

**INTERNATIONAL EUROPEAN UNIVERSITY
EDUCATIONAL AND SCIENTIFIC INSTITUTE
"EUROPEAN MEDICAL SCHOOL"**

APPROVED

Director of ESI"EMS"

Ph.D. Associate Professor

Alexandrina



**COURSE TRAINING PROGRAM
on
BIOLOGICAL AND BIOORGANIC CHEMISTRY**

Degree level	Master
Field of study	22 "Health care"
Specialty	222 "Medicine"

Kyiv - 2022

DEVELOPED AND SUBMITTED: Educational and Scientific Institute "European Medical School", Department of Fundamental and Medical and Preventive Disciplines.

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Head of the department Kostynskyi G.B.



Approved at the meeting of the Scientific Council of the ESI"EMS"

№ 1 of " 29 " 08 of 2022

INTRODUCTION

Study program of the academic discipline "Biological and bioorganic chemistry" composed in accordance to Standard higher education the second (master's) equal preparation acquirers higher education educational degree

"Master", industry of knowledge 22 – "Protection health", specialty – 222

"Medicine", educational and qualification equal "Master of medicine".

Description educational disciplines (annotation). Discipline "*Biological and bio-organic chemistry*" is studying structure and reactionary ability different classes organic substances, and on their basis most important biologically are active substances, what are included to composition alive organisms - low molecular weight biomolecules , biopolymers (proteins, nucleic acids, polysaccharides), natural and synthetic physiologically active compounds (hormones, vitamins, medicines, toxic substances, etc.). The tasks of bioorganic chemistry are to determine the structure biomolecules , natural and synthetic bioregulators , detection of dependence between their molecular, electronic structure and physiological, in particular pharmacological, effects, detection regularities their transformations

Organization educational process is carried out by credit system in accordance to requirements European credit transfer and storage systems.

Program disciplines structured on **three sections** .

Section AND. Biologically important classes bioorganic compounds . Biopolymers and their structural components.

Section II. general regularities metabolism Metabolism carbohydrates, lipids, proteins and its regulation.

Section III. Molecular biology. Biochemistry intercellular communications Biochemistry fabrics and physiological functions

Informative description primary disciplines

Name indicators	Field of knowledge, direction training, educational - qualifying level	Characteristics of the educational disciplines		
		daytime form teaching		
Number loans – 8.0	Branch of knowledge 22 "Health care"	Normative		
	Direction preparation "Medicine"			
Sections – 3	Specialty: 222 "Medicine"	Year preparation:		
Content sections – thirteen		1st	2nd	
the total number of hours - 240		Semester		
		2nd	3rd	4th
Weekly load: classrooms - 120 independent work student - 120		Educational qualification level: "Master of Medicine" qualifications professional "doctor"	Lectures	
	8 hours		16 hours	-
	Practical			
	40 hours		32 hours	32 hours
	Independent work			
	42 hours		42 hours	28 hours
Type of control:				
		test	test	exam

Subject of study academic discipline is the molecular structure of organics compounds , physical and chemical properties of bioorganic compounds , biological activity organic compounds ,

dependence between structure and properties organic compounds , including metabolites and drugs. Chemical composition of living organisms (organism human) and chemical transformation, which subject to molecules, what are included to their composition

Interdisciplinary connections . Biological and bio-organic chemistry as educational discipline is based on studies students medical biology, biophysics, medical chemistry (bioinorganic , physical chemistry) and morphological disciplines and integrates with these disciplines; lays the foundations for the study of molecular biology by students, genetics, physiology, pathology, general and molecular pharmacology, toxicology and propaedeutics of clinical disciplines, which involves the integration of teaching with these disciplines and formation skill apply knowledge with biological chemistry, primarily biochemical processes that take place in the body of a healthy and sick person person, in the process of further education and professional activity; lays the foundations clinical diagnostics the most common diseases, monitoring I will run disease, control by efficiency application medical means and activities, directed on warning occurrence and development pathological processes.

1. Goal and task educational disciplines

1.1. The purpose of teaching the educational discipline "Biological and bioorganic chemistry" is study of biomolecules and molecular organization cellular structures, general laws of enzymatic catalysis and biochemical dynamics transformation basic classes biomolecules (amino acid, carbohydrates, lipids, nucleotides, porphyrins, etc.), molecular biology and genetics of informative macromolecules (proteins and nucleic acids), i.e molecular mechanisms heredity and implementation genetic information, hormonal regulations metabolism and biological functions cells, special physiological biochemistry functions.

1.2. The main ones tasks study disciplines is

- Mastery knowledge and skills conduct biochemical research on detection normal and pathological components in biological liquids
- Analyze the results of biochemical research for diagnosis the most common human diseases.
- Analyze biochemical processes exchange substances and his regulations in security functioning organs and body systems a person
- Mastery knowledge about biochemical properties and exchange basic biomolecules in the human body in norms and by pathological conditions.
- Carrying out biochemical of research in biological liquids and assessment results with interpretation of clinical and diagnostic value.

1.3 Competences and the results teaching, formation whose promotes discipline (relationship with normative content preparation acquirers higher education, formulated in terms results teaching in Standards higher education).

According to requirements Standard higher education of Ukraine (second (master's) level higher education, branch of knowledge 22 "Protection health", specialty 222 "Medicine") discipline provides students with the following

competencies:

- **integral:** the ability to integrate knowledge and solve complex specialized problem tasks in wide and multidisciplinary contexts professional activity doctor, solve practical problems in new or unfamiliar environments for availability incomplete or limited information, with taking into account aspects social and ethical responsibility in the industry Health Care.

- general and professionals:

general competence (ZK)	
ZK 1.	Ability to abstract thinking, analysis and synthesis.
ZK 2.	Ability to learn and master modern knowledge.
ZK 3.	Ability to apply knowledge in practical situations.
ZK 4.	Knowledge and understanding of the subject area and understanding of professional activity

ZK 5.	Ability to adapt and act in a new situation
ZK 6.	Ability to make informed decisions
ZK 7.	Ability to work in a team
ZK 8.	Ability to interpersonal interaction
ZK 10.	Ability to use information and communication technologies
ZK 11.	Ability to search, process and analyze information from
ZK 12	Determination and persistence of delivered tasks and taken responsibilities
Professionals competencies (FC)	
FC 2	The ability to define necessary list laboratory and instrumental research and evaluation their results .
FC 17	Ability to evaluate impact surrounding environment , socio-economic and biological determinant of health status individual , family , population
FC 23	Ability develop and implement scientific and applied projects in the field protection health _
FC 24	Compliance ethical principles when working with patients , laboratory animals
FC 25	Compliance professional and academic integrity , to be responsible for reliability received scientific results
Software the results teaching (PRN)	
PRN 1.	Have thorough knowledge of the structure of professional activity. 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
PRN 2	Understanding and knowledge of basic and clinical biomedical sciences, on level sufficient for solving professional tasks in the field of health care
PRN 21	Search for the necessary information in professional literature and databases data from other sources, analyze, evaluate and apply this information
PRN 24	Organize the necessary level of individual security (own and persons cared for) in case of occurrence of typical dangerous situations in the individual field of activity

Integrative learning outcomes according to the Standard of higher education of Ukraine (second (master's) level of higher education, field of knowledge 22 "Protection health", specialty 222 "Medicine" , formation whose helps academic discipline: "Biological and bioorganic chemistry" lays the foundation for formation in further the following software results teaching according to with Standard higher education of Ukraine undergraduate preparation specialists the second (master's) level specialty "Medicine".

On completion study disciplines "Biological and bio-organic chemistry" students should know:

- The structure bioorganic compounds and functions, which they perform in body a person
- The reactivity of the main classes of biomolecules that provide them functional properties and metabolic transformations in the body
- Biochemical mechanisms occurrence pathological processes in body a person
- Features of diagnosing the physiological state of the organism and development pathological processes on based on biochemical research.
- Communication features structures and transformations in body bioorganic compounds as foundations their pharmacological actions in quality medicines.
- The main ones mechanisms biochemical actions and principles directed application different classes of pharmacological agents.
- Biochemical and molecular foundations physiological functions cells, bodies and systems body a person

- Functioning enzymatic processes, what are happening in membranes and organelles for integration metabolism in individual cells.
- norms and changes biochemical indicators, what are applied for diagnostics the most common diseases a person
- Value biochemical processes exchange substances and his regulations in security functioning bodies, systems and whole human organism.

On completion study disciplines "Biological and bio-organic chemistry" students should be able to:

- Analyze conformity structures bioorganic compounds physiological functions, which they perform in the human body.
- Interpret features physiological state body and development pathological processes on on the basis of laboratory of research
- Analyze reactionary ability carbohydrates, lipids, amino acids, what provides their functional properties and metabolic conversion to body
- Interpret the peculiarities of the structure and transformations in the organism of bioorganics compounds as foundations their pharmacological actions in quality medicines.
- Interpret biochemical mechanisms occurrence pathological processes in body human and principles of their correction.
- Explain the main ones mechanisms biochemical actions and principles directed application different classes of pharmacological means
 - Explain the biochemical and molecular basis of the physiological functions of cells, bodies and human body systems.
 - Analyze functioning enzymatic processes, what are happening in membranes and organelles for integration exchange substances in individual cells
 - Analyze the results biochemical of research and changes biochemical and enzymatic indicators, what are applied for diagnostics the most common diseases a person
 - Interpret value biochemical processes exchange substances and his regulations in security functioning bodies systems and holistic body a person

2. Informative amount educational disciplines

8 ECTS credits, 240 hours (24 hours lectures, 104 practical classes, 112 hours SRS). First semester 90 hours (3 ECTS credits). Second semester 90 hours (3 ECTS credits.) Third semester 60 hours (2 ECTS credits.)

CHAPTER 1. BIOLOGICALLY IMPORTANT CLASSES OF BIOORGANIC COMPOUNDS. BIOPOLYMERS AND THEIR STRUCTURAL COMPONENTS

Contentful section 1. Theoretical foundations structures and reactionary ability bioorganic compounds.

Topic 1. Classification, nomenclature and isomerism bioorganic compounds . Nature chemical bond.

Types of scientifically based classifications and nomenclature that take into account how the structure of the carbon chain, as well as the presence of certain functional ones in the molecule groups Prefixes, suffixes and endings used in bioorganic names compounds , what have functional groups, by international substitute nomenclature (IUPAC). Theory structures bioorganic compounds . Contribution O.M. Butlerov in the development of the basic principles of isomerism. Schematic image distribution electrons on atomic orbitals (AO) atom carbon in normal and excited state Valence states of the carbon atom corresponding to sp^3 , sp^2 and sp - hybridizations. Mutual influence of atoms. Electronegativity .

