aldehydes and ketones. Iodoform test and its application in analytics.	2
4	**Analysis of chemical properties of carboxylic acids.** Explain classification of carboxylic acids. Name the most important monocarboxylic acids. Reactions of nucleophilic substitution (S_N) at the sp^2-hybridized carbon atom in the carbonyl group. The esterification reaction and its biochemical importance. The amidation reaction and its biochemical importance. Chemical properties. Biological importance of certain carboxylic acids (oxalic, malonic, succinic, glutaric, fumaric).	2
5	**Analysis of chemical properties of high fatty acids. Lipids. Phospholipids.** Biological function of lipids. High fatty acids as constituents of neutral lipids. Physiological importance of hydrolysis of neutral lipids. Soaps. Role of phospholipids in biomembranes. Classification of phospholipids. Physical and chemical properties of phospholipids	2
6	**Analysis of reaction ability of heterofunctional compounds (aminoalcohols, hydroxyacids, ketoacids and phenolacids).** Classification and isomerism of hydroxyacids. The assymmetric carbon atom, chirality, optical activity. Enantiomers. Diasteromers. Chemical properties and biological importance of hydroxyacids and amino acids. Biological importance of ketoacids and their derivatives. The ketone bodies, diagnostic importance of their measurement in diabetes mellitus. Keto-enol tautomerism of ketoacids and their derivatives. Salycilic acid and its derivatives as antiinflammatory and antimicrobial remedies.	2
7	**Practical skills and problem solving in the subject "Theoretical basics of structure and reaction ability of bioorganic compounds".** 1. What structure characteristics are responsible for the inertness of alkanes and high reaction ability of aldehydes. 2. Write structure of isomers of pentane. Name them according to the IUPAC nomenclature. 3. Is the acidity of aromatic and aliphatic alcohols different? How can it be explained? 4. What reactions can be applied to discriminate primary alcohols from secondary alcohols? 5. What reactions can be applied to discriminate propantriol-1,2,3 from propanol-1? 6. Write reaction equations of oxidation of propanol-2 and propanol-1. What products are obtained? Name them according to the IUPAC nomenclature. 7. Write the reaction of formation of diethyl ether. Write the reaction of its hydrolysis. What products of hydrolysis are obtained? 8. Write the reaction of bromination of phenol. What products are obtained? Name them according to the IUPAC nomenclature. 9. Write the reaction of formation of 2,4,6-trinitrophenol. What is the reaction type? 10. To which reaction type do the reactions of bromination and nitration of benzene belong? Write the schemes of the reactions.	2

	11. Explain characteristics of the structure of the carbonyl group. What reactions are typical for carbonyl compounds? 12. Write the reaction of formation of semiacetal from acetic aldehyde (ethanal) and methanol. 13. Write the reaction between trichloroacetic aldehyde and water. Where is the product of the reaction used in medicine? What is its common name? 14. Write the reaction between propanone and hydroxylamine. Which reaction type is it? Name the product of the reaction. 15. Write the reaction of oxidation of propanal by silver oxide. Name the products of the reaction according to the IUPAC nomenclature. 16. Write the reaction between ethanal and Fehling's reactant. Name the reaction products. Where are they used? 17. Write structure formulas of the first five saturated monocarboxylic acids. 18. Compare the acidity of acetic and trichloroacetic acids. Why is the acidity different? 19. Write the reaction of esterification between ethanoic acid and ethanol. 20. Write the structure formula of acetylsalycilic acid. What is the common name of the compound? How is it used in medicine? 21. Write structure formulas of aniline, ethylamine and ammonia. Which of the compounds has the greatest basicity? 22. Write the reaction of sulfonation of aniline. What product is formed in the reaction? How are derivatives of the compound used in medicine? 23. Write the structure formula of paraaminobenzoic acid (PABA). Name the antagonist of the acid. How is it used in medicine? 24. Write the structure formulas of oxaloacetic and α-ketoglutaric acids, explain their biochemical role. 25. Write the structure formula of acetoacetic acid. What products are formed as a result of its reduction and decarboxylation. Explain the biochemical role of the acid and the products. 26. Write the structure formulas of dopamine and epinephrine. What is the biological role of the aminophenols? 27. Explain what lipids are. Explain biological functions of lipids. 28. Write formulas of palmitic and stearic acids. Explain their biochemical role. 29. Write formulas of the unsaturated acids: linoleic, linolenic and arachidonic. Explain their structure characteristics and biochemical role. 30. Write the reaction of hydrolysis of tristearin in alkaline environment. What products are formed? How are they used? 31. Write the formula of phosphatidylcholine. What is the biochemical role of the compound?	
8	**Analysis of amino acid composition of proteins and peptides.** Explain classification of amino acids by the structure of the carbohydrate chain; Explain classification of amino acids by ability to be synthesized by the organism; Explain classification of amino acids by the polarity of the radical. Optical properties of amino acids. Chemical properties of amino acids as heterofunctional compounds: a) formation of derivatives of carboxylic acids (salts, esters, amides, halogenanhydrides); b) formation of derivatives of the amino group: (reactions of acylation, alkylation, formation of salts with mineral acids). . Write an equation of the reaction of decarboxylation of amino acids with formation of biogenic amines (glutamic acid, serine, histidine, tryptophane), explain their physiological functions. Write schemes of the reactions of deamination and transamination of α-amino acids, explain their biological importance. Write a scheme of the reaction of formation of amides of glutamic and aspartic acids. Explain their biological importance. The Van Slijk's reaction. The Sërensen's reaction. Qualitative reactions for α-amino acids, peptides, proteins. Mechanism of formation of the peptide bond.	2
9	**Analysis of protein structure.** Functions of proteins. Bonding between α-amino acids in protein molecules. Bonds, that form primary, secondary, tertiary and quaternary structures. Primary, secondary, tertiary and quaternary structures, types of bonds that stabilize the structures. Sequencing of proteins (after Senger and Edman)	2

	Simple and complex proteins. Classification of proteins by the nature of the prosthetic group and spatial structure (globular and fibrillar). Factors of stability of proteins in colloidal solutions. Reversible precipitation of proteins, its application in medical practice. Irreversible precipitation of proteins, factors, that cause it.	
10	**Analysis of chemical properties of monosacharides.** Classification of monosaccharides. Isomerism. Tautomeric forms of monosaccharides. Mutarotation. Chemical reactions of monosaccharides with participation of the carbonyl group: oxidation-reduction reactions (qualitative for presence of the aldehyde group). Formation of glycosides, their role in formation of oligo- and polysaccharides, nucleosides, nucleotides and nucleic acids. Phosphorus esters of glucose and fructose, their importance in metabolic transformations of carbohydrates. Ascorbic acid as a hexose derivative, its biological role.	2
11	**Analysis of chemical properties of di- and polysaccharides**. Structure and properties of sucrose, lactose, maltose. Inversion of sucrose in hydrolysis. Classification of disaccharides by their ability to take part in reduction-oxidation reactions. Two types of bonds between the residues of monosaccharides and their effect on reactive ability of disaccharides. Classification of polysaccharides. Structure, biological role, application of starch, its components. Structure of amylase and amylopectin. Hydrolysis of starch, the qualitative reaction for starch. Structure and biological role of glycogen, cellulose, their functions in metabolic processes. Heteropolysaccharides. Role of glucuronic acid, glucosamine and galactosamine in formation of heteropolysaccharides.	
12	**Analysis of chemical properties of biologically important heterocyclic compounds.** Classification of heterocycles: a) by the size of the cycle; b) by the number and nature of heteroatoms. Characteristics of five-membered heterocycles with one and two heteroatoms and their derivatives. Benzpyrrole (indole) as a component of tryptophane and its derivatives – biologically active compounds (tryptamine, serotonine). Benzpyrrole as a component of toxic compounds (skatole, indole) and products of their detoxication. Obtaining of pyrazole derivatives as drugs Six-membered heterocycles with two heteroatoms as components of biologically important compounds. Six-membered heterocycles as components of nitrogenous bases.	2
13	**Analysis of chemical properties of nucleosides and nucleotides.** Structure of the nucleotides: AMP, GMP, UMP, CMP, d-TMP. Structure and importance of 3',5'-cAMP, Its role in action of hormones on cells. Phosphorylated derivatives of nucleotides, role of ATP and ADP. Role of nucleotides in coenzymes. Mechanism of action of the NAD coenzyme	2
14	**Analysis of structure and properties of nucleic acids.** Write formulas of components of DNA, RNA, examples of structure of their monomers, bonds between monomers in DNA and RNA in the notebook. Biological role of DNA. The principle of DNA structure, primary and secondary structures, types of chemical bonds. The principle of RNA structure, primary and secondary structures, types of chemical bonds. Types of RNA: mRNA, rRNA, tRNA, their structure and biological role. Role of the principle of complementarity in functioning of DNA and RNA. Minor bases.	2
15	**Final control of content module I.**	2

Content module 2. General principles of metabolism. Carbohydrate, lipid and amino acid metabolism and its regulation.		
1	**Control of initial level of knowledge. The subject and tasks of biochemistry. Aim and methods of biochemical research, its clinical and diagnostic value. Analysis of structure, physical and chemical properties of protein enzymes.** Biochemistry as a science. Tasks of biochemistry. The basic stages of development of biochemistry. Value of biochemistry for diagnostics and treatments of the basic diseases of the person. Static biochemistry. Dynamic biochemistry. Functional biochemistry. Clinical biochemistry as section of biochemistry. Physical and chemical properties of proteins - enzymes. Electrochemical properties, solubility. Thermodynamic stability of protein molecules of enzymes; denaturation.	2
2	**Measurement of enzymic activity. Units of catalytic activity of enzymes. Analysis of enzymic processes by the reaction type of main classes of enzymes. Analysis of the mechanism of enzymic action and kinetics of enzymic catalysis.** At concrete examples explain principles of methods of determination of the enzyme's activity. a) By quantity of a product that is formed under action of enzyme for a time unit; b) By quantity of the spent substratum for a time unit; c) spectrophotometric methods of determination of the enzymes activity and visualization of results of ferment reactions. Units of measurements of activity and quantity of enzymes: a) International units; b) Katal; To explain the principle of the international classification and the nomenclature of enzymes. To name six classes of enzymes and to explain types of catalytic reactions by them. Specific activity of enzyme. Thermodynamic principles of ferment catalysis. The active centers of enzymes. Differences in structure of the active centers in simple and complex enzymes. The ferment transformation of substrata at catalytic action of enzyme by the example of chymotrypsin and acetylcholinesterase action. Sequence of stages of catalytic process. Dependence of speed of reactions on concentration of enzyme, a substratum, pH and temperatures. Constant of Michaelis-Menten, their semantic value.	2
3	**Analysis of regulation of enzymic processes.** Explain the biological importance of specificity of enzymes action, by what it is caused? What kinds of specificity of enzymes are known to you? Give examples. Regulation of enzymic activity by change of enzyme catalytic activity: a) allosteric regulation of enzymes activity; b) covalent updating of enzymes; c) activation of enzymes by limited proteolysis; d) action of regulatory proteins – effectors (of calmodulin, proteinases, proteinase inhibitors, cyclic Convertible and irreversible inhibition of enzymes. Physiologically active connections and xenobiotics as convertible (competitive and not competitive) and irreversible inhibitors of enzymes. Convertible and irreversible inhibition of enzymes. Physiologically active connections and xenobiotics as convertible (competitive and not competitive) and irreversible inhibitors of enzymes. On an example of isoenzymes of lactate dehydrogenase (LDH), creatine phosphokinase explain value of their determination in clinic. Proenzymes, their biological role and value.	2
4	**Medicinal enzymology.** Modern aspects of enzymodiagnostics:	2

