MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal state autonomous educational institution
of higher education
«Far Eastern Federal University»
(FEFU)

SCHOOL OF BIOMEDICINE

«AGREED»
Head of education program
«General medicine»
_____ Khotimchenko Yu.S._____
(signature) (Full name)
«09» of July 2019

«APPROVED»
Director of the Department of Clinical Medicine
_____ Geltser B.I._____
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«09» of July 2019

WORKING PROGRAM OF ACADEMIC DISCIPLINE (WPAD)
«Biochemistry»
Educational program
Specialty 31.05.01 «General medicine»
Form of study: full time

year 2 semester 3,4
lectures 36 hours
practical classes 72 hours
laboratory works 36 hours
total amount of in-classroom work 144 hours
independent self-work 72 hours
including exam preparation 36 hours
control works ()
credit with rating 3 semester
exam 2 year, 4 semester

The working program is drawn up in accordance with the requirements of the Federal state educational standard of higher education (level of training), approved by the order of the Ministry of education and science of the Russian Federation from 09.02.2016 № 95.

The working program of the discipline was discussed at the meeting of the Department of fundamental and clinical medicine. Protocol No. 8, 09 of July 2019

Author: PhD Dobrzhanskaya A.V.

Annotation

The discipline " Biochemistry "is designed for students enrolled in the educational program of higher education 31.05.01" General Medicine", is included in the basic part of the curriculum, implemented in the 2nd year in the 3rd and 4th semesters. The total complexity of the discipline is 252 hours, 7 credits, 36 hours of lectures, practical classes-72 hours, laboratory classes-36 hours, independent work of students-72 hours, including 36 hours to prepare for the exam.

In the development of the working program of the discipline used the Federal state educational standard of higher education in the specialty 31.05.01 " General Medicine " (level of training specialty).

Modern biochemistry is an extensive field of knowledge, including a number of sections. The most important of them are Bioorganic chemistry, dynamic biochemistry, molecular biology, functional biochemistry. Formed as an independent industry and medical biochemistry, including all of the above sections, and not only in the part that is relevant to human health and disease. Medical biochemistry studies the molecular basis of human physiological functions, molecular mechanisms of pathogenesis of diseases (molecular pathology), the biochemical basis of the prevention and treatment of disease, biochemical diagnostics of diseases and monitoring the effectiveness of treatment. Biological chemistry together with such medical and biological disciplines as biology and General genetics, normal human anatomy, histology, normal physiology forms students ' knowledge about the structure and functioning of a healthy body, and together with pathophysiology, pathological anatomy and pharmacology-knowledge about the essence of common pathological processes and the most common diseases, the mechanisms of action of drugs.

Knowledge of biochemistry is fundamental in the education of the doctor, serve as the basis for the study of subsequent theoretical disciplines and the formation of clinical thinking of the doctor in the medical departments.

The discipline "Biochemistry" is logically and meaningfully connected with such courses as General and inorganic chemistry, physiology, histology, biology.

The course program is based on the basic medical knowledge gained by students:

ability to abstract thinking, analysis, synthesis (GC-1);

the willingness to solve common tasks of professional activity with the use of information and bibliographic resources , biomedical terminology , information and communication technologies , taking into account the main requirements for information security (GPC-1);

the readiness to use basic physical and chemical, mathematical and other natural science concepts and methods in solving professional problems (GPC-7);

Goals and objectives of the discipline:

The goal is to provide the students with knowledge about the chemical essence of the phenomena of life, to learn to apply when studying of the subsequent disciplines and professional activities the knowledge on the chemical composition and biochemical processes in the human body, as about the characteristics of norms and the signs of disease.

Tasks:

- formation of knowledge about the molecular organization and molecular mechanisms of functioning of the living.

- formation of the ability to apply knowledge about the chemical composition and biochemical processes as characteristics of the norm or signs of the disease in the study of subsequent disciplines and in practical work.

- formation of initial practical skills in biochemical diagnostic Informatics and Analytics, knowledge of the principles of basic clinical and biochemical analyses, mastery of rapid methods of biochemical analysis, the ability to choose adequate research methods and interpret the results.

For the successful study of the discipline "Biochemistry" students should be formed the following preliminary competence:

- have the ability and willingness to analyze the patterns of functioning of individual organs and systems, to use the knowledge of anatomical and physiological bases, the basic methods of clinical and immunological examination

and evaluation of the functional state of the organism of an adult and a teenager for the timely diagnosis of diseases and pathological processes;

- have the ability and willingness to form a systematic approach to the analysis of medical information, based on the comprehensive principles of evidence-based medicine, based on the search for solutions using theoretical knowledge and practical skills to improve professional performance.

As a result of studying this discipline the following General cultural/ General professional/ professional competences are formed: as a result of studying this discipline the following General professional competences are formed:

Code and concept of competence	**Steps of competence evolution**	
the readiness to use basic physical and chemical, mathematical and other natural science concepts and methods in solving professional problems (GPC – 7)	Knows	main metabolic pathways of amino acids and proteins, carbohydrates, lipids, nucleotides and nucleic acids and the main disorder of their metabolism in the human body.
	Is able	evaluate the relevance's of various biochemical parameters for blood and urine analysis under certain pathological conditions (diabetes mellitus, pathology of the liver, kidneys, heart)
	Is skilled	skills for solving biochemical and professional problems.
the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	Knows	principles of biochemical analysis and clinical biochemical laboratory diagnostic of diseases
	Is able	uses measuring equipment while performing biochemical studies
	Is skilled	skills of making a preliminary diagnosis based on the results of patients laboratory study

The following active methods are used to form the above competences within the discipline "Biochemistry": practical exercises in the form discussions and brainstorming.

I. STRUCTURE AND CONTENT OF THEORETICAL PART OF THE COURSE

(36 hours, 10 hours of them in the form of active training).

Section I. Static Biochemistry (20 hours).

Topic 1. Biochemistry among the biological sciences, its importance for a doctor (1 hour) – open talk lecture.

The Biological Chemistry subject. Biochemistry among other biological disciplines. Biochemistry as a molecular ground of living things studying. Distinctive features of living organisms –compounds and energy metabolism with the environment, the ability to reproduce itself, a high level of structural organization. The main sections of Biochemistry: static, dynamic and functional biochemistry. Biochemistry and Medicine.

Topic 2. Chemical nature of amino acids. Proteins structure and their function (3 hours).

Amino acids chemical nature and their classification according with physical chemical properties. Biological role of proteinogenic and non-proteinogenic amino acids not only as structural units of proteins. Physical chemical properties of proteins: solubility, ionization, hydration, precipitation, reversible changing of their structure, ability to chemical modification amino acid residues within protein (phosphorylation, methylation, sulfation, etc). Levels of protein structural organization: primary, secondary, tertiary and quaternary structures, subunits and domains, chemical basis of those structures (disulfide, ionic, hydrogen, hydrophobic bonds). Classification of proteins: simple and complex, globular and fibrillar, monomeric and oligomeric in connection with their biological role an examples hemoglobin and actin-myosin complex. Denaturation and renaturation an examples heat shock protein family and insulin renaturation process. Protein functions: structural (collagen), catalytic (hemoglobin), transport (denein), receptor, regulatory (G proteins family), protective, contractile (myosin).

Topic 3. Enzymes. Vitamins (4 hours).

Enzymes as biological catalysts (2 hours).

Enzymes as biological catalysts by protein and nucleotide natures and their biological significant. The physical reasons of enzymes catalysis: entapy and entropy of living system, energy of activation, Stick model of enzymes activity.

Multistage enzyme reaction: successive stages of catalysis, induced state, active, binding and regulation sites of enzymes and their role in enzyme working. Condition for enzymes activating: cofactors and coenzymes, environmental condition (pH, temperature), proteolysis (zymogens). Reaction and substrate specificity. Absolute and relative specificity. Allosteric regulation. Michaelis-Menten equation and constant. Quantitative determination of enzyme activity (by the loss of the substrate and by the increase of the product), the ways of its expression. Inhibition of enzyme activity: reversible, irreversible, competitive, noncompetitive. Positive and negative feedback as a regulator enzymes catalytic process. Enzymes classification: International Classification of Enzymes. General characteristics of the main classes of enzymes: oxidoreductase, transferase, hydrolase, lyase, isomerase, ligase (synthetase). The systematic and trivial name of the enzyme. Isozymes.

Vitamins (2 hours).

Vitamins as coenzymes. Sources of vitamins. Fat-soluble vitamins, characteristics of individual vitamins: chemical structure, sources of input into the body, daily need, biological role and mechanisms for its implementation, biochemical and clinical consequences of insufficiency and excess in the body. Water-soluble vitamins, characteristics of individual vitamins: chemical structure, sources of input into the body, daily need, biological role and mechanisms for its implementation, biochemical and clinical consequences of insufficiency and excess in the body.

Topic 4. Carbohydrates (4 hours).

Monosaccharides and disaccharides their chemical structure and properties: aldoses and ketoses sugars, line and cycle structure, stereoisomers, enantiomers and epimers, α and β cycle configuration, hemiacetal and hemikatal reaction as a reason to go a cycle structure and glycosidic bond formation. Glycosidic bond configuration, monosaccharides and disaccharides chemical nomenclature. Sugars derivates according by substitutes of hydroxyl group, their biological role. Polysaccharides structure: homo- and heteropolysaccharides, brunch and unbrunch.

Biological role according with polysaccharides structure: structural (bacterial cell wall), storage (starch and glycogen), extracellular matrix (heparin, hyaluronate). Glycoconjugates: proteoglicans, glycoproteins and glycolipids. Oligosaccharides as a part of glycoconjugates. Trisaccharide bridge, O-linked and N-linked bond, S domain, NA domain as a base for signaling function of glycoconjugates (syndican). Four types of protein interaction with S domains in signaling pathway. Covalent oligosaccharides attaching with protein (aggrecan). Lectin protein family as protein which read sugar code and mediate many biological process. Blood groups characteristic based on erythrocytes receptors.

Topic 5. Nucleotides and nucleic acids (2 hours)

Nucleic acids structure: pyrimidine and purine basics, sugars, phosphodiester bond, structural functional units – nucleoside. Biological role of nucleosides: energy currency (ATP), essential component of cell response to hormones, component of coenzymes and repositories of genetic information. DNA and RNA are features of similarity and differences in composition, primary structure, cell localization, function. The secondary structure of DNA: A form, B form, Z form. Stabilization forces of the DNA secondary structure. Unusual structures: palindroms and mirror repeats, hairpins and cruciforms. Antiparallel DNA structure, replication of DNA. Superspiralizationas as regulatory factor of DNA working. Denaturation and renaturation of DNA. Hybridization of DNA-DNA, DNA-RNA. Nonenzymatic DNA transformation. Methylation of DNA as a regulatory factor of their activity. New scientific field is epigenetic. RNA structure and function: single-stranded, secondary structure, helical structure, loops and hairpins. Types of RNA, their structure and function: mRNA, tRNA, rRNA, their distribution in the cell and the biological role. Ribozymes – nucleotide based type of enzymes. Newly approaches in genetic science - crispr/cas9, methods of gene redaction.

Topic 6. Lipids (2 hours).

Fatty acids are lipids structural units of the storage lipids: chemical and physical properties, their biological consequences, principles of classification, essential fatty acids. Triacylglycerols: structure, biological functions, localization in the body.

Phospholipids are structural lipids in cell membrane, their biological role, basic principles of structure, physical chemical properties. Sterols: chemical structure, biological functions, principles of classification. Lipids as a signals, cofactors and pigments.

Topic 7. Biological membranes and transport. Biosignaling (4 hours)

Biological membranes and transport (2 hours).

Composition and architecture of membranes. Membranes protein and lipid interrelation, lipid bilayer. Membranes protein: peripheral and integral proteins. Membrane Dynamics: flip-flop diffusion, laterally diffusion, microdomains, membrane fusion. Solute transport across membranes: passive transport by permeases (carriers, channels and uniports), primary active transport, secondary active trancport. Membrane pump is organized electrochemical gradient. Glucose transport into erythrocytes cells. Defective glucose and water transport in two forms of diabetes. Water transport, aquaporin transmembrane protein family.

Biosignaling (2 hours).