Topic 2. Classification chemical reactions Reactionary ability alkanes, alkenes , arenas _

General characteristics of chemical reactions of bioorganic compounds . Classification reactions by orientation and as a result Classification reactions by mechanism

Characteristic nucleophiles and electrophiles . Radical substitution near saturated atom carbon (SR). Electrophilic accession to unsaturated compounds (AE). Electrophilic substitution in aromatic compounds. Influence substitutes on reactionary ability arenas (SE). Nucleophilic substitution near

saturated atom carbon (SN).

Topic 3. Reactionary ability alcohols, phenols, amines

Types of reactions. Hydroxyl -containing compounds: alcohols, phenols - structure, properties and transformation one- and polyatomic alcohols Biomedical characteristic monoatomic and polyatomic alcohols (methanol, ethanol, glycerin, xylitol, sorbitol). simple broadcasts: building, properties Phenols, thiols: building, properties

Amen in bioorganic chemistry: nomenclature, chemical properties, biomedical value. Aliphatic amines. Biogenic amines: adrenaline , norepinephrine , doaramine , tryptamine , serotonin, histamine _ Aromatic amines Aniline – predecessor pharmaceutical drugs: sulfonamides, anesthetic, novocaine Amino alcohols, ethanolamine - biomedical value.

Topic 4. Building and chemical properties aldehydes, ketones

Carbonyl compounds aldehydes, ketones Building and reactionary ability carbonyl groups. Reactions nucleophilic accession (AN) to oxo compounds The effect of a nucleophile on the formation of new bonds with aldehydes and ketones: CC, C- O, CH, CN. Aldol condensation and its significance for carbon elongation chain Oxidation aldehydes and ketones Quality reactions on detection aldehyde groups (Tollens and Trommer). Reaction disproportionation (dismutations , Cannizzaro). Haloform reactions Iodoform sample, her using in analytical purposes. Properties and biomedical significance of the most common representatives

Topic 5. Structure, properties and biological significance of carboxylic acids and their functional derivatives.

Classification of carboxylic acids, individual representatives of monocarboxylic acids. Nucleophilic substitution (SN) reactions near the sp²-hybridized carbon atom oxogroups . Building and properties dicarbonate acids: sorrel, malonova , amber, glutamate , fumarova _ Reactions decarboxylation . Functional derivatives carbon acids: salt, anhydrides, amides, complex ethers Coal acid and its derivatives.

Topic 6. Higher fat acid Lipids. Phospholipids.

Higher fat acid (VZHK) as components neutral lipids: palmitic acid, stearic, oleinova, linoleum , linoleic, peanut _ lipids, simple lipids Triglycerides , neutral fats: building, chemical properties, physiological value. Hydrolysis of fats (acidic, alkaline, enzymatic). Sweetie: structure, physico-chemical and biological properties as surface-active compounds . Complicated lipids Classification, structure phospholipids: phosphatidic acid, phosphatidylethanolamine , phosphatidylserine . Role complex lipids in construction biomembrane . Concept about terpenes, steroids cholesterol, vitamin D, bilious acids concept of sex hormones.

Topic 7. building, reactionary ability and biological value heterofunctional compounds (α -, β -, γ -hydroxy acid , keto acids and phenoacids).

Classification and isomerism hydroxy acid . Asymmetric atom carbon, chirality , optical activity. Enantiomers . Diastereoisomers . Properties and specific chemical reactions of aliphatic α -, β -, γ - hydroxy acids . Monocarbon (lactic, β -hydroxybutyric), dicarboxylic (malic, tartaric) acids. Optical activity. Reactions demining, transamination , decarboxylation.

Oxoacids . Pyruvogradna , acetoacetic, oxalic acetic acid , α - ketoglutarate . Biological value keto acids and their derivatives Ketones bodies, diagnostic value their definition at sugar diabetes Keto- enol tautomerism keto acids and their derivatives.

Phenoacids and their derivatives. The use of salicylic acid and its derivatives in medicine (methyl salicylate , salol, aspirin, salicylates sodium) in in the form medical drugs

Contentful section 2. Structure and biological functions carbohydrates

Topic 8. Carbohydrates Building and chemical properties monosaccharides.

Carbohydrates Definition, classification (aldoses and ketoses , trioses , tetroses, pentoses, hexoses), biomedical value. Pentoses: ribose, a-deoxyribose. Hexoses: glucose, galactose, fructose. Isomerism. Tautomeric forms of monosaccharides (D- and L-forms), open and cyclical forms (Fisher, Collie-Tolensa , Heworth). Furanose and pyranose rings α - and β -anomers . Mutarotation. Chemical reactions of monosaccharides by participation carbonyl groups: redox reactions (quality on detection

aldehyde groups). Formation glycosides, their role in construction oligo - and polysaccharides, nucleosides, nucleotides and nucleic acids. Phosphorus esters glucose and fructose, their value in metabolic transformations carbohydrates Ascorbic acid as a hexose derivative, the biological role of vitamin C. Recovery monosaccharides, formation of sorbitol.

Topic 9. Structure and functions disaccharides and polysaccharides.

Oligosaccharides. Classification disaccharides by ability to redox reactions Two types connections between leftovers monosaccharides and their influence on reactionary ability disaccharides building, properties and role in structural formation disaccharides maltose and cellobiose, their tautomeric forms Structure lactose and sucrose, their properties. Sucrose inversion because of hydrolysis

Polysaccharides. Homopolysaccharides: starch, glycogen, cellulose (cellulose), dextrans The structure, biological role and application of starch, its components. Scheme structures amylose and amylopectin. Conformational structure – secondary structure – amylose Hydrolysis starch and quality reaction his detection. Building and biological role glycogen, fiber, her role in processes life activities body Heteropolysaccharides. Definition, structure. Role glucuronic acid acid, glucosamine and galactosamine in the formation of heteropolysaccharides. Building and biomedical value hyaluronic acids chondroitin sulfate and heparin

Contentful section 3. Biologically are active heterocyclic compounds

Topic 10. Classification, structure and value biologically important heterocyclic compounds.

Classification heterocycles by sizes cycle, quantity and quality heteroatoms. Five-membered heterocycles with one and by two heteroatoms and their derivatives Five-membered heterocycles with one heteroatom. Pyrrole, furan, thiophene - structure, properties Biomedical significance of porphins, heme. Benzopyrrole (indole) as a component tryptophan and products his transformation – biologically active compounds (tryptamine, serotonin) and toxic substances (skatole, indole) and products their neutralization Five-membered heterocycles with by two heteroatoms. Imidazole and his derivatives: histidine, histamine _ Formation derivatives pyrazole as medical drugs

membered heterocycles with one and two heteroatoms are biologically fundamental important compounds and nitrogenous basics pyridine, his aromatic, chemical properties, derivatives Nicotynova acid and her amide (vitamin RR) as ingredient part coenzymes Six-membered heterocycles with by two atoms nitrogen Pyrimidine and his derivatives (uracil, cytosine, thymine). Medicines: potassium orotate, barbiturates. Condensed systems of heterocycles. Purine and its derivatives: adenine, guanine, their tautomeric shapes, biochemical value. Sechova acid, xanthine, derivatives: caffeine, theophylline

Topic 11. Structure and biochemical functions of nucleosides and nucleotides. Nucleosides and nucleotides – products incomplete hydrolysis nucleic acids Structure nucleotides – components components nucleic acids: AMP, GMF, UMF, CMF, d-TMF. Building and value 3', 5'-c-AMP, his role in actions hormones on cells Phosphorylated derivatives nucleotides, value ADP and ATP Participation nucleotides in structural coenzymes Mechanism actions coenzyme OVER+. **Topic 12. Structural and biological role nucleic acids.**

Nucleic acids are polynucleotides, biopolymers that store and transmit hereditary information and take part in protein biosynthesis. Types of RNA: i-RNA, p-RNA, T-RNA, their structural organization and biological role. Structure and biochemical functions DNA. Differences in structures, place location and functions RNA and DNA.

Contentful section 4. α -Amino acids. Peptides. Squirrels

Topic 13. Amino acid composition of proteins and peptides. Structural organization proteins

Amino acids. Properties. Classification by structure carbon chain, the ability to synthesize in the body and the polarity of the radical. General properties amino acids. Formation bipolar ions Acid-base properties amino acids. Chemical reactions α -amino acids in vivo and in vitro. Reactions on carboxyl and amino groups. Decarboxylation, deamination, formation basics Schiff. Reactions quantitative

definition α -amino acids (Van Slyka and Serensen). Polycondensation reactions with the formation of peptides. Qualitative reactions to α - amino acids, peptides, proteins.

Topic 14. Physico-chemical properties proteins Reactions sedimentation proteins Denaturation.

Proteins as biopolymers. Ways of combining α -amino acids in protein molecules. Bonds forming primary, secondary, tertiary and quaternary structures. Globular and fibrillar proteins Study levels structural organizations protein molecules Chemical synthesis of peptides and proteins. Factors of stability of existence proteins in colloidal solutions. Mechanism sedimentation proteins Kinds sedimentation. Reagents causing salting out. Irreversible deposition. Factors that cause irreversible sedimentation. denaturation, her signs factors, what cause denaturation of proteins. Renaturation .

SECTION 2. GENERAL REGULARITIES METABOLISM. METABOLISM CARBOHYDRATES, LIPIDS, PROTEINS AND ITS REGULATION.

Contentful section 5. Role enzymes and vitamins in exchange substances

Topic 15. CONTROL day off equal of knowledge Subject and tasks biochemistry. Study structures and physical and chemical properties proteins Quantitative definition squirrel biuret method Evidence protein the nature of enzymes.

Definition of biochemistry as science The place of biochemistry among other medical and biological discipline Objects study and task biochemistry. History biochemistry; development biochemical of research in Ukraine, scientific biochemical schools Value biological chemistry in the higher system medical education

Sections biochemistry: static (communication with organic chemistry, molecular biology); dynamic; functional (communication with molecular physiology). Medical biochemistry (biochemistry person). Clinical biochemistry as section medical biochemistry. Achievement and prospects development biochemistry, theoretical and molecular biology, biotechnology, genetic engineering and their value for diagnosis and treatment of the main human diseases - cardiovascular, oncological, infectious, etc. Role biochemistry in defined molecular genetic mechanisms pathogenesis diseases, clarification value hereditary and ecological factors in arising pathological became and their impact on duration life of the population.

