

**PRIVATE HIGHER EDUCATIONAL INSTITUTION
"INTERNATIONAL ACADEMY OF ECOLOGY AND MEDICINE"
Department of Fundamental Disciplines**

WORKING PROGRAM OF EDUCATIONAL DISCIPLINE

" Biologic and bioorganic chemistry "

LEVEL OF HIGHER EDUCATION Second (master's) level

DEGREE OF HIGHER EDUCATION Master's degree

BRANCH OF KNOWLEDGE 22 Healthcare

SPECIALTY 222 Medicine

Reviewed and approved
at the meeting of the Academic Council
Protocol No. 1, dated August 01, 2016

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Working program of education discipline “ Biologic and bioorganic chemistry “ for the preparation of students of higher education of the second (master’s) level of higher education in specialty 222 Medicine.

Introduction

The program of the discipline “ Biologic and bioorganic chemistry ” is composed according to the educational-professional program for training specialists of the second (master's) level of specialty 222 Medicine, field of knowledge 22 Health care, the Law of Ukraine "On Higher Education" from 01.07.2014 № 1556-VII (Article 13, item 7), the provision "On the organization of the educational process in the PHEE" International Academy of Ecology and Medicine ", methodological recommendations approved by the Central Methodical Cabinet of Higher Medical Education of the Ministry of Health of Ukraine on curriculum development standards of higher education. The discipline " Biologic and bioorganic chemistry " belongs to the section of the General preparation of the curriculum for the preparation of higher education applicants of the second educational (master's) level.

Description of the discipline

The structure of educational discipline	Branch of knowledge, training direction, specialty, education level	Characteristics of educational discipline		
		Daily learning		
Credits ECTS – 9,0	Field of knowledge: 22 Healthcare			
Modules – 3 Submodules – 18	Specialty: 222 Medicine	Year of the education:		
The amount of hours - 270		1 st , 2 nd		
		Semester		
		2 nd	3 rd	4 th
	Lectures			
	Educational level: master's degree Type: mandatory	10 h.	14 h.	16 h.
		Practical classes		
		30 h.	36 h.	34 h.
		Self-education (individual work)		
		40 h.	40 h.	50 h.
		Type of control: Current and final, exam		

The subject of study of the discipline are:

- molecular structure of organic compounds;
- physical and chemical properties of bioorganic compounds;
- biological activity of organic compounds;
- the relationship between the structure and properties of organic compounds, including metabolites and drugs.

Interdisciplinary links: - general and inorganic chemistry; biophysics; biology; biological chemistry; normal physiology; pathological physiology; pharmacology; histology.

1.PURPOSE AND TASKS OF THE DISCIPLINE.

1.1. The purpose of teaching the discipline " Biologic and Bioorganic Chemistry" is: mastering by students of theoretical laws concerning chemical properties of bioorganic compounds in interrelation with their structure and on this basis understanding of biochemical processes which take place in biological systems; acquaintance with the basic methods of identification of bioorganic compounds as the main prerequisites for further mastering of laboratory methods of diagnosis and understanding of many pathological processes in the human body; disclosure of practical aspects of bioorganic chemistry, ways and methods use of its achievements in medical practice.

1.2. The main tasks of studying the discipline "Biologic and bioorganic chemistry" are: to teach students the general principles of chemical reactions of bioorganic compounds as the basis of biochemical processes in the human body; formation of the relationship between the structure and function of bioorganic compounds; to reveal practical aspects of bioorganic chemistry, ways and methods of use its achievements in medical practice.

1.3. Competencies and learning outcomes, the formation of which is facilitated by the discipline of Biologic and bioorganic chemistry (relationship with the normative content of training of higher education, formulated in terms of learning outcomes in the Standard) In accordance with the requirements of the Standard, the discipline of Biologic and bioorganic chemistry provides students with the acquisition of competencies:

- integral
- general
- special (professional, subject).

Matrix of competencies

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
1	2	3	4	5	6
Integrated competence					
Ability to solve typical and complex specialized problems and practical problems in a professional health care activity, or in a learning process that involves research and / or innovation and is characterized by the complexity and uncertainty of conditions and requirements.					
General competencies					
1	Ability to apply knowledge in practical situations	To have specialized conceptual knowledge acquired in the learning process.	To be able to solve complex problems and problems that arise in professional activities.	Clear and unambiguous communication of own conclusions, knowledge and explanations that substantiate them to specialists and non-specialists.	To be responsible for making decisions in difficult conditions.
2	Knowledge and understanding of the subject area and understanding of the profession	To have deep knowledge of the structure of professional activity.	To be able to carry out professional activities that require updating and integration of knowledge.	Ability to effectively form a communication strategy in professional activities	To be responsible for professional development, ability to further professional training with a high level of autonomy.
	Ability to exercise self-regulation, lead a healthy lifestyle, ability to adapt and act in a new situation.	To know ways to self-regulate, lead a healthy life.	To be able to apply the means of self-regulation, be able to lead a healthy lifestyle and adapt to new situations (circumstances) of life and activity.	To establish appropriate connections to achieve results.	To be responsible for a healthy lifestyle and timely use of self-regulation methods.
4	Ability to choose a communication strategy; ability to work in a team; interpersonal skills	To know the tactics and strategies of communication, laws and ways of communicative behavior	To be able to choose ways and strategies of communication to ensure effective teamwork	To use communication strategies and interpersonal skills	To be responsible for the choice and tactics of communication.
5	Ability to communicate in the native language both orally and in writing; ability to communicate in another language	To have a perfect knowledge of the native language and basic knowledge of a foreign language	To be able to apply knowledge of the native language, both orally and in writing, be able to communicate in a foreign language.	To use the native language in professional and business communication and in the preparation of documents. Use a foreign language in a professional activities.	To be responsible for fluency in the native language, for the development of professional knowledge.
3	Skills in the use of information and communication technologies	To have deep knowledge in the field of information and communication technologies used in professional activities	To be able to use information and communication technologies in the professional field, which requires updating and integration of knowledge.	To use information and communication technologies in professional activities.	To be responsible for the development of professional knowledge and skills.
4	Ability to abstract	To know the methods of	To be able to analyze information,	To establish appropriate	To be responsible for the timely

	thinking, analysis and synthesis, the ability to learn and be modernly trained.	analysis, synthesis and further modern learning.	make informed decisions, be able to acquire modern knowledge.	connections to achieve goals.	acquisition of modern knowledge.
8	Ability to evaluate and ensure the quality of work performed.	To know the methods of evaluating performance indicators.	To be able to ensure quality work.	To establish connections to ensure quality work.	To be responsible for the quality of work.
9	Determination and perseverance are persistent in the tasks and responsibilities.	To know the responsibilities and ways to perform the tasks.	To be able to set goals and objectives to be persistent and conscientious in the performance of duties.	To establish interpersonal relationships to effectively perform tasks and responsibilities.	To be responsible for the quality of the tasks.
10	The ability to act socially in accordance with public consciousness.	To know your social and community rights and responsibilities.	To form one's civic consciousness, to be able to act according to it	Ability to convey one's public and social position.	To be responsible for your civic position and activities.
11	The desire to preserve the environment.	To know the problems of environmental protection and ways to preserve it.	To be able to form requirements for themselves and others to preserve the environment.	To make proposals to the relevant authorities and institutions on measures to preserve and protect the environment.	To be responsible for the implementation of environmental protection measures within its competence.