Molecular mechanisms of signal transduction. Four futures of signal-transducing: specificity, amplification by enzymes cascades, desensitization and integration. Six general types of signal trancducers: gate ion channels (transmembrane potential), receptor enzymes (insulin receptor), receptor proteins (G-proteins), nuclear receptors (steroid receptors, an example estrogen), receptors attracts and activate cytoplasmic enzymes (gene regulators), adhesion receptors (integrins).

Section II. Dynamic Biochemistry (12 hours).

Topic 1. Metabolism and bioenergetics (2 hours) – open talk lecture.

Catabolism and anabolism as energy-related processes. The structure and functioning of mitochondrial membranes. Mitochondrial processes of release and use of energy. Mechanisms of oxidative and substrate phosphorylation. Reactive oxygen species and oxidative stress. Krebs cycle. The organization of the mitochondrial respiratory chain.

Topic 2. Carbohydrate metabolism (2 hours).

Digestion, absorption and interconversion of carbohydrates, enzymes involved in their process. Glycogen synthesis, breakdown and mobilization. Glycolysis and glyconeogenesis: steps, energy output, enzymes. Pentose phosphate pathway of glucose oxidation. Mhetabolism of glycogen in animals: coordinated regulation of glycolysis and glyconeogenesis, synthesis and breakdowns. Pathologies in absorption and exchanging of carbohydrates. Diabetes.

Topic 3. Fatty acid catabolism and lipid biosynthesis (2 hour).

Fats daily needs, the main food sources. Fats digestion and absorption. The breakdown and synthesis of fatty acids. Oxidation of fatty acids. Keton bodies. Synthesis of fatty acids, eicosanoids, triacylglycerols, phospholipids, steroids, cholesterol and isoprenoids. Pathology of lipid metabolism.

Topic 4. External and intermediate metabolism of amino acids and proteins. (2 hours) - lecture.

The body's need for proteins. Digestion and absorption of proteins. Common ways to exchange amino acids. Methabolic fates of amino groups. The exchange of individual amino acids. Nitrogen excretion and urea cycle. Pathways of amino acid degradation.

Topic 5. Biosynthesis of nucleic acids, nucleotides and related molecules (2 hour).

Overview of nitrogen metabolism. Biosynthesis of amino acids. Molecules derived from amino acids. Biosynthesis and degradation of nucleotides. Pathology exchange. Biosynthesis of chromoproteins and their breakdowns. Synthesis and degradation of heme. Porphyrias. Bilirubin. Icterus.

Topic 6. Integration and Hormonal regulation of mammalian metabolism (2 hours).

The role of hormones in the regulation of metabolism. Classification: diverse structures, diverse function. Hormonal regulation of fuel metabolism. Long term regulation of body mass. Hormones of the hypothalamus and hypophysis. Thyroid hormones. Hormones of the pancreas. The role of hormones in the regulation of water and salts (antidiuretic hormone, aldosterone).

Section III. Biochemistry of tissues and organs (4 hours).

Topic 1. Blood biochemistry (1 hour) - lecture.

General characteristics of the blood as a tissue function. Blood buffer systems. Features of the metabolism of blood cells, its importance for specialized functions. The constituent components of blood plasma. Proteins and plasma enzymes. Albumins, globulins, their characteristics and functions. Blood biochemical parameters, their use in practice.

Topic 2. Liver biochemistry (2 hour).

The role of the liver in the metabolism of carbohydrates, lipids, proteins and amino acids, vitamins, minerals. Neutralizing function of the liver. The role of microsomal oxidation in the neutralization of xenobiotics. Cytochrome P-450 hydroxylase cycle. Exchange of bilirubin. Types of Icterus. The formation and secretion of bile as a way of removing the end products of metabolism. Enteric-hepatic circulation of bile acids, a role in lipid digestion and absorption. Biochemical mechanisms of development of hepatocellular insufficiency and hepatic coma, laboratory diagnostics.

Topic 3. Biochemistry of kidneys and urine (1 hour).

The main functions of the kidneys. The mechanism of urine formation in different parts of the nephron. Characteristics of the most important components of urine in health and disease. Biochemistry of the kidneys and water-electrolyte metabolism.

I. STRUCTURE AND SUBGECTS OF PRACTICAL PART OF COURSE

Practical training (72 hours, including 6 hours of active training).

Class 1. Introduction into biochemistry (4 hours) - seminar.

Discussion: subject and aims of biochemistry. Biochemistry methods. A brief history of the development of biochemistry as a science. Checking residual knowledge of organic chemistry. Introduction into the structure of the biochemistry practice. Rules and safety principals in the laboratory. Chemical glassware and equipment.

Class 2. The structure and function of amino acids and proteins (4 hours).

1. Main furthest of amino acids structure and peptides structure.

2. Structure and function of simple proteins.

Class 3. The final lesson in the section "Proteins, amino acids" (4 hours).

1. Structure, physical and chemical properties and classification of amino acids.

2. Biological functions.

3. Methods of separation and identification.

4. Peptide bond. The primary structure of proteins.

5. Connection of primary structure and spatial conformation.

6. Methods of decoding the primary structure.

7. Secondary protein structures. Fibrous proteins. Collagen.

8. The tertiary conformation of proteins. Types of bonds, their stabilizing.

9. Quaternary conformation.

10. Relationship of the native structure and the biological activity of proteins. Chaperones and prions.

11. Protein solutions - like colloidal systems.

12. Salting out.

13. Denaturation.

14. Isoelectric focusing.

15. Preparative and differential centrifugation.

16. Chromatography.

17. Electrophoresis.

18. Biologically active peptides.

19. Simple proteins. Albumen. Histones

20. Examples of proteins of different composition and conformation. Collagen. Hemoglobin, myoglobin.

Class 4. Enzymes (4 hours).

1. Enzymes as biocatalysts.

2. Classification and nomenclature of enzymes.

3. Structure and function of enzymes.

4. Molecular mechanisms of enzymatic catalysis.

5. Enzymopathology.

6. Enzymodiagnostics and enzyme therapy.

Class 5. Vitamins (4 hours).

1. Ideas about vitamins, their classification.

2. Water soluble vitamins.

3. Fat-soluble vitamins.

4. Coenzyme, antioxidant and prohormonal functions of vitamins.

Class 6. The final lesson in the section "Enzymes, vitamins". (4 hours)

1. The concept of enzymes as biological catalysts.

2. Enzymes, structural organization and function.

3. Simple and complex enzymes.

4. The biochemical function of vitamins, their role in the regulation of metabolism.

5. Coenzyme forms of water-soluble vitamins, their role in metabolic processes.

6. The concept of the active, substrate and allosteric center of enzymes. The mechanism of action of enzymes.

7. Regulation of enzyme activity.

8. Specific and nonspecific properties of enzymes.

9. Classification and nomenclature of enzymes.

10. The use of enzymes, vitamins and coenzymes in medicine and pharmacy.

11. Enzymopathology, enzymodiagnostics and enzyme therapy. Non-Vitamin Coenzymes.

Class 7. Introduction into bioenergetics. Chemistry and carbohydrate metabolism (4 hours).

1. Catabolism and anabolism as energy-dependent processes.

2. The structure and functioning of mitochondrial membranes.

3. Mitochondrial processes of release and use of energy.

4. Mechanisms of oxidative and substrate phosphorylation.

5. Reactive oxygen species and oxidative stress.

6. Chemistry and biological role of mono - and disaccharides.

7. Chemistry and biological role of homopolysaccharides.

8. Chemistry and biological role of heteropolysaccharides.

9. Digestion, absorption and interconversion of carbohydrates.

10. Synthesis, breakdown and mobilization of glycogen.

11. Chemistry and energy of anaerobic glycolysis and glycogenolysis.

12. Chemistry and energy of aerobic glycolysis and glycogenolysis.

13. Apotomic breakdown of carbohydrates.

14. Pathologies of absorption and exchange of carbohydrates. Diabetes.

Class 8. The final lesson in the section "Chemistry and carbohydrate metabolism" (4 hours).

1. Catabolism and anabolism as energy-dependent processes.

2. The structure and functioning of mitochondrial membranes.

3. Mitochondrial processes of release and use of energy.

4. Mechanisms of oxidative and substrate phosphorylation.

5. Reactive oxygen species and oxidative stress.

6. Chemistry and the biological role of mono - and disaccharides.

7. Chemistry and the biological role of homopolysaccharides.

8. Chemistry and the biological role of heteropolysaccharides.

9. Digestion, absorption and interconversion of carbohydrates.

10. Synthesis, breakdown and mobilization of glycogen.

11. Chemistry and energy of anaerobic glycolysis and glycogenolysis.

12. Chemistry and energy of aerobic glycolysis and glycogenolysis.

13. Apotomic breakdown of carbohydrates.

14. Pathologies of absorption and exchange of carbohydrates. Diabetes.

Class 9. Chemistry and lipid metabolism (4 hours) - discussion.

1. Chemistry, biological role and classification of lipids.

2. Lipids as components of biological membranes.

3. Digestion and absorption of fats.

Class 10. The final lesson in the section "Chemistry and lipid metabolism" (4 hours).

1. Chemistry, biological role and classification of lipids.

2. Lipids as components of biological membranes.

3. Digestion and absorption of fats.

4. Breakdown and synthesis of fatty acids.

5. Synthesis of cholesterol and phospholipids.

6. Pathology of lipid metabolism.

Class 11. Exchange of simple and complex proteins (8 hours).

1. Proteins daily supplement.

2. Non-essential and essential amino acids.

3. Digestion and absorption of proteins.

4. Common pathways for the exchange of amino acids.

5. Exchange of individual amino acids.

6. Biosynthesis of proteins.

7. Biosynthesis of nucleic acids.

8. Breakdown and synthesis of nucleoproteins. Pathology exchange.

9. Biosynthesis of chromoproteins. Heme and porphyrias.

10. Breakdown of chromoproteins. Bilirubin. Icterus.

Class 12. The final lesson in the section "Exchange of simple and complex proteins" (4 hours).

1. Proteins daily supplement.

2. Digestion and absorption of proteins.

3. Common pathways for the exchange of amino acids.

4. Exchange of individual amino acids.

5. Protein biosynthesis.

6. Nucleic acids as primary information carriers for matrix biosynthesis in living organisms.

7. DNA and RNA – common features and differences, primary structure, localization in the cell, function.

8. The secondary structure of DNA. Bonds that stabilize the secondary structure of DNA.

9. Anti-parallelism. Superspiralization. Denaturation and renaturation of DNA.

10. Hybridization of DNA-DNA, DNA-RNA.

11. Features of the primary and spatial structure of histones.

12. The role of histones in the formation of nucleosomes. Nucleosomal core. Linker DNA.

13. Further DNA packaging: solenoids, loops and folds.

14. Covalent modification of histones, its role in regulating the structure and activity of chromatin.

15. RNA structure and function. mRNA, tRNA, rRNA, their distribution in the cell and the biological role.

16. Biosynthesis of nucleic acids. Breakdown and synthesis of nucleoproteins.

17. Pathology of exchange. Biosynthesis of chromoproteins. Heme and porphyrias. Chromoprotein breakdown. Bilirubin. Icterus.

Class 13. Blood biochemistry (4 hours).

1. Blood composition.

2. Biochemical features of blood cells.

3. Biochemical functions of blood and their characteristics.

Class 14. Liver biochemistry (4 hours).

1. Functions of the liver.

2. Liver dysfunction.

Class 15. The final lesson in the section "Biochemistry of blood and liver" (4 hours).

1. Blood composition.

2. Biochemical features of blood cells.

3. Biochemical functions of blood and their characteristics.

4. Functions of the liver.

5. Liver dysfunction.

Class 16. Biochemistry of the kidneys and urine. Water and mineral metabolism (4 hours).

1. The main functions of the kidneys.

2. Characteristics of the most important components of urine in health and disease.

3. Biochemistry of water-mineral metabolism.

Class 17. The final lesson in the section "Biochemistry of the kidneys and urine. Water-salt metabolism (4 hours).

1. The main functions of the kidneys.
2. Characteristics of the most important components of urine in health and disease.
3. Biochemistry of water-mineral metabolism.
4. Buffer system of blood.

Laboratory work (36 hours)

Lab 1. The ways of concentration expressions. Rules for solution preparing, pH of solution, making solution for protein preparation (2 hours).