	cellular, secretory and excretory enzymes. Isoenzymes in enzymodiagnostics, tissue specificity of distribution of enzymes. Change of activity of enzymes of plasma and whey of blood as diagnostic parameters of development of pathological processes in an organism. Application of enzymodiagnostics in cardiology, hepathology, nephrology, urology, oncology, pulmonology, orthopedy, and so forth (examples). Infringement of the course of ferment processes: hereditary and got enzymopathies. Congenital defects of a metabolism and their clinical-laboratory research. Use of enzymes as medical products. Pharmacological application of enzymes of a gastroenteric path; coagulative and fibrinolytic systems of blood, kalicrein- kinine and renin-angiotensive systems. Inhibitors of enzymes as medical drugs.	
5	**Analysis of the role of cofactors and coenzyme vitamins in catalytic activity of enzymes.** Structure and properties of coenzymes. Classification of coenzymes by the chemical nature. Classification of coenzymes by the type of a reaction, that is catalysed: a) coenzymes that are the carriers of hydrogen protons and electrons; b) coenzymes that are the carriers of chemical groups; c) coenzymes of synthesis, isomerization and splittings of carbon - carbon bonds. Participation of coenzyme forms of vitamins B_2 and PP in oxidation-reduction reactions. Influence of coenzyme derivative of vitamins B_6 on separate parts of a metabolism. Coenzyme of acetylization (Coenzyme-A) – a derivative of pantothenic acid. Biological properties of vitamin B_3, the mechanism of action. Coenzymes – derivatives of a folic acid. Vitamin Bc (folic acid): biological properties, the mechanism of action. Lipoic acid: coenzyme in reactions of oxidative decarboxylation of ketoacids and aerobic oxidation of glucose. Coenzyme thiamine pyrophosphate. Vitamin B_1 (thiamine): a structure, biological properties, the mechanism of action. Coenzyme carboxybiotin. Vitamin H (biotin): biological properties, the mechanism of action. Coenzymes – derivatives of vitamin $B_{12.}$ Vitamin B_{12} (cobalamin): biological properties, the mechanism of action.	2
6	**Basic concepts of metabolism. Common metabolic pathways of proteins, carbohydrates, lipids. Analysis of the tricarboxylic acid cycle. Bioenergetics processes: biological oxidation, oxidative phosphorylation. Chemiosmotic theory of oxidative phosphorylation. Inhibitors and discouplers of oxidative phosphorylation.** Connection of catabolism and anabolism with energetic exchange. Role of ATP and others macroergs in catabolic and anabolic ways of a metabolism. Stage 1 – disintegration of complex macromolecules up to simple components. Stage 2 – endocellular catabolism of carbohydrates, lipids and amino acids. 3Acetyl - CoA – the general end-product of the second stage of an endocellular metabolism of carbohydrates, lipids and amino acids. Stage 3 – oxidation of acetyl - CoA up to end-products – CO_2 and H_2O. General characteristics of TCA and system of electron transport in mitochondrion membranes (tissue breathing) and interfaces with oxidative phosphorylation. Biochemical value of the tricarboxylic acid cycle.The scheme of functioning, sequence of reactions.Ferment reactions of tricarboxylic acid cycle: the characteristics of enzymes.Features of functioning of α-ketoglutarate dehydrogenase multienzyme complex.Reactions of substratum phosphorylation in the tricarboxylic acid cycle.Total balance of ATP molecules which are formed at functioning of a cycle. Interrelation of processes of formation and consumption of energy in alive systems. Ways of synthesis of ATP in cells. Reactions of biological oxidation. The molecular organization of a mitochondrial chain of biological oxidation. Oxidative phosphorylation. ATP-synthetase of mitochondria. The chemiosmotic theory of oxidative phosphorylation – the molecular mechanism of generation of ATP during biological oxidation. Conditions of effective interface of oxidation and phosphorylation in mitochondria. Inhibitors and uncouplers of tissue breathing.	2
7	**Analysis of aerobic and anaerobic oxidation of glucose.**	2

	Gluconeogenesis. General characteristics of anaerobic oxidation of glucose. Sequence of reactions and enzymes of glycolysis. Glycolytic oxidoreduction: substratum phosphorylation and shuttle mechanisms of glycolytic oxidation of $NADP^+$. Pasteur's effect. Regulation of glycolysis.Alcoholic and other kinds of fermentation. Ways of recycling of a lactic acid. The reasons and consequences of hyperlactatemia. What process refers to "gluconeogenesis"? In what tissues does it actively pass? Physiological value of gluconeogenesis. Metabolic way of gluconeogenesis; irreversible reactions of glycolysis, reactions and enzymes that allow to evade them. Compartmentalisation of transformation of pyruvate in phosphoenolpyruvate. Substrata of gluconeogenesis. Lactate and alanine as substrata of gluconeogenesis.Glucose-lactate cycle (cycle of Cori). Glucose-alanine cycle.Metabolic and hormonal regulation of gluconeogenesis. Regulatory enzymes. Illness of Cushing (steroid diabetes). Stages of aerobic oxidation of glucose. Oxidative decarboxylation of pyruvate. Multienzymatic pyruvate dehydrogenase complex – features of functioning at participation of three enzymes and five coenzymes. The total equation of process.	
8	**Alternate pathways of monosaccharide metabolism.** Biological value and features of functioning of pentose-phosphate pathway for different tissues. Sequence of ferment reactions of PPhP: a) oxidative stage; b) stage of isomeric transformations. 2Infringement of pentose-phosphate pathway of an exchange of glucose in erythrocytes: enzymopathy of glucose-6-phosphate-dehydrogenase. Explain a biological role of glucuronate way of oxidation of glucose; on concrete examples explain its structural role and a role in neutralization of toxic substances. Write a structure of glucuronic acid, UBP-glucuronic acid, hexosamine (glucosamine or galactosamine). Metabolic way and ferment reactions of transformation of fructose in the person organism. Hereditary enzymopathies, connected to genetic defects of enzymes synthesis of fructose metabolism – intolerance of fructose (fructosemia). Metabolic way and ferment reactions of transformation of galactose in the person organism. Hereditary enzymopathies, connected to genetic defects of enzymes synthesis of a galactose metabolism – galactosemia.	2
9	**Analysis of catabolism and biosynthesis of glycogen. Regulation of glycogen metabolism.** Structure of glycogen and its biological role. Explain mechanisms of biosynthesis of glycogen (reactions, enzymes). Genetic infringements of enzyme systems of glycogen synthesis, the characteristic of the most widespread aglycogenoses. Explain biochemical mechanisms of disintegration of glycogen in a liver and muscles: reactions, enzymes, a biological role. What are the differences of glycogen disintegration in a liver and muscles? Hormonal regulation of an exchange of glycogen: the cascade mechanism of regulation of activity c-AMP-depending glycogen phosphorylase and glycogen synthetase. Genetic infringements of process of disintegration of glycogen (glycogenoses).	2
10	**Analysis of mechanisms of metabolic and hormone regulation of carbohydrate metabolism.** Mechanisms of hypoglycemic effect of insulin. The mechanism of influence on a carbohydrate exchange of glucagon, adrenaline, glucocorticoids. Normoglycemia: mechanisms of its support. Hypoglycemia: the reasons of occurrence and a consequence for an organism. Hyperglycemia – the reasons and complications Clinical-biochemical characteristic. Diagnostic criteria of a diabetes mellitus: a) glucose-tolerant test;b) double sugar loading.c) glycosilative HbA_{C1}.	2
11	**Transportation forms of lipids.** To name classes of lipoproteins of blood plasma, their value. To characterize qualitative and quantitative structure of lipoproteins of blood plasma.	

	Classes of apoproteins, their biological role. Formation of transport forms of lipoproteins of blood. Quantitative and qualitative changes of blood lipoproteins at their circulation in blood and cells. The clinical-biochemical characteristic of primary and secondary lipoproteinemias by WHO classification. Principles of laboratory diagnostics of dislipoproteinemias.	
12	**Analysis of catabolism and biosynthesis of triacylglycerols. Determination of molecular mechanisms of regulation of lipolysis. Metabolism of complex lipids.** Biological functions of the main classes of lipids: energetic, structural, regulatory. Catabolism of triacylglycerols in adipocytes of adipose tissue: sequence of reaction, mechanisms of regulation of triglyceridlipase activity. Neuro-humoural regulation of lipolysis with participation of adrenaline, noradrenaline, glucagon and insulin. Oxidation of glycerol: enzyme reactions, bio-energetics. Biosynthesis of triacylglycerols. Adipocytes of adipose tissue and their role in lipid exchange and bioenergetic processes in organism. Pathochemistry of obesity. Complex lipids/ biosynthesise of phospholipids/ What lipotropic factors (irreplaceable components of meal) are necessary for synthesis of phosphotedylcholine? Infringement of an exchange of compound lipids – steatosis of liver. Sphingolipidoses: a) Illness of Nimane-Peak. b) Illness of the Tay-Sachs. c) Illness of Gaucher's.	2
13	**β-oxidation of fatty acids. Analysis of metabolism of fatty acids and ketone bodies. Biosynthesis of fatty acids.** Oxidation of fatty acids (β-oxidation) a) Activation of fatty acids; b) Role of carnitine in transport of fatty acids in mitochondria; c) Sequence of ferment reactions. Biosynthesis of the supreme fatty acids, metabolic sources. Biosynthesis of the saturated fatty acids (palmitate). Synthesis of malonyl-CoA. Features of fatty acids synthase structure, acetyl-transport protein. Sources of NADPH for biosynthesis of fatty acids.Regulation of biosynthesis of fatty acids. Elongation of the saturated fatty acids. Formation of mono- and poly-unsaturated fatty acids. Physiological value. Biological role of compound lipids.Biosynthesis of phospotedylcholine. Energetics of β-oxidation of fatty acids. Oxidation of glycerol. Ketone bodies. Reactions of biosynthesis and recycling of ketone bodies, their physiological value. Metabolism of ketone bodies in conditions of a pathology. Mechanisms of superfluous rising of the contents of ketone bodies at a diabetes mellitus and starvation. Consequences of ketosis.	2
14	**Biosynthesis and biotransformation of cholesterol. Analysis of deficiencies of lipid metabolism: steatorrhea, atherosclerosis, obesity.** Biological role of cholesterol. Circulatory transport of cholesterol. Norm of the contents of cholesterol in whey of blood. Transport of cholesterol, change in system of lipoproteins at a pathology, their functional value. The scheme of reactions of cholesterol synthesis. Key reaction of biosynthesis. Regulation of cholesterol synthesis. The mechanism of cholesterol etherefication . Biosynthesis of bile acids from cholesterol.Biosynthesis of steroid hormones from cholesterol.Formation of vitamin D_3 from cholesterol. Mechanisms of development of an atherosclerosis.Mechanisms of obesity development.Infringement of lipid exchange at a diabetes mellitus (macroangiopathies, ketosis), mechanisms of their development. Steatorrhea, the mechanism of its development.	2
15	**Analysis of amino acid metabolism (transamination, deamination,**	2