Special competencies

1	Ability to evaluate results laboratory and instrumental research.	To have specialized knowledge about the person, his organs and systems, know the standard methods of laboratory and instrumental research (according to list 4).	To be able to analyze the results of laboratory and instrumental studies and on their basis to assess information about the diagnosis of the patient (according to list 4).	It is reasonable to assign and evaluate the results of laboratory and instrumental research (according to list 4).	To be responsible for deciding on the evaluation of laboratory and instrumental research results.
2.	Ability to determine the principles and nature of disease treatment.	To have specialized knowledge of algorithms and standard schemes for the treatment of diseases (list 2).	To be able to determine the principles and nature of treatment of the disease (according to list 2).	To form and communicate to the patient and specialists their own conclusions about the principles and nature of treatment (according to list 2).	To be responsible for deciding on the principles and nature of treatment of the disease (according to list 2).
3.	Ability to diagnose emergencies.	To have specialized knowledge about the person, his organs and systems, standard methods of human examination (at home, on the street, in a health care facility) in the absence of information.	To be able, in the absence of information, using standard techniques, to by making an informed decision to assess the human condition and make a diagnosis (according to list 3).	Under any circumstances, in compliance with the relevant ethical and legal norms to make an informed decision to assess the human condition, diagnosis and organization of the necessary medical measures depending on the human	To be responsible for the timeliness and effectiveness of medical measures to diagnose emergencies.

				condition; fill in the relevant medical documents.	
4.	Ability to determine therapeutic nutrition in the treatment of diseases.	To have specialized knowledge about man, his organs and systems; knowledge of algorithms and standard schemes of medical nutrition in the treatment of diseases (according to list 2).	To be able to determine, on the basis of a preliminary clinical diagnosis, the nature of therapeutic nutrition in the treatment of diseases (according to list 2).	To form and convey to the patient, specialists conclusions on therapeutic nutrition in the treatment of the disease (according to list 2).	To be responsible for the validity of the definition of therapeutic nutrition in the treatment of the disease (according to list 2).
5.	Ability to assess the impact of the environment on the health of the population (individual, family, population).	To know the methods of assessing the health of the population (individual, family, population); environmental factors that negatively affect the health of the population; methods of statistical analysis and laboratory research (according to list 4), assessment of the health of certain contingents, assessment of environmental factors and methods of determining the relationship between them; measures to prevent the negative impact of environmental factors on public health. Know the principles of risk groups, risk areas, time and risk factors.	To be able to assess the health of the population, assess the state of the environment and the negative factors influencing the health of the population. To have methods of statistical and laboratory (according to list 4) analysis of the state of health of different groups of the population.	To draw conclusions about the state of health of the population, based on data on communication with environmental factors and make proposals to the relevant authorities and institutions for preventive measures. Interact with specialists of sanitary and hygienic profile and heads of enterprises, institutions and relevant departments on nature protection, environment.	To be responsible for timely conclusions about the state of health of the population on the basis of data on the negative impact of environmental factors; for timely submission of proposals for appropriate preventive measures.

Learning outcomes of the discipline "Biologic and bioorganic chemistry"

Learning outcomes:

Integrative final learning outcomes, the formation of which is facilitated by the discipline:

" Biologic and bioorganic chemistry " as an academic discipline lays the foundation for the further formation of the following program learning outcomes in accordance with the

Standard of Higher Education of Ukraine for undergraduate training of specialists of the second (master's) level of the specialty 222"Medicine":

- to determine the relationship between the state of the environment and the state of health of a particular contingent;
- to develop preventive measures on the basis of data on the relationship between the state of the environment and the state of health of a certain contingent.
- to evaluate information on the diagnosis, using a standard procedure based on the results of laboratory and instrumental studies.
- to determine the necessary medical nutrition in the treatment of the disease.
- to determine the principles and nature of treatment (conservative, operative) of the disease.
- to determine the tactics of emergency medical care on the basis of a diagnosis of emergency.
- to identify negative environmental factors; analyze health status.

2. CONTENTS OF EDUCATIONAL DISCIPLINE.

270 hours of 9.0 ECTS credits are for the study of the academic discipline, incl. lectures 40 hours, practical 100 hours, independent work 130 hours. Normative discipline. According to with requirements educational and professional programs after Biologic and bioorganic chemistry discipline students should:

Know:

- Water and electrolyte management in biological systems;
- Classification of bioorganic compounds according to the structure of the carbon skeleton and the properties of functional groups;
- Classes of bioorganic compounds according to the properties of their functional groups;
- Biological role of basic organic compounds;
- Structure and properties of alcohols, phenols;
- Structure and properties of aldehydes and ketones;
- Structure and properties of carboxylic acids;
- Classification, structure and properties of lipids;
- Structure and properties of amino acids;
- Structure and properties of peptides and proteins;
- Basic heterocyclic compounds;
- Structure of nucleosides, nucleotides and nucleic acids.
- Acid-base balance and buffer mechanism, and their importance in systemic homeostasis;
- Terms: solubility, osmotic pressure, isotonia, colloidal solutions and Gibbs-Donnan equilibrium;
- Processes: cell cycle, cell proliferation, differentiation and aging, apoptosis and necrosis and their importance for the functioning of the body;

- Principles of conducting scientific, observational and experimental studies and in vitro studies for the development of medicine;
- Basic reactions of inorganic and organic compounds in aqueous solutions;
- Structure of simple organic compounds included in macromolecules present in cells, extracellular matrix and body fluids;
- Structure of lipids and polysaccharides and their functions in cellular and extracellular structures;
- Basic catabolic and anabolic pathways, ways of regulating them, and the influence of genetic and environmental factors on them;
- Metabolic profiles of basic organs and systems;
- Primary, secondary, tertiary and quaternary structure of proteins, as well as post-translational and functional modifications of proteins and their importance;
- Nucleotide functions in the cell, primary and secondary DNA and RNA structures and chromatin structure;
- Biochemical fundamentals of xenobiotic metabolic processes.
- Methods of intercellular communication, as well as between the cell and the extracellular matrix, and signal pathways in the cell, and examples of disorders in these processes leading to the development of cancer and other diseases;
- Functions of the genome, transcriptome and human proteome, and basic methods used in their examination, processes of DNA replication, repair and recombination, transcription and translation and degradation of DNA, RNA and proteins, as well as concepts for regulation of gene expression.