Lab 2. Steps of protein isolation: homogenization, extraction and isolation, protocol preparing (2 hours).

Lab 3. Homogenization, extraction and isolation of proteins from rat skeletal muscle (2 hours).

Lab 4. Growing of calibration curve based on BSA. Measuring of ATPase activity if actomyosin complex (2 hours)

Lab 5. Protein purification - differential centrifugation.

Lab 6. Three ways of concentration measuring. Measuring of protein concentration in different fraction (2 hours).

Lab 7. Protein purification – ammonium sulfate salting with further fraction dialysis (2 hours)

Lab 8. Sample preparation for SDS-PAGE: sample solution, calculation of dilution (2 hours).

Lab 9. SDS-PAGE making and result analysis (2 hours).

Lab 10. Colon affinity chromatography of actomyosin complex. Result analysis (2 hours).

Lab 11. Fermentation activity of amylase. The effect of temperature on amylase activity (2 hours).

Lab 12. Specificity of amylase to sucrose breakdown. Sample Trommer (2 hours).

Lab 13. Fermentation and glycolysis enzymes (2 hours).

Lab 14. Quantitative determination of vitamins C and P. Qualitative reactions to vitamins A, D, B2 (2 hours).

Lab 15. Determination of phospholipids and cholesterols in blood serum (2 hours).

Lab 16. DNA or RNA isolation, selection with Trizol, or selection using phenolic reagent. Fractionation stages and replanting with alcohols (2 hours).

Lab 17. Nucleic acid concentrate measuring by method spectrophotometry / spectrofluoriumetria. Results analysis by native selection agarose gel electrophoresis.

Lab 18. Determination of the buffer capacity of blood (2 hours).

I.

II. TRAINING AND METHODOLOGICAL SUPPORT OF INDEPENDENT WORK OF STUDENTS

The educational and methodological support of students' independent work in the discipline "Biochemistry" is presented in Appendix 1 and includes:

- the schedule of the independent work on the discipline, including the approximate standard time to perform for each task;
- characteristics of tasks for independent work of students and methodological recommendations for their implementation;
- requirements for the presentation of independent work results;
- criteria for evaluation of independent work results.

II. EVOLUATION OF ACHIEVEMENT OF COURSE AIMS

№ I/n	Chapters / topics of discipline which under control	Code and steps of competencies formation		Evaluation approaches	
				Current control	Intermedial control
1	Chapter I. Topic: 1-3. Chapter II. Topic: 1-6.	ОПК-7 to be able to use basic physicochemical, mathematical and other natural science concepts and	Knows: the main metabolic pathways of amino acids, proteins, carbohydrates, lipids, nucleotides, nucleic acids and the main disorders of their metabolism in the	УО-1 ПР-4	Questions for the exam: 1-82.

		methods in solving professional problems	human body		
			Able to: evaluate the information content of various biochemical parameters for blood and urine analysis under certain pathological conditions (diabetes, pathology of the liver, kidneys, heart)	УО-1 ПР-4	
			Skilled: skills for solving biochemical and professional problems.	ПР-6	
2	Chapter II. Topic: 1-6. Chapter III. Topic: 1-4.	ОПК-9 ability to assess morphofunctional, physiological states and pathological processes in the human body to solve professional problems	Knows: the principles of biochemical analysis and clinical biochemical laboratory diagnosis of diseases	УО-1 ПР-4	Questions for the exam: 83-106
			Able to: use measuring equipment for biochemical studies performing	УО-1 ПР-4	
			Skilled: skills of making a preliminary diagnosis based on the results of patients laboratory examination	ПР-6	

Standard control tasks, methodological materials, determining the procedures for knowledge and skills evaluation and (or) work experience, as well as the criteria and indicators necessary for evaluating knowledge and skills, and describing the stages of formation of competences in the process of mastering an educational program, are presented in the Appendix 2.

V. LIST OF EDUCATIONAL LITERATURE, INFORMATION AND METHODICAL GROUND OF DISCIPLINE

Basic literature

1. Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

2. Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

Additional literature

1. Hermann D. Bioorganic chemistry : A chemical approach to enzyme action // New York: Springer, 3th edition. 1996. P 700.

2. Williams A. Concerted Organic and Bio-organic Mechanisms // Boca Raton, Colorado London New York: CRC Press Inc. 2000. P 286.

3. Baev A.K. Specific Intermolecular Interactions of Nitrogenated and Bioorganic Compounds // Springer Berlin Heiderberg. 2014. http://link.springer.com/openurl?genre=book&isbn=978-3-642-37472-2

LIST OF INFORMATION TECHNOLOGIES AND SOFTWARE

The location of the computer equipment on which the software is installed, the number of jobs	**List of licensed software**
Multimedia auditorium Vladivostok Russian island, Ayaks 10, building 25.1, RM. M723 Area of 80.3 m2 (Room for independent work)	Windows Seven enterprice SP3x64 Operating System Microsoft Office Professional Plus 2010 office suite that includes software for working with various types of documents (texts, spreadsheets, databases, etc.); 7Zip 9.20 - free file archiver with a high degree of data compression; ABBYY FineReader 11 - a program for optical character recognition; Adobe Acrobat XI Pro 11.0.00 - software package for creating and viewing electronic publications in PDF; WinDjView 2.0.2 - a program for recognizing and viewing files with the same format DJV and DjVu.

In order to provide special conditions for the education of persons with disabilities all buildings are equipped with ramps, elevators, lifts, specialized places equipped with toilet rooms, information and navigation support signs

VI. METHODICAL RECOMMENDATION FOR THE DISCIPLINE DEVELOPING

1. Subject matter: Introduction into biochemistry. Structure and biological functions of proteins. Amino acids. Color reactions to amino acids and protein.

2. The class aims: introduction into the rules and safety principals in the biochemical laboratory. Work with measuring glassware, dispensers, equipment. Practical skills for conducting qualitative analysis of biological fluids and solutions for the amino acids and proteins presence, based on knowledge of the principles of color reactions (biuret, xantoprotein, ninhydrin, Fol's reaction).

3. Class tasks:

1) discover with the organizational structure of a laboratory classes, methodology of laboratory classes and checking classes;

2) get the safety rules while working in chemical laboratory;

3) get the recommended list basic and additional biochemistry studying literature;

4) overview information about research methods in biochemistry;

5) refresh the structures of the main classes of organic substances of human tissues.

4. Basic concepts that should be learned by students in the process of studying the topic

Amino acids. Proteins. Metabolism. Catabolism. Anabolism.

5. Questions for the lesson

1. What organic molecules are called proteins? Characterize the elemental composition of proteins.

2. What is the role of proteins in the body?

3. What principles underlie the classification of amino acids? Give examples of classifications.

4. What amino acids are proteinogenic?

5. Do amino acids occur in the body in free form?

6. List the basic physicochemical properties of amino acids. What is the role of functional groups of amino acids?

7. What is called the radical of amino acids? Give examples and their functional role.

8. What amino acids are called essential? List essential amino acids and provide examples of their chemical structure.

9. Which amino acids are most hydrophobic? Give examples of their chemical structure.

10. Which amino acids are the most hydrophilic? Give examples of their chemical structure.

11. Name the amino acids that have an additional negative charge at pH 7.0, draw their formulas in the ionized state.

12. Name amino acids having an additional positive charge at pH 7.0, draw their formulas in ionized form.

13. How does the change in pH of the medium on the ionization of amino acids.

14. Draw the formulas for sulfur-containing amino acids.

15. Draw the cyclic amino acid formulas.

16. Draw imino acid formulas.

17. Draw examples of the chemical structure of amino acids with neutral, acidic and basic properties.

18. What is the peptide bond? Draw a peptide bond formation reaction. Show cis- and trans- conformation of the peptide bond.

19. Build a tripeptide and give it a name. Indicate its solubility and charge at pH 7.0. What pH range is its isoelectric point?

20. Name examples of amino acids used as drugs.

6. Questions for self-control

The student should know:

1. The concepts of "amino acid", "peptide", "protein".

2. The elemental composition and function of proteins in the body.

3. Basic physicochemical properties of amino acids. The role of their functional groups.

4. Classification of amino acids according to the biological role and structure of the radical (formulas of 20 essential amino acids)

5. Formation of the peptide bond underlying the construction of the peptides and the primary structure of the protein molecule. Be able to build and name a peptide.

7. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

- Williams A. Concerted Organic and Bio-organic Mechanisms // Boca Raton, Colorado London New York: CRC Press Inc. 2000. P 286.

- Baev A.K. Specific Intermolecular Interactions of Nitrogenated and Bioorganic Compounds // Springer Berlin Heiderberg. 2014. http://link.springer.com/openurl?genre=book&isbn=978-3-642-37472-2

8. Content of the practical part of the lesson (laboratory work):

The ways of concentration expressions. Rules for solution preparing, pH of solution, making solution for protein preparation.

Steps of protein isolation: homogenization, extraction and isolation, protocol preparing.

Homogenization, extraction and isolation of proteins from rat skeletal muscle (2 hours).

Subject matter: Structure and biological functions of proteins.

2. The class aims:

to form an idea about the main stages of stadying amino acid composition of proteins, overview methods for proteins isolating.

3. Class tasks:

1) study method of acid hydrolysis of proteins, as an important step studying the amino acid composition of proteins;

2) study principles of chromatographic separation of amino acids, their identification and quantitative determination.

4. Basic concepts that should be learned by students in the process of studying the topic:

- protein amino acid compositions, types of bonds stabilizing the protein structure: peptide, disulfide, hydrogen, ionic, hydrophobic.

- protein hydrolysis, chromatographic analysis: ion-exchange, adsorption, affinity chromatography, gel filtration.

5. Questions for the class:

1. Amino acid composition of proteins;

2. The main stages of the study of the amino acid composition of proteins: hydrolysis, formol titration, chromatographic analysis of protein hydrolyzate;

3. Types of protein hydrolysis;

4. The principle of formol titration;

5. Physical and chemical basics of chromatographic analysis.

6. Self-control questions:

1. The structure of simple proteins.

2. What are the functions of proteins?

3. What principle underlies the division of proteins into groups and famyles?

4. General characteristics of myosin.

5. General characteristics of hemoglobin.

6. General characteristics of G-proteins.

7. What are the main operations for protein isolating?

8. The significant of homogenization procedure?

9. The main process which take place in extraction procidure?

10. What components to preserve the native conformation of proteins while isolating process?

11. Isolation steps of skeletal muscle myofibrils.

12. Dissociation of myofibrils into thin and thick filaments.

13. Protein composition of thin and thick filaments.

7. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

- Williams A. Concerted Organic and Bio-organic Mechanisms // Boca Raton, Colorado London New York: CRC Press Inc. 2000. P 286.

- Baev A.K. Specific Intermolecular Interactions of Nitrogenated and Bioorganic Compounds // Springer Berlin Heiderberg. 2014. http://link.springer.com/openurl?genre=book&isbn=978-3-642-37472-2

8. **Laboratory work:**

Growing of calibration curve based on BSA. Measuring of ATPase activity if actomyosin complex

Protein purification - differential centrifugation.

1. Subject matter: Structure and biological functions of proteins. Amino acids, simple and complex proteins. Protein precipitation.

2. Class aims: to consolidate knowledge about the basic physicochemical properties of proteins and their applied medical significance in medical practice, about the methods used in laboratory practice for quantitative determination of proteins in biological fluids.

3. Class tasks:

- study physicochemical properties of solutions proteins and their biomedical value;

- study coloring methods protein concentration measuring, conduct measuring protein concentration by Biuret method;

- perform experiments illustrating the main physical and chemical protein properties.

4. Basic concepts that must be learned by students in the process of topic studying:

Solubility of proteins, factors determining that. Hydrate shell. Protein sedimentation reactions. Denaturation. Dehydration. Ultracentrifugation. Ionization of proteins.

5. Questions for the class:

1. Physical and chemical properties of simple proteins.

2. Classification of proteins.

3. Methods of analysis of amino acids and proteins used in medicine.

6. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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7. Laboratory work

Three ways of concentration measuring. Measuring of protein concentration in different fraction.

Protein purification – ammonium sulfate salting with further fraction dialysis (2 hours)

Sample preparation for SDS-PAGE: sample solution, calculation of dilution (2 hours).