	decarboxylation). Analysis of ammonia detoxication and urea biosynthesis. Ways of obtaining of free amino acids in tissues. Ways of using of free amino acids in tissues. Transamination of amino acids: reactions and their biochemical value. To write the equation of reamination reactions of glutamic acid and pyruvate. The mechanism of aminotransferases action. Direct and indirect of deamination of free L-amino acids in tissues. Decarboxylation of L-amino acids in the organism of the person. Physiological value of the formed products. Oxidation of biogenic amines. To explain molecular mechanisms of toxic influence of ammonia on an organism. Circulatory transport of ammonia. Explain 4 molecular mechanisms of urgent neutralization of ammonia. What ways of use by an organism of the formed nitrogenous products exist? What processes deliver free ammonia at the first stage of synthesis of urea? Write the reactions of glutamine and carbomailphosphate synthesis. To give a general characteristic of process of biosynthesis of urea, chemism of reactions, the name of enzymes. Primary and secondary hyperamoniemias (the reasons and consequences). Explain changes of protein exchange at uremia, hepatic and kidney insufficiency, radiation sickness. Name the digital values of the contents in norm in blood of ammonia, urea, daily their allocation with urine. At disease of what organs and systems is it necessary for the doctor to appoint the analysis for the contents of urea in blood and urine?	
16	**Biosynthesis of glutathione and creatine. Analysis of intermediate products of porphyrin biosynthesis and their accumulation at porphyries.** Ways of ammonia formation.Biological role of creatinphosphate.Biosynthesis of creatine.Precursors of creatine biosynthesis.Features of the second stage of creatine biosynthesis – transmetilation of glycociamine (guadenine acetate). Sources of CH_3 - groups.Reaction of creatine phosphorylation. Clinical value of determination of the creatine and creatinine contents in blood and urine.Clinical value of creatine phosphokinase determination. Isoforms of creatine phosphokinase Precursors of glutathione biosynthesis.Role of glutathione in an exchange of organic peroxides. Porphyrins: structure, biological role. Reactions of protoporphyrin IX biosynthesis; formation of heme. Regulation of porphyrins synthesis. Hereditary infringements of an porphyrins exchange (enzymopathies): erythropoetic porphiria, hepatic porphyrias, neurologic infringements, photodermatites.	2
17	**Biosynthesis and catabolism of purine and pirimidine nucleotides. Analysis for the end products of their metabolism.** Biosynthesis of purine nucleotides. Biosynthesis of pyrimidine nucleotides Biosynthesis of deoxyribo-nucleotides. Hereditary infringements of uric acid metabolism. Clinical and biochemical characteristics of hyperuricemia, gout, Lesch-Nyhan syndrome.	2
18	**Final control of content module 2.**	2
	Content module 3. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions	
1	**Study of molecular-cellulary mechanisms of action of peptide and protein hormones on target cells.** Cyclicity of hormonal secretion in the organism. Circulatory transport of hormones. Targets of hormones: types of cell reactions to hormone action. Hormone receptors: membrane (ionotropic, metabotropic) and cytosolic receptors. Biochemical systems of endocellular transduction of hormone signals. . Classification of protein-peptide hormones. Molecular-cellular action mechanisms of protein-peptide hormones. Cascade systems of	2

	transduction of bioregulator chemical signal: receptors → G-protein → secondary intermediates → protein kinases. Messenger functions of cyclic nucleotides, Ca^{+2} /calmodulin system, phosphoinositols. Serine, threonine and tyrosine protein kinases and effectory functions of cells	
2	**Hormones of hypothalamus and hypophysis.** Hormones of hypothalamic-hypophysial system. Liberins and statins of hypothalamus. Hormones of anterior pituitary. Group of growth hormone (somatotropin) – prolactin – chorionic somatotropin, pathological processes caused by infringement of STH function, somatomedins, prolactin. Group of glycoproteids – tropic hormones of hypophysis (thyrotropin, gonadotropin – FSH, LH, chorionic gonadotropin). Family of proopiomelanocortin (POMC) – products of POMC processing (adrenocorticotropin, lipotropins, endorphins). Hormones of the pituitary posterior lobe. Vasopressin (antidiuretic hormone); diseases caused by infringement of ADH production (diabetes mellitus, insipidus, Parhon syndrome). Oxytocin	
3	**Study of molecular-cellulary mechanisms of action of steroid hormones on target cells. Steroid hormones.** Chemical nature and action mechanism of steroid hormones on the target cell. Action mechanism of glucocorticoids and mineralcorticoids in metabolism. Hyper- and hypofunction of adrenal cortex. Sex hormones. Hormones of adrenal cortex in stress reactions. Methods of biochemical diagnostics of functioning of adrenal cortex and sex glands.	2
4	**Study of the role of thyroid hormones and biogenic amines in regulation of metabolic processes.** Structure and biosynthesis of thyroid hormones. Write their structural formulas. Explain molecular-cellular mechanisms of action of thyroid hormones. Biological effects of T_3 and T_4. Pathology of the thyroid gland, infringements of metabolic processes at hyper- and hypo-thyreosis. Catecholamines (epinephrine, norepinephrine, dopamine): structure, biosynthesis, physiological effects, biochemical mechanisms of action. Indolamines (serotonin, melatonin): structure, biosynthesis, physiological effects, biochemical mechanisms of action. Histamine: structure, biosynthesis, physiological effects, biochemical mechanisms of action. Receptors of biogenic amines; receptor action of mediciness, antagonists of histamine receptors.	2
5	**Hormones of the pancreas. Hormones of the gastrointestinal tract.** Insulin – structure, biosynthesis and secretion. Effects of insulin on metabolism of carbohydrates, lipids, amino acids and proteins. Growth-stimulating effects of insulin; growth factors and oncoproteins. Glucagon – structure, mechanism of action. Effect of glucagon on the metabolism. Infringement of metabolism at diabetes mellitus. Biochemical diagnostics of diseases of the pancreas. Gastrin – structure, biological functions.Cholecystokinin – structure, physiological effects. Secretin – structure, properties.	2
6	**Hormonal regulation of calcium homeostasis.** Distribution of Ca^{2+} in organism; molecular forms of calcium in blood plasma. Role of the bone tissue, small intestine and kidneys in calcium homeostasis. Parathyroid hormone – structure, mechanism of hypercalcemic action. Calcitriol: biosynthesis, influence to absorption of Ca^{2+} and phosphates in intestine. Calcitonin: structure, effect on calcium and phosphate metabolism. Clinical-biochemical characteristic of calcium homeostasis infringements (rickets, osteoporosis).	2
7	**Physiologically active eicosanoids.** Precursors of eicosanoid formation. Prostanoids, thromboxanes and leukotrienes, examples of structure of prostaglandins. Arachidonic acid – the precursor of eicosanoid synthesis (role of phospholipase A_2). Role of prostaglandin synthase complex in synthesis of prostaglandins and thromboxanes. Types of leukotrienes. Biosynthesis of leukotrienes (5-HPETE – leukotrienes). Biological role of prostaglandins.	2

	Biological role of thromboxanes. Biological role of leukotrienes (role of slowly reacting substance in genesis of allergies). Eicosanoids as central mediators of inflammation (chemoattractors, vasodilators, stimulators of exudation, migrations and degranulation of leukocytes and phagocytosis). Clinical application of eicosanoids. NSAIDs blockade cyclooxygenase and its consequences.	
8	**Study of digestion of nutritients: proteins, carbohydrates in the gastrointestinal tract.** General characteristic of components and the contents of nutrients in the common foods in nutrition: a) Macrocomponents (carbohydrates, fats, proteins). b) Microcomponents (vitamins, microelements). Physiological requirements, energetic and biological value of the main nutrients. Microelements, biological and biochemical functions. Symptoms of microelement deficiency. Explain biological value of proteins, write names and structures of essential amino acids in the notebook for self-preparation. Explain the concepts: nitrogen balance, positive and negative nitrogen balance. Role of their study for definition of norms of protein nutrition. On the ground of what conditions are norms of protein nutrition established? Explain role of free HCl in composition of gastric juice. What components does it contain, their role, the mechanism of HCl formation. Name normal values of gastric juice acidity, "debit hour" free HCl, principles of its measurement. Explain the mechanism of activation of pepsinogen, action of pepsin on proteins. What parameter is named "debit hour" of free HCl. Why does its measurement characterize acid producing function of the stomach more exactly? Explain pathological changes of gastric juice acidity: hypo- and hyperchlorhydria, achlorhydria, achylia. Name pathological components of gastric juice, their diagnostic value. . Tell about cavity and membrane digestion of proteins. Proteolytic enzymes of intestinal juice. How do actions of trypsin, chimotrypsin, amino- and carboxypeptidases differ? Specificity of enzyme action. Name enzymes of cavity and membrane digestion of carbohydrates; explain the mechanism of their action. Name monosaccharides that are formed at digestion of starch, sucrose, lactose. Their absorption in blood. Tell about “disaccharide intolerance”, clinical symptoms and approaches to treatment.	2
9	**Study of digestion of nutritients: lipids in the gastrointestinal tract.** General characteristics of lipids. Physiological requirements and energy value of lipids. The organism’s lipid requirement (fats, phospholipids). Biological value of lipids. Balanced diet. Amount of lipids in normal nutrition.General characteristics of lipid digestion. Enzymes, biochemical mechanisms of lipid digestion in the departments of the digestive tract. Structure of bile. Biochemical mechanisms of development of bile stone disease (cholelithiasis). Biochemical changes of lipid metabolism at infringements of stomach and intestine functions and their clinical-biochemical diagnostics. Infringement of the secretory function of the pancreas at acute and chronic pancreatitis, their clinical-biochemical characteristics. Kinds of steatorrheas: pancreatic steatorrhea (deficiency of pancreatic lipase at pancreatitis), hepatogenic steatorrhea (deficiency of bile in the intestine), enterogenic steatorrhea (inhibition of lipolysis enzymes and resynthesis of triacylglycerols in intestine).	2
10	**Study of the functional role of fat-soluble vitamins in metabolism and realization of cell functions.** Classification of vitamins. Exogeneous and endogeneous hypo- and avitaminosises. Use of vitamin preparations in prevention and treatment of diseases. Vitamins as components of nutrition. Biochemical mechanisms of participation of fat-soluble vitamins A, E, K, F, D in metabolism. Biochemical manifestations of deficiency of vitamins A, D, E, K. Biochemical manifestations of hypervitaminoses A, D. Mechanism of antioxidant action of vitamins.Concept of physiological antioxidant system.	2
11	**Study of blood plasma proteins: proteins of acute inflammation phase, own enzymes and indicator enzymes.**	2