To be able to:

- Explain the basic rules of the IUPAC substitution nomenclature and be able to use them in constructing the names of bioorganic compounds.
- Draw conclusions and analyze the relationship between the structure, configuration and conformation of bioorganic compounds.
- Explain the dependence of biological activity on the spatial structure of matter.
- Interpret the dependence of the reactivity of bioorganic compounds on the nature of the chemical bond and the interaction of atoms in the molecule.
- Explain the possibility of using the reactivity of certain classes of bioorganic compounds for the synthesis of drugs and analogues of natural compounds.
- Draw conclusions about the existence of monosaccharides in different tautomeric forms, which affects their reactivity and allows laboratory research of monosaccharides in biological fluids.
- Analyze the principles of methods for detection and determination of monosaccharides.
- Calculate the molar and percentage concentrations of compounds and the concentrations of substances in isoosmotic, mono- and multicomponent solutions.
- Calculate the solubility of inorganic compounds, determine the chemical background to the solubility or absence of organic compounds and its practical importance for dietetics and therapy.
- Explain the mechanisms of the biological role of hetero polysaccharides (glycosaminoglycans) in biological fluids and tissues.

- Explain the dependence of the reactivity of heterocyclic compounds on their structure, which promotes their biosynthesis in the body and laboratory synthesis in order to obtain drugs.
- Analyze the value of mononucleotides for the construction of nucleic acids and the action of nucleotide coenzymes.
- Interpret the mechanisms of participation of vitamins in the construction of coenzymes that channel biochemical reactions in the body.
- Interpret the peculiarities of the structure of α -amino acids as the basis of biopolymers - proteins that are structural components of all body tissues.
- Draw conclusions about the variants of transformations in the body of α -amino acids and to analyze the dependence of the formation of physiologically active compounds (FAS) on them from the structure and reactivity.
- Explain the dependence of physicochemical properties of proteins on their amino acid composition.
- Analyze qualitative reactions on α -amino acids to determine the amino acid composition of proteins and use the biuret reaction to quantify proteins.
- Analyze the stages and patterns of formation of biochemistry as a fundamental medical and biological science and academic discipline;
- Explain the principles and basics of methods of biochemical studies of the functional state of the human body in normal and in pathology.
- Use the results of biochemical analysis to assess the state of certain metabolic links.
- Determine the pH of the solution and the effect of changes in pH on inorganic and organic compounds.
- Predict the direction of biochemical processes depending on the energetic state of cells;
- Use basic laboratory techniques such as qualitative analysis, titration, colorimetry, pH-metry, chromatography, electrophoresis of proteins and nucleic acids.
- Use databases, including online databases, and search for the necessary information using the available tools.
- Interpret the basic biochemical concepts that characterize metabolic transformations and regulatory adaptive processes.
- Analyze the mechanisms of regulation of major metabolic processes;
- Interpret the biochemical patterns of structure and function of different classes of enzymes;
- Interpret the role of vitamins and their biologically active derivatives in the mechanisms of catalysis with the participation of the main classes of enzymes;
- Analyze the ways and mechanisms of regulation of enzymatic processes as the basis of metabolism in the body in normal and in pathologies;
- Explain changes in the course of enzymatic processes and the accumulation of intermediate products of metabolism in congenital (hereditary) and acquired metabolic defects - enzymopathy;
- Analyze changes in the activity of indicator enzymes in blood plasma in pathologies of certain organs and tissues;
- Explain the use of enzyme preparations and enzyme inhibitors as pharmacological drugs in certain pathological conditions.

- Interpret the biochemical patterns of metabolism: catabolic, anabolic, amphibolic pathways of metabolism;
- Interpret the biochemical patterns of the tricarboxylic acid cycle, its anaplerotic reactions and amphibolic nature;
- Explain the biochemical mechanisms of regulation of the tricarboxylic acid cycle and its key role in metabolism and energy;
- Explain the biochemical mechanisms of regulation of anabolism and catabolism.
- Interpret the role of biological oxidation, tissue respiration and oxidative phosphorylation in the generation of ATP under anaerobic conditions;
- Analyze the violation of ATP synthesis under the influence of pathogenic factors of chemical, physical, biological origin on the human body;
- Explain the biochemical basis of the processes of disposal of endogenous toxins with the participation of microsomal oxidation enzymes (cytochrome P-450
- Interpret the biochemical patterns of intracellular carbohydrate metabolism: anaerobic and aerobic oxidation of glucose;
- Interpret the biochemical patterns of alternative pathways of monosaccharide metabolism: pentose phosphate pathway of glucose oxidation, pathways of fructose and galactose conversion;
- Interpret the functional features and biological significance of glucose biosynthesis (glucogenesis), glycogen synthesis and breakdown in tissues;
- Analyze changes in blood glucose levels, mechanisms of its hormonal regulation (insulin, glucagon, adrenaline), pathological manifestations of glucose metabolism disorders: diabetes, starvation;
- Explain the molecular and biological basis of hereditary enzymopathies (congenital defects of metabolism) of fructose, galactose, glycogen metabolism;
- Interpret the concepts of normoglycemia, hyper-, hypoglycemia, glucosuria as normal and pathological states of glucose metabolism.
- Interpret the biochemical functions of simple and complex lipids in the body: participation in the construction and functioning of biological cell membranes, reserve, energy functions, use as precursors in the biosynthesis of biologically active compounds of lipid nature;
- Interpret the biochemical patterns of intracellular lipid metabolism: catabolism and biosynthesis of fatty acids, triacylglycerols, phospholipids, hormonal regulation of lipolysis;
- Interpret the biochemical patterns of regulation of cholesterol biosynthesis and its biotransformation: esterification, formation of bile acids, steroid hormones, vitamin D₃;
- Analyze changes in the system of circulatory transport lipids: CM, VLDL, LDL, HDL in pathologies, explain their functional significance;
- Explain the biochemical basis of the origin and development of genetic abnormalities of lipid metabolism, lipoproteins, cholesterol (lipoproteinemia), as well as acquired disorders of lipid metabolism: atherosclerosis, obesity, diabetes.
- Interpret the biochemical patterns of intracellular amino acid metabolism: the processes of deamination, transamination, decarboxylation, explain the biological action of the formed biological amines: serotonin, histamine, gamma-aminobutyric acid, etc .;