SDS-PAGE making and result analysis.

1. Subject matter: The final lesson "PROTEIN CHEMISTRY"

2. Class aims: consolidate theoretical knowledge.

3. Class tasks: checking knowledge by written test.

4. Basic concepts to be learned by students in the process of studying the topic: all concepts of previous studies on the topic.

5. Questions for the class:

1. Proteins as a special class of polymeric high molecular organic compounds. Elementary composition of proteins. Protein content in animals and humans tissues. Protein significant in human life. The protein content in the child tissues.

2. Amino acid composition of proteins. The general structure of amino acids included in the composition of proteins. The main groups of amino acids Changes in the tissues protein composition into ontogenesis.

3. Types of bonds exist between amino acid residues in protein molecules.

4. Modern ideas about the structure of protein molecules. Primary protein structure. The dependence of the biological properties of proteins on primary structure. Species specificity of the primary structure.

5. Secondary and tertiary structures of proteins, methods for their study.

6. Quaternary protein structure. The dependence of protein biological role from the quaternary structure. Cooperative conformational changes protomers in oligomeric proteins (an example hemoglobin and myoglobin). Self-assembly of supramolecular protein structures: polyenzyme complexes; cell organelles, viruses.

7. Physical and chemical properties of proteins: molecular weight, size and forms of protein molecules, ionization, hydration, solubility, etc.

8. Reactions of protein precipitation. Denaturation of proteins. Proteins salting out. Practical application of precipitation reactions.

9. Discovery of proteins in solutions. General reactions to proteins: color and precipitation. Methods for isolating individual proteins. Definition protein content in tissues and biological fluids.

10. Classification of proteins. The main groups of simple and complex proteins. Characteristics of the main groups of simple proteins.

11. Complex proteins (proteids), their chemical composition, functions.

6. Self-control questions:

Questions which had been presented above.

7. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

- Williams A. Concerted Organic and Bio-organic Mechanisms // Boca Raton, Colorado London New York: CRC Press Inc. 2000. P 286.

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8. Laboratory work:

Colon affinity chromatography of actomyosin complex. Result analysis

1. Subject matter: Enzymes and vitamins as their cofactors.

2. Class aims: study the classification of enzymes, the characteristics of enzymatic catalysis and the practical study of their properties. Approaches for enzymes detection in tissues and biological samples.

3. Class task:

- study the general properties of enzymes,

- conduct experiments on the effect of temperature and pH on the enzymes activities.

4. Basic concepts to be learned by students in process of topic studying:

Apoferment, coenzyme, isozymes. Thermolability, photolability, pH dependence of the catalytic effect.

5. Questions for the class:

1. The concept of catalysis (energy barrier, activation energy, etc.). Role of enzymes in catalysis.

2. Structural organization of enzymes (apoenzyme, cofactor, coenzyme, holoenzyme).

3. Name the classification of cofactors and their role in catalysis.

4. Functional organization of enzymes (active, allosteric centers).

5. Stages of the enzymatic catalysis mechanism, the modern principles of the enzymes catalysis is “stick model”, principal of induced state.

6. What are the similarities and differences in the action of enzymes and inorganic (non-biological) catalysts.

7. Describe the basic properties of enzymes: specificity, thermolability, dependence of activity on the pH of the medium, etc.

8. What are the features of the kinetics of enzymatic catalysis, depending on changes in the amount of enzyme and substrate in the cell?

9. Name and characterize the ways of regulation of enzyme activity (allosteric mechanisms, covalent modification, etc.).

10. What are the types of inhibition of their features, as well as the use of enzyme inhibitors as drugs.

11. Principles of the modern nomenclature and classification of enzymes.

12. Give a general description of the enzymes of different classes, what are the main subclasses, biological role.

13. Principles of quantitative determination of enzyme activity. Specify the activity units of the enzymes.

6. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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- Hermann D. Bioorganic chemistry : A chemical approach to enzyme action // New York: Springer, 3th edition. 1996. P 700.

7. Laboratory work:

Fermentation activity of amylase. The effect of temperature on amylase activity.

1. Subject matter: Enzymes and vitamins as their cofactors.

2. Class aims: study of high-quality methods of vitamins indentification in standard solutions and foods.

3. Class task: study classification and properties of the most important vitamins.

4. Basic concepts to be learned by students in the process of topic studying: hypovitaminosis and hypervitaminosis.

5. Class questions:

1. Classification and nomenclature of vitamins.

2. Chemical structure of fat-soluble vitamins A, D3.

3. Chemical structure of vitamins K, E, F.

4. Chemical structure of water-soluble vitamins (B1, B2, B6, PP, C, H) and their biologically active (coenzyme) forms (TDF, FMN and FAD, NAD and NADF, PF).

5. Chemical structure of vitamins B12, BC, (folic acid), B3 (pantothenic acid).

6. Characteristics of individual fat-and water-soluble vitamins, their biological role and the clinical feature hipo- and hypervitaminosis, the daily need.

6. Self-preparation task:

Make a table indicating the structure, biological role and other characteristics of fat-soluble vitamins. Name the drugs containing them.

7. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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- Hermann D. Bioorganic chemistry : A chemical approach to enzyme action // New York: Springer, 3th edition. 1996. P 700.

8. Laboratory work: Quantitative determination of vitamins C and P. Qualitative reactions to vitamins A, D, B2.

1. Subject matter: The final lesson "ENZYMES, VITAMINS"

2. Class aims: the assimilation of theoretical material

3. Class tasks: checking the knowledge by written test.

4. Basic concepts to be learned by students in the process of topic studying: questions which had been presented above.

6. Class questions:

1. Enzymes - biological catalysts. Development of enzymology. Principles of isolation and purification of enzymes.

2. Preparation of enzymes in the crystalline state.

3. Modern ideas about the chemical nature of enzymes. Isozymes. Coenzymes, their connection with vitamins. Metal ions as cofactors of many enzymes. Variability of isoenzymes into ontogenesis.

4. Nomenclature and classification of enzymes. Characteristics of the main classes of enzymes.

5. The mechanism of action of enzymes. The formation of enzyme-substrate complexes. The concept of active centers, general information about their chemical structure.

6. The mechanism of action of enzymes. Complementarity of the structure of the substrate and the active center of the enzyme according modern concept of enzymes activity “stick model”. The concept of binding zones and the catalytic zone of the enzyme. The role of conformational changes in the enzyme during catalysis. The change in the structure of substrate molecules under the influence of the catalytic zone of the enzyme. Influence enzymes for activation energy and steric coefficient.

7. General properties of enzymes. High catalytic activity, specificity, the dependence of the rate of enzymatic reactions on the medium temperature and pH, the photoviability of enzymes.

8. Dependence of the rate of enzymatic reactions on the concentration of the enzyme and the substrate. The Michaelis-Menten equation. Michaelis constant. Graphic definition of the Michaelis constant.

9. Enzyme activators. The mechanism of their action.

10. Enzyme inhibitors. The mechanism of their action. Reversible, irreversible, competitive and noncompetitive inhibition. The use of activators and inhibitors as drugs.

11. Structural organization of enzymes in the cell. The functional activity of intracellular organelles. Changes in the activity of enzymes into ontogenesis.

12. Regulation of enzyme activity in the process of metabolism. Regulatory and catalytic centers. Cooperative changes in the conformation of protomers in allosteric enzyme molecules. Other ways of regulating the activity of enzymes.

13. Detection of enzymes. Units of measurement of enzymes activity and quantity.

14. Basics of clinical enzymology.

7. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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- Hermann D. Bioorganic chemistry : A chemical approach to enzyme action // New York: Springer, 3th edition. 1996. P 700.

1. Subject matter: Nucleic acid structure.

2. Class aims: study structure and functions of nucleic acids.

3. Basic concepts to be learned by students in the process of topic studying: levels of structural organization of nucleic acids. Structure and properties different types of RNA. DNA structure and properties. Denaturation and Renaturation of DNA. Hybridization of DNA-DNA and DNA-RNA.

4. Class questions:

1. What are the concepts: nucleic acid, nucleotide, nucleoside.
2. What caused the diversity of nucleotides in the composition of nucleic acids?
3. What are the features of the chemical composition of DNA nucleotides and RNA.
4. Describe the primary structure of nucleic acids, and bonds which stabilized it.
5. What are the features of the secondary structure of DNA, the type of stabilizing bond, the complementarity of the bases.
6. Specify the features of the tertiary structure of DNA, the structural organization of DNA in the chromatin of the cell nucleus.

7. Characterize the secondary and tertiary structures of RNA, its functional types (m-RNA, t-RNA, r-RNA).

8. Name the physical and chemical properties of nucleic acids.

Classes are held in an interactive form in the form of a round table. Students will be invited to discuss on a problem.

5. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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6. Laboratory work:

DNA or RNA isolation, selection with Trizol, or selection using phenolic reagent. Fractionation stages and replanting with alcohols.

Nucleic acid concentrate measuring by method spectrophotometry / spectrofluoriumetria. Results analysis by native selection agarose gel electrophoresis.

1. Subject matter: **Biological membranes.**

2. Class aims: structure of biological membranes.

3. Basic concepts that must be learned by students in the process of the topic studying: exocytosis, endocytosis, membrane transport.

4. Class questions:

1. Biological membranes, their composition and significans.

2. Membrane lipids.

3. Integral and peripheral membrane proteins, basic properties and functions of biomembranes.

4. Transmembrane transport of large molecules, endocytosis, exocytosis, their significance.

5. Liposomes, their structure and prospects for use in pharmacy and medical practice.

The lesson is conducted in an interactive form in the form of brainstorming. This is a widely used method of producing new ideas to solve scientific and practical problems. Designed for the organization of collective-mental activity to search for innovative methods of solving problems.

5. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: Introduction into bioenergetics. General characteristics of the intermediate metabolism. Biological oxidation.

2. Class aims: discuss the characteristics of rational nutrition, its main and minor components and the mechanisms of participation of vitamins in metabolism. Strengthen knowledge of the functions of biological oxidation, its various options.

3.Class tasks: study the role of oxygen in tissue respiration, participation in the oxidation of some oxidoreductases an example of catalase, cytochromeoxidase, tyrosinase.

4. Basic concepts that should be learned by students in the process of the topic studying:

Aerobic, anaerobic and heterotrophic organisms. Catabolism, macroergical metabolism. Redox reaction, cytochromes respiratory chain. Dehydrogenase, oxygenase, peroxidase.

5. Class questions:

1. Basic requirements for balanced nutrition.

2. The significans of proteins, fats, carbohydrates, vitamins and other substances in human nutrition. The chemical composition of human food. Organic and mineral components of food.

3. Positive and negative effects of excess or deficiency of carbohydrates, fats, proteins in the human diet.

4. The concept of metabolism, catabolism and anabolism.

5. The concept of cell energy metabolism.

6. ATP - universal macroergi compaumds. ATP synthesis by oxidative and substrate phosphorylation. Give examples of other macroergs.

7. General mechanisms of metabolism (catabolism and anabolism) of proteins, fats, carbohydrates. The concept of a universal metabolite.

8. The tricarboxylic acid cycle as a classic example of the general pathway of metabolism of proteins, fats, carbohydrates.

9. Describe the reactions of the tricarboxylic acid cycle (enzymes, coenzymes, features of these reactions).

10. Reactions of dehydrogenation and decarboxylation in the tricarboxylic acid cycle: features of their course, the fate of the final products.

11. Regulation of the speed and energy balance of the tricarboxylic acid cycle.

12. Biological value of the cycle. Anabolic functions of TCA.

6. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: Carbohydrates and carbohydrate metabolism.

2. Class aims: study the chemical properties of carbohydrates and the characteristics of their reactions in a living organism. Discussion of the role of carbohydrates and ways to use them in a living organism. The study of the processes of glycolysis and alcohol fermentation.

3. Basic concepts that must be learned by students in the process of the topic studying: glycolysis, glycosuria, anaerobic glycolysis.

4. Class questions:

1. Indicate the structure of the main representatives of mono-, di-, polysaccharides (ribose, glucose, fructose, galactose, maltose, lactose, sucrose, starch, glycogen, cellulose), their biological role according with the structure of starch, glycogen and pulp.