The purpose of biochemical laboratory research is to obtain new information that may be used for knowledge new ones phenomenon explanation mechanisms functioning bodies and fabrics in norms and at pathology, for productions diagnosis, monitoring I will run disease and efficiency applied treatment. Criteria evaluations used method laboratory of research include certainty, precision, specificity, sensitivity and error method Material for diagnostic studies: blood, urine, spinal cord liquid, gastric and duodenal contents, filtered fluids (exudates and transudates), sweat, amniotic liquid, etc.

Principles of taking material for research: standard preparation of the patient, blood sampling for laboratory tests (venous, arterial, capillary blood), urine collection for laboratory tests (single, daily). Errors that occur during laboratory tests: preparation error, fence and storage material for research, analytical (laboratory) error, error interpretations result Biochemical components cells (biomolecules), their biochemical functions. The main classes of biomolecules : proteins, peptides, amino acids and their derivatives; nucleic acids and nucleotides.

Topic 16. Study of the structure and physical and chemical properties of enzymes. Enzymes as biological catalysts reactions exchange substances; properties proteins- enzymes Units measurement activity and quantity enzymes: international units, rolled , specific activity enzyme Nomenclature enzymes and their classification by by type reactions: oxidoreductases , transferases , hydrolases , lyases , isomerase , ligases . Building enzyme proteins; oligomeric proteins-enzymes; multi-enzyme complexes, membrane -associated enzymes Isoenzymes – multiple molecular forms proteins, result expression different genetic loci

Physico-chemical properties enzyme proteins: electrochemical properties, solubility. Thermodynamic stability protein molecules enzymes; denaturation Interaction with different chemical ligands, her mechanisms and functional value. Complex proteins-enzymes; prosthetic groups of complex protein enzymes. Methods of extracting enzymes from biological objects , their fractionation

(ultracentrifugation, gel- and ion exchange chromatography, affine chromatography, electrophoresis) and activity analysis enzymes

Topic 17. Definition activity enzymes, research kinetics enzymatic catalysis and influence activators and inhibitors.

Mechanisms actions enzymes: thermodynamic regularities enzymatic catalysis; active centers of enzymes. The enzyme does not convert substrates by of the catalytic action of the enzyme on the example of the action of chymotrypsin and acetylcholinesterase . Sequence stages of the catalytic process.

Methods definition activity enzymes: by quantity product, which is formed under action enzyme by unit time, by quantity spent substrate per unit of time. Spectrophotometric methods of activity determination enzymes and visualization results enzymatic reactions Kinetics enzymatic reactions: dependence speed reactions from concentration enzyme, substrate, pH and temperature Constant Michaelisa-Menten , her semantic value. Treatment of the Michaelis-Menten equation by the dual method reverse values equation Lineweaver - Burke. inhibitors, activators enzymes Reversible (competitive and non-competitive) and irreversible inhibition enzymes Physiologically are active compounds and xenobiotics as reverse (competitive, non-competitive) and irreversible enzyme inhibitors.

Regulation of enzymatic processes. Ways and mechanisms of regulation: allosteric interaction in enzymes; covalent modification enzymes; action regulatory effector proteins (calmodulin , proteinase , proteinases inhibitors). Cyclic nucleotides as regulators enzymatic reactions and biological functions cells Main aspects of modern enzyme diagnostics . Cellular, secretory and excretory enzymes Isoenzymes in enzyme diagnostics , fabric specificity distribution isozymes. Changes activity enzymes plasma and serum of blood as diagnostic indicators of the development of pathological processes in organs and tissues. Application of enzyme diagnostics in cardiology, hepatology , nephrology, urology, oncology, pulmonology , orthopedics, etc.

Violation of the course of enzymatic processes: born (hereditary) and acquired enzymopathy , born defects metabolism, their clinical and laboratory diagnosis

Enzyme therapy – using enzymes in quality medical of persons Pharmacological application enzymes gastrointestinal tract, collapsible and fibrolytic systems blood kallikrein-kinin and renin-angiotensin systems Inhibitors enzymes as Medicines.

Topic 18. Study of the role of cofactors and coenzyme forms of vitamins catalytic enzyme activity.

Cofactors and coenzymes Building and properties coenzymes; vitamins as precursors in the biosynthesis of coenzymes. Chemical classification of coenzymes by the nature of the type of reaction they catalyze : coenzymes that are carriers hydrogen atoms and electrons; coenzymes that are carriers of chemical groups; coenzymes of synthesis, isomerization and splitting of carbon-carbon bonds. Most common coenzymes: derivatives vitamin RR (nicotinamide); derivatives vitamin In ₂ (riboflavin); derivatives vitamin At ₆ (pyridoxine); metal porphyrins

– coenzymes cytochromes; coenzyme acylation – derivative pantothenic acids; coenzymes – derivatives folic acids; lipoeva acid; thiamine diphosphate – derivative vitamin In ₁ ; coenzyme carboxybiotin ; coenzymes

– derivatives vitamin At ₁₂ .

Topic 19. Research participation vitamins and coenzyme forms vitamins in different biochemical processes.

The structure of vitamin C. Its biological role, manifestations of vitamin deficiency. Vitamin R. His biological role, manifestations of vitamin deficiency. Folic acid. Its biological role, manifestations vitamin deficiency Vitamin B12. Its biological role, manifestations of vitamin deficiency. Principles quantitative determination of vitamins C and R in food products.

Contentful section 6. Exchange substances and energy.

Topic 20. Research of oxidative phosphorylation and ATP synthesis, inhibitors and disconnectors oxidative phosphorylation.

Paths synthesis ATP in cells: substratum and will oxidize phosphorylation. Formation of ATP in cells under anaerobic and aerobic conditions. Advantages of aerobic oxidation nutritious compounds . Autotrophic and heterotrophic organisms It will oxidize phosphorylation is a process in which chemical energy released during of transport electrons on respiratory chain mitochondria, is used for synthesis ATP with ADP and inorganic phosphate. Release energy in respiratory chains and areas of ATP formation. Energy of ATP hydrolysis and synthesis. Number free chemical energy, what is formed in chain transport electrons Coefficient oxidative phosphorylation, points conjugation

Topic 21. Exchange substances and energy Research functioning cycletricarbons acids

General patterns of metabolism; catabolic , anabolic and amphibolic ways of metabolism. Exergonic and endergonic biochemical reactions; the role of ATP and others macroergic phosphates in conjugated processes, what flow with release and stockpiling energy Stages catabolism biomolecules in body

Contentful section 7. Metabolism carbohydrates and its regulation

Topic 22. Research features digestion carbohydrates Biosynthesis and catabolism glycogen Transformation other monosaccharides in glucose

General characteristic carbohydrates as components food a person General characteristics of carbohydrate digestion. Enzymes, biochemical mechanisms digestion of food carbohydrates in separate departments of the alimentary canal. Violation digestion of individual carbohydrates in the intestines. Hereditary enzymopathies of deficiency disaccharidase intestines Clinical and biochemical diagnosis intolerance lactose, sucrose. Cleavage and biosynthesis of glycogen: enzymatic reactions glycogenesis and glycogenolysis ; cascading mechanisms cAMP -dependent regulations activities glycogen phosphorylase and glycogen synthase . Hormonal regulation exchange glycogen in muscles and liver Concept glycogen diseases: glycogenosis and aglycogenoses .

Metabolic pathway and enzymatic reactions of fructose conversion in the body a person Hereditary enzymopathy are related with genetic defects synthesis enzymes metabolism fructose: intolerance fructose, fructosemia _Metabolic way and enzymatic reactions transformation galactose in body a person Hereditary enzymopathy , are related with genetic defects synthesis enzymes galactose metabolism: galactosemia .

Topic 23. Study of anaerobic oxidation of glucose. Glucose biosynthesis - gluconeogenesis .

Paths intracellular catabolism carbohydrates Anaerobic oxidation glucose – glycolysis: enzymatic reactions glycolysis, energy, regulation Glycolytic redox , substratum phosphorylation in glycolysis Deposit works Embden and Meyerhof in installation sequence enzymatic reactions glycolysis (lactic acid fermentation). Alcoholic fermentation. Biosynthesis glucose – gluconeogenesis : physiological value, enzymatic reactions, regulatory enzymes Substrates gluconeogenesis . Glucose - lactate cycle (cycle Corey).

Topic 24. Research aerobic oxidation glucose Pentose phosphate way glucose conversion.

Stages aerobic oxidation glucose, oxidizing decarboxylation pyruvate, Multi-enzyme pyruvate dehydrogenase complex – features functioning with the participation of three enzymes and five coenzymes. Comparative characteristic bioenergy aerobic and anaerobic oxidation glucose Effects Pasteur and Crabtree . Features regulations glycolysis To the shuttle mechanisms oxidation glycolytic SUPERIOR Malate-aspartate and glycerol phosphate shunts transport restorative equivalents glycolytic SUPERIOR in mitochondria in aerobic conditions Pentose phosphate way (PFSH) oxidation glucose: scheme, biological value, features functioning in different fabrics Sequence of enzymatic reactions of PFSH, oxidation stage and the stage of isomeric transformations of pentose, hexose and heptose phosphates . Value PFSH as donor NADPH in restorative synthesis fatty acids and steroids, as supplier ribose-5-phosphate for formation nucleotides in synthesis nucleic acids Violation pentose phosphate way in erythrocytes: enzymopathy glucose-6-phosphate dehydrogenase.

Contentful section 8. Metabolism lipids and his regulation

Topic 25. Structure and functions cell membranes.

Functions biomembrane . lipids, squirrels and carbohydrates biomembrane . Molecular organization biomembrane . Fluidity and viscosity lipid phases biomembrane , personalty lipids and proteins biomembrane . Asymmetry membrane structures. Mechanism active transport of substances through membranes.