	Practical study of determination of C-reactive protein in blood plasma. Proteins of blood plasma and their clinical-biochemical characteristics. Components of the nonspecific resistance system and test proteins of "acute phase " (PAPh) of inflammatory processes. Enzymes of blood plasma and their value in enzymodiagnostics of diseases of internal organs. The kallikrein-kinin system (KKS).	
12	**Study of acid-base state of blood and respiratory function of erythrocytes. Pathological hemoglobins.** Hemoglobin: structure, properties. Mechanism of hemoglobin participation in transport of oxygen and carbon dioxide. Variants of hemoglobins; molecular infringements of hemoglobin structure – hemoglobinopathies, thalassemias. Mechanisms of regulation and maintenance of acid-base state: buffer systems of blood; functions of lungs and kidneys. Parameters of acid-base balance which are measured in clinic. Mechanisms of regulation and maintenance of acid-base state: buffer systems of blood; functions of lungs and kidneys. Metabolic alkalosis and acidosis, mechanisms of their occurrence. Respiratory alkalosis and acidosis, their mechanisms. Parameters of acid-base balance which are measured in clinic. Mechanisms of hypoxia. Methods of laboratory diagnostics of hypoxias.	2
13	**Study of nitrogen balance and non-protein nitrogen containing components of blood – end products of geme catabolism.** Norm of residual nitrogen in blood plasma. Clinical value of its determination. Composition of residual nitrogen. Origin, norms and clinical value of determination: urea, ammonia, uric acid, creatine, creatinine, indican, amino acids, bilirubin. Causes of retention and production azotemias, their relationship with certain forms of organ and system pathology. What components of residual nitrogen are characteristic for different kinds of azotemias? . Scheme of hemoglobin and heme catabolism. Structure of bile pigments. Norms of their concentration in blood plasma, urine, feces. 3 Clinical value of determination of bile pigments.	2
14	**Biochemical patterns of realization of immune processes. Immunodeficiency states.** General characteristics of the immune system; cellular and biochemical components. Immunoglobulins: structure, biological functions, regulatory mechanisms of synthesis of immunoglobulins. Biochemical characteristics of classes of human immuno-globulins. Mediators and hormones of the immune system; cytokines (interleukins, interferons, protein-peptide factors of regulation of growth and proliferation of cells). Biochemical components of the complement system. Classic and alternate (properdinal) mechanisms of activation. Biochemical mechanisms of immunodeficiency conditions: primary (hereditary) and secondary immunodeficiencies. Acquired Immune Deficiency Syndrom.	2
15	**Biochemistry of the liver. Patobiochemistry of jaundices.** Carbohydrate (glycogenic) function of the liver. Protein synthesis and urea synthesis function of the liver. Biochemical mechanisms of development of hepatic encephalopathy . Role of the liver in regulation of lipid composition of blood. Bile formation function of the liver. Biochemical composition of bile. Changes of biochemical parameters at acute hepatites caused by viruses or alcoholic intoxication, their estimation for diagnostics. Changes of biochemical parameters at chronic hepatites, cirrhosis, bile-stone diseases, dyskinesia and cholecystitis, their diagnostic estimation. Relationship of infringements of excretory functions of the liver and infringements of digestion processes in the intestine, diagnostics of these infringements. Role of the liver in metabolism of bile pigments. Catabolism of hemoglobin. Hemolytic (prehepatic), hepatocellular (hepatic), obturative (posthepatic) jaundices. Enzymic, hereditary jaundices: of Crigler-Najjar syndrome, Gilbert's syndrome, Dubin-Johnson's syndrome, jaundices of newborns.	2
16	**Study of processes of biotransformation of xenobiotics and endogeneous toxins. Microsomal oxidation, cytochrome P-450.** Biotransformation of xenobiotics and endogenic toxins. Reactions of microsomal oxidation.	2

	Inductors and inhibitors of microsomal monooxygenases. Reactions of conjugation in hepatocytes: biochemical mechanisms, functional role. Genetic polymorphism and inducibility of cytochrome P_{P450} synthesis. Occurrence and nature of development of tolerance to medical drugs. Formation of indole and stages of its neutralization. Clinical value of indican determination in blood and urine?	
17	**Study of normal components of urine.** Explain functions of the kidneys in the organism, their role in maintenance of water and electrolyte balance, constancy of osmotic pressure, pH, excretion of end-products of metabolism. Explain role of the kidneys in synthesis of regulatory substances (renin-angiotensin-aldosterone system), metabolism of creatine and formation of calcitriol. Mechanism of formation of primary urine in the nephron glomerulus. Chemical composition of primary urine. Creatinine clearance. Mechanism of secondary urine formation. Regulation of urine formation. Features of energy metabolism in the kidneys. Explain molecular mechanisms of renal regulation of ABE (acid-base equilibrium). Basic physical and chemical properties of urine. Name main organic and mineral components of urine, quantity of their daily excretion. . With examples explain value of analysis of urine for revealing pathology of the kidneys, estimation of their function, diagnosis and prognosis of diseases of other organs and systems.	2
18	**Study of pathological components of urine.** Biochemical structure of urine in pathological processes. Clinical diagnostic value of analysis of urine composition. Biochemical characteristics of kidney clearance and kidney threshold, their diagnostic value. Clinical biochemical changes at glomerulonephritis, amiloidosis, pyelonephritis, acute kidney deficiency. Diagnostics of chronic kidney deficiency. Characteristics of conditions of formation of kidney stones, their chemical composition and prevention.	2
19	**Biochemistry of muscle tissue.** Ultrastructure and biochemical structure of myocytes. Molecular mechanisms of muscle contraction: modern understanding of interaction of muscle filaments. Cellular organization and features of cardiac muscle. Damage of heart at some diseases. Pathobiochemistry of hypertonic disease and other diseases.	2
20	**Biochemistry of connective tissue.** General characteristic of morphology and biochemical structure of the connective tissue. Biosynthesis of collagen. Distribution of different glycosaminoglycans in the organs and tissues. Pathobiochemistry of the connective tissue.	2
21	**Biochemistry of bone tissue. Factors of osteoporosis risk.** Chemical composition and metabolism of the bone tissue. Hormonal regulation of the bone tissue metabolism. . Biochemical tests in diagnostics of bone tissue diseases.	2
22	**Biochemistry of nervous tissue.** Features of biochemical composition and metabolism of the nervous system. Chemical composition of the brain. Energy metabolism in the brain. Neurotransmitters and receptors of neurotransmitters, physiologically active compounds.	2
23	**Solving of situation and tests problems.**	2
	Exam	
	Total	**112**

Self-preparatory work

Item no.	Names of topics	Number of hours
Module 1. Biological and Bioorganic Chemistry		
1	Preparation for practical classes – theoretical preparation training of the practical skills	79
2	Elaboration of topics that are not part of the classroom lesson plan with an indication of the main issues that should be studied:	47
Content module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components		
1	**Classification, nomenclature and isomerism of bioorganic compounds. Nature of chemical bonds.** Acyclic, carbocyclic (alicyclic and aromatic) and heterocyclic compounds. Structure of their representatives. Classes of organic compounds and their respective functional groups. Priority of functional groups and their names. Common nomenclature International nomenclature. Radical-functional nomenclature. Structure isomerism. Stereoisomerism Configuration isomerism: optical, cis-trans and conformation isomers. Distribution of electrons on the atomic orbitals of the carbon atom. sp^3-hybridization of the carbon atom. sp^2- and sp-hybridization. σ- and π-bonds in organic compounds. Electronegativity of atoms. Distribution of electron density in organic molecules 2) inductive effect; 2)mesomeric effect	5
2	**Types of chemical reactions. Analysis of reaction ability of alkanes, arenes, alcohols, phenoles, amines.** The homological series of alkanes: names and molecular formulas. Chemical properties of alkanes. Radical substitution at the saturated carbon atom (S_R). Representatives of alkenes, alkadienes and alkynes. Their structure and chemical properties. Electrophilic substitution in unsaturated compounds (A_E). General characteristics of aromatic hydrocarbons, their electron structure and chemical properties. Electrophilic substitution in aromatic compounds (S_E). Effect of substitutients on the reactive ability of arenes. Structure of alcohols and phenols, their representatives, physical and chemical properties of the hydroxil compounds. Nucleophilic substitution at the saturated carbon atom (S_N). Polyatomic acyclic and cyclic alcohols Aliphatic and aromatic amines: representatives and their structure. Chemical properties of amines: reactions of amines as nucleophylic reagents. Aniline: its pharmacological and biological derivatives. The homological series of alkanes: names and molecular formulas. Chemical properties of alkanes. Radical substitution at the saturated carbon atom (S_R). Representatives of alkenes, alkadienes and alkynes. Their structure and chemical properties. Electrophilic substitution in unsaturated compounds (A_E). General characteristics of aromatic hydrocarbons, their electron structure and chemical properties. Electrophilic substitution in aromatic compounds (S_E). Effect of substitutients on the reactive ability of arenes. Structure of alcohols and phenols, their representatives, physical and chemical properties of the hydroxil compounds. Nucleophilic substitution at the saturated carbon atom (S_N).	5