2. Describe the structure of glycosaminoglycans (mucopolysaccharides): hyaluronic, chondroitin sulfuric, neuraminic, sialic acids, heparin. What is their biologic role?

3. Name the carbohydrates entering the human body with food, as well as the daily need for carbohydrates.

4. Name the enzymes of the digestive juices involved in the digestion of carbohydrates. Ways of absorption of monosaccharides from the intestine into the blood.

5. What are the reasons for the indigestion of cellulose in the gastrointestinal tract of a person? The role of cellulose in the human diet.

6. Ways of carbohydrates penetration into the cells of tissues (the role of carriers - GLUT) and the ways of their intracellular transformation.

7. What is the value of glucose phosphorylation reactions in the cell, the localization of glucokinase and hexokinase in body tissues.

8. Describe the synthesis of glycogen and the regulation of the process of deposition.

9. What process is called glycogen mobilization? Name the regulation process.

10. Name the features of glycogen metabolism in the liver and muscles.

11. Describe the adenylate cyclase mechanism of regulation of the activity of glycogen metabolism enzymes. The role of cAMP and the effects of adrenaline, glucagon and insulin on cAMP concentration in the cell.

5. Recommended basic and additional literature

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1. Subject matter: Anaerobic transformation of carbohydrates in the cells.

2. Class aims: methods of studying glycolysis: absorption of inorganic phosphate and detection of lactic acid.

3. Basic concepts that must be learned by students in the process of the topic studying: hypoglycemia, hyperglycemia. Glycosaminoglycans, proteoglycans, phosphorolysis.

4. Class questions:

1. What are the most important ways to convert glucose in tissues? The role of glucose-6-phosphate in intracellular glucose metabolism.

2. What process is called glycolysis? Write the chemistry of the process. Specify the enzymes, as well as its localization, energy effect, the total equation.

3. Write the glycolysis reactions associated with the consumption of ATP; glycolysis reactions coupled with ATP synthesis. Describe the method of substrate phosphorylation, and its significance.

4. Specify the fate of reduced NAD formed during the oxidation of glyceraldehyde-3-fosphat. What is the significance of the cycle of glycolytic oxygen reduction?

5. What process is called glycogenolysis? Write the chemistry compounds, specify the enzymes, the total equation. Compare the energy effect of the processes: glycogenolysis and glycolysis.

6. Describe the metabolism of fructose and galactose. Name the biochemical basis of fructosuria and galactosemia.

7. Name glucose precursors in gluconeogenesis, specific reactions, reaction sequence, enzymes, gluconeogenesis localization, total equation, energy consumption for the synthesis of 1 glucose molecule.

8. What is called the glucose-lactate cycle (the Corey cycle)? Glucose-alanine cycle? What is their significance during prolonged physical work and fasting?

9. Name the regulatory enzymes of glycolysis and gluconeogenesis, their allosteric effectors and hormones affecting these processes.

5. Recommended basic and additional literature

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Laboratory work:

Fermentation and glycolysis enzymes.

1. Subject matter: Aerobic carbohydrate conversion.

2. Class aims: study the method of quantitative determination of blood glucose and plotting glycemic curves.

3. Class questions:

1. Name the paths of aerobic catabolism of glucose, specify the specific and general stages of catabolism.

2. Describe the aerobic oxidation of glucose to CO_2 and H_2O as the main catabolism of aerobic organisms. Write the process chemistry, enzymes, total equation, energy effect.

3. What are the features of anaerobic and aerobic glycolysis, switching the anaerobic pathway of carbohydrate decomposition to aerobic. What is called the Pasteur effect?

4. Indicate the yield of ATP in aerobic glucose decomposition, the difference from anaerobic glycolysis. Name the role of aerobic glucose decomposition in muscles during muscular work, as well as the role of aerobic glucose decomposition in the brain.

5. Describe the general path of catabolism. What are the main stages and their significance?

6. Write the chemistry of the oxidative decarboxylation of pyruvate, specify the structure of the polyenzyme pyruvate dehydrogenase complex.

7. Write the chemistry of the tricarboxylic acid cycle, name the enzymes, their role in the generation of hydrogen for the mitochondrial respiratory chain.

8. Describe the process of energy production on the mitochondrial respiratory chain. Specify the mechanism of conjugation of the processes of oxidation and phosphorylation.

9. Name the role of glycerol phosphate and malate-aspartate shuttle mechanisms in aerobic oxidation of glucose to CO_2 and H_2O, their localization in the tissues of the body.

10. Write the chemistry of the pentose phosphate pathway of glucose oxidation: the reaction of oxidative and non-oxidative formation of pentoses. Name the enzymes, the distribution and role of the pentose phosphate pathway, the relationship of the process with glycolysis.

11. Name the level of glucose in the blood and its sources.

4. Recommended basic and additional literature

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1. Subject matter: Lipids and lipid metabolism.

2. Class aims: study chemical structure and biological functions of the main lipids of human tissues, the properties of lipids, their chemical composition. Study some qualitative reactions to lipids. Digestion of fats in the gastrointestinal tract, the role of bile acids in this process, tissue lipid metabolism, the formation of acetone bodies, the clinical significance of ketonemia and ketouria.

3. Class tasks: study composition, structure, functions of the main lipids; study the chemical composition and qualitative reactions to phospholipids, cholesterol; emulsify fats. Determine the conditions for the digestion of fats in the gastric intestinal tract, the participation of enzymes, bile acids in this process, conduct with qualitative reactions to bile acids and acetone bodies.

4. Basic concepts that should be learned by students in the process of the topic studying: cholesterol, phosolipids, lysophosphatides, sphingolipids, gangliosides, cerebrosides, triacylglycerols. Lipolysis, lipogenesis, emulsification, surface active agents. Bile acids, lipoproteins, chylomicrons, lipolysis, lipogenesis, sphingolipidosis. Atherosclerosis, hypercholesterolemia.

5. Class questions:

1. What class of organic substances is called lipids? What is biological role?

2. Classification of lipids. Describe the main groups of lipids (chemical structure, physicochemical properties, biological role).

3. Name the fatty acids, their structure, classification, physicochemical properties, sources of fatty acids in the body.

4. Name the essential nutritional factors of lipid nature, the precursors of the synthesis of eicosanoids.

5. Name the most important lipids of animal and vegetable origin, their daily need.

6. Describe the external metabolism of lipids, the role of enzymes and bile acids, the chemical structure of taurocholic and glycocholic acids.

6. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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- Baev A.K. Specific Intermolecular Interactions of Nitrogenated and Bioorganic Compounds // Springer Berlin Heiderberg. 2014. http://link.springer.com/openurl?genre=book&isbn=978-3-642-37472-2

7. Laboratory work: cholesterol and phospholipids detection in blood serum.

1. Subject matter: The exchange of proteins and amino acids.

2. Class aims: study the processes of protein digestion, their decay in the large intestine and the mechanism of detoxification of rotting products in the liver, tissue catabolism of proteins and amino acids.

3. Class tasks: study effects of proteolytic digestion of proteins with gastric juice pepsin and proteases of pancreatic extract, detection indican in urine, presence of transaminases in the liver tissue and consider the clinical and diagnostic significants of their quantitative determination in serum blood.

4. Basic concepts that should be learned by students in the process of the topic studying: nitrogen balance, protein optimum, protein minimum. Proteases of the gastrointestinal tract, their specificity and activation. Mechanisms of absorption of amino acids in the intestines. The decay of proteins in the colon. Mechanisms of neutralization of rotting products in the large intestine. Deamination of amino acids. Transamination of amino acids. Amino acid decarboxylation. Biogenic amines. Mono and diamine oxidase.

5. Class questions.

1. What are the main ways for replacement the amino acid pool in cells?

2. Name the system of transport of amino acids across cell membranes.

3. What are the common ways of catabolism of amino acids, specific transformations by radical?

4. What process is called amino acid deamination? What are its types and meanings for the cell?

5. Name the features of the oxidative deamination of glutamic acid, the structure of the enzyme glutamate dehydrogenase, its localization.

6. What process is called transamination? Specify the structure of aminotransferases, the mechanism of their action, as well as the significance of the process in the cells of the body. Name aminotransferases of clinical and diagnostic significance.

7. What are the features of the indirect deamination of amino acids, its significance. Describe the collector function of glutamate in the metabolic flux of nitrogen of amino acids.

8. Ways of using nitrogen-free amino acid residues in the metabolism. What amino acids are called glycogenic and ketogenic?

9. What process is called decarboxylation of amino acids. Structure of enzymes, the role of reaction products.

10. Draw the chemistry of inactivating biogenic amines. Specify aminooxidases and their structure. Drugs which work as aminooxidases inhibitors.

11. Role of histamine in the development of allergic reactions and inflammation. Give examples of antihistamine drugs.

12. Features of the catabolism of certain amino acids.

13. Specify the anabolic processes in which amino acids are involved.

14. Nitrogen balance and its types.

15. Criteria for protein nutrition. Protein diet of young children. Kwashiorkor.

16. Digestion of proteins in the gastrointestinal tract. Specificity and activation features of proteolytic enzymes. Age characteristic of digestion and absorption of proteins.

17. Breakdown of tissue proteins. Cathepsins. Sources and disposal routes amino acids in the tissues.

5. Recommended basic and additional literature

- Zurabyan S.E. Fundamentals of bioorganic chemistry // Publisher: GOETAR-Media. 2012. P. 304.

- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: final products of nitrogen exchange

2. Class aims: study the mechanisms of detoxification of ammonia in the tissues and the ways of removing the end products of nitrogen metabolism from the body.

3. Class tasks: consider of ammonia toxicity for issues, ways of its binding in tissues and transport to the liver and kidneys, to study the ornithine cycle. Clorimetric determination of urea in the serum and in the urine, as well as the determination of ammonia in the urine by the Conway-Bairn diffusion method.

4. Basic concepts that should be learned by students in the process of the topic studying: sources of ammonia and its toxicity. Mechanisms of ammonia binding in tissues. Ammonia transport to the liver and kidneys. Ornithine cycle. Clinical and diagnostic significans of determining the daily excretion of ammonium salts, serum urea and urine. Hyperammonemia. Uremia.

5. Class questions:

1. The final products of nitrogen metabolism. Sources of ammonia in the body, its toxicity.

2. Mechanisms of ammonia binding in tissues and its transport to the liver and kidneys. Glutaminase of the liver and kidneys.

3. Ornithine cycle, its connection with the Krebs cycle, the origin of urea. Congenital and acquired disorders of the urea synthesis cycle. Hyperammonemia.

6. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: structure and exchange of nucleic acids

2. Class aims: study the structure, digestion and exchange of nucleic acids.

3. Class tasks: consider the mechanisms of nucleic acid breakdown in the tissues, especially their synthesis, isolation of DNA, colorimetric method for determining DNA/RNA, agarose electrophoresis. Consider the clinical and diagnostic significance of these indicators.

4. Basic concepts that should be learned by students in the process of the topic studying:

Levels of nucleic acids structural organization. Structure and fuction of various RNA types. DNA structure and properties. DNA denaturation and renaturation. Hybridization of DNA-DNA and DNA-RNA. Nuclease, nucleotidase in gastrointestinal tract and tissues. Catabolism of purine nucleotides. The final decay products. Hyperuricemia. Hyperuricuria. Gout. Urolithiasis disease. Allopurinol in the treatment of gout. Synthesis of purine nucleotides. The origin of the atoms of the purine nucleus. Inosinic acid is a precursor of adenylic and guanylic acids. Synthesis of purine nucleotides from ready-made forms. Lesh-Nykhan syndrome. Breakdown of pyrimidine nucleotides, the final products. Synthesis of pyrimidine nucleotides. Synthesis of deoxyribonucleotides.

5. Class questions:

1. Describe the digestion of nucleoproteins and the absorption of their breakdown products in the gastrointestinal tract.

2. Describe the anabolism of purine nucleotides. Draw the reaction of formation of 5-phosphoribosylamine, the sources of nitrogen atoms and carbon of the purine ring during the synthesis of IMP.

3. Write the reaction of synthesis of AMP and GMP from IMP, the conversion of nucleoside monophosphates to triphosphates.

4. Write the biosynthesis of pyrimidine nucleotides of UMF and CMP, their transformation into triphosphates. What are the metabolic disorders of the pyrimidine metabolism in orotaciduria?