Topic 26. Research features digestion lipids Violation digestion lipids and transport in of blood exogenous lipids

General characteristic lipids as components food a person and their energy value _ Need body in lipids Features digestion lipids enzymes, biochemical mechanisms digestion food lipids in individual departments May channel Mechanism digestion triacylglycerols , phospholipids and cholesterol Mechanisms absorption products hydrolysis triacylglycerols , phospholipids and cholesterol Structure, features and role bile acids indigestion lipids and absorption products their hydrolysis Enterohepatic circulation of bile acids . The mechanism of resynthesis of triacylglycerols and cholesterol in intestines Transport exogenous lipids in of blood Concept chylomicrons and lipoproteins very low density Violation digestion of lipids and transport of exogenous lipids in the blood: steatorrhea , hyperchylomicronemia . **Topic 27. Research exchange fatty acids and ketones bodies Beta-oxidation fatty acids Biosynthesis and biotransformation cholesterol .**

Ways of lipid metabolism. Adipocytes of adipose tissue and their role in the exchange lipids and bioenergetic processes in the body. Catabolism of triacylglycerols : reactions; mechanisms regulations activity triglyceride lipase . Neurohumoral regulation of lipolysis with the participation of adrenaline, norepinephrine , glucagon , insulin. Oxidation fatty acids (beta oxidation): activation fatty acids, role carnitine in transport fatty acids in mitochondria, sequence enzymatic reactions. Energetics of beta-oxidation of fatty acids. Oxidation glycerol . Ketones bodies Reactions biosynthesis and disposal ketones bodies their physiological value. Metabolism of ketone bodies under pathological conditions. Mechanisms excessive growth content ketones bodies at sugar diabetes and starvation Cholesterol biosynthesis : metabolic precursors; reaction sequence diagram. Regulation synthesis cholesterol . Transport cholesterol in of blood Paths biotransformation cholesterol : esterification; formation bile acids, steroid hormones, vitamin D3; excretion cholesterol with body Gallstone disease. Atherosclerosis: mechanisms of development, role of lipoproteins high and low density in development atherosclerosis.

Topic 28. Research biosynthesis fatty acids, triacylglycerols and phosphoglycerides . Violation lipid exchange: adiposity and fatty infiltration liver

Biosynthesis higher fatty acids, metabolic sources Biosynthesis saturated fatty acids (palmitate): synthesis of malonyl-CoA , acyl -transporting protein, sources NADPH, necessary for biosynthesis fatty acids, enzymatic reactions Regulation of the biosynthesis process at the level of acetyl - CoA carboxylase and on levels of fatty acid synthetase . Elongation of saturated fatty acids. Formation mono - and polyunsaturated fatty acids in body a person Biosynthesis triacylglycerols . Biosynthesis phosphoglycerides . Violation lipid exchange: adiposity and fatty liver infiltration.

Content section 9. Metabolism of amino acids. Amino acid enzymopathies exchange

Topic 29. Research chemical composition stomach juice Features digestion proteins

The role of proteins in human nutrition. The completeness of protein nutrition. Syndrome kwashiorkor as a manifestation of protein starvation. The concept of nitrogen balance and his varieties Features digestion proteins in stomach and intestines Proteolytic enzymes (pepsin, trypsin, chymotrypsin , elastase , carboxypeptidases , dipeptidases), mechanism their activation and actions Concept exopeptidase and endopeptidase . Chemical composition of gastric juice. Normal and pathological components of gastric juice. Types of acidity of gastric juice and their definition. Decay of proteins in the large intestine: formation of phenol, cresol and indole

Topic 30. Research transformations amino acids (transamination , demining, decarboxylation).

Ways of formation and maintenance of the pool of free amino acids in the human body. General

ways of conversion of free amino acids. Deamination of amino acids. Mechanism indirect demining L-amino acids. Transamination amino acids: reactions; biochemical value; mechanism actions aminotransferase. Glucose- alanine cycle. Decarboxylation amino acids: enzymes, physiological value. Formation of physiologically active compounds - biogenic amines (gamma- aminobutyric acids histamine , serotonin, dopamine ,norepinephrine , adrenaline) in tissues . Oxidation biogenic amines

Topic 31. Study of ammonia detoxification processes and urea biosynthesis. Paths formation ammonia Toxicity ammonia and mechanisms his neutralization Features neutralization ammonia in nervous fabric Transport ammonia (glutamine, asparagine, alanine). Biosynthesis urea: enzymatic reactions, genetic defects of urea synthesis enzymes.

Topic 32. Specialized ways exchange individual amino acids. Biosynthesis creatine Violation of amino acid metabolism.

general ways metabolism nitrogen-free skeleton amino acids in body a person Glucogenic and ketogenic amino acids. Specialized ways of exchange acyclic amino acids. Exchange of glycine and serine ; the role of tetrahydrofolate (H⁴- folate) in transfer one-carbon fragments, inhibitors dihydrofolate reductase as antitumor means Exchange sulphur-containing amino acids; reactions methylation . Homocystinuria as hereditary violation exchange sulphur-containing amino acids. Formation creatine and creatinine, clinical and biochemical value violations exchange creatine and creatinine Glutathione , his role in transport amino acids and detoxification organic peroxides Features exchange amino acids with branched chains; participation coenzyme forms vitamin B12 in metabolism of amino acids. Exchange arginine; biological role of nitric oxide, NO- synthase Specialized pathways of cyclic amino acid phenylalanine metabolism and tyrosine, sequence enzymatic reactions Hereditary enzymopathy exchange cyclic acyclic amino acids phenylalanine and tyrosine - phenylketonuria , alkaptonuria , albinism. Exchange tryptophan: kynurenine and serotonin ways

SECTION 3. MOLECULAR BIOLOGY. BIOCHEMISTRY INTERCELLULAR COMMUNICATIONS. BIOCHEMISTRY OF TISSUES AND PHYSIOLOGICAL FUNCTIONS.

Contentful section 10. Foundations molecular of biology

Topic 33. Study of biosynthesis and catabolism of purines nucleotides. Definition final products their exchange.

Biochemical functions nucleotides. Components nucleotides and nucleosides . Minors nitrogenous foundations and nucleotides. free nucleotides and their biochemical functions: participation in metabolic reactions (ATP, NAD, NADP, FAD, FMN, CTP, UTP) and their regulation (cyclic nucleotides - 3',5'-AMP, 3',5'-HMF). Biosynthesis of purines nucleotides; Scheme of IMF synthesis reactions; formation of AMP, HMF, ATP, GTP. Regulation biosynthesis purines nucleotides by principle negative reverse connection (retroinhibition). Biosynthesis deoxyribonucleotides . Formation thymidyl nucleotides; inhibitors biosynthesis dTMP as antitumor agents (structural analogues of dTMP , derivatives of pterin). Catabolism purine nucleotides; Hereditary disorders of uric acid metabolism. Clinical- biochemical characteristic hyperuricemia , gout, syndrome Lesha-Nikhan .

Topic 34. Research on the metabolism of pyrimidine nucleotides. Research composition nucleic acids.

Biosynthesis pyrimidines nucleotides: reactions; regulation Orotaciduria as violation biosynthesis pyrimidines nucleotides. Nucleic acids: structure, properties, historical stages study. Features structures and expression of the genome of eukaryotes. Molecular organization of DNA of eukaryotes (exons , introns ; sequences, what repeated). Nuclear chromatin and chromosomes eukaryotes; karyotype a person Primary structure nucleic acids, polarity polynucleotides, features primary structures DNA and RNA. Structure, properties and biological functions of DNA. Experimental proof of genetic roles DNA (phenomenon transformation). Molecular mass, dimensions and nucleotide composition of DNA molecules of viruses, prokaryotes and eukaryotes. The secondary structure of DNA, the role of hydrogen bonds in its formation (Chargaf rules, Watson-Crick model), antiparallelism chains Tertiary structure DNA. Physico-chemical properties DNA: interaction with cationic ligands; hypochromic effect; denaturation and renaturation of DNA. Structure, properties and biological functions RNA. Types RNA: mRNA , tRNA , rRNA ; features structural organization

(secondary, tertiary) different types RNA. Molecular organization nuclear chromatin and ribosomes eukaryotic cells Chromatin: nucleosomal organization, histones and non-histone proteins. Ribosomes: subunit structure, protein composition and RNA.

Topic 35. Research replication DNA. Analysis mechanisms mutations and reparations DNA.

Biological significance of DNA replication. Essence discovery of J. Watson and F. Crick (1953). Semi-conservative mechanism replication; scheme experiment M. Meselson and F. Stal . General scheme of DNA biosynthesis. Enzymes of replication DNA in prokaryotes and eukaryotes Molecular mechanisms replication DNA: topological problems (topoisomerases , helicases); value antiparallelism DNA chains; Okazaki fragments . Stages of synthesis of subsidiaries chains of molecules DNA. General scheme of transcription; coding and non-coding strands of DNA. RNA-polymerases of prokaryotes and eukaryotes. Stages and enzymes RNA synthesis. Signals transcription: promoter , initiator , terminator regions of the genome . Processing - post-transcriptional modification of RNA. Antibiotics are transcription inhibitors. Regulation expression genes eukaryotes on levels transcriptions; system transcriptional signals - promoter sequences, enhancers , attenuators, silencers . Covalent modification of histones and non-histone proteins as one of mechanisms control expression genes Mutations: genomic , chromosomal, genes (point); role in arising enzymopathies and hereditary diseases a person Biochemical mechanisms actions chemical mutagens - analogues nitrogenous basics, demining , alkylating agents, ultraviolet and ionizing radiation. Biological value and mechanisms reparations DNA. Reparation UV-induced gene mutations; xeroderma pigmentosum. Amplification of genes (metallothionein genes , dihydrofolate reductase). Lantsiugova polymerase reaction; her biomedical application in the diagnosis of human viral and hereditary diseases, identification individuals (DNA diagnostics). Genna engineering, or technology recombinant DNA: general concepts, biomedical significance. Technology of gene transplantation and obtaining hybrid DNA molecules; application of restrictive measures endonuclease . Gene cloning for the purpose of obtaining biotechnological medicines and diagnostic centers (hormones, enzymes, antibiotics, interferons and etc.).

Topic 36. Transcription RNA. Biosynthesis squirrel in ribosomes Stages and mechanism broadcasting, broadcasting regulation. Antibiotics - transcription inhibitors and broadcasting

Genetic (biological) code; triplet structure code, his properties Genetic code table. Ribosomal protein synthesizing system. Components protein -synthesizing system of ribosomes. Transport RNAs and amino acid activation. Aminoacyl-tRNA synthetases . Stages and mechanisms of translation: initiation, elongation, termination _ Initiating and terminating codons mRNA ; role protein factors ribosomes in broadcasting Post-transmission modification peptide chains Broadcast regulation. Molecular mechanisms of translation control on an example globin biosynthesis . Influence of physiologically active compounds on translation processes. Antibiotics – inhibitors broadcasting, their biomedical application. Biochemical mechanisms antivirus actions interferons. Locking biosynthesis squirrel diphtheria toxin (ADP- ribosylation factors broadcasting). Regulation expression genes prokaryotes: scheme regulations by F. Jacob and J. Mono . Building lac -operon E. Coli : structural and control genes; promoter, operator; regulatory gene and formation of protein repressors . Principles of functioning of the Lac operon : repression, induction.