	Polyatomic acyclic and cyclic alcohols Aliphatic and aromatic amines: representatives and their structure. Chemical properties of amines: reactions of amines as nucleophylic reagents. Aniline: its pharmacological and biological derivatives.	
3	**Analysis of chemical properties of aldehydes and ketones**. Explain the structure of the carbonyl group, write formulas and names of most abundant aldehydes and ketones. Try qualitative reactions: a) Fehling's with a water solution of formaldehyde; b) acetone with iodine solution in an alkaline media; c) precipitation of protein with formaline. Reactions of nuclephilic addition (A_N) of water, cyanides, alcohols and amines to aldehydes. The reaction of aldol condensation and its importance for elongation of hydrocarbon chains. Reactions of oxydation and reduction of aldehydes and ketones. Qualitative tests for the aldehyde group (Tollen's, Trommer's, Fehling's), their clinical importance. The reaction of disproportionation (dismutation, Cannizzaro's). Haloform reactions of aldehydes and ketones. Iodoform test and its application in analytics.	4
4	**Analysis of chemical properties of carboxylic acids.** Explain classification of carboxylic acids. Name the most important monocarboxylic acids. Reactions of nucleophilic substitution (S_N) at the sp^2-hybridized carbon atom in the carbonyl group. The esterification reaction and its biochemical importance. The amidation reaction and its biochemical importance. Chemical properties. Biological importance of certain carboxylic acids (oxalic, malonic, succinic, glutaric, fumaric).	4
Content module 3. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions		
5	**DNA replication and RNA transcription.** Biological role of DNA replication. Essence of the DNA replication discovery by D.Watson and F.Crick (1953). Half-conservative mechanism of replication; the scheme of Meselson - Stahl experiment. General scheme of DNA biosynthesis. Enzymes of DNA replication. Molecular mechanisms of DNA: topological problems (Okazaki fragments). General scheme of transcription; coding and non-coding chains of DNA. RNA polymerases. Stages and enzymes of RNA synthesis. Signals of transcription: promotor, initial, termination sites of genome. Processing as posttranscriptional modification of RNA. Antibiotics – inhibitors of transcription.	7
6	**Biosynthesis of proteins in ribosomes. Initiation, elongation and termination in the synthesis of polypeptide chain. Inhibitory action of antibiotics.** Genetic code. Ribosomal protein synthesis system Stages and mechanisms of translation. Posttranslation modification of peptide chains. Regulation of translation. Effect of physiologically active compounds on processes of transcription and translation.	7
7	**Regulation of gene expression.** Regulation of genes expression. Features of structure and expression in eukaryotic genome. Genetic recombinations; transposons.Amplification of genes (genes of metallothioneine, dihydrofolatereductase). Regulation of eukaryotic gene expression at the transcription level. Phases of the cell cycle of eukaryots.	8
8	**Analysis of mutation mechanisms, DNA reparation. Principles of synthesis of recombinatory DNA, transgenic proteins.** Mutations: genomic, chromosomal, gene (point). Biochemical mechanisms of chemical mutagen action – nitrogenous base analogues, deaminative, alkylating agents, ultraviolet and ionizing radiation. Role of inductive mutations in occurrence of enzymopathies and hereditary diseases. . Biological role and mechanisms of DNA reparation. Reparation of UV-induced gene mutations: xeroderma pigmentosum. Genetic engineering. Recombinant DNA designing: general concepts, biomedical importance.	7

	Technology of gene transplantation and obtaining of hybrid DNA molecules; application of restriction endonucleases. Cloning of genes to obtain biotechnological medicines and for diagnostics.	
	Total	**126**

The list of theoretical questions for preparing students for final controls of content module 1,2 and exam.

Content module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components*

1. Bioorganic chemistry as a science: definition, subject, aims, branches, research methods. Importance in high medical education.
2. Classification of organic compounds by the structure of hydrocarbon radical and nature of functional groups.
3. Classification of the most important classes of bioorganic compounds by structure of functional groups: alcohols, phenols, thiols, aldehydes, ketones, carboxylic acids, esters, amides, nitric compounds, amines.
4. Nomenclature of organic compounds: common, rational, international. Principles of naming organic compounds with the IUPAC nomenclature; nomenclature of substituents, radical-functional.
5. Nature of chemical bonds in organic compounds: hybridization of orbitals, electron structure of compounds of carbon.
6. Spatial structure of organic compounds: stereoformulas; configurations and conformations. Stereoisomers: cis-, trans, optical, conformers.
7. Optical isomerism; chirality of molecules of organic compounds. D/L- and R/S stereochemical nomenclatures. Enantiomers and diastereomers of bioorganic compounds. Correlation of spatial structure and physiologic activity.
8. Types of reactions in bioorganic chemistry. Classification (examples).
9. Carbonyl compounds in bioorganic chemistry. Chemical properties and biological importance of aldehydes and ketones.
10. Carboxylic acids in bioorganic chemistry: structure and chemical properties, functional derivatives of carboxylic acids (anhydrides, amides, esters). Decarboxylation reactions.
11. Structure and properties of dicarboxylic acids: oxalic, malic, succinic, glutaric, fumaric.
12. Lipids: definition, classification. Higher fatty acids: palmitic, stearic, oleic, linoleic, linolenic, arachidonic. Simple lipids. Triacylglycerols (neutral fats): structure, biological importance, hydrolysis.
13. Complex lipids. Phospholopids: phosphatidic acid, phosphatidylethanolamine, phosphatidylcholine, phosphatidylserine. Sphingolipids. Glycolipids. Role of complex lipids in biomembranes.
14. Amines: nomenclature, properties. Biological importance of biogenic amines (epinephrine, norepinephrine, dopamine, tryptamine, serotonine, histamine) and polyamines (putrescine, cadaverine).
15. Aminoalcohols: structure, properties. Biological role of ethanolamine (colamine), choline, acetylcholine.
16. Hydroxyacids in bioorganic chemistry: structure and properties of monocarboxylic (lactic and β-hydroxybutyric), dicarboxylic (malic, tartaric) hydroxyacids.
17. Amino acids: structure, stereoisomerism, chemical properties. Biological importance of L-α-amino acids. Biochemical transformations of amino acids: deamination, transamination, decarboxylation.
18. Amino acid composition of proteins and peptides; classification of proteinogenic L-α-amino acids. Chemical and physico-chemical properties of the amino acids. The ninhydrin reaction, its importance in analysis of amino acids.
19. Proteins and peptides: definition, classification, biological functions. Types of bonds between amino acid moieties in protein molecules. The peptide bond: formation, structure; the biuret reaction.
20. Organizational levels of protein structure: primary, secondary, tertiary, quaternary. Oligomeric proteins.

21. Physico-chemical properties of proteins; their molecular mass. Methods of sedimentation. Denaturation of proteins.
22. Carbohydrates: definition, classification. Monosaccharides (aldoses and ketoses; trioses, tetroses, pentoses, hexoses, heptoses), biological importance of certain representatives.
23. Monosaccharides: pentoses (ribose, 2-deoxyribose, xylose), hexoses (glucose, galactose, mannose, fructose) – structure, properties. Qualitative reactions for glucose.
24. Structure and properties of derivatives of monosaccharides. Amino derivatives: glucosamine, galactosamine. Uronic acids. L-ascorbic acids (vitamin C). Products of reduction of monosaccharides: sorbitol, mannitol.
25. Oligosaccharides: structure, properties. Disaccharides (sucrose, lactose, maltose), their biomedical importance.
26. Polysaccharides. Homopolysaccharides: starch, glycogen, cellulose, dextrines – structure, hydrolysis, biomedical importance. Qualitative reactions for starch.
27. Heteropolysaccharides: definition, structure. Structure and biomedical importance of glycosaminoglycans (mucopolysaccharides) – hyaluronic acid, chondroitin sulfates, heparin.
28. Five-membered heterocycles with one heteroatom (pyrrole, furan, thiophene). Biomedical importance of tetrapyrrole compounds: porphins, porphyrins, heme.
29. Indole and its derivatives: tryptophane and reactions of formation of tryptamine and serotonine; indoxyle, skatole, skatoxyle – role in the processes of protein decomposition in the intestine.
30. Five-membered heterocycles with two nitrogen heteroatoms. Pyrazole, pyrazolone; derivatives of pyrazolone-5 as medicines (antipyrine, amidopyrine, analgin). Imidazole and its derivatives: histidine, histamine.
31. Five-membered heterocycles with two different heteroatoms: thiazole, oxazole. Thiazole as a structure component of the thiamine molecule (vitamin B_1).
32. Six-membered heterocycles with one nitrogen atom: pyridine. Nicotinamide (vitamin PP) as the component of reduction-oxidation pyridine coenzymes. Pyridoxine and molecular forms of vitamin B_6.
33. Six-membered heterocycles with two nitrogen atoms. Diazines: pyrimidine, pyrazine, pyridazine. Nitrogenous compounds – derivatives of pyrimidine (uracil, cytosine, thymine).
34. Derivatives of pyrimidine as medical preparations: 5-fluoruracil, potassium orotate. Barbituric acid; barbiturates as sedatives and antiepilepthic compounds (phenobarbital, veronal).
35. Purine and its derivatives. Amino derivatives of purine (adenine, guanine), their tautomeric forms; their biochemical role in formation of nucleotides and coenzymes.
36. Hydroxyderivatives of purine: hypoxantine, xantine, uric acid. Methylated derivatives of xantine (caffeine, theophylline, theobromine) as physiologically active compounds that act on the central nervous system and the cardiovascular system.
37. Nucleosides, nucleotides. Nitrogenous bases of the purine and pyrimidine series as components of nucleotides. Minor nitrogenous bases.
38. Nucleosides. Nucleotides as phosphorylated derivatives of nucleosides (nucleoside mono-, di- and triphosphates). Nomenclature of nucleosides and nucleotides as RNA and DNA components.
39. Structure and biochemical functions of free nucleotides: nucleotide coenzymes, cyclic nucleotides 3',5'-cAMP and 3',5'-cGMP.
40. Nucleic acids (deoxyribonucleic, ribonucleic) as polynucleotides. Polarity of polynucleotide chains of DNA and RNA.
41. Structure and properties of DNA; nucleotide composition, complementarity of nitrogenous bases. Primary, secondary and tertiary structure of DNA.
42. RNA: structure, types of RNA, their role in protein biosynthesis.
43. Vitamins: general characteristics; coenzyme action of vitamins. Structure and properties of the vitamins B_1, B_2, B_6, PP.

Note - * Questions of content module 1 are included in the list of questions for preparation for exam!