5. Name the mechanism of formation of deoxyribonucleotides, the role of thioredoxin and NADPH2 in this process.

6. Describe the synthesis of dTMP. Name the enzymes catalyzing the process, the role of methylene - THPK and S-adenosylmethionine.

7. Regulation of the synthesis of purine and pyrimidine nucleotides by the type of feedback, its features.

8. Name the nucleotide coenzymes, indicate the idea of their function.

9. Describe the catabolism of purine nucleotides. Write the chemistry of uric acid formation from AMP and GMP. Specify the content of uric acid in the blood and urine.

10. What are the molecular mechanisms of the development of urolithiasis, Lyosha-Nihena syndrome, gout. Specify a diet for hyperuricemia, the reasons for the effectiveness of allopurinol in the treatment of gout.

11. Draw the chemistry of the breakdown of pyrimidine nucleotides, the final products of the process and their utilization.

12. Inhibitors of the synthesis of purine and pyrimidine nucleotides, which one present in drugs.

13. Draw the DNA replication mechanism. Name synthesis matrix, enzymes, structural material, energy sources, features, significance and localization of the process.

14. Draw the transcription mechanism. Name the synthesis matrix, enzymes, structural material, process significance and localization. Describe the pre-RNA maturation process.

6. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: hormonal regulation of metabolic processes. Hormones chemical structure.

2. Class aims: study of the neuro-endocrine regulation of metabolism.

3. Class tasks: classification of hormones, metabolism and mechanisms of their action; to study the synthesis, secretion and inactivation of hormones, regulation of metabolism by hormones of individual endocrine glands.

4. Basic concepts to be learned by students in the process of the topic studying:

Neuronal humoral regulation of metabolism. The principle of feedback in the production of hormones. Hyper- and hypofunction of the endocrine glands. Mechanisms of action of lipophilic and water-soluble hormones. Secondary messengers transfer hormonal signal into the cell. Communication of a hypophysis with a hypothalamus. Structure and effect on the metabolism of the hormones of the hypophysis, pineal gland, thymus gland, thyroid gland, gonads, pancreas, cortical and cerebral layer of the adrenal glands.

5. Class question:

1. What are the general principles of regulation of metabolic processes, and its levels.

2. Name the concept of "hormone", the general biological signs of hormones.

3. Classification of hormones by chemical structure, belonging to the endocrine glands and biological functions.

4. Neuroendocrine interactions, the role of the hypothalamus. Specify the mechanism of feedback (negative) connection in the regulation of the hormones formation and their action.

5. What are the main mechanisms for the transfer of hormonal signals to target cells; systems of secondary mediators and their interaction (cAMP, cGMP, DAG, IF3, Ca^{2+}). Hormones classification are based on the formation of a secondary mediator, and hormones, which act at the level of the cell genome.

6. Name the hormones of the hypothalamus and hypophysis, their chemical nature and biological role. Describe the main disorders in the hypophysial and hyperactive functions of the hypophysis (hypophysial nanism, acromegaly, gigantism).

7. Name the chemical nature, regulation of formation, mechanisms of biological effects of the hormones vasopressin and oxytocin. Specify the pathogenesis of the main symptoms of diabetes.

8. Name the thyroid hormones. Describe the structure of triiodothyronine and thyroxin, the main stages of the synthesis and catabolism of hormones, the regulation of their formation, the biological effect of hormones. Specify the hypo- and hyperfunctions of the thyroid gland: metabolic disorders and organ functions in cretinism, myxedema, and Graves' disease.

9. Name the chemical nature, describe the hormones parathormone and calcitonin involved in the regulation of calcium and phosphate metabolism. Specify the role of vitamin D, the main symptoms of hypo- and hyperparathyroidism.

10. Describe the hormone of the pancreas - glucagon. Name its chemical nature, participation in the regulation of metabolism. Specify the mechanism of hyperglycemia under the influence of glucagon.

11. Describe the hormone of the pancreas - insulin. Specify the structure, the formation of proinsulin, the regulation of synthesis and secretion, the target organs and the mechanism of action of the hormone, the role in the regulation of carbohydrate, lipid and protein metabolism, the biochemical mechanisms of the anabolic effects of insulin.

12. Name the form of diabetes. Specify the possible causes of insulin deficiency, clinical symptoms and metabolic disorders in diabetes.

13. Name the hormones of the adrenal medulla. Adrenaline, structure and synthesis of the hormone, blood levels and its transport forms, cardiovascular effect, role in the metabolism, mechanisms of hyperglycemia and the lipolytic action of the hormone.

14. Specify the half-life of adrenaline and the end products of catabolism, the participation of the hormone in adaptive reactions under stress.

6. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: blood biochemestry. Structure and metabolism of hemoproteins.

2. Class aims: stady structure, biological functions, metabolism and metabolic disorders of hemoproteins.

3. Class tasks: method of quantitative determination of bilirubin in serum, clinical interpretation of the results.

4. Basic concepts to be learned by students in the process of the topic studying: hemoproteins, hemoglobin, delta - aminolevulinic acid, porphobilinogen, uroporphyrinogen, coproporphyrinogen, potoporphyrinogen, porphyrias, verdoglobin, biliverdin, bilirubin. Associated and free bilirubin. Mesobilinogen, sterobilinogen. Icterus: hemolytic, parenchymal, mechanical, conjugated, unconjugated.

5. Class questions:

1. What are the physical and chemical characteristics of blood (density, pH, osmotic pressure) and the mechanisms for their maintenance at a constant level?

2. Name the blood components: cellular elements, serum, plasma, their biochemical features.

3. Indicate the chemical composition of the blood: organic compounds (main groups) and mineral components.

4. Name the composition of nitrogen-containing blood substances: proteins, enzymes, non-protein nitrogen-containing compounds.

5. Indicate the origin of blood enzymes, indicator enzymes. What is called enzymodiagnosis?

6. Name the concept of "residual nitrogen in the blood." Specify the residual nitrogen fractions, their origin, their role in metabolism, and the diagnostic value of residual nitrogen determination.

7. What condition is called azotemia? Indicate the differentiation of azotemia by biochemical parameters.

8. Name the origin, content, composition, function of blood proteins.

9. Describe the main serum protein fractions, separated by electrophoresis. Give examples of electrophoregrams of a healthy person.

10. What condition is called dysproteinemia? Specify the nature of changes in the composition of blood proteins according to examples of pathological conditions in case of nephrosis, cirrhosis of the liver, protein starvation, myeloma, acute infection.

11. What is the diagnostic value of determining the total blood protein index?

12. Indicate the characteristics of the main methods for the quantitative determination of whey protein and its fractions.

6. Recommended basic and additional literature

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Laboratory work:

Determination of the buffer capacity of blood.

1. Subject matter: Liver biochemistry.

2. Class aims: clinical and biochemical diagnostic of the liver function. Work with the literature on the proposed topic. Identification the main syndromes of liver damage.

3. Basic concepts to be learned by students in the process of the topic studying: cholestasis, bilirubin.

4. Class questions:

1. The functions of the liver in the body.
2. The role of the liver in carbohydrate metabolism.
3. The role of the liver in protein metabolism.
4. The role of the liver in lipid metabolism.
5. The role of the liver in the metabolism of chromoproteins.
6. The role of the liver in the processes of neutralization.
7. Indicated, secretory and excretory enzymes of blood plasma, their diagnostic role.
8. How to evaluate the proteinsynthetic function of the liver.
9. How to evaluate the detoxification function of the liver.
10. Biochemical parameters reflecting the inflammation syndrome, cytolysis, hepatocellular insufficiency and cholestasis syndrome.

5. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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1. Subject matter: water-salt exchange. Urine biochemistry.

2. Class aims: study the clinical and diagnostic significance of the definition physical and chemical properties and chemical components of urine.

3. Class tasks: physical and chemical properties of urine, methods of quantitative and qualitative determination of the physiological and pathological components of urine.

4. Basic concepts to be learned by students in the process of the topic studying: Diuresis, polyuria, oligouria, anuria. Urine density, isohyposthenuria. Changes in color, transparency, pH of urine. Physiological and pathological components of urine. Proteinuria, hematuria, glycosuria, bilirubinuria, urobilinuria, ketonuria, indicanuria.

5. Class questions:

1. What are the features of the structure of the nephron.

2. What are the main processes of urine formation: filtration in the glomeruli, reabsorption and secretion in the tubules. Specify the concept of clearance.

3. Describe the main regulatory mechanisms underlying the formation of urine: renin-angiotensin-angiotensin system, vasopressin (antidiuretic hormone), aldosterone, parathyroid hormone, calcitonin.

4. Describe the role of the kidneys in maintaining the acid-base state (CBS): acidogenesis, ammoniogenesis, acid excretion.

5. What are the features of renal tissue metabolism, enzymes used to diagnose kidney disease: glycine aminotransferase, lactate dehydrogenase isoenzymes (LDH-1 and LDH-2), and alanine aminopeptidase (AAP-3).

6. Describe the general properties of the urine of a healthy person: the quantity, color, transparency, odor, relative density, pH.

7. Name the chemical composition of the urine of a healthy person: containing and non-nitrogen organic components, inorganic components.

8. Indicate the change in the function of the nephron and kidney tubules in pathology.

9. Name violations of the main regulatory mechanisms underlying the formation of urine.

10. What is the amount of urine released in normal and pathological conditions (anuria, polyuria, oliguria), its color, density in pathological conditions, and the pathogenesis of these conditions.

11. What are the causes of ammonia and putrid odor, as well as the smell of acetone urine.

12. Name the reasons for the change in urine pH in pathology.

13. Name the reasons for the change in urine transparency.

14. Indicate changes in the chemical composition of urine in pathology.

15. What are the causes of changes in the activity of enzymes in the urine in pathology.

7. Recommended basic and additional literature

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- Diederichsen U., Lindhorst T.K., Westermann B. Bioorganic Chemistry : Highlights and New Aspects // Weinheim New York Chichester: Wiley-VCH. 1999. P 439.

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VII. MATERIAL AND TECHNICAL SUPPORT OF DISCIPLINE

The location of the computer equipment on which the software is installed, the number of workplaces	**Main equipment list**
Computer class of the School of Biomedicine, room M723, 15 workplaces	Screen with an electric drive 236 * 147 cm Trim Screen Line; DLP Projector, 3000 ANSI Lm, WXGA 1280x800, 2000: 1 EW330U Mitsubishi; The subsystem of specialized fixing equipment CORSA-2007 Tuarex; Video switching subsystem: DVI DXP 44 DVI Pro Extron matrix switcher; DVI extension cable for twisted pair DVI 201 Tx / Rx Extron; Audio switching and sound reinforcement subsystem; ceiling speaker system SI 3CT LP Extron; DMP 44 Extron digital audio processor; extension for the control controller IPL T CR48; Wireless LANs for students are provided with a system based on 802.11a / b / g / n access points 2x2 MIMO (2SS). Monoblock HP RgoOpe 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty
690922, Primorsky krai territory, Vladivostok, Russky island, Saperny peninsula, Aiaks village, street 10, room M 432, laboratory of biochemistry	Dry-air thermostat MIR-262; Weight Pioneer series (PA413); Laboratory centrifuge LMC-4200R; Magnetic shaker MSH-300i with thermoregulation; Distiller GFL-2008; Electric stove “Mechta” 111Ch; Spectrophotometer with accessories for sample processing BioSpectrometer-kinetic
Multimedia audience	Monoblock HP ProOne 400 G1 AiO 19.5 "Intel Core i3-4130T 4GB DDR3-1600 SODIMM (1x4GB) 500GB; Projection Screen Projecta Elpro Electrol, 300x173 cm; Multimedia Projector, 4000 Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Embedded Interface, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Embedded, Embedded, Mitsubishi FD630U, 4000 ANSI Lumen, 1920x1080; Embedded; TLS TAM 201 Stan cables; Avervision CP355AF Document Camera; Sennheiser EW 122 G3 Microphone UHF-band microphone system as part of a wireless microphone and receiver; LifeSizeExpress 220-Codeconly-Non-AES video conferencing codec; Multipix MP-HD718 Network Video Camera; Dual LCD Panels 47 ", Full HD, LG M4716CCBA; Audio switching and sound reinforcement subsystem; central uninterrupted power supply
Reading rooms of the FEFU Scientific Library with open access to the Foundation (Building A - Level 10)	Monoblock HP RgoOpe 400 All-in-One 19.5 (1600x900), Core i3-4150T, 4GB DDR3-1600 (1x4GB), 1TB HDD 7200 SATA, DVD +/- RW, GigEth, Wi-Fi, BT, usb kbd / mse, Win7Pro (64-bit) + Win8.1Pro (64-bit), 1-1-1 Wty Internet access speed 500 Mbit / s. Workplaces for people with disabilities are equipped with braille

	displays and printers; equipped with: portable devices for reading flat-printed texts, scanning and reading machines with a video optimizer with the ability to adjust color spectra; magnifying electronic loops and ultrasonic markers

MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal state autonomous educational institution
of higher education
«Far Eastern Federal University»
(FEFU)

SCHOOL OF BIOMEDICINE

TRAINING AND METHODOLOGICAL SUPPORT OF STUDENTS SELF STUDYING WORK
ON DISCIPLINE "BIOCHEMISTRY"
HONOR'S PROGRAMM 31.05.01. "GENERAL MEDICINE"
FULL-TIME TRAINING

Vladivostok
2018

Schedule of the self studying work on the discipline

№ l/n	Date/Due date	Types of self studying work	hours	Type of checking
1.	**1-2 week**	Note taking Topic: The main directions of science development, objectives, goals.	4h	Note checking
2.	**3-4 week**	Note taking Topic: Classification of proteins. Simple (albumin, globulins, protamines, histones). Structural proteins - collagens, elastins, keratins) and complex proteins (phospho-, lipo- and metalloproteins)	5h	Note checking
3	**5-6 week**	Eassy Topic: method of protein isolation and puryfication	5h	Oral presentation
4.	**7-8 week**	Eassy Topic: vitamin-like substances. Antivitamins.	5h	Oral presentation
5.	**9-10 week**	Note taking Topic: Basic carbohydrates of human tissues, their structure and biological role. Basic carbohydrates food supplements. Carbohydrates of structural and functional components of the cell.	4h	Note checking
6.	**11-12 week**	Note taking Topic: The most important lipids of human tissues. Lipid functions	4h	Note checking
7.	**13-14 week**	Eassy Topic: The clinical significance of the enzymes identification. Enzymes in medicine.	4h	Oral presentation
8.	**15-16 week**	Compilation of situational tasks Topic: Lipid metabolism.	5h	Note checking
7.	**17-18 week**	Eassy	5h	Oral presentation

		Topic: Specific pathways of amino acids exchange. Disorder of the individual amino acids metabolism		
8.	**Preparing for the pass**	Pass	10h	Pass
9.	**19-20 week**	Essay Topic: Biogenic amines: serotonin, γ-aminobutyric acid, β-alanine, formation and biological functions.	6h	Oral presentation
10.	**21-22 week**	Note taking Topic: Specific pathways for the amino acids exchange. Disruption of the individual amino acids metabolism.	6h	Note checking
11.	**23-24 week**	Essay Topic: Endorphins. Hormonoids: prostaglandins, thromboxanes, leukotrienes and biologically active substances, local hormones of the APUD system.	6h	Oral presentation
12.	**25-26 week**	Draw the scheme with explanation: Structure, functions, properties of biological membranes.	6h	Discussion
13.	**27-28 week**	Essay Topic: The role of microsomal oxidation in the neutralization of xenobiotics. Cytochrome P-450 hydroxylase cycle.	4h	Oral presentation
14.	**30-31 week**	Essay Topic: Characteristics of the most important components of urine in health and disease.	4h	Oral presentation
15.	**Exam week**	Exam prepering	27h	Exam
	Total:		108 hours	

METHODICAL RECOMMENDATIONS ON ORGANIZATION DISCIPLINES LEARNING

The assay preparing based on studying and scientific literature proposes an in-depth study of scientific researches, which should provided development skills for working with scientific literature. This will be improving scientific view and critical thinking, increase their theoretical ground, the formation of scientific competence.

Study books, monographic and scientific papers covered by the program of the academic discipline are offered for studying. It is necessary to takes the most important areas of development of this science and up-to-date research findings. Particular are consider literary that (directly or indirectly) has an information which can assist a specialist in his practical work. However, this section also includes literature sources and scientific studies on issues beyond the limits of the discipline. This literature is recommended to use if you wish to expand your knowledge in any branch of science.

Along with literature on general grounds, students are assumed to find out other literatures source an example by using scientific databases (pubmed.com, openscience.news). Not all the proposed literature is equivalent in content and volume, therefore a different approach to its study is possible. In one case, this may be a general reviewing of several literary sources by various authors look at same problem, in another case - a detailed study and reviewing of big works or even its individual sections, depending on the degree of problem complexity. In order to decide what to do in each case, you should consult with the teacher.

Choosing of a precise paper for referencing should be preceded by a detailed review with the list of all the literature provided in the curriculum of the discipline. It is recommended on the selected work first to view subtitles, selected texts, diagrams, tables, general conclusions. Then it must be thoughtfully (look into the ideas and methods of the author) to read, making notes along the way on a separate sheet of paper about the main points, key problems. After reading, you should consider the content of the article or a separate chapter, paragraph (if we are

talking about a monograph) and take a note. Literally, you should write out only strict definitions, the wording of laws. Sometimes it is useful to enrich notes by one or two examples for illustration. If you are misunderstanding some points, it is recommended to read the following statement, as it can help to understand the previous part, and then return again to the understanding of the previous presentation.

The result of the work on literary sources is the assay or paper review.

In preparing the essay, it is necessary to highlight the most important theoretical propositions and substantiate them independently, paying attention not only to the result, but also to the methodology used in studying the problem. Reading scientific literature should be critical. Therefore, we must strive not only to master the basic content, but also the method of proof, reveal the peculiarities of different points of view on the same issue, evaluate the practical and theoretical significance of the results of the reviewed work. A very desirable element of the essay is that the listener expresses his own attitude to the ideas and conclusions of the author, supported by certain arguments (personal experience, statements by other researchers, etc.).

Review of monographs, journal articles of research character must necessarily contain, as mentioned above, the definition of the problem and the specific objectives of the study, a description of the methods used by the author, as well as the conclusions he came to as a result of the research. The proposed literature for referencing is constantly updated.

Instructions for essays writing:

General requirements for the assey:

The assey should be written according to the standard scheme, including:

- title page
- table of contents
- introduction
- the main part
- conclusion

- bibliography.

It is would be good to include in the text of the assay tables and (or) figures: diagrams, graphs.

The volume of the abstract: 10-20 pages of A4 format of computer layout in the editor of Times New Roman, 1.5 spaced, 14 font. The title of the abstract should be fully consistent with the selected option.

The structure of the abstract must meet the standard requirements for assay writing: introduction, reasons for the choice of topic, statement of the topic, conclusion. More detailed requirements for assay writing are presented in the Procedure "Requirements for the design of written work performed by FEFU students and students" http://law.wl.dvgu.ru/docs/treb_2012.pdf

Approximate list of essay topics:

1. Mechanisms of energy production in mitochondria.
2. Liver - its role for the human body.
3. Alcoholism and drug addiction - metabolic disorders.
4. The effect of trace elements on the activity of enzymes.
5. Metabolic connections of the Krebs cycle.
6. Types of icterus.
7. Biotransformation of xenobiotics in the body.
8. Cholesterol in the human body and how it is spent.
9. The biological role of iron, molybdenum and zinc.

Criteria and indicators used in the essay evaluation

Criteria	Options
1.Originality of the reviewed text Max - 5 points	- the relevance of the problem and the topic; - novelty and independence in the formulation of the problem, in the formulation of a new aspect of the problem selected for analysis; - the presence of the author's position, independence of thinking.
2. The degree of problem coverage Max - 5 points	- compliance of the plan with the assay topic; - compliance with the content of the topic and assay plan; - completeness and depth of coverage of the problem basic concepts;

	- grounding of the methods which choosing for working with the material; - ability to work with literature, to systematize and structure the material; - ability to generalize, compare different points of view on the problem under consideration, to argue the main points and conclusions.
3. Grounding of literature source choosing Max - 5 points	- amount and source of literature uses in problems reviewing; - uses of the up-to-date researches on the problem (scientific papers, current monographs and conference abstracts etc.).
4. Compliance with the requirements for formalization Max - 5 points	- correct design of references used literature; - literacy and culture of presentation; - possession of terminology and conceptual apparatus of the problem; - compliance with the requirements for the volume assayt; - proper formalozation: the selection of paragraphs.
5. Literacy Max - 5 points	- lack of spelling and syntax errors, stylistic errors; - absence of typos, abbreviations of words, except the generally accepted; - literary style.

Presentation requirements and summary evaluation criteria

A summary is a written text that summarizes the content of the main source of information in a concise and consistent manner. A certain is lead to a order of information gathered from the original. The process is based on the systematization of what is read or heard. Notes can be made both in the form of exact excerpts, quotations, and in the form of a free flow of meaning. The manner of summary writing, as a rule, is close to the style of the original source. If the summary is correct, it should reflect the logic and semantic connection of the noted information.

In well-made entries, you can easily find specialized terminology, clearly interpreted and clearly distinguished for memorizing the meanings of various words. Using outlined information, it is easier to create meaningful creative or scientific work, various abstracts and articles.

Summary making rules

1. Read the text carefully. Along the way, mark incomprehensible places, new words, names, dates.

2. Inquire about the persons, events mentioned in the text. When noting, do not forget to make reference data on the field.

3. When you first read a text, make a simple plan. When re-reading, try to summarize the main provisions of the text, noting the arguments of the author.

4. The final note taking stage consists of rereading previously marked places and their brief sequential noteing.

5. When taking notes, you should try to express the author's thought in your own words.

6. Strive to ensure that one paragraph of the author's text is transmitted when taking notes in one, maximum two sentences.

When taking notes of lectures, it is recommended basic rules following.

1. Do not start noting material from the teacher's first words, first listen to his thought to the end and try to understand it.

2. Start writing at the moment when the teacher, finishing the presentation of one thought, begins to comment on it.

3. In the abstract, separate parts must be distinguished. It is necessary to distinguish between headings, subheadings, conclusions, to isolate one topic from another. You can make the selection underlined, in a different color (just do not turn the text into motley pictures). It is recommended to indent for paragraph and paragraph designations, whitespace to separate one thought from another, numbering. If definitions, formulas, rules, laws in the text can be made more visible, they are framed. Over time, you will have your own system of discharge.

4. Create your notes using the accepted conventions. Speaking out, be sure to use a variety of characters (they are called signal). These can be pointers and directional arrows, exclamation point and question marks, combinations of PS (afterword) and NB (pay attention). For example, the word "therefore" you can designate the mathematical arrow =>. When you develop your own sign set, create a synopsis, and then and learn it will be easier and faster.

5. Do not forget about abbreviations (abbreviated words), signs of equality and inequality, more and less.

6. Abbreviations provide great benefits for creating the correct outline. However, be careful. Experts believe that the reduction of the type "t-k" (think) and the like should not be used, since subsequently a large amount of time is spent on decoding, and in fact the reading of the abstract should not be interrupted by extraneous actions and reflections. It is best to develop your own system of abbreviations and designate the same words in them (and nothing else). For example, the abbreviation “SK” will always and everywhere with the word “speak”, and the big letter “W” with the word “work”.

7. Undoubtedly, to organize a good summary will help foreign words. The most used among them are English. For example, the abbreviated “ok” successfully denotes the words “excellent”, “wonderful”, “good”.

8. It is necessary to avoid complex and long arguments.

9. When taking notes, it is better to use narrative sentences, to avoid independent questions. Questions are relevant in the outline fields.

10. Do not try to fix the material verbatim, while often the main idea is lost, besides this notes is difficult to keep. Discard minor words, without which the main idea is not lost.

11. If there are terms incomprehensible to you in the lecture, leave a place, after classes specify their meaning with the teacher.