Content section 11. Molecular mechanisms of hormone action on target cells and hormonal biochemistry regulations

Topic 37. Study of molecular and cellular mechanisms of action of hormones on target cells. Hormones of the pituitary gland and hypothalamus.

Hormones and others bioregulators in system intercellular integration functions body human their chemical nature, classes hormones: protein-peptide hormones; hormones - derivatives of amino acids; steroid hormones; bioregulators - derivatives arachidonic acid acid Synthesis and secretion hormones Cycle hormonal secretion in the human body. Circulatory transport of hormones. targets hormonal actions; types reactions cells on action hormones Receptors hormones: membrane (ionotropic , metabotropic) and cytosolic receptors Biochemical systems intracellular transduction hormonal

signals Molecular and cellular mechanisms of action of protein-peptide and biogenic hormones amines
Cascading systems transfers chemical signal bioregulator : receptors → G-proteins → secondary messengers → protein kinases .

messengers functions cyclical nucleotides, systems Ca^{2+} calmodulin , phosphoinositides . Serine , threonine and tyrosine protein kinases and effectors cell functions. Hormones of the hypothalamic-pituitary system. Liberins and statins hypothalamus Hormones front particles pituitary gland Group "hormone growth (somatotropin) - prolactin - chorionic somatomammotropin "; pathological processes, are related with violation functions STG, somatomedins , prolactin A group of glycoproteins - tropic hormones of the pituitary gland (thyrotropin , gonadotropins - FSH, LH, chorionic gonadotropin). Family proopiomelanocortin (POMK) products processing POMC (adrenocorticotropin , lipotropins , endorphins). Hormones back particles pituitary gland Vasopressin (antidiuretic hormone); pathology, connected with violation products of ADH. Oxytocin .

Topic 38. Research actions hormones pancreatic glands and gastric intestinal tract Mechanism violations exchange substances at sugar diabetes

Pancreatic hormones. Insulin - structure, biosynthesis and secretion; impact on exchange carbohydrates, lipids, amino acids and proteins Growth stimulants effects insulin; growth factors and oncoproteins . Glucagon . Sugar diabetes; insulin dependent and insulin -independent forms; clinical and biochemical characteristics. Digestive hormones channel Gastrin . Cholecystokinin . secretin

Topic 39. Hormonal regulation equal glucose in of blood Construction sugar curves Adrenal hormones.

Glucosemia : normal state and his violation (hyper -, hypoglycemia and glycosuria). Sugar diabetes; insulin dependent and insulin independent forms; clinical and biochemical characteristics and diagnostic criteria of diabetes mellitus - glucose tolerant test, double sugary load. Biogenic amines with hormonal and mediator properties: structure, biosynthesis, physiological effects, biochemical mechanisms actions Catecholamines - adrenalin, norepinephrine . Steroids hormones: nomenclature, classification. Scheme genesis steroid hormones from cholesterol . Steroid hormones of the adrenal cortex (C₂₁-steroids) - cortisol , corticosterone , aldosterone Physiological and biochemical effects corticosteroids. Glucocorticoids ; the role of cortisol in the regulation of gluconeogenesis ; anti-inflammatory properties glucocorticoids . Disease Itsenko-Cushing . Mineralocorticoids ; role aldosterone in regulations water-salt exchange; aldosteronism .

Topic 40. Hormonal regulation exchange calcium Research iodine in thyroid gland Physiologically active eicosanoids .

Distribution of Ca^{2+} in the body; molecular forms of calcium in human blood plasma. Role bone fabrics, thin intestines and kidney in homeostasis calcium Parathyroid hormone – structure, mechanism of hypercalcemic action. Calcitriol : biosynthesis; influence on the absorption of Ca^{2+} and phosphates in the intestines. Calcitonin - structure, influence on exchange calcium and phosphates Clinical and biochemical characteristic violations calcium homeostasis (rickets, osteoporosis). Hormones thyroid glands Structure and biosynthesis thyroid hormones Biological effects T₄ and T₃ . Pathology thyroid gland; features of disorders of metabolic processes under conditions of hyper - and hypothyroidism. Eicosanoids : general characteristics, nomenclature. Biosynthesis prostanoids , thromboxanes , leukotrienes . Biological and pharmacological properties of eicosanoids , their clinical application. Aspirin and other non-steroidal anti-inflammatory means as synthesis inhibitors prostaglandins .

Topic 41. Steroids hormones sexual glands Hormonal regulation biochemical transformations of substances during nutrition. Regulation of metabolism during starvation.

Steroids hormones sexual glands Women's sexual hormones: estrogens - estradiol, estrone (C₁₈-steroids), progesterone (C₂₁-steroids); physiological and biochemical effects; regulation synthesis and secretions Men's sexual hormones (androgens) - testosterone, dihydrotestosterone (C₁₉-steroids); physiological and biochemical effects, regulation of synthesis and secretion. Clinical application of analogues and antagonists hormones sexual glands Regulation exchange substances at normal rhythm of nutrition. Peculiarities of metabolism during starvation. Concept genetically modified organisms, their role in biochemistry food and are possible consequences of their use.

Topic 42. Interconnection of all kinds exchange substances and his regulation

The main ones principles control metabolism Generation energy in process metabolic ways Generation restorative equivalents. Construction builder blocks for processes biosynthesis. Role acetyl CoA in integration exchange carbohydrates, lipids, proteins Mechanism formation final product – water in exchange carbohydrates, lipids, proteins Role vitamins in exchange carbohydrates, lipids, proteins General scheme catabolism carbohydrates, lipids, proteins Association anabolic and catabolic stages of transformations of carbohydrates, lipids, proteins. Influence hormones on all types of metabolism.

Contentful section 12. Biochemistry and pathobiochemistry of blood

Topic 43. Research of the chemical composition and acid-base state of blood. Definition residual blood nitrogen.

Physiological and biochemical functions of blood Squirrels plasma of blood and their clinical biochemical characteristic; factions proteins of blood Components systems non-specific resistance body and test squirrels "sharp phases" inflammatory processes – (C-reactive protein, α 2-macroglobulin, α 1-proteinase inhibitor, fibronectin , cryoglobulin , etc). Enzymes plasma blood; value in Enzymodiagnosis of diseases of internal organs. Kallikrein-kinin system. Non-protein (nitrogenous and nonnitrogenous) organic compounds of blood plasma. Inorganic components plasma Classes lipoproteins plasma blood: chemical storage; apoproteins . Quantitative and qualitative changes in blood lipoproteins during their circulation in of blood and cells Clinical and biochemical characteristic primary and secondary lipoproteinemia according to the WHO classification. Principles of laboratory diagnostics dyslipoproteinemia .

The acid-base state of the human body. Mechanisms of regulation and support acid-base status: buffer systems blood function lungs and kidney Hormonal mechanisms regulations Indicators acid-base state what are being investigated in clinic Violation acid-base status: metabolic alkalosis and acidosis, respiratory alkalosis and acidosis, their mechanisms occurrence

Topic 44. Research collapsible , anticoagulation and fibrinolytic systems of blood

Functional and biochemical characteristics systems hemostasis in body a person; coagulation and vascular and thrombocytic hemostasis

Wrapping system blood; characteristic individual components (factors) folding Mechanisms of activation and functioning of the cascade coagulation system blood; internal and external ways of coagulation. The role of vitamin K in reactions coagulation (carboxylation glutamine acid in \square -carboxyglutamine acid, role in calcium binding). Medicines are agonists and antagonists vitamin K. Hereditary violation process folding of blood Anti-coagulant system of blood Functional characteristic heparin, antithrombin III, lemon acids prostacyclin . Changes biochemical indicators of blood at long introductions heparin Fibrinolytic system blood: stages and components fibrinolysis. Medicinal means, what affect on processes fibrinolysis. Plasminogen activators and inhibitors plasmin

Topic 45. Research chemical composition erythrocytes Normal and pathological forms hemoglobins . Research final products catabolism heme Pathobiochemistry of jaundice.

Respiratory function of erythrocytes. Hemoglobin: structure, properties, mechanisms participation in the transport of oxygen and carbon dioxide. Variants of human hemoglobins ; molecular disorders of the structure of hemoglobins (hemoglobinosis) - hemoglobinopathies , thalassemia .

Porphyrins: structure; biosynthesis reactions of protoporphyrin IX; formation of heme. Regulation synthesis porphyrins. Hereditary violation exchange porphyrins (enzymopathies): erythropoietic porphyria , hepatic porphyria , neurological violation, photodermatitis .

Catabolism hemoglobin: gap tetrapyrrole rings heme, decay verdoglobin , transformation biliverdin on bilirubin, formation bilirubin- diglucuronide , excretion in bile. Pathobiochemistry jaundice; hemolytic (prehepatic), parenchymatous (hepatic), obturational (posthepatic). Enzymatic, hereditary jaundice.

Contentful section 13. Tissue biochemistry and organs.

Topic 46. Liver biochemistry. Microsomal oxidation, cytochromes P-450. Homeostatic role liver in exchange substances holistic body Biochemical functions of hepatocytes.

Carbohydrate (glycogenous), lipid -regulating , protein, urea-forming, pigmented, bile -forming functions liver; Detoxifying function liver; biotransformation xenobiotics and endogenous toxins

Types reactions biotransformation chemical compounds in liver Reactions microsomal oxidation; inductors and inhibitors microsomalmonooxygenase . Reactions conjugation in hepatocytes: biochemical mechanisms, functional value.

Electronic transport chains endoplasmic reticulum . Genetic polymorphism and inducibility synthesis cytochromes R - 450. Occurrence and nature development tolerance to medical means Chemical carcinogenesis .

Topic 47. Study of types of biological oxidation . The role of fat-soluble vitamins in the functioning of tissues and organs.