Content module 2. General principles of metabolism. Carbohydrate, lipid and amino acid metabolism and its regulation.*

1. Enzymes: definition; properties of enzymes as biological catalysts.
2. Classification and the nomenclature of enzymes, the characteristic of separate classes of enzymes.
3. Structure and mechanisms of enzymes action. Active and allosteric (regulatory) centers.
4. Cofactors and coenzymes. Structure and properties of coenzymes; vitamins as precursors in biosynthesis of coenzymes.
5. Coenzemes: types of reactions, that catalyse separate classes of coenzymes.
6. Vitamin B_1 (thiamine): a structure, biological properties, the mechanism of action.
7. Vitamin B_2 (riboflavin): a structure, biological properties, the mechanism of action.
8. Vitamin PP (nicotinic acid, nicotinamid): a structure, biological properties, the mechanism of action.
9. Vitamin B_6 (pyridoxine): a structure, biological properties, the mechanism of action.
10. Vitamin B_{12} (cobalamin): biological properties, the mechanism of action.
11. Vitamin Bc (folic acid): biological properties, the mechanism of action.
12. Vitamin H (biotin): biological properties, the mechanism of action.
13. Vitamin B_3 (pantothenic acid): biological properties, the mechanism of action.
14. Vitamin C (ascorbic acid): a structure, biological properties, the mechanism of action.
15. Vitamin P (flavonoids): a structure, biological properties, the mechanism of action.
16. Isoenzymes, features of a structure and functioning, importance in diagnostics of diseases.
17. Mechanisms of action and kinetics of enzymes reactions: dependence of speed of reaction on the concentration of a substrate, pH and temperature.
18. Activators and inhibitors of enzymes: examples and mechanisms of action.
19. Types of inhibition of enzymes: reversible (competitive, non-competitive) and irreversible inhibition.
20. Regulation of enzymes processes. Pathways and mechanisms of regulation: allosteric enzymes; covalent modification of enzymes.
21. Cyclic nucleotides (cAMP, cGMP) as regulators of enzymes reactions and biological functions of a cell.
22. Enzymopathies – are congenital (hereditary) defects of a metabolism of carbohydrates, amino acids, porphyrins, purines.
23. Enzymodiagnostics of pathological processes and diseases.
24. Enzymotherapy – application of enzymes, their activators and inhibitors in medicine.
25. Principles and methods of revealing of enzymes in bioobjects. Units of measurements of activity and amount of enzymes.
26. Metabolism - the general principles of course of catabolic and of anabolic processes.
27. The general stages of endocellular catabolism of biomolecules: proteins, carbohydrates, lipids.
28. Tricarboxylic acid cycle. Localization, sequence of ferment reactions, importance in a metabolism.
29. Energetic balance of a tricarboxylic acid cycle. Physiologic importance of reactions TCA.
30. Reactions of biological oxidation; types of reactions (dehydrogenasational, oxidasational, oxigenisational) and their biological importance. Tissue respiration.
31. Enzymes of biological oxidation in mitochondria: pyridin-, flavin-dependent dehydrogenasis, cytochromes.
32. Sequence of components of a respiratory chain of mitochondria. Molecular complexes of inner membrane of mitochondria.
33. Oxidative phosphorylation: points of coupling of electron's transport and of phosphorylation, coefficient of oxidative phosphorylation.
34. Chemiosmotic theory of oxidative phosphorylation, ATP-synthetase of mitochondria.
35. Inhibitors of electron's transport and uncouplers of oxidative phosphorylation.
36. Microsomal oxidation: cytochrome P-450; the molecular organization of a chain of electron's carrying.
37. Anaerobic oxidation of glucose, general characteristic of process.

38. Aerobic oxidation of glucose. Stages of transformation of glucose up to CO_2 and H_2O.
39. Oxidative decarboxylatoin of puryvate. Enzymes, coenzymes and sequence of reactions in multienzyme complex.
40. The comparative characteristic of bioenergetics of aerobic and anaerobic oxidations of glucose, Pasteur's effect.
41. Phosphorylytic pathway of glycogen break down in liver and muscles. Regulation of glycogen phosphorylase activity.
42. Biosynthesis of glycogen: enzyme reactions, physiologic value. Regulation of glycogen synthase activity.
43. Mechanisms of reciprocal regulation of glycogenolysis and glycogenesis due to cascade cAMP-dependent phosphorylation of proteins-enzymes.
44. Role of adrenaline, glucagon and insulin in hormonal regulation of an glycogen metabolism in muscles and liver.
45. Genetic disorders of glycogen metabolism (glycogenosis, aglycogenosis).
46. Gluconeogenesis: substrates, enzymes and physiologic significance of process.
47. Glucose-lactate (cycle of Cori) and glucose-alanine cycles.
48. Glucose of blood (glucosemia): normoglycemia, hypo- and hyperglycemias, glucosuria. Diabetes mellitus – pathology of glucose metabolism.
49. Hormonal regulation of glucose concentration in the blood and glucose metabolism.
50. Pentose-phosphate pathway of glucose oxidation: the scheme of process and biological significance
51. Metabolic pathways of fructose and galactose transformations; hereditary enzymopathies of its metabolism.
52. Catabolism of triacylglycerols in adipocytes of an adipose tissue: sequence of reactions, mechanisms of regulation of triglycerydlipase activity.
53. Neuro-humoral regulation of lipolysis at participation of adrenaline (epinephrine), noradrenaline (norepinephrine), glucagon and insulin.
54. Reactions of fatty acids oxidation (β-oxidation); role of carnitine in transport of fatty acids in mitochondria.
55. Oxidation of glycerol: enzyme reactions, bioenergetic.
56. Ketone bodies. Reactions of biosynthesis and recycling of ketone bodies, physiological significance.
57. Disorders of ketone bodies metabolism in conditions of a pathology (diabetes mellitus, starvation).
58. Biosynthesis of the high fatty acids: reactions of biosynthesis of the saturated fatty acids (palmitate) and regulation of process.
59. Biosynthesis mono- and polynonsaturated fatty acids in the human body.
60. Biosynthesis of triacylglycerols and phopholipids.
61. Metabolism of sphingolipids. Genetic anomalies of an sphingolipids – sphingolipidoses.
62. Biosynthesis of cholesterol: the scheme of reactions, regulation of cholesterol synthesis.
63. Pathways of cholesterol biotransformation: etherification; formations of bile acids, steroid hormones, vitamin D_3.
64. Circulatory transport and lipids deposition in the adipose tissue. Lipoproteinlipase of endotelium.
65. Lipoproteins of blood plasma: lipid and protein (apoprotein) structure. Hyperlipoproteinemias.
66. Pathologies of lipid metabolism: atherosclerosis, adiposity, diabetes mellitus.
67. Poole of free amino acids in an organism: sources of amino acids and pathways of its utilization in tissues.
68. Transamination of amino acids: reactions and their biochemical significance, mechanisms of aminotransferases action.
69. Direct and indirect deamination of free L-amino acids in tissues.
70. Decarboxylation of L-amino acids in the human body. Physiological significance of the formed products. Oxidation of biogenic amines.
71. Pathways of formation and neutralization of ammonia in organism.

72. Biosynthesis of urea: sequence of enzyme reactions of biosynthesis, genetic anomalies of enzymes of urea cycle.
73. The general pahtways of amino acids metabolism of in the human body. Glucogenic and ketogenic amino acids.
74. Biosynthesis and biological role of creatine and creatine phosphate.
75. Glutathione: structure, biosynthesis and biological functions of glutathione.
76. The specialized pathways of cyclic amino acids metabolism – phenylalanine and tyrosine.
77. Hereditary enzymopathies of cyclic amino acids metabolism – phenylalanine and tyrosine.
78. Metabolism of porphyrins: structure of heme; the scheme of reactions of protoporphyrins IX and heme biosynthesis.

Note - * Questions of content module 2 are included in the list of questions for preparation for exam!

Content module 3. Biochemistry of intercellular communications Biochemistry of tissues and physiological functions*

1. Biosynthesis of purine nucleotides: scheme of reactions of IMP synthesis; formation of AMP and GMP; mechanisms of regulation.
2. Biosynthesis of pyrimidine nucleotides: scheme of reactions; regulation of synthesis.
3. Biosynthesis of deoxyribonucleotides. Formation of thymidine nucleotides; inhibitors of dTMP biosynthesis as antitumour medicines.
4. Catabolism of purine nucleotides; hereditary infringements of uric acid metabolism.
5. The scheme of catabolism of pyrimidine nucleotides.
6. Replication of DNA: biological role; semiconservative mechanism of replication.
7. Sequence of stages and enzymes of DNA replication in prokaryotes and eukaryotes.
8. Transcription of RNA: RNA-polymerases of prokaryotes and eukaryotes, signals of transcription (promotor, initiation and termination sites of genome).
9. Processing – posttranscriptional modification of mRNA.
10. Genetic (biological) code; triplet structure of code, its property.
11. Transport-RNA (tRNA) and activation of amino acids. Aminoacyl-tRNA synthetases.
12. Stages and mechanisms of translation (biosynthesis of protein) on ribosomes: initiation, elongation and termination.
13. Post translational protein modification. Regulation of translation.
14. Inhibitors of transcription and translation in prokaryotes and eukaryotes: antibiotics and interferons – their application in medicine; diphtheria toxin.
15. Regulation of prokaryotic gene expression: regulatory and structural sites of lactose (Lac-) operon (regulatory gene, promotor, operator).
16. Mutations: genomic, chromosomal, gene; mechanisms of mutagens action; role of induced mutations in enzymopathies and hereditary diseases.
17. Biological role and mechanisms of DNA reparation. Reparation of UV-induced genetic mutations: xeroderma pigmentosum.
18. Genetic engineering: design of recombinant DNA; cloning of genes; genetic-engineering synthesis of enzymes, hormones, interferons, etc.
19. Hormones: general characteristic; role of hormones and other bioregulators in the system of intercellular integration of functions of the organism.
20. Classification of hormones and bioregulators: relation of structure and mechanisms of hormone action.
21. Reaction of target cells to hormone action. Membrane (ionotropic, metabotropic) and cytosole receptors.
22. Biochemical systems of endocellular transfer of hormonal signals: G-proteins, secondary messengers (cAMP, Ca^{2+}/ calmodulin, IP_3, DAG).
23. Molecular-cellular mechanisms of action of steroid and thyroid hormones .
24. Hormones of the hypothalamus: liberins and statins.