- Interpret the metabolic patterns of formation and disposal of ammonia, circulatory transport of ammonia, urea biosynthesis;
- Analyze changes in the systems of transport and disposal of ammonia in genetic abnormalities of enzymes of ammonia metabolism;
- Explain the features of the functioning of the general pathways of metabolism of nitrogen-free skeletons of amino acids and specialized transformations of cyclic amino acids;
- Explain the biochemical basis of the occurrence and manifestations of genetic abnormalities of cyclic amino acid metabolism and analyze the causes of accumulation of intermediate products of their metabolism in phenylketonuria, alkaptonuria, albinism;
- Interpret the biochemical and physiological functions of hormones and bioregulators in the system of intercellular integration of the human body;
- Analyze and explain the compliance of the structure of hormones of protein-peptide nature, amino acid derivatives and steroid hormones to perform functions and mechanism of action on target cells;
- Interpret the molecular mechanisms of action of hormones of protein-peptide nature and derivatives of amino acids (catecholamines) on target cells with the participation of signaling molecules - mediators;
- Interpret the molecular mechanisms of direct regulation of the action on the genome of target cells of steroid hormones;
- Use on-line databases of the human genome;
- Operate simple measuring instruments and evaluate the accuracy of measurements made;
- Analyze changes in metabolism and biochemical parameters that characterize the metabolism of carbohydrates, proteins and lipids in disorders of the endocrine glands and summarize the prognostic assessment of these disorders;
- Interpret the mechanisms of hormonal regulation of calcium homeostasis: the distribution of calcium ions in the body, forms of calcium in human blood plasma, the contribution of bone tissue, small intestine and kidneys to calcium homeostasis;
- Explain the biochemical mechanisms of occurrence and development of pathological processes and typical manifestations of disorders of the endocrine system of the body;
- Explain the biochemical principles of regulation of porphyrin metabolism, the emergence and development of hereditary disorders of porphyrin synthesis - porphyria.
- Interpret the mechanisms of gene expression regulation at the level of operon transcription, which include structural and regulatory genes, promoter and operator;
- Interpret biochemical mechanisms of genetic recombination, gene amplification, features of regulation of gene expression in eukaryotes;
- Analyze the consequences of genomic, chromosomal and gene mutations, mechanisms of action of the most common mutagens, biological significance and mechanisms of DNA repair (repair of UV-induced gene mutations);

- Explain the biochemical and molecular biological principles of genetic engineering methods, recombinant DNA technology, gene transplantation and production of hybrid DNA molecules;
- Explain the principles of gene cloning in order to obtain biotechnological drugs.
- Interpret the physiological needs and energy value of essential nutrients - components of human nutrition: proteins, carbohydrates, lipids, vitamins, trace elements.
- Explain the biochemical mechanisms of enzymatic processes of digestion and entry into the tissues of the constituent components of nutrients in hereditary and acquired disorders of synthesis and activation of enzymes for the breakdown of proteins, carbohydrates and lipids.
- Explain the occurrence of the main pathological processes of digestion in the stomach and intestines.
- Interpret the biochemical patterns of functioning of vitamins as components of human nutrition and regulators of enzymatic reactions and metabolic processes.
- Interpret the functions of water-soluble coenzyme vitamins B1, B2, PP, B6, B12, H, C, R.
- Explain the bioregulatory (hormone-like) and antioxidant functions of fat-soluble vitamins A, E, K, F, D.
- Plan and perform simple scientific research and interpret its results and draw conclusions;
- Analyze the causes and molecular biochemical mechanisms of pathologies in hypo-hyperitaminosis.
- Interpret the biochemical principles of functioning of the coagulation, anticoagulation and fibrinolytic systems of the blood.
- Analyze the biochemical composition of blood and explain the diagnostic role of plasma proteins, non-protein nitrogenous compounds (residual nitrogen), nitrogen-free organic components of the cow in normal and under conditions of pathology.
- Analyze human health based on biochemical parameters of changes in intermediate and final products of metabolism in the blood.
- Explain the biochemical basis of the functioning of blood pressure regulation systems (kallikrein-kinin) and renin-angiotensin system) and scientifically sound use of antihypertensive drugs - angiotensin-converting enzyme inhibitors.
- Interpret the biochemical patterns of liver function: carbohydrate, lipid-regulating, protein-synthesizing, urea-forming, pigment, bile-forming.
- Interpret the biochemical mechanisms of functioning of the liver detoxification system: refraction of microsomal oxidation and conjugation, biotransformation of xenobiotics and endogenous toxins.
- Analyze differential changes in blood and urine biochemical parameters (free conjugated bilirubin) to assess the pathobiochemistry of jaundice.
- Explain the role of the liver in the provision of normoglycemia (synthesis and catabolism of glycogen, glucogenesis) and pathological changes - hypo-, hyperglycemia, glucosuria.

- Explain the biochemical basis for the development of liver failure under conditions of chemical, biological and radiation damage.
- Interpret the biochemical mechanisms of regulation of water-salt metabolism and the role of the kidneys in the formation of urine.
- Analyze the biochemical composition of urine in normal and under conditions of pathological processes: to assess the functional significance of the final products of nitrogen metabolism (urea, uric acid, creatinine) and detoxification products (animal indican, hippuric acid), changes in their daily excretion.
- Analyze human health based on biochemical parameters of changes in intermediate and final products of metabolism in blood and urine.
- Explain the biochemical basis of energy supply and molecular mechanisms of muscle contraction.
- Explain the peculiarities of the metabolism of the nervous system, the molecular mechanisms of action of neurotransmitters, the biochemical basis of metabolic disorders of mediators and modulators of the brain in mental disorders.

Is ready to:

- Formulate conclusions from own measurements or observations.
- Perceive and recognize own limitations and self-assessing educational deficits and needs.
- Use objective sources of information.

3. THE STRUCTURE OF EDUCATIONAL DISCIPLINE

Names of modules, submodules and topics	Amount of hours					
	Full-time education					
	total	including				
lec.		pr.	s.	ind.	iws.	
Module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components.						
Topic 1. Classification, nomenclature and isomerism of bioorganic compounds. Nature of the chemical bond.		2	2			3
Topic 2. Classification of chemical reactions. Reaction ability of alkanes, arenes, alcohols, phenols, amines.		2	2			3
Topic 3. Structure and properties of aldehydes and ketones.			2			2
Topic 4. Structure, properties and biological importance of carboxylic acids.			2			3
Topic 5. High fatty acids. Lipids. Phospholipids.		2	2			3
Topic 6. Structure, reaction ability and biological importance of heterofunctional compounds (hydroxyacids, α -, β , γ -amino acids, ketoacids and phenolacids).			2			3
Topic 7. Amino acid composition of proteins and peptides.		2	2			3
Topic 8. Structural organization of proteins. Physico-chemical properties of proteins.			2			3
Topic 9. Reactions of protein precipitation. Denaturation.			2			4
Topic 10. Carbohydrates. Structure and chemical properties of monosaccharides.			2			3
Topic 11. Structure and functions of di- and polysaccharides.			2			2
Topic 12. Classification, structure and functions of biologically important heterocyclic compounds.			2			2
Topic 13. Structure and biochemical functions of nucleosides and nucleotides.			2			2
Topic 14. Structure and biological role of nucleic acids.		2	2			2
Topic 15. Final modular control 2.			2			2
Total on the module 1	80	10	30	-	-	40