Interrelationship of processes of formation and consumption of energy in tissues and organs. Energy chemical connections as basic kind energy, what is used cells for software their life activities Reactions biological oxidation: types reactions (dehydrogenase , oxidase , oxygenase) and theirs biological significance. Enzymes of biological oxidation: pyridine-, flavin -dependent dehydrogenase , cytochromes. Molecular organization mitochondrial and microsomal chains biological oxidation. General characteristic fat soluble vitamins as components food a person Fat soluble vitamins A, D, E, K, F. Their biological properties, role in metabolism, manifestations deficiencies and hypervitaminosis. Bioantioxidant properties of fat-soluble vitamins Using vitamin drugs in prevention and treatment diseases

Topic 48. Study of normals and pathological components of urine. Functions kidney Physico-chemical characteristics urine Biochemical storage urine a person in norms and by conditions pathological processes. Clinical and diagnostic value analysis composition of urine

Topic 49. Biochemistry of connective tissue fabrics

General characteristic morphology and biochemical composition connecting fabrics Biochemical structure intercellular substances loose fibrous connecting fabrics: fibers (collagen, reticular, elastic); main amorphous substance. Squirrels fibers connecting fabrics: collagens , elastin, glycoproteins and proteoglycans . Biosynthesis collagen and formation fibrillar structures. Complicated carbohydrate the main amorphous matrix of connective tissue – glycosaminoglycans(mucopolysaccharides). Mechanisms participation molecules glycosaminoglycans (hyaluronic acids chondroitin -, dermatan -, keratan sulfates) in construction main substances of loose fibrous connective tissue. The distribution of different glycosaminoglycans in bodies and fabrics a person Pathobiochemistry connecting fabrics Biochemical mechanisms of occurrence of mucopolysaccharidoses and collagenoses .

Topic 50. Nervous biochemistry fabrics

Peculiarities of the biochemical composition and metabolism of nervous tissue. Chemical storage main brain Features amino acid composition brain; role systems glutamine acid Energetic exchange in to the main brain human the meaning of aerobic oxidation glucose Violation exchange mediators and modulators main brain at mental disorders Neurochemical mechanisms actions psychotropic means (neuroleptics, antidepressants, anxiolytics , nootropics).

3. Structure educational disciplines

Name content modules, topics	of hours between species works			
	Auditorium			Independent
	In total	Lectures	Practical	
Section 1. Biologically important classes bioorganic compounds . Biopolymers and their structural components				

<i>Contentful section 1. Theoretical foundations structures and reactionary ability bioorganic compounds .</i>				
Topic 1. Classification, nomenclature and isomerism bioorganic compounds . Classification of chemical reactions. Reactivity of alkanes, alkenes , arenes . Nature chemical bond.	7	1	3	3
Topic 2. Classification, nomenclature and isomerism bioorganic compounds . Nature chemical bond.	6	-	3	3
Topic 3. Reactionary ability alcohols, phenols, amines	6	-	3	3
Topic 4. Building and chemical properties aldehydes, ketones	7	1	3	3
Topic 5. Structure, properties and biological significance carbon acid and their functional derivatives	7	1	3	3
Topic 6. Higher fatty acids. Lipids. Phospholipids.	7	1	3	3
Topic 7. building, reactionary ability and biological value heterofunctional compounds (α -, β -, γ -hydroxy acid , keto acids and phenoacids).	6	-	3	3
<i>Contentful section 2. Structure and biological functions carbohydrates</i>				
Topic 8. Carbohydrates Building and chemical properties monosaccharides.	7	1	3	3
Topic 9. Structure and functions of disaccharides and polysaccharides.	7	1	3	3
<i>Contentful section 3. Biologically are active heterocyclic compounds</i>				
Topic 10. Classification, structure and value biologically important heterocyclic compounds .	7	1	3	3
Topic 11. Structure and biochemical functions nucleosides and nucleotides.	6	-	3	3
Topic 12. Building and biological role nucleic acids	6	-	3	3
<i>Contentful section 4. α-Amino acids. Peptides. Squirrels</i>				
Topic thirteen. Amino acid storage proteins and peptides Structural organization proteins	5	-	2	3
Topic 14. Physico-chemical properties proteins Reactions sedimentation proteins Denaturation.	6	1	2	3
<i>Together for chapter 1</i>	90	8	40	42
Section 2. general regularities metabolism Metabolism carbohydrates, lipids, proteins and its regulation.				
<i>Contentful section 5. Role enzymes and vitamins in exchange substances</i>				
Topic 15. Subject and tasks of biochemistry. Studying the structure and physical and chemical properties of enzymes. proteins Quantitative definition squirrel biuret method Evidence protein the nature of enzymes.	8	1	3	4
Topic 16. Study structures and physical and chemical properties proteins	7	-	3	4
Topic 17. Determination of enzyme activity, research kinetics enzymatic catalysis and influence activators and inhibitors.	8	1	3	4

Topic 18. Research roles cofactors and coenzyme forms vitamins in catalytic activity enzymes Research participation vitamins and coenzyme forms vitamins in different biochemical processes.	9	2	3	4
<i>Contentful section 6. Exchange substances and energy.</i>				
Topic 19. Research oxidative phosphorylation and synthesis ATP, inhibitors and disconnectors oxidative phosphorylation. Exchange substances and energy Research functioning cycle tricarboxylic acids	9	2	3	4
<i>Contentful section 7. Metabolism carbohydrates and its regulation</i>				
Topic 20. Study of the peculiarities of digestion carbohydrates Glycogen biosynthesis and catabolism. Transformation other monosaccharides into glucose.	8	1	3	4
Topic 21. Study of anaerobic oxidation glucose Glucose biosynthesis - gluconeogenesis . Research on aerobic oxidation of glucose.	8	1	3	4
Topic 22. Research aerobic oxidation glucose Pentose phosphate way transformation glucose	7	-	3	4
<i>Contentful section 8. Metabolism lipids and his regulation</i>				
Topic 23. Structure and functions cell membranes. Research features digestion lipids Violation digestion lipids and transport in of blood exogenous lipids	9	2	3	4
Topic 24. Research exchange fatty acids and ketones bodies Beta oxidation fatty acids Biosynthesis and biotransformation cholesterol . Research biosynthesis fatty acids, triacylglycerols and phosphoglycerides . Violation lipid exchange: adiposity and fatty infiltration liver	9	2	3	4
<i>Contentful section 9. Metabolism amino acids. Enzymopathies amino acid exchange</i>				
Topic 25. Research chemical composition stomach juice Features digestion proteins Study of amino acid transformations (transamination , deamination, decarboxylation). Research of ammonia detoxification processes and biosynthesis urea Specialized ways of exchange of individual amino acids. Biosynthesis creatine Violation exchange amino acids.	8	4	2	2
<i>Together for section 2</i>	90	16	32	42
Section 3. Molecular biology. Biochemistry intercellular communications Biochemistry fabrics and physiological functions.				
<i>Contentful section 10. Foundations molecular of biology</i>				
Topic 26. Research biosynthesis and catabolism purine nucleotides . Determination of end products their exchange.	7	-	3	4
Topic 27. Research metabolism pyrimidines nucleotides. Research composition nucleic acids	6	-	3	3
Topic 28. Study of DNA replication. Analysis mechanisms mutations and DNA repair. Transcription RNA. Biosynthesis squirrel in ribosomes Stages and mechanism of translation, regulation broadcasting Antibiotics - inhibitors transcription and broadcasting	7	-	3	4

Contentful section 11. Molecular mechanisms actions hormones on target cells and biochemistryhormonal regulations				
Topic 29 . Molecular and cellular studies mechanisms actions hormones on target cells. Hormones hypophysis and hypothalamus Research actions hormones pancreatic glands and gastrointestinal tract Mechanism violations exchange substances at sugar diabetes	6	-	3	3
Topic 30 . Hormonal regulation equal glucose in of blood Construction sugar curves Hormones adrenal glands Hormonal regulation exchange calcium Research iodine in thyroid gland Physiologically are active eicosanoids	5	-	3	2
Topic 31. Steroids hormones sexual glands Hormonal regulation biochemical transformations substances at nutrition Regulation exchange substances at starvation Interconnection everyone species exchange substances andhis regulation	5	-	3	2
Contentful section 12. Biochemistry and pathobiochemistry of blood				
Topic 32 . Research chemical composition and acidic the main state of blood Definition residual nitrogen of blood Research collapsible , anticoagulation and fibrinolytic blood systems	6	-	3	3
Topic 33 . Study of the chemical composition of erythrocytes. Normal and pathological forms hemoglobins . Research final products catabolism heme Pathobiochemistry jaundice	6	-	3	3
Contentful section thirteen. Tissue biochemistry and organs.				
Topic 34 . Biochemistry liver Microsomal oxidation, cytochromes R-450. Research types biological oxidation _ The role of fat-soluble vitamins in the functioning of tissues and bodies Research normal and pathological components urine	5	-	3	2
Topic 35 . Biochemistry connecting fabrics	5	-	3	2
Topic 36 _ Biochemistry nervous fabrics	4	-	2	2
Together for section 3	60	-	32	28
Together, for all sections of the discipline	240	24	104	112

4. Topics lectures

No s/p	Name topics	K-t Mr
important classes of bioorganic compounds . Biopolymers and theirstructural components		
1	Classification, nomenclature and isomerism of bioorganic compounds . The nature of chemical bonding. Classification of chemical reactions. Reactionary ability of alkanes, alkenes , arenes . Reactivity of alcohols, phenols, amines Building and chemical properties aldehydes, ketones	2
2	Structure, properties and biological value carbon acid and their functional derivatives. Higher fatty acids. Lipids. Phospholipids. Structure, reactivity and biological significance heterofunctional compounds (α -, β -, γ -hydroxy acid , keto acids and phenoacids).	2

3	Carbohydrates Building and chemical properties monosaccharides. Structure and functions disaccharides and polysaccharides. Classification, structure and value biologically important heterocyclic compounds . Structure and biochemical functions of nucleosides and nucleotides. Building and biological role nucleic acids.	2
4	Amino acid composition of proteins and peptides. Structural organization proteins Physico-chemical properties proteins Reactions sedimentation proteins Denaturation.	2
Together for chapter 1		8
Principles of metabolism. Metabolism of carbohydrates, lipids, proteins and its regulation.		
5	Study of the structure and physical and chemical properties of enzymes. Definition activity enzymes, research enzymatic kinetics catalysis and influence activators and inhibitors.	2
6	Research roles cofactors and coenzyme forms vitamins in the catalytic activity of enzymes. Study of participation of vitamins and coenzyme forms vitamins in different biochemical processes.	2
7	Research of oxidative phosphorylation and ATP synthesis, inhibitors and disconnector oxidative phosphorylation. Exchange substances and energy Research functioning cycle tricarboxylic acids	2
8	Study of the peculiarities of digestion of carbohydrates. Biosynthesis and glycogen catabolism. Conversion of other monosaccharides into glucose. Study of anaerobic oxidation of glucose. Glucose biosynthesis - gluconeogenesis . Research aerobic oxidation glucose Pentose phosphate way transformation glucose	2
9	Structure and functions cellular membranes Research features digestion of lipids. Violation of lipid digestion and transport in the blood exogenous lipids	2
10	Study of the metabolism of fatty acids and ketone bodies. Beta oxidation fatty acids Biosynthesis and biotransformation cholesterol . Research on the biosynthesis of fatty acids, triacylglycerols and phosphoglycerides . Violation lipid exchange: adiposity and fatty infiltration liver	2
11	Study of the chemical composition of gastric juice. Features digestion of proteins. Study of amino acid transformations (transamination , deamination, decarboxylation).	2
12	Process research detoxification ammonia and biosynthesis urea Specialized ways exchange individual amino acids. Biosynthesis creatine Violation exchange amino acids.	2
Together for section 2		16
TOGETHER		24