25. Hormones of the anterior lobe of the hypophysis: somatotropin (STH or GH), prolactin. Pathological processes caused by disfunction of the hypophysis.
26. Hormones of the posterior lobe of the hypophysis. Vasopressin and oxytocin: structure, biological functions.
27. Insulin: structure, biosynthesis and secretion; effect on carbohydrate, lipid, amino acid and protein metabolism. Growth-stimulating effects of insulin.
28. Glucagon: regulation of carbohydrate and lipid metabolism.
29. Thyroid hormones: structure, biological effects of T_4 and T_3. Infringement of metabolic processes at hypo- and hyperthyreosis.
30. Catecholamines (epinephrine, norepinephrine, dopamine): structure, biosynthesis, physiological effects, biochemical mechanisms of action.
31. Steroid hormones of the adrenal cortex (C_{21}-steroids) – glucocorticoids and mineralocorticoids; structure, properties.
32. Female sex hormones: estrogens, progesterone. Physiological and biochemical effects; relation with phases of the ovulation cycle.
33. Male sex hormones (C_{19}-steroids). Physiological and biochemical effects of androgens; regulation of synthesis and secretion.
34. Hormonal regulation of calcium homeostasis in the organism. Parathyroid hormone, calcitonin, calcitriol.
35. Eicosanoids: structure, biological and pharmacological properties. Aspirin and other nonsteroidal anti-inflammatory medicines as inhibitors of prostaglandin synthesis.
36. Biochemistry of nutrition: components and nutrients of a balanced diet; biological value of certain nutrients.
37. Mechanisms of nutrient transformation (proteins, carbohydrates, lipids) in the digestive tract. Enzymes of the stomach and intestine.
38. Disorders of digestion of certain nutrients in the stomach and in the intestine; hereditable enzymopathies of digestion processes.
39. Microelements in nutrition. Biological functions of certain microelements; manifestations of deficiency of microelements.
40. Vitamins in nutrition. Water-soluble and fat-soluble vitamins; exogenic and endogenic causes of vitamin deficiency.
41. Vitamin A (retinol, retinal, retinoic acid): biological properties, mechanism of action, manifestations of deficiency, sources, daily need.
42. Vitamin K (phylloquinone, pharnoquinone): biological properties, mechanism of action, manifestations of deficiency, sources, daily need.
43. Vitamin E (α-tocopherol): biological properties, mechanism of action, manifestations of deficiency, sources, daily need.
44. Vitamin D_3 (cholecalciferol): biological properties, mechanism of action, manifestations of deficiency, sources, daily need.
45. Biochemical and physiological functions of blood in the human organism. Respiratory function of erythrocytes.
46. Hemoglobin: mechanisms of participation in the transport of oxygen and carbon dioxide. Variants and pathological forms of human hemoglobins.
47. Buffer systems of blood. Infringement of the acid-base balance in the organism (metabolic and respiratory acidosis, alkalosis).
48. Biochemical composition of blood. Proteins of blood plasma and their clinical and biochemical characteristics.
49. Enzymes of blood plasma; importance in enzymodiagnostics of organ and tissue diseases.
50. Kallicrein-kinin system of blood and tissues. Medical remedies – antagonists of kinin formation.
51. Non-protein organic compounds in blood plasma. Inorganic components of plasma.
52. Biochemical and functional characteristics of the hemostasis system.

53. The blood coagulation system; characteristics of individual factors; mechanisms of the cascade system of blood coagulation.
54. Role of vitamin K in reactions of coagulation; medical remedies – agonists and antagonists of vitamin K.
55. The blood anticoagulation system; characteristics of anticoagulants. Hereditary infringements of blood coagulation process.
56. Fibrinolytic system of blood. Medical remedies that effect fibrinolysis processes.
57. Antibodies; biochemical characteristics of individual classes of human immunoglobulins.
58. Mediators and hormones of the immune system: interleukins; interferons; protein-peptide factors of growth and cell proliferation regulation.
59. The complement system; biochemical components of the human complement system; classical and alternate ways of activation.
60. Biochemical mechanisms of immunodeficient conditions: primary (hereditary) and secondary immunodeficiencies.
61. Biochemical functions of the liver: glycostatic, protein synthesis, urea synthesis, bile synthesis, regulation of lipid composition of blood.
62. Detoxification function of the liver; reaction types of biotransformation of xenobiotics and endogenic toxins.
63. Reactions of microsomal oxidation. Cytochrome P_{450}; electron transport chain in membranes of the endoplasmatic reticulum of the hepatocytes.
64. Reactions of conjugation in the hepatocytes: biochemical mechanisms, role.
65. Role of the liver in the metabolism of bile pigments. Pathobiochemistry of jaundices; types of jaundices; hereditary (enzyme) jaundices.
66. Water-salt metabolism in the organism. Endocellular and extracellular water; exchange of water, sodium, potassium.
67. Role of the kidneys in regulation of volume, electrolyte composition and pH of organism fluids. Biochemical mechanisms of urine formation function of the kidneys.
68. The renin-angiotensin system of the kidneys. Hypotensive medical remedies – inhibitors of angiotensin converting enzyme.
69. Biochemical composition of the human urine in norm and in development of pathological processes. Clinical-diagnostic value of the analysis of urine composition.
70. Biochemical structure of the muscles. Proteins of myofibrils: myosin, actin, tropomyosin, troponin.
71. Molecular mechanisms of muscular contraction. Role of Ca^{2+} ions in regulation of contraction and relaxation of muscles.
72. Bioenergetics of the muscle tissue; sources of ATP; role of creatine phosphate in energy supply of muscle contraction.
73. Biochemistry of the nervous system: features of biochemical composition and metabolism of the brain.
74. Energy metabolism in the human brain. Role of aerobic oxidation of glucose; changes at conditions of physiological sleep and anaesthesia.
75. Biochemistry of neurotransmitters; receptors of neurotransmitters and physiologically active compounds.
76. Peptidergic system of the brain: opiod peptides, receptors of opioid peptides.
77. Abnormality of the brain transmitter and modulator metabolism at mental disorders. Neurochemical mechanisms of action of psychotropic remedies.
78. Structure and properties of collagen. Stages of collagen synthesis.

Note - * Questions of content module 3 are included in the list of questions for preparation for exam!

List of practical skills on biological and bioorganic chemistry
Content module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components*

1.Prove presence of formaldehyde in a solution with the Trommer's test. Make conclusions.
2.Explain the iodineformic test for acetone. Make conclusions.
3.How and why does the color of $KMnO_4$ solution change when oleic acid is added?
4.Why is the Wagner's test for unsaturation of fat qualitative? Analyze the results.
5.Explain difference in chemical behaviour of salole and aspirin in their reactions with $FeCl_3$. Explain the conclusions.
6.Explain steps of obtaining Fehling's reagent. Where is it used?
7.Why does the reaction of glucose and lactose with Fehling's reagent differ from the interaction of sucrose with Fehling's reagent?
8.What is the qualitative reaction for starch?
9.Why are different products obtained in the reaction of glucose with $Cu(OH)_2$ at different conditions (room temperature and heating)? Explain your reasoning.
10.Explain qualitative reactions for amino acids and proteins:
a) xantoproteic;
b) ninhydrin;
c) Fohl's;
d) biuret.
Why solutions of different colors are obtained?
11.What reaction can be used to differentiate peptides from proteins?
12.How do ammonium sulfate, trichloroacetic acid and sulfosalycilic acid react with proteins? Explain your reasoning.
13.How and why does the composition of nucleic acids change in hydrolysis. Determine components of the hydrolysate. Make conclusions.

Note - * Questions of content module 1 are included in the list of questions for preparation for exam!

Content module 2. General principles of metabolism. Carbohydrate, lipid and amino acid metabolism and its regulation.*

1. Concentration of glucose in the blood serum. Causes and consequences of hyper- and hypoglycemia.
2. Clinical significance of ketone bodies determination in serum and urine. Causes and consequences of ketosis.
3. Clinical significance of determination of pyruvic acid concentration in biological fluids.
4. What is the normal concentration of cholesterol in the blood? Clinical significance.
5. Clinical significance of determination of amylase and lipase activity in blood serum. Which class of enzymes?
6. Write reaction of transamination of alanine with α-ketoglutaric acid. Clinical significance of the activity of transaminases in the blood.
7. Clinical significance of determination of creatine phosphokinase activity in serum. Isoforms of creatine phosphokinase.
8. Clinical significance of determination of lactate dehydrogenase (LDH) activity in blood serum. Write a reaction that is catalyzed by LDH. Isoforms of LDH.
9. Causes and consequences of hyperlactatemia.
10. Causes of glucosuria. Renal threshold of glucose.
11. Draw glycemic graphs of glucose tolerance test in normal and latent diabetes mellitus.
12. Clinical significance of HbA_{1c} (glycated hemoglobin) determination.
13. Biochemical diagnostics of hyperlipoproteinemia types according the World Health Organization (WHO).

14. Clinical significance of determination of urea concentration in serum.
15. Daily excretion of urea. Clinical significance.
16. Causes and consequences of hyperammonemia.
17. Causes of hypo- and hypercreatininemia.
18. Causes of hypo- and hypercreatininuria.
19. Causes of porphyrias. Draw a diagram of the heme synthesis.
20. At what disease in the urine, the Fehling's test ($FeCl_3$) is positive?
21. Biochemical diagnostics of diabetes mellitus.
22. The concentration of uric acid in serum. Clinical significance of the analysis.

Note - * Questions of content module 2 are included in the list of questions for preparation for exam!

Content module 3. Biochemistry of intercellular communications Biochemistry of tissues and physiological functions*

1 The concentration of uric acid in serum. Clinical significance of the analysis.
2. Explain the anticancer effect of antibiotics. Can all antibiotics be used as anticancer?
3. Explain the mechanism of action of interferons.
4. Explain the mechanism of action of diphtheria toxin.
5.Explain the molecular mechanisms of mutations. What are the most common mutagens you know?
6. Determination of acidity of gastric juice: total acidity, free and bound hydrochloric acid.
7. Determination of pathological components in the gastric juice: lactic acid, "blood pigments".
8. Quantitative evaluation of proteinogram and common patterns of its changes at pathological processes (acute and chronic inflammation, liver and kidney disease)
9. Clinical significance of the definition of proteins of acute phase of inflammation (acute phase reactants) and their role in the system of nonspecific resistance.
10. Concentration of fibrinogen in blood plasma. Clinical significance of the analysis.
11. Biochemical values of the acid-base balance of the blood.
12. Serum residual nitrogen (RN) and its clinical significance. Types of azotemia.
13. The content of bilirubin and its fractions in serum. Clinical significance of the analysis.
14. Biochemical diagnostics of cytolytic syndrome of hepatocytes.
15. Biochemical diagnostics of cholestatic syndrome.
16. Biochemical diagnostics of liver failure.
17. Biochemical criteria for determining the violation of detoxification function of the liver. Mechanisms of development of hepatic encephalopathy.
18. Biochemical diagnostics of violation of glomerular filtration rate.
19. Biochemical blood test in a patient with renal insufficiency.
20. Biochemical analysis of urine in a patient with renal insufficiency.
21. Research of pathological components of urine: proteinuria, hematuria.
22. Research of pathological components of urine: glucosuria, ketonuria.
22. Research of pathological components of urine: urobilinuria, bilirubinuria.
23. Clinical and biochemical diagnostics of collagenoses.
24. Clinical and biochemical diagnostics of mucopolysaccharidoses.
25. Modern methods of diagnosis of bone diseases (markers of osteogenesis and bone resorption).

Note - * Questions of content module 3 are included in the list of questions for preparation for exam!

The form of final control of academic performance

Exam.

The system of continuous and final control

Control measures include incoming, continuous and final control.

Incoming control is carried out at the beginning of the study of "Biological and Bioorganic Chemistry" in order to determine the recipients for higher education to master it. The control is carried out by means of test tasks.