Module 2. General patterns of metabolism. Metabolism of carbohydrates, lipids, and its regulation.						
1. Subject and tasks of biochemistry. Aim and methods of biochemical research, its clinical and diagnostic value.			2			1
2. Analysis of structure, physical and chemical properties of protein enzymes. Measurement of enzymic activity. Units of catalytic activity of enzymes. Analysis of enzymic processes by the reaction type of main classes of enzymes.			2			1
3. Analysis of the mechanism of enzymic action and kinetics of enzymic catalysis.			1			1
4. Analysis of regulation of enzymic processes.			2			1
5. Medicinal enzymology.			1			1
6. Analysis of the role of cofactors and coenzyme vitamins in catalytic activity of enzymes.			1			2
7. Fundamental principles of metabolism. Common metabolic pathways of proteins, carbohydrates, lipids. Analysis of the tricarboxylic acid cycle.		1	1			2
8. Bioenergetics processes: biological oxidation, oxidative phosphorylation.		1	1			2
9. Chemiosmotic theory of oxidative phosphorylation. Inhibitors and decouplers of oxidative phosphorylation.			2			1
10. Analysis of aerobic and anaerobic oxidation of glucose.			2			1
11. Alternate pathways of monosaccharide metabolism.			1			1
12. Analysis of catabolism and biosynthesis of glycogen. Regulation of glycogen metabolism. Gluconeogenesis.		2	1			2
13. Analysis of mechanisms of metabolic and hormone regulation of carbohydrate metabolism.		2	2			2
14. Analysis of catabolism and biosynthesis of triacylglycerols. Determination of molecular mechanisms of regulation of lipolysis.		2	2			1
15. Transport forms of lipids.			2			1
16. β -oxidation of fatty acids. Analysis of metabolism of fatty acids and ketone bodies.			2			2
17. Biosynthesis of fatty acids. Metabolism of compound lipids.		2	1			2
18. Biosynthesis and biotransformation of cholesterol. Analysis of deficiencies of lipid metabolism: steatorrhea, atherosclerosis, obesity.			2			2

19. Analysis of amino acid metabolism (transamination, deamination, decarboxylation).		2	2			2
20. Biosynthesis of glutathione and creatine.			1			2
21. Analysis of ammonia detoxication and urea biosynthesis.			1			3
22. Biosynthesis of porphyrins. Hereditary disorders of porphyrin metabolism.			2			3
23. Final modular control 2.			2			4
Total on the module 2	90	14	36	-	-	40
Module 3. Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.						
1/Structure and functions of nucleic acids.			2			2
2. Biosynthesis and catabolism of purine and pyrimidine nucleotides. Analysis for the end products of their metabolism.			2			2
3. DNA replication and RNA transcription. Biosynthesis of proteins in ribosomes.			3			1
4. Initiation, elongation and termination in the synthesis of polypeptide chain. Inhibitory action of antibiotics.		2	3			2
5. Regulation of gene expression.			3			2
6. Analysis of mutation mechanisms, DNA reparation. Principles of synthesis of recombinatory DNA, transgenic proteins.		1	3			1
7. Study of molecular-cellular mechanisms of action of peptide and protein hormones on target cells.		1	2			2
8. Hormones of hypothalamus and hypophysis.			2			2
9. Study of molecular-cellular mechanisms of action of steroid hormones on target cells. Steroid hormones.			2			2
10. Study of role of thyroid hormones and biogenic amines in regulation of metabolic processes.			3			1
11. Hormones of the pancreas. Hormones of the gastrointestinal tract.			2			1
12. Hormonal regulation of calcium homeostasis.			2			1
13. Physiologically active eicosanoids.			3			1
14. Study of digestion of nutrients: proteins, carbohydrates in the gastrointestinal tract.			2			2
15. Study of digestion of nutrients: lipids in the gastrointestinal tract.			2			1
16. Study of the functional role of fat-soluble vitamins in metabolism and realization of cell functions.			2			2

17.Study of blood plasma proteins: proteins of acute inflammation phase, own enzymes and indicator enzymes.		1	2			1
18.Study of acid-base condition of blood and respiratory function of erythrocytes. Pathological forms of hemoglobins.		1	3			2
19.Study of nitrogen balance and nonprotein nitrogenous components of blood – end products of heme catabolism.		2	2			2
20.Biochemical principles of realization of immune processes.		2	2			2
21.Immunodeficiency conditions.			2			1
22.Biochemistry of the liver.		1	3			1
23.Patobiochemistry of jaundices.		1	3			1
24.Study of processes of biotransformation of xenobiotics and endogeneous toxins.			2			2
25.Microsomal oxidation, cytochrome P-450.			3			1
26.Study of normal components of urine.		2	2			1
27.Study of pathological components of urine.		2	2			1
28.Biochemistry of muscle tissue.			2			2
29.Biochemistry of connective tissue.			2			1
30.Biochemistry of bone tissue. Risk factors of osteoporosis.			2			1
31. Biochemistry of nervous tissue.			3			2
32. Final modular control 3.			2			4
Total on the module 3	100	16	34	-	-	50
TOTAL:	270	40	100	-	-	130

4. THEMATIC PLAN OF LECTURES

The 1st course. The 2nd semester	
№	Topic
	<i>Module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components.</i>
1.	Bioorganic chemistry as a science. Classification, structure and reactivity of bioorganic compounds.
2.	Classification, structure and chemical properties of carbohydrates.
3.	Structure and chemical properties of lipids.
4.	Structural organization and physicochemical properties of proteins.
5.	Structure, properties and biological role of nucleic acids.
	Total

	The 2nd course. The 3rd semester
	<i>Module 2. General patterns of metabolism. Metabolism of carbohydrates, lipids, and its regulation.</i>
1.	Bioenergetics: general pathways of carbohydrate, lipid and amino acid metabolism. Tricarboxylic acid cycle. Biological oxidation and oxidative phosphorylation.
2.	Study of the structure and physicochemical properties of enzyme proteins. Determination of enzyme activity. Types of reactions of the main classes of enzymes.
3.	Carbohydrate metabolism. Glycolysis, aerobic and anaerobic oxidation of glucose, gluconeogenesis. Alternative ways of metabolism of monosaccharides.
4.	Glycogen metabolism, gluconeogenesis. Regulation and pathology of carbohydrate metabolism. Diabetes mellitus.
5.	Lipid metabolism. Catabolism of triacylglycerols: oxidation of fatty acids and glycerol; ketogenesis.
6.	Lipid metabolism. Lipogenesis. Cholesterol metabolism. Regulation and pathology of lipid metabolism: obesity, atherosclerosis.
7.	Protein metabolism. General pathways of transformation of amino acids.
	Total
	The 2nd course. The 4th semester
	<i>Module 3. Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.</i>
1.	Regulation of gene expression.
2.	Molecular genetic basis of health. Regulation of metabolism. Biochemical mechanisms of hormone action.
3.	Blood biochemistry. Acid-base state of the blood. The role of erythrocytes and plasma proteins.
4.	Biochemical principles of realization of immune processes.
5.	Biochemical functions of the liver. Biochemistry of jaundices. Biotransformation of foreign compounds in the liver.
6.	Biochemical functions of the kidney. Biochemistry of urine and urine formation. Patobiochemistry of urine.
7.	Biochemistry of the connective and bone tissues. Factors of osteoporosis risk.
8.	Nervous tissue biochemistry: features of brain metabolism. Neurotransmitters. Pathobiochemistry of mental disorders.
	Total:

5. THEMATIC PLAN OF PRACTICAL CLASSES

The 1st course. The 2nd semester	
№	Topic
Module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components.	
1.	Classification, nomenclature and isomerism of bioorganic compounds. Nature of the chemical bond.
2.	Classification of chemical reactions. Reaction ability of alkanes, arenes, alcohols, phenols, amines.
3.	Structure and properties of aldehydes and ketones.
4.	Structure, properties and biological importance of carboxylic acids.
5.	High fatty acids. Lipids. Phospholipids.
6.	Structure, reaction ability and biological importance of heterofunctional compounds (hydroxyacids, α -, β -, γ -amino acids, ketoacids and phenolacids).
7.	Amino acid composition of proteins and peptides.
8.	Structural organization of proteins. Physico-chemical properties of proteins.
9.	Reactions of protein precipitation. Denaturation.
10.	Carbohydrates. Structure and chemical properties of monosaccharides.
11.	Structure and functions of di- and polysaccharides.
12.	Classification, structure and functions of biologically important heterocyclic compounds.
13.	Structure and biochemical functions of nucleosides and nucleotides.
14.	Structure and biological role of nucleic acids.
15.	Diff.credit (Final modular control 1).
The 2nd course. The 3rd semester	
Module 2. General patterns of metabolism. Metabolism of carbohydrates, lipids, and its regulation.	
1.	Subject and tasks of biochemistry. Aim and methods of biochemical research, its clinical and diagnostic value.
2.	Analysis of structure, physical and chemical properties of protein enzymes. Measurement of enzymic activity. Units of catalytic activity of enzymes. Analysis of enzymic processes by the reaction type of main classes of enzymes.
3.	Analysis of the mechanism of enzymic action and kinetics of enzymic catalysis.
4.	Analysis of regulation of enzymic processes.
5.	Medicinal enzymology.
6.	Analysis of the role of cofactors and coenzyme vitamins in catalytic activity of enzymes.
7.	Fundamental principles of metabolism. Common metabolic pathways of proteins, carbohydrates, lipids. Analysis of the tricarboxylic acid cycle.

8.	Bioenergetics processes: biological oxidation, oxidative phosphorylation.
9.	Chemiosmotic theory of oxidative phosphorylation. Inhibitors and discouplers of oxidative phosphorylation.
10.	Analysis of aerobic and anaerobic oxidation of glucose.
11.	Alternate pathways of monosaccharide metabolism.
12.	Analysis of catabolism and biosynthesis of glycogen. Regulation of glycogen metabolism. Gluconeogenesis.
13.	Analysis of mechanisms of metabolic and hormone regulation of carbohydrate metabolism.
14.	Analysis of catabolism and biosynthesis of triacylglycerols. Determination of molecular mechanisms of regulation of lipolysis.
15.	Transport forms of lipids.
16.	β -oxidation of fatty acids. Analysis of metabolism of fatty acids and ketone bodies.
17.	Biosynthesis of fatty acids. Metabolism of compound lipids.
18.	Biosynthesis and biotransformation of cholesterol. Analysis of deficiencies of lipid metabolism: steatorrhea, atherosclerosis, obesity.
19.	Analysis of amino acid metabolism (transamination, deamination, decarboxylation).
20.	Biosynthesis of glutathione and creatine.
21.	Analysis of ammonia detoxication and urea biosynthesis.
22.	Biosynthesis of porphyrins. Hereditary disorders of porphyrin metabolism.
23.	Final modular control 2.
The 2nd course. The 4th semester	
<i>Module 3. Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.</i>	
1.	Structure and functions of nucleic acids.
2.	Biosynthesis and catabolism of purine and pirimidine nucleotides. Analysis for the end products of their metabolism.
3.	DNA replication and RNA transcription. Biosynthesis of proteins in ribosomes.
4.	Initiation, elongation and termination in the synthesis of polypeptide chain. Inhibitory action of antibiotics.
5.	Regulation of gene expression.
6.	Analysis of mutation mechanisms, DNA reparation. Principles of synthesis of recombinatory DNA, transgenic proteins.
7.	Study of molecular-cellulary mechanisms of action of peptide and protein hormones on target cells.
8.	Hormones of hypothalamus and hypophysis.
9.	Study of molecular-cellulary mechanisms of action of steroid hormones on target cells. Steroid hormones.

10.	Study of role of thyroid hormones and biogenic amines in regulation of metabolic processes.
11.	Hormones of the pancreas. Hormones of the gastrointestinal tract.
12.	Hormonal regulation of calcium homeostasis.
13.	Physiologically active eicosanoids.
14.	Study of digestion of nutrients: proteins, carbohydrates in the gastrointestinal tract.
15.	Study of digestion of nutrients: lipids in the gastrointestinal tract.
16.	Study of the functional role of fat-soluble vitamins in metabolism and realization of cell functions.
17.	Study of blood plasma proteins: proteins of acute inflammation phase, own enzymes and indicator enzymes.
18.	Study of acid-base condition of blood and respiratory function of erythrocytes. Pathological forms of hemoglobins.
19.	Study of nitrogen balance and nonprotein nitrogenous components of blood – end products of heme catabolism.
20.	Biochemical principles of realization of immune processes.
21.	Immunodeficiency conditions.
22.	Biochemistry of the liver.
23.	Patobiochemistry of jaundices.
24.	Study of processes of biotransformation of xenobiotics and endogeneous toxins.
25.	Microsomal oxidation, cytochrome P-450.
26.	Study of normal components of urine.
27.	Study of pathological components of urine.
28.	Biochemistry of muscle tissue.
29.	Biochemistry of connective tissue.
30.	Biochemistry of bone tissue. Risk factors of osteoporosis.
31.	Biochemistry of nervous tissue.
32.	Final modular control 3.

6. THEMATIC PLAN OF INDEPENDENT WORK OF STUDENTS (IWS)

№	Topic
	The 1st course. The 2nd semester
	Module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components.
1.	Preparation for the practical classes - theoretical preparation and working off the practical skills.
2.	Working off the topics which are not included into the classes plan:
2.1.	Isomerism of bioorganic compounds. Electronic effects.