5. Topics seminary classes – not provided by the program

6. Topics practical classes

No s/p	Name topics	Number hours
Section 1. Biologically important classes of bioorganic compounds . Biopolymers and their structural components		
1	Classification, nomenclature and isomerism bioorganic compounds .	3
2	The nature of chemical bonding. Classification of chemical reactions. Reactivity alkanes, alkenes , arenes .	3

3	Reactivity of alcohols, phenols, amines.	3
4	Structure and chemical properties aldehydes, ketones.	3
5	Structure, properties and biological significance of carboxylic acids and their functional derivatives..	3
6	Higher fatty acids. Lipids. Phospholipids	3
7	Structure, reactivity and biological significance heterofunctional compounds (α -, β -, γ -hydroxy acid, keto acids and phenoacids).	3
8	Carbohydrates Building and chemical properties monosaccharides.	3
9	Structure and functions disaccharides and polysaccharides.	3
10	Classification, structure and significance of biologically important heterocyclic compounds.	3
11	Structure and biochemical functions nucleosides and nucleotides.	3
12	Building and biological role nucleic acids	3
13	Amino acid storage proteins and peptides Structural organization proteins	2
14	Physico-chemical properties proteins Reactions sedimentation proteins Denaturation.	2
Together for chapter 1		40
Section 2. general regularities metabolism Metabolism carbohydrates, lipids, proteins and its regulation.		
15	CONTROL day off equal of knowledge Subject and tasks biochemistry. Study of the structure and physical and chemical properties of proteins. Quantitative definitions squirrel biuret method Evidence protein the nature of enzymes.	3
16	Study structures and physical and chemical properties enzymes	3
17	Definition activity enzymes, research enzymatic kinetics catalysis and influence activators and inhibitors.	3
18	Research roles cofactors and coenzyme forms vitamins in the catalytic activity of enzymes. Study of participation of vitamins and coenzyme forms vitamins in different biochemical processes.	3
19	Research of oxidative phosphorylation and ATP synthesis, inhibitors and disconnectors oxidative phosphorylation. Exchange substances and energy Research functioning cycle tricarboxylic acids	3
20	Study of the peculiarities of digestion of carbohydrates. Biosynthesis and catabolism glycogen Transformation others monosaccharides in glucose	3
21	Study of anaerobic oxidation of glucose. Glucose biosynthesis - gluconeogenesis	3
22	Research on aerobic oxidation of glucose. Pentose phosphate pathway transformation glucose	3
23	Structure and functions of cell membranes. Study of features digestion lipids Violation digestion lipids and transport in of blood exogenous lipids	3
24	Study of the metabolism of fatty acids and ketone bodies. Beta oxidation fatty acids. Biosynthesis and biotransformation cholesterol. Research biosynthesis fatty acids, triacylglycerols and phosphoglycerides. Violation lipid exchange: adiposity and fatty infiltration liver	3
25	Study of the chemical composition of gastric juice. Peculiarities of digestion proteins Study of amino acid transformations (transamination, deamination, decarboxylation). Study of detoxification processes ammonia and biosynthesis urea Specialized ways exchange individual amino acids. Biosynthesis creatine Violation exchange amino acids.	2
Together for section 2		32

Section 3. Molecular biology. Biochemistry intercellular communications Tissue biochemistry and physiological functions.		
23	Research biosynthesis and catabolism purines nucleotides. Definition final products their exchange	3
24	Research metabolism pyrimidines nucleotides. Research composition nucleic acids	3
25	Research replication DNA. Analysis mechanisms mutations and reparations DNA. Transcription RNA. Biosynthesis squirrel in ribosomes Stages and mechanism of translation, regulation of translation. Antibiotics are inhibitors transcription and broadcasting	3
26	Study of the molecular and cellular mechanisms of the action of hormones on cells-targets Hormones of the pituitary gland and hypothalamus. Study of the action of hormones pancreatic glands and gastrointestinal tract. Mechanism violations exchange substances at sugar diabetes	3
27	Hormonal regulation of blood glucose level. Construction of sugar mills curves Adrenal hormones. Hormonal regulation of metabolism calcium Research iodine in thyroid gland Physiologically are active eicosanoids .	3
28	Steroids hormones sexual glands Hormonal regulation biochemical transformations of substances during nutrition. Regulation of metabolism at starvation Interconnection everyone species exchange substances and his regulation	3
29	Research of the chemical composition and acid-base state of blood. Definition residual nitrogen of blood Research collapsible , anticoagulation and fibrinolytic systems of blood	3
30	Research chemical composition erythrocytes Normal and pathological forms of hemoglobins . Research of end products of heme catabolism. Pathobiochemistry jaundice	3
31	Liver biochemistry. Microsomal oxidation, cytochromes P-450. Study of types of biological oxidation . The role of fat-soluble vitamins in functioning fabrics and bodies Research normal and pathological components urine	3
32	Biochemistry connecting fabrics	3
33	Biochemistry nervous fabrics	2
Together for section 3		32
TOGETHER		104

7. Topics laboratory classes – not provided for program

8. Topics for independent classes

No s/p	Name topics	Numberhours
Section 1. Biologically important classes of bioorganic compounds . Biopolymers and their structural components		
1	Classification, nomenclature and isomerism bioorganic compounds . Nature chemical connection	3
2	Classification, nomenclature and isomerism bioorganic compounds . Nature chemical connection	3
3	Reactionary ability alcohols, phenols, amines	3
4	Building and chemical properties aldehydes, ketones	3
5	Structure, properties and biological significance of carboxylic acids and their functional derivatives.	3

6	Higher fat acid Lipids. Phospholipids.	3
7	building, reactionary ability and biological value heterofunctional compounds (α -, β -, γ -hydroxy acids, keto acids, etc phenoacids).	3
8	Carbohydrates Building and chemical properties monosaccharides.	3
9	Structure and functions disaccharides and polysaccharides.	3
10	Classification, structure and meaning of biologically important heterocyclic compounds .	3
11	Structure and biochemical functions nucleosides and nucleotides.	3
12	Building and biological role nucleic acids	3
thirteen	Amino acid composition of proteins and peptides. Structural organization proteins	3
14	Physicochemical properties of proteins. Protein precipitation reactions. Denaturation.	3
Together for chapter 1		42
Principles of metabolism. Metabolism of carbohydrates, lipids, proteins and its regulation.		
15	Control of the initial level of knowledge. The subject and problems of biochemistry. Study structure and physicochemical properties of proteins. Quantitative definition squirrel biuret method. Evidence protein nature enzymes	4
16	Study of the role of cofactors and coenzyme forms of vitamins catalytic activity enzymes	4
17	Research on the participation of vitamins and coenzyme forms of vitamins in different biochemical processes.	4
18	Research oxidative phosphorylation and synthesis ATP, inhibitors and disconnectors oxidative phosphorylation.	4
19	Exchange substances and energy Research functioning cycle tricarboxylic acids	4
20	Research features digestion carbohydrates Biosynthesis and catabolism glycogen Transformation others monosaccharides in glucose	4
21	Research anaerobic oxidation glucose Biosynthesis glucose – gluconeogenesis .	4
22	Research aerobic oxidation glucose Pentose phosphate way transformation glucose	4
23	Structure and functions cellular membranes	4
24	Study of the peculiarities of digestion of lipids. Indigestion lipids and transport in the blood of exogenous lipids.	4
25	Research exchange fatty acids and ketone bodies Beta oxidation fatty acids Biosynthesis and biotransformation cholesterol .	2
26	Research on the biosynthesis of fatty acids, triacylglycerols and phosphoglycerides . Violation lipid exchange: adiposity and fatty infiltration liver	2
27	Research chemical composition stomach juice Features digestion proteins	2
28	Study of amino acid transformations (transamination , deamination, decarboxylation).	2
29	Research processes detoxification ammonia and biosynthesis urea	2
30	. Specialized ways exchange individual amino acids. Biosynthesis creatine Violation exchange amino acids.	2

Together for section 2		42
Section 3. Molecular biology. Biochemistry intercellular communications Tissue biochemistry and physiological functions.		
33	Research biosynthesis and catabolism purines nucleotides. Definition final products their exchange	2
34	Research metabolism pyrimidines nucleotides. Research composition nucleic acids	2
35	Research replication DNA. Analysis mechanisms mutations and reparations DNA.	2
36	Transcription RNA. Biosynthesis squirrel in ribosomes Stages and mechanism broadcasting, broadcasting regulation. Antibiotics are inhibitors transcription and broadcasting	2
37	Research molecular and cellular mechanisms actions hormones on target cells. Hormones hypophysis and hypothalamus	1
38	Study of the effects of pancreatic and gastric hormones intestinal tract Mechanism violations metabolism at sugar diabetes	1
39	Hormonal regulation equal glucose in of blood Construction of sugar mills curves Hormones adrenal glands	1
40	Hormonal regulation exchange calcium Research iodine in thyroid gland Physiologically are active eicosanoids .	1
41	Steroid hormones of the gonads. Hormonal regulation of biochemical transformations substances at nutrition Regulation exchange substances at starvation	1
42	Interconnection everyone types of exchange substances and his regulation	1
43	Research chemical composition and acid-base state of blood Definition residual nitrogen of blood	2
44	Research collapsible , anticoagulation and fibrinolytic systems of blood	2
45	Study of the chemical composition of erythrocytes. Normal and pathological forms hemoglobins .. Pathobiochemistry jaundice	2
46	Biochemistry liver Microsomal oxidation, cytochromes R-450.	2
47	Research types biological oxidation _ Role fat soluble vitamins in functioning fabrics and bodies	2
48	Research normal and pathological components urine	2
49	Biochemistry connecting fabrics	1
50	Biochemistry nervous fabrics	1
Together for section 3		28
TOGETHER		120

9. Individual tasks are not foreseen by the program

10. Teaching methods

According to the sources of knowledge, teaching methods are used: verbal - story, explanation, lecture, instruction; visual - demonstration, illustration; practical - practical work, problem solving. According to the nature of the logic of knowledge, methods are used: analytical, synthetic, analytical-synthetic, inductive, deductive. According to the level of independent mental activity, the following methods are used: problem-based, searching, research.