Continuous control is carried out by scientific and pedagogical staff of the Department of Biological and Bioorganic Chemistry during practical classes. Current control should be carried out in the form of oral interviews, solving situational tasks, written control, written or software computer testing in practical classes.

Forms of continuous control during practical classes at the department of biological and bioorganic chemistry:

- Oral survey. Verification of answers to questions during self-preparation for a practical lesson.
- Solution of tests I and II levels and tests for the licensed exam "Krok 1" with an explanation of the correct answer.
- Laboratory work according to the algorithm.

At each practical lesson, the success of each student is evaluated on a four-point (traditional) scale.

Final control of content module - a form of final control, which is carried out in the assessment of the mastering of higher education educational material from content module 1. “Biologically important classes of bioorganic compounds. Biopolymers and their structural components” and content module 2. “General principles of metabolism. Carbohydrate, lipid and amino acid metabolism and its regulation”.

Exam is a form of final control of mastering by the applicant of theoretical and practical material on "Biological and biological chemistry".

General characteristics of control measures

The final evaluation of learning outcomes in "Biological and Bioorganic Chemistry" is carried out on a single 200-point scale. The assessment of the learner corresponds to the ratio of the level of professional and general competencies established in the assessment to the planned learning outcomes. The standardized generalized criteria for assessing the knowledge of higher education seekers are described in “Regulation on the organization and methods for assessment of educational activities of higher education recipients at Poltava State Medical University”.

https://www.pdmu.edu.ua/storage/department-npr/docs_links/NMQ6RVrpAGYuKpw1JoSJaApnMMMwbKdxQN9FC2hu.pdf

Final Control of content module

Final control of content module is carried out upon completion of the study of software content module 1 and content module 2 and is carried out at the last practical lesson of the module. Compilation and re-compilation of the final module control is carried out in accordance with the "Regulation on the organization of the educational process at Poltava State Medical University "

Before conducting the final control of content module, the average student score is calculated: the sum of all grades for all practical classes, divided by the number of classes.

The final control is allowed for the recipients for higher education who attended all the lecture and practical classes or worked out the missed classes in the prescribed manner, completed all the requirements of the curriculum and scored is not less than 3,0. The recipients for higher education is obliged to retake “2” if the average grade point for current performance for the module does not reach the minimum (3.0 points) for admission to the final control.

Algorithm of the final control of content module:

The recipients for higher education will get examination cards. Cards for final control 1 consist of 3 questions (2 theoretical and 1 - practical). Examination cards for final control 2 consist of 4 questions (3 theoretical and 1 - practical). Each question is evaluated on a traditional, 4-point score. Then, the arithmetic mean of the three responses is calculated. The list of questions for the final

control of the corresponding content module is indicated above and is provided to the applicants at the beginning of the study of the corresponding content module.

Applicants who received an unsatisfactory grade for the final control of the content module are obliged to rewrite it. Unsatisfactory evaluation of the final control of the module is a reason for not being allowed to take the exam at the end of studying the discipline.

Conducting the exam.

The recipients for higher education take the exam during the summer exam session provided by the curriculum and "Regulation on the organization and methods for assessment of educational activities of higher education recipients at Poltava State Medical University": https://www.pdmu.edu.ua/storage/department-npr/docs_links/NMQ6RVrpAGYuKpw1JoSJaApnMMMwbKdxQN9FC2hu.pdf

The exam according to a separate schedule, which is approved by the First Vice-Rector for Academic Affairs and Reseach. The schedule of examinations is brought to the notice of scientific and pedagogical workers of the Department of Biological and Bioorganic Chemistry and applicants for higher education not later than one month before the examination session.

Before the exam, the Department of Biological and Bioorganic Chemistry must organize consultations. The schedule of pre-examination consultations, time and place of the examination the department informs the students not later than 2 weeks before the examination session.

The recipients for higher education are allowed for the exam, who do not have unfinished missed classes, scored a minimum of at least 3,0, final control of contemt module 1 and 2.

The recipients for higher education who have received an average score of performance from 4.5 to 5.0 and they automatically get the score according to Regulation on the organization and methods for assessment of educational activities of higher education recipients at Poltava State Medical University": https://www.pdmu.edu.ua/storage/department-npr/docs_links/NMQ6RVrpAGYuKpw1JoSJaApnMMMwbKdxQN9FC2hu.pdf

A student who is exempted from taking the exam must be present at the exam. In case of disagreement with the assessment, the specified category of higher education applicants will take the exam according to general rules.

The algorithm for conducting of* semester final attestation*:

1. Solve the 20 tasks from the Krok 1 licensed exam database in a computer format. Each task is evaluated at 1 point (the maximum number of points scored is 20).

2. Give an answer to 2 theoretical questions and one practical (maximum 20 x 3 = 60 points). The maximum number of points for SFA is 80, the minimum is 50. SFA 3 in biological and bioorganic chemistry is counted together with SFA.

The maximum number of points scored at the SPA - 80, the minimum - 50.

Exam is accepted on a commission basis, in accordance with the "Regulations on the examination commission". Examinations are open and public. Grades obtained during the exam by the attested persons are set out in the "Statement of final semester control" and in the individual plans of the recipients.

In addition, the results of the exam edition appeared in the "Journal of the recipients for higher education assessment and performance" and the individual recipient curriculum.

The retaking of the exam is allowed no more than twice. The recipients who fail the exam may be expelled from the university.

Teaching methods

- ***Verbal*** (lecture, explanation, story, conversation, briefing, solving situational tasks).
- ***Visual*** (observation, illustration and demonstration of laboratory experiments).
- ***Practical*** (performing laboratory and practical work, conducting a scientific experiment in a research laboratory).

- ***Methods of testing*** and evaluating knowledge, skills.

Control methods

Oral interrogation allows you to control not only knowledge, but also verbal ability, helps to correct speech errors. Reproduction of the material contributes to its better memorization, the active use of scientific concepts. Used in practical exercises. The following types of questions are used in the oral interrogation: reproductive (involving the reproduction of the studied); reconstructive (require the application of knowledge and skills in slightly changed conditions); creative (application of knowledge and skills in significantly changed, non-standard conditions, transfer of the mastered principles of proof to performance of more difficult tasks). In addition, the birds are the main, additional and auxiliary.

A written survey helps to determine the level of assimilation of the material, but the possibility of cheating should be excluded and the recipients for higher education should be carefully monitored during this survey. Written works require a sufficiently large amount of time for the teacher to check. It is used during the final modular control and in practical exercises.

Testing as a standardized assessment method that meets the new goals and objectives of higher medical education and contributes to the individualization and controllability of the educational process and is designed to ensure the quality of training of the future doctor. Tests of different difficulty levels are used to assess the initial, current and final level of knowledge.

Method of self-control. It allows students to realize their mistakes, correct them and understand why it is necessary to master certain knowledge.

Self-assessment method. Provides an objective assessment of the recipient's results.

Methodical support

1. Calendar and thematic plans of lectures and practical classes.
2. Syllabus, educational and control computer programs for test control of knowledge of higher education students on each topic of practical training, final control of the content module, exam.
3. Algorithms for laboratory work.
4. Lists of recommended literature.
5. Tests of various difficulty levels.
6. Tests from the bank license exam "Krok-1".
7. Multimedia presentations of lectures.

Recommended reading

Basic

1. Biological and Bioorganic Chemistry : textbook : in 2 books. Book 1. Bioorganic Chemistry / B.S. Zimenkovsky, V.A. Muzychenko, I.V Nizhenkovska, G.O. Syrova ; edited by B.S. Zimenkovsky, I.V Nizhenkovska. — 3rd edition. — Kyiv : AUS Medicine Publishing, 2020. — 288 p.
2. Biological and Bioorganic Chemistry: in 2 books. Book 2. Biological Chemistry /Yu.Gubsky, I.V. Nizhenkovska, M.M. Korda et al. ; edited by Yu.Gubsky, I.V.Nizhenkovska. – Kyiv:AUS Medicine Publishing, 2020.- 544 p.
3. Gubsky Yu. Biological chemistry: textbook. – Vinnytsia: Nova Knyha, 2017. – 488 p.

Supplementary

1. Hordiienko L.P., Bilets M.B., Neporada K.S. Biological chemistry: collection tascs. Poltava, 2018. 148 p.
2. Harper`s Biochemistry. R.K.Murray, D.K.Granner, P.A.Mayes, V.W.Rodwell. Prentice-Hall International Inc., 2010. – 1134 p.
3. Koolman J. Color Atlas of Biochemistry, 3rd Edition / J.Koolman, K.-H. Rom. – Stuttgart. New York. – Thieme Verlag. — 2012. – 506 p.

4. Lehninger A. Principles of Biochemistry / Lehninger A. – New York. – W.H.Freeman and Company. – 2005. – 1010 p.
5. Pamela C.Champe Lippincott's Illustrated Reviews: Biochemistry, 3rd Edition / Pamela C.Champe and Richard A.Harvey. – Baltimore, Lippincott Williams & Wilkins, MD ©, 2005. – 534p.
6. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto Biochemistry - New York. - Macmillan Learning, - 2015. – 135 p.

Information resources

www.pdmu.edu.ua
https://www.pdmu.edu.ua
https://cosmolearning.org/courses/biochemistry-i/video-lectures/
https://podcasts.ox.ac.uk/keywords/biochemistry
https://www.studocu.com/latam/document/universidad-de-el-salvador/bioquimica/lecture-notes-clinical-biochemistry-9th-ed-booksmedicos/11891840

Official sites of High medical schools of Ukraine:

1. Bogomolets National Medical University - www / nmu.edu.ua - Kiev.
2. Bukovinian State Medical University - https://www.bsmu.edu.ua/en/main/ - Chernivtsi
3. Danylo Halytsky Lviv National Medical University - https://new.meduniv.lviv.ua/en/ - Lviv
4. Donetsk National Medical University - http://mmf.dsmu.edu.ua - Kropivnitskiy
5. Dnipro State Medical University - https://study.dmu.edu.ua - Dnipro.
6. I. Horbachevsky Ternopil National Medical University.- https://www.tdmu.edu.ua/en/ – Тернопіль.
7. Ivano-Frankivsk National Medical University - https://www.ifnmu.edu.ua/en/ - Ivano-Frankivsk
8. Kharkiv National Medical University - https://knmu.edu.ua/en/ - Kharkiv.
9. Luhansk State Medical University - https://www.lsmu.edu.ua/en/ – Rivne.
10. National Pirogov Memorial Nedical University - https://www.vnmu.edu.ua/en– Vinnytsya
11. . Zaporizhzhya State Medical University - https://int.zsmu.edu.ua - Zaporizhzhia
12. . Odessa National Medical University - https://onmedu.edu.ua/?lang=en – Odessa.

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