2.2.	Characteristics of nucleophiles and electrophiles. Reactivity of alkanes, alkenes, arenes, amines.
2.3.	Aldol condensation and its significance for elongation of the carbon chain.
2.4.	Functional derivatives of carboxylic acid compounds.
2.5.	Structure, reactivity and biological significance of heterofunctional compounds of phenolic acids.
2.6.	Structure of phospholipids, their biological significance.
3.	Preparation for the final control of mastering of the module 1.
The 2nd course. The 3rd semester	
Module 2. General patterns of metabolism. Metabolism of carbohydrates, lipids, and its regulation.	
1.	Preparation for the practical classes - theoretical preparation and working off the practical skills.
2.	Working off the topics which are not included into the classes plan:
2.1.	Subject and tasks of biochemistry. Aim and methods of biochemical research, its clinical and diagnostic value.
2.2.	Ascorbic acid as a derivative of hexose, the biological role of vitamin C.
2.3.	The role of glucuronic acid, glucosamine and galactosamine in the formation of heteropolysaccharides.
2.4.	Condensed heterocycles. Structure and biochemical functions.
2.5.	Structure and biochemical functions of nucleosides and nucleotides.
3.	Preparation for the final control of mastering of the module 2.
The 2nd course. The 4th semester	
Module 3. Molecular biology. Biochemistry of intercellular communications. Biochemistry of tissues and physiological functions.	
1.	Preparation for the practical classes - theoretical preparation and working off the practical skills.
2.	Working off the topics which are not included into the classes plan:
2.1.	Chromatography. The principle of ascending distribution chromatography on paper.
2.2.	Methods of isolation, purification and fractionation of proteins.
2.3.	Hyper- and hypoproteinemias, their causes and consequences.
2.4.	Biological properties of water- and fat-soluble vitamins, role in metabolism, manifestations of insufficiency and hypervitaminosis.
3.	Preparation for the final control of mastering of the module 3

7. THE LIST OF THEORETICAL QUESTIONS FOR PREPARATION OF STUDENTS FOR THE FINAL CONTROL.

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. Phospholipids: 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, serotonin, 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, dextrans – 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: porphyrins, porphyrins, heme.
29. Indole and its derivatives: tryptophan and reactions of formation of tryptamine and serotonin; indoxyl, skatole, skatol – 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 B₁).
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 B₆.
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-fluorouracil, potassium orotate. Barbituric acid; barbiturates as sedatives and antiepileptic 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: hypoxanthine, xanthine, uric acid. Methylated derivatives of xanthine (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 B₁, B₂, B₆, PP.
44. Prove presence of formaldehyde in a solution with the Trommer's test. Make conclusions.
45. Explain the iodineformic test for acetone. Make conclusions.
46. How and why does the color of KMnO₄ solution change when oleic acid is added?
47. Why is the Wagner's test for unsaturation of fat qualitative? Analyze the results.
48. Explain difference in chemical behaviour of salole and aspirin in their reactions with FeCl₃. Explain the conclusions.
49. Explain steps of obtaining Fehling's reagent. Where is it used?
50. Why does the reaction of glucose and lactose with Fehling's reagent differ from the interaction of sucrose with Fehling's reagent?
51. What is the qualitative reaction for starch?
52. Why are different products obtained in the reaction of glucose with Cu(OH)₂ at different conditions (room temperature and heating)? Explain your reasoning.
53. Explain qualitative reactions for amino acids and proteins:
 - a) xantoproteic;
 - b) ninhydrin;
 - c) Fohl's;
 - d) biuret.
 Why solutions of different colors are obtained?
54. What reaction can be used to differentiate peptides from proteins?
55. How do ammonium sulfate, trichloroacetic acid and sulfosalicylic acid react with proteins? Explain your reasoning.
56. How and why does the composition of nucleic acids change in hydrolysis. Determine components of the hydrolysate. Make conclusions.

8. TEACHING METHODS

1. Verbal (lecture, explanation, story, conversation, instruction);
2. Visual (observation, illustration, demonstration);
3. Practical (different types of exercises, graphic works, experiment, practice).

The training process uses the following teaching methods:

-explanatory-illustrative or informational-receptive, which provides for the ready presentation of information by the teacher and its assimilation by students;

-reproductive, which is based on the performance of various types of tasks on the sample;

-method of a problem statement - the teacher puts the problem and he solves it, demonstrating the contradictions that characterize the process of cognition, the task of students is to monitor the sequence of presentation, evidence of materiality, the prediction of the next steps of the teacher; the MN is implemented by teaching students to problem situations to ensure successful preliminary preparation for upcoming work in real conditions of practical medical institutions;

-partially search or heuristic, aims at the mastery of the separate elements of search activity, for example: the teacher formulates the problem, students hypothesis;

-research, the essence of which is to organize teacher search creative activity of students by setting new problems and problem tasks.

-methods to ensure the perception and assimilation of knowledge by students (lectures, independent work, instruction, consultation);

-methods of application of knowledge and acquisition and consolidation of skills (practical sessions, assignments);

-methods of verification and assessment of knowledge and skills.

9. METHODS OF CONTROL

9.1. Current control is performed based on the control of theoretical knowledge, skills and abilities in practical classes. Independent study students are assessed in practical classes, and is an integral part of the final grade of the student. Current control is performed during the training sessions and aims at checking the assimilation of students learning the material. Forms of current control are:

a) test tasks with a choice of one correct answer, with the definition of the correct sequence of actions, with determination of the conformity, defining the specific portion of the photo or diagram ("detection");

b) individual oral questioning, interview;

c) the solution of typical situational tasks;

d) control of practical skills;

e) the typical problems of Biological and bioorganic chemistry.

9.2. Form of final control of education is carried out in the form of the exam (written, oral) (second semester).

The semester examination is a form of final control of mastering by the student the theoretical and practical material of the discipline. The final control (exam) is held on the last control class.

To FC allowed students who attended all included in the curriculum for the discipline of classroom training and the study module scored points not less than the minimum (**72 points**). A student who for good or without good reason, had the missing classes, you are allowed to work on academic debt to a fixed term.

The form of the final control should be standardized and include control of theoretical and practical training.

10. SCHEME OF CALCULATION AND DISTRIBUTION OF POINTS RECEIVED BY APPLICANTS FOR HIGHER EDUCATION.

Evaluation of current educational activities. During the assessment of mastering each topic for the current educational activity of the student scores are set on a 4-point (national) assessment scale. This takes into account all types of work provided by the discipline program. The student must receive a score on each topic. Scores on the traditional scale are converted into points. The final assessment of the current academic activity is the arithmetic mean (the sum of scores for each lesson is divided by the number of lessons per semester) and translated into points according to **Table 1**.

The maximum number of points that a student can collect for current educational activity during semester in order to be admitted to the exam is **120 points**.

The minimum number of points that a student can collect for current educational activity during semester in order to be admitted to the exam is **72 points**.

Calculating of the number of points is based on obtained marks of student according to traditional scale while learning subject during the semester, by calculating the arithmetic mean (AM) that is rounded to two signs after comma.