1. Verbal methods: lecture, conversation;
 2. Visual methods: illustration, demonstration
 3. Practical methods: performing practical work and solving situational tasks to develop skills and abilities;
 4. Students' independent work on understanding and assimilation of new material
 5. Use of control and educational computer programs
 6. Innovative teaching methods: business game, case method.
- The types of training according to the curriculum are: lectures; practical training; independent work of students.

11. Control methods

Current control is carried out on the basis of control theoretical knowledge, practical skills and abilities.

Forms of current control are: *in the* dream survey (frontal, individual, combined), interview; practical verification of professional skills (conducted based on the results of practical work at the end of the class); test control ("open" and "closed" test tasks).

Current control is mandatory. During the evaluation of mastering of each topic from all disciplines of the curriculum for the current educational activity, the student is given grades on a 4-point (traditional scale) taking into account the approved evaluation criteria for the discipline. All types of work provided by the curriculum are taken into account. The student must receive a grade in each topic. The teacher conducts a survey of each student in the group at each lesson and assigns a grade in the journal of attendance and student performance according to the traditional scale ("5", "4", "3", "2").

When evaluating the student's current educational activity, 20% of the grade is the student's independent work, which takes into account the knowledge of the topic of independent study and the performance of work in the notebook.

The final (summary) control of the sections is carried out at the end of the section in the form of a written test, which includes test tasks from the "Step-1" bank, theoretical questions and control of practical skills (solving situational problems, defining and describing macro- and micropreparations, etc.) .

Such methods of control as oral, written and test are used, which should contribute to increasing the motivation of students-future specialists for educational and cognitive activities. According to the specifics of professional training, preference is given to test and written control. In the case of final control, preference is given to written or test control.

12. Form of final control of study success .

The final control of the discipline is carried out on the basis of theoretical control knowledge, practical skills and abilities.

Assessment is a form of final control, which consists in assessing the student's learning of the learning material based solely on the results of his performance of certain types of work in practical, seminar or laboratory classes. Semester assessment of subjects is carried out after the end of its study, before the beginning of the examination session.

An exam (differential assessment) is a form of final control of a student's assimilation of theoretical and practical material from an educational discipline.

13. Scheme of accrual and distribution of points received by students.

The maximum number of points for a discipline is 200 points. The ratio between the results of the evaluation of the current educational activity and the final control of knowledge is 60% and 40%.

The first and second semesters of studying the discipline end with a credit.

The maximum number of points that a student can score for the current educational activity while studying the discipline is 200 points, *the minimum number of points* - the minimum number of points - is 120 points.

The calculation of the number of points is carried out on the basis of the grades received by the student on a 4-point (national) scale during the study of the discipline, by calculating the arithmetic mean, rounded to two decimal places.

The student receives a credit in the last lesson of the discipline based on the results of the current assessment.

Only those students who do not have academic debt and whose average score for the current academic activity in the academic discipline is at least 3.00 are admitted to the credit.

The average grade for the current activity is converted into points on a 200-point scale, according to the conversion table (Table 1).

Table 1.
Recalculation of the average grade for the current activity into a multi-point scale (for disciplines ending with 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	4.44	178	3.92	157	3.39	136
4.94	198	4.42	177	3.89	156	3.37	135
4.92	197	4.39	176	3.87	155	3.34	134
4.89	196	4.37	175	3.84	154	3.32	133
4.87	195	4.34	174	3.82	153	3.29	132
4.84	194	4.32	173	3.79	152	3.27	131
4.82	193	4.29	172	3.77	151	3.24	130
4.79	192	4.27	171	3.74	150	3.22	129
4.77	191	4.24	170	3.72	149	3.19	128
4.74	190	4.22	169	3.69	148	3.17	127
4.72	189	4.19	168	3.67	147	3.14	126
4.69	188	4.17	167	3.64	146	3.12	125
4.67	187	4.14	166	3.62	145	3.09	124
4.64	186	4.12	165	3.59	144	3.07	123
4.62	185	4.09	164	3.57	143	3.04	122
4.59	184	4.07	163	3.54	142	3.02	121
4.57	183	4.04	162	3.52	141	3	120
4.54	182	4.02	161	3.49	140	< 3	70-119 (refolding)
4.52	181	4.00	160	3.47	139		
4.49	180	3.97	159	3.44	138		

The learning result is also evaluated on a two-point scale (passed/failed).

Table 2
The scale of transferring points to the national system

According to the national system	On a 200-point scale
counted	from 120 to 200 points
not counted	less than 119 points

Students' independent work, which is provided for by the topic of the lesson along with

classroom work, is evaluated during the current control of the topic in the corresponding lesson.

The third semester (the last semester of studying the discipline) ends with a final control in the form of an exam.

Only those students who do not have academic debt (all missed classes have been completed) and whose average score for the current educational activity in the academic discipline is at least "3" are admitted to the exam.

The maximum number of points that a student can score for the current educational activity for admission to the exam is 120 points and is defined as the sum of the arithmetic average of all grades received in the semester.

The minimum number of points that a student must score for the current educational activity for admission to the exam is 72 points. Recalculation of the average grade for the current academic performance (on a 120-point scale) in the table. 3.

Table 3.

Recalculation of the average grade for the current academic performance in a multi-point scale for disciplines ending with an exam

4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale
5	120	4.29	103	3.58	86
4.96	119	4.25	102	3.54	85
4.92	118	4.21	101	3.50	84
4.87	117	4.17	100	3.46	83
4.83	116	4.12	99	3.42	82
4.79	115	4.08	98	3.37	81
4.75	114	4.04	97	3.33	80
4.71	113	4.00	96	3.29	79
4.67	112	3.96	95	3.25	78
4.62	111	3.92	94	3.21	77
4.58	110	3.87	93	3.17	76
4.54	109	3.83	92	3.12	75
4.50	108	3.79	91	3.08	74
4.46	107	3.75	90	3.04	73
4.42	106	3.71	89	3	72
4.37	105	3.67	88	Less than 3	Not enough
4.33	104	3.62	87		

The maximum number of points that a student can score when taking the exam is 80 (the minimum number is at least 50).

Discipline assessment is defined comprehensively as the sum of points for the current educational activity and points for the exam.

From the allocated 120 points for the current educational activity, 4 to 12 additional points are allocated for the assessment of individual independent work of higher education applicants, according to the work curriculum. Encouragement points are added to the final grade for the discipline at the end of its study.

Points with disciplines for students, which successfully completed the program are converted into the national scale and **ECTS system** (Table 4, 5).

Table 4.

Discipline points	Evaluation on a 4-point scale
From 180 to 200 points	5
From 150 to 179 points	4

From 149 points to the minimum number of points that the student must score	3
Below the minimum number of points that the student must score	2

Table 5

Scale assessment: national and ECTS

The sum of points for teaching activities	Rating for ECTS	Rating by national scale	
		for exam, difzalik	for offset
180-200	A	perfectly	counted
160-179	B	okay	
150-159	C		
130-149	D	satisfactorily	
120-129	E		
50-119	FX	unsatisfactorily with the possibility of refolding	counted with possibility rearrangement
0-49	F	unsatisfactorily with mandatory repeated studying the discipline	not counted with mandatory repeated study disciplines

14. Methodological support

1. Working curriculum of the discipline;
2. Plans of lectures, practical classes and independent work of students;
3. Abstracts of lectures on the discipline;
4. Methodical instructions for practical classes for students;
5. Methodical materials that ensure independent work of students;
6. Test and control tasks for practical classes;
7. List of exam questions

15. Recommended literature

The main one literature

1. Biological and bioorganic chemistry: in 2 books: textbook. Kn . 2. Biological chemistry / Yu.I. Gubskiy, I.V. Nizhenkovska , M.M. Korda and others; under the editorship Yu.I. Gubsky, I.V. Nizhenkovskaya - 3rd edition.– K.: VSV "Medicine", 2021. - 544 p.
2. Biological and bioorganic chemistry: in 2 books: textbook. Kn . 1. Biological chemistry / B.S. Zimenkovsky , V.A. Muzychenko, I.V. Nizhenkovskaya , H.O. Raw;by ed. B.S. Zimenkovsky , I.V. Nizhenkovskaya . – 2nd kind., Ex . – K.: VSV "Medicine", 2017. – 272 p.

Auxiliary literature

1. Biochemistry: textbook / by general editorial office Prof. A.L. Zagayka , Prof. K. V. Aleksandrova – Kh.: "Fort" edition. - 2014. - 728 with.
2. Biological and bioorganic chemistry: in 2 books : textbook. Kn . 1. Bioorganic chemistry (University of the 4th year of the a.) / edited by B.S. Zimenkovsky , I.V. Nizhenkovskaya . – Ed.: VSV "Medicine". - 2014. - 272 p.

3. Gonsky Ya.I., Maksymchuk T.P., Kalinsky E. Biochemistry a person Textbook. – Ternopil: Ukrmedknyga . - 2013. – 744 with.
4. Biological and bio-organic chemistry [Text]: teach _ help _ for study _ higher _ teach _ app . / O.O. Mardashko , L. M. Myronovych, G. F. Stepanov. – AT. : Odesa honey university. - 2011. - 235 p.
5. Functional biochemistry: study guide for students . of higher Pharm . teach _ app . Level IV accreditation / A.L. Zagayko [and etc.]. - Kharkiv. : NFaU . - 2010. – 219 with.

16. Informational resource:

1. <http://guides.lib.vt.edu/oer/chemistry> - Books with chemistry
2. www.ncbi.nlm.nih.gov/PubMed - free access to the scientific database in the field biomedical of science
3. <https://pubchem.ncbi.nlm.nih.gov/> - free access to the scientific database in the field biomedical of science
4. www.biochemistry.org.ua - the official website of the Institute of Biochemistry named after O.V. Paladin National Academy of Sciences of Ukraine.
5. www.bpci.kiev.ua - the official website of the Institute of Bioorganic Chemistry and Petrochemistry National Academy of Sciences of Ukraine.
6. <https://ojs.tdmu.edu.ua/index.php/ijmr> - International Journal of Medicine and Medical Research
7. <https://ojs.tdmu.edu.ua/index.php/bmb> - Herald medical and biological of research