Table 1. Conversion of the average score for the current activity into a multi-scale scale (for disciplines completed by credit)

4- point scale	200- point scale	4- point scale	200- point scale	4- point scale	200- point scale	4- point scale	200- point scale
5	200	4,47	179	3,94	158	3,42	137
4,97	199	4,45	178	3,92	157	3,4	136
4,95	198	4,42	177	3,89	156	3,37	135
4,92	197	4,4	176	3,87	155	3,35	134
4,9	196	4,37	175	3,84	154	3,32	133
4,87	195	4,35	174	3,82	153	3,3	132
4,85	194	4,32	173	3,79	152	3,27	131
4,82	193	4,3	172	3,77	151	3,25	130
4,8	192	4,27	171	3,74	150	3,22	129
4,77	191	4,24	170	3,72	149	3,2	128
4,75	190	4,22	169	3,7	148	3,17	127
4,72	189	4,19	168	3,67	147	3,15	126
4,7	188	4,17	167	3,65	146	3,12	125
4,67	187	4,14	166	3,62	145	3,1	124
4,65	186	4,12	165	3,6	144	3,07	123
4,62	185	4,09	164	3,57	143	3,05	122
4,6	184	4,07	163	3,55	142	3,02	121
4,57	183	4,04	162	3,52	141	3	120
4,55	182	4,02	161	3,5	140	<3	Not enough
4,52	181	3,99	160	3,47	139		
4,5	180	3,97	159	3,45	138		

Evaluation of individual student tasks. Points for individual tasks are accrued only if they are successfully completed and defended. The number of points awarded for different types of individual tasks depends on their scope and significance, but not more than 10-12 points. They are added to the amount of points gained by the student in the classroom during the current educational activity. In no case may the total amount for current activities exceed 120 points.

Evaluation of independent work of students. Independent work of students, which is provided by the topic of the lesson together with the classroom work, is evaluated during the current control of the topic in the relevant lesson. Assimilation of topics that are submitted only for independent work is checked during the final module control.

Evaluation of final control.

The maximum number of points that a student can score during the exam is **80 points**.

The final control is considered credited if the student scored at least 60% of the maximum amount of points (for a 200-point scale - at least **50 points**).

Determining the number of points that a student scored in the discipline: the number of points that a student scored in the discipline is defined as the sum of points for the current academic activity and for the final control (exam).

Conversion of the number of points from the discipline into grades on the ECTS scale and on a four-point (traditional) scale

Scores from disciplines are independently converted into both the ECTS scale and the national assessment scale, but not vice versa. **Table 2.**

Table 2. Conversion of the average score for the current activity into a multi-point scale (for disciplines completed by exam)

4- point scale	120- point scale	4- point scale	120- point scale	4- point scale	120- point scale	4- point scale	120- point scale
5	120	4,45	107	3,91	94	3,37	81
4,95	119	4,41	106	3,87	93	3,33	80
4,91	118	4,37	105	3,83	92	3,29	79
4,87	117	4,33	104	3,79	91	3,25	78
4,83	116	4,29	103	3,74	90	3,2	77
4,79	115	4,25	102	3,7	89	3,16	76
4,75	114	4,2	101	3,66	88	3,12	75
4,7	113	4,16	100	3,62	87	3,08	74
4,66	112	4,12	99	3,58	86	3,04	73
4,62	111	4,08	98	3,54	85	3	72
4,58	110	4,04	97	3,49	84	<3	Not enough
4,54	109	3,99	96	3,45	83		
4,5	108	3,95	95	3,41	82		

Criteria for establishing the assessment on the traditional 4-point and ECTS scale after passing the exam:

Points by the multi-point (200) scale	Grade by the 4-point scale (National assessment scale)	Score ECTS
180-200	5	A
160-179	4	B
150-159		C
130-149		D
120-129	3	E
50-119		FX

0-49	2	F
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The criteria for the evaluation.

During assessment of the assimilation of each topic for current educational activities of the applicant higher education grades are given on a national scale (traditional) scale with regard to the approved evaluation criteria:

- *“excellent” (5)*- student flawlessly learned the theoretical material of the topic, demonstrates deep and comprehensive knowledge of the relevant topics, the main provisions of scientific sources and recommended literature, to think logically and builds a response, freely use the acquired theoretical knowledge in the analysis of practical material, expresses his attitude to certain issues, demonstrates a high level of mastering of practical skills;

- *“good” rating (4)* - the student has well learned the theoretical material of the lesson has the basic aspects of primary sources and recommended literature, convincingly expounds it; possesses practical skills and expressed their concerns about certain problems, but it is assumed certain inaccuracies and errors in the logic of presentation of theoretical content or performing practical skills.

- *“satisfactory” (3)* - the student has basically mastered the theoretical knowledge training topics, versed in the primary sources and recommended literature, but unconvincing answers, confuses, additional issues are the student's uncertainty or lack of stable knowledge; answering questions of a practical nature, reveals inaccuracies in knowledge, does not know how to evaluate facts and phenomena linked with the future activity, allows for errors in the performance of practical skills;

- *“unsatisfactory” (2)* the student has not mastered the learning material of the topic, knows scientific facts, definitions, is almost oriented in the primary sources and recommended literature, no scientific thinking, practical skills are not formed.

Exhibited on the traditional scale are converted in points. The minimum number of points that need to recruit a student for current educational activity per semester for admission to the exam is 120 points.

11. METODICAL SUPPLY

1. Work program of the discipline.
2. Calendar-thematic plans of lectures and practical classes.
3. Examples of test tasks for classes.
4. Test tasks for the exam.
5. "Test tasks for the state license exam "Krok-1. General medical training" in Biological and Bioorganic Chemistry. For independent work of students specialty 222 "Medicine". Electronic edition (issued annually with updates, in Ukrainian, Russian and English).

12. RECOMMENDED LITERATURE

Basic:

1. J. Komarytsia. Organic Chemistry. Handbook for medical students. Lviv 2005.-74p.
2. Stoker, H.S. (2001). Organic and biological chemistry. Houghton Mifflin. 2001.556p.

Additional:

3. L.G. Wade Jr. Organic Chemistry. 8th edition. - Pearson. 2013. - 547p.
4. T. Graham Solomons, Craig B. Fryhle. Organic Chemistry. Tenth edition. Hoboken, NJ. – 2011. - John Willey and Sons, Inc.- 1218 p.
5. David C. Eaton. Laboratory investigation in Organic Chemistry. – McGRAW-HILL BOOK COMPANY. – New York – Toronto. – 893 p.

Information resources

- www.ncbi.nlm.nih.gov/PubMed – free access to the database of scientific data in the field of biomedical sciences.
- <https://pubchem.ncbi.nlm.nih.gov/> free access to the database of scientific data in the field of biomedical sciences.
- www.biochemistry.org.ua – official site of the Institute of Biochemistry. O.B. Palladin of the National Academy of Sciences of Ukraine.
- www.bpci.kiev.ua – official site of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
- www.xumuk.ru– articles on biochemistry in free access.
- www.pereplet.ru/cgi/soros/readdb.cgi – Soros Educational Journal - free access to popular science articles in biochemistry, biology and chemistry.
- www.chem.msu.su/rus/ – Russian chemical educational portal. The resource is part of the ChemNet virtual system, which combines a large number of information resources on chemistry.
- www.bioorganica.org.ua – scientific publication presenting works on bioorganic and medical chemistry.

Approved:



B.o.Пектора /Acting Rector

Mykhailo SALIUTA