Evaluation criteria:

86-100 points are awarded to a student, if the abstract is presented in the most understandable form, has in its structure a plan, diagrams and drawings, reveals all the basic concepts and questions cited above;

76-85 points are awarded to a student, if the abstract is presented in a fairly clear form, has in the structure of the scheme and / or drawings, reveals more than half of the basic concepts and questions;

75-61 points are awarded to a student if the abstract is presented in a relatively understandable form and reveals half of the basic concepts and questions;

60-50 points are given to a student if the abstract is presented in an incomprehensible form and reveals less than half of the basic concepts and questions.

MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
Federal state autonomous educational institution
of higher education
«Far Eastern Federal University»
(FEFU)

SCHOOL OF BIOMEDICINE

ASSESSMENT FUND
ON DISCIPLINE "BIOCHEMISTRY"
HONOR'S PROGRAMM 31.05.01. "GENERAL MEDICINE"
FULL-TIME TRAINING

Vladivostok
2018

Passport of assessment fund

Completed in accordance with the Regulations on the Funds of Evaluation Assets of Educational Programs of Higher Education - Bachelor's Programs, Specialties, FEFU Magistrates, approved by order of the Rector No. 12-13-850 of May 12, 2015.

Code and concept of competence	**Steps of competence evolution**	
the readiness to use basic physical and chemical, mathematical and other natural science concepts and methods in solving professional problems (GPC – 7)	Knows	main metabolic pathways of amino acids and proteins, carbohydrates, lipids, nucleotides and nucleic acids and the main disorder of their metabolism in the human body.
	Is able	evaluate the relevance's of various biochemical parameters for blood and urine analysis under certain pathological conditions (diabetes mellitus, pathology of the liver, kidneys, heart)
	Is skilled	skills for solving biochemical and professional problems.
the capacity for the assessment of morphological and physiological states and pathological processes in the human body for solving professional tasks (GPC – 9)	Knows	principles of biochemical analysis and clinical biochemical laboratory diagnostic of diseases
	Is able	uses measuring equipment while performing biochemical studies
	Is skilled	skills of making a preliminary diagnosis based on the results of patients laboratory study

№ I/n	Chapters / topics of discipline which under control	Code and steps of competencies formation		Evaluation approaches	
				Current control	Intermedial control
1	Chapter I. Topic: 1-3. Chapter II. Topic: 1-6.	ОПК-7 to be able to use basic physicochemical, mathematical and other natural science concepts and methods in solving professional problems	Knows: the main metabolic pathways of amino acids, proteins, carbohydrates, lipids, nucleotides, nucleic acids and the main disorders of their metabolism in the human body	УО-1 ПР-4	Questions for the exam: 1-82.
			Able to: evaluate the information content of	УО-1 ПР-4	

			various biochemical parameters for blood and urine analysis under certain pathological conditions (diabetes, pathology of the liver, kidneys, heart)		
			Skilled: skills for solving biochemical and professional problems.	ПР-6	
2	Chapter II. Topic: 1-6. Chapter III. Topic: 1-4.	ОПК-9 ability to assess morphofunctional, physiological states and pathological processes in the human body to solve professional problems	Knows: the principles of biochemical analysis and clinical biochemical laboratory diagnosis of diseases	УО-1 ПР-4	Questions for the exam: 83-106
			Able to: use measuring equipment for biochemical studies performing	УО-1 ПР-4	
			Skilled: skills of making a preliminary diagnosis based on the results of patients laboratory examination	ПР-6	

Methodical recommendations determining the procedures for results evaluating of discipline studying

Current evaluating of discipline studying. The current evaluating of students studying in the discipline "Biochemistry" is carried out in accordance with the local regulations of FEFU and is mandatory.

The current evaluating of students studying for the discipline "Biochemistry" is carried out in the form of control measures (oral presentation, testing, assay, report on laboratory work) to assess the actual learning outcomes of students and is carried out by the leading teacher.

Objects of evaluation are:

- academic discipline (activity in the classroom, timeliness of performing various types of tasks, attendance of all types of classes in a certified discipline);

- the degree of assimilation of theoretical knowledge;

- the level of studying of practical skills in all types of practical works;

- the results of self-prepering work.

Intermediate tasting of students. Intermediate tasting of students in the discipline "Biochemistry" is carried out in accordance with the local regulations of FEFU and is mandatory.

For the discipline there is a pass in the 3rd semester and an exam in the 4th semester, which is conducted orally on the questions for the exam presented below.

Evaluation approaches for intermediate tasting
Questions for the exam

1. The general structure, functional groups and chemical properties of amino acids (including the characteristic reactions of amino acids). Features of the structure and properties of amino acids: types of isomerism, zwitterionic properties, ionization conditions, pKa, pI. Polar and non-polar substituents, classification of amino acids by types of radicals.
2. The primary structure of proteins and peptides. The formation of peptide bonds, peptides, their names. Peptide and amide bonds. Examples of synthetic polymers with amide bond. N- and C-ends. Sequencing of proteins. Edman's method. Molecular mass of proteins.
3. Properties of the peptide bond, cis- trans- conformation of the peptide bond, hydrogen bonds. Torsion (dihedral) angles, Ramachandran maps for glycine, alanine and proline.
4. The secondary structure of proteins. Regular and irregular secondary structures. Types of spiral structures by nm parameter, saturation by hydrogen bonds, properties of spirals. Beta-folded structures, parallel, antiparallel. Types of irregular structures.

5. The spatial organization of protein molecules. Tertiary structure of proteins. Principles of domain organization of protein molecules. Hydrophobic cores. Classification of proteins by tertiary structures. Quaternary structure, protomers, oligomers, subunits.

6. Types of interactions that stabilize the spatial organization of proteins. Covalent bonds, hydrogen bonds. Electrostatic interactions, ionic bonds. Types of van der Waals interactions: interactions of constant dipoles, dipole-induced dipole interactions, London dispersion forces.

7. Folding proteins. Fibers promote folding. Protein disulfide isomerase. Peptidylprolyl-cis, trans-isomerase. Classification and functioning of chaperones. HSP70, chaperonins, nucleoplasmins.

8. Denaturation and renaturation of proteins. Renaturation mechanism on the example of ribonuclease A. Effect of post-translational modifications on the renaturation of proteins, renaturation on the example of insulin and cross-linked insulin.

9. Classification and function of proteins. Protein-molecular motors, mechanochemical conjugation in the functioning of proteins on the example of myosin. Binding proteins. Features of the functioning of DNA-binding proteins.

10. Enzymes, classification of enzymes. Structure and dynamics of enzyme proteins. Activation energy Active center, substrate binding and catalytic center. Theory of the transition state. Induced correspondence. Transient states and intermediates. The mechanism of enzymatic catalysis on the example of serine proteases. Why enzymes are the best catalysts. Enthalpy and entropy catalysis.

11. Structure and properties of carbohydrate-containing biopolymers. Carbohydrates. Monosaccharides, disaccharides, oligosaccharides. Glycosidic bonds, types of glycosidic bonds. Stereochemistry of carbohydrates. Projections of Fisher and Heours. Aldoz, ketozy, aldohexose, ketohexose. Pyranose, furanose. Chemical reactions of carbohydrates. Reducing and non-reducing sugars. Mutation Ring-chain tautomerism.

12. Polysaccharides, structure and diversity. Neutral, polyanionic (acidic), polycationic (basic) polysaccharides. Branched and unbranched polysaccharides. Homoglycans, heteroglycans. Amylose, amylopectin, cellulose. Agarose and agaropectin. Pectins and alginates. Carrageenans Chitin, chitosan. Aldonic and uronic acids, and their derivatives. Glycoconjugates, glycans, a variety of glycan-containing biopolymers of the extracellular matrix. Mucopolysaccharides, peptidoglycans, proteoglycans, glycoproteins. N- and O-glycosylation.

13. Structure, classification and properties of lipids. Fatty acids, saturated, unsaturated. Polyic fatty acids. IUPAC lipid nomenclature and ω-nomenclature. Washable and indelible lipids, simple and complex washable lipids. Wax, fats, alkylacylates and triacylglycerols. Phosphatidic acid. Phospholipids (phosphoglycerides, phosphatides, plasmalogens). Sphingolipids, sphingomyelins, ceramides. Glycolipids, cerebrosides, gangliosides.

14. Lipid aggregates, micelles, liposomes. Biological membranes. The structure and functioning of membrane lipids. Molecular dynamics of membrane lipids, lipid rafts, liquid crystal properties.

15. Structure, classification and properties of nucleic acids. Nitrogenous bases, purine and pyrimidine bases, nucleosides, nucleotides, nucleoside triphosphates. Ribose, deoxyribose, the role of substituents in various positions of sugar residues in biosynthetic processes involving nucleosides and their derivatives.

16. Levels of structural organization of nucleic acids. The structure of the sugar-phosphate backbone, a chain of nucleic acids. The structure of DNA, the principle of complementarity, the role of hydrogen bonds, A, B, Z - forms of DNA, the basic principles of DNA replication.

17. Features of the structure of RNA, modern classification of RNA types and their functions: messenger RNA, ribosomal, transport, small nuclear, small nucleolar, small RNA, Cajal bodies, miRNA, small interfering RNA.

18. What is a low molecular weight bioregulators? List the groups of compounds that are traditionally classified as low molecular weight bioorganic compounds.

19. What is called vitamins? What are cofactors? What are prosthetic groups? Give examples of cofactors.

20. Vitamin A, structure and functional properties.

21. Vitamin C, its structure and function.

22. Describe the B vitamins (at least 5 names, biochemical role, chemical structure).

23. Structure and functional properties of NAD and NADP. NAD + / NADH reduction / oxidation reaction.

24. Structure and properties of FAD. FAD / FADH2 reduction / oxidation process.

25. Isolation and purification of biomolecules. Main steps. Homogenization, extraction. Types of homogenizers. Lightening, centrifuges, types of rotors, the concept of rcf. Methods of coarse and fine fractionation.

26. The concept of pH, isoelectric point, the method of isolation and analysis of proteins by isoelectric focusing. The principle of operation of the pH meter, the device of the combined glass electrode.

27. Protein precipitation by salting out. Give an explanation of the process. Tell the main steps (preparation of a saturated solution, the calculation of the concentration of saturation).

28. Electrophoresis of proteins in polyacrylamide gel according to Laemmli.

29. Analysis of enzyme activity.

30. Methods for isolation, fractionation and analysis of lipids.

31. Methods for the isolation, purification and analysis of nucleic acids.

32. Types and principles of chromatography. Thin layer and column chromatography. Movable and stationary phase. Column Chromatography The concept of "theoretical plates", the effectiveness of chromatography. The concepts of full and free column volumes.

33. The principles of separation of substances in the distribution and adsorption chromatography.

34. The principles of separation of substances in ion exchange chromatography.

35. The principles of separation of substances in affinity chromatography.

36. Principles of separation of substances in gel filtration chromatography.

37. Draw a general outline of the catabolism of basic nutrients. Be sure to explain the individual steps.

38. Give a detailed description of the processes of digestion and absorption of carbohydrates.

39. Draw a general scheme of glucose metabolism (from where it enters the body and what it turns into).

40. Draw (with comments or detailed description) the glycogen metabolism scheme.

41. Draw a general diagram of the ways glucose catabolism (anaerobic glycolysis, aerobic decomposition). Where are the main stages of this process?

42. Aerobic breakdown of glucose. Detailed scheme of the sequence of transformations.

43. Glycerophosphate and malate-aspartate shuttle systems: draw diagrams of chemical transformations.

44. What is the main difference between anaerobic glycolysis and the aerobic pathway of glucose decomposition. What and why does pyruvate transform (draw an enzyme reaction scheme) during anaerobic glycolysis?

45. Give the balance of ATP (in the form of a table that includes the individual stages of the process) for aerobic glucose decomposition to the final products.

46. What is the Corey cycle? Draw the Corey cycle schematically. What is gluconeogenesis?

47. What is and why the pentose phosphate pathway of glucose oxidation (glucose-6-phosphate) is needed. Draw a diagram of the oxidative and non-oxidative stages of the pentose phosphate pathway.

48. The main reactions and functions of the citrate cycle (Krebs cycle). What chemical compounds and in what quantity are formed in the citrate cycle?

49. The biological role of food lipids. Digestion, absorption and resynthesis of lipids in the organs of the digestive system.

50. Oxidation of higher fatty acids in the tissues. Features of the oxidation of higher fatty acids with an odd number of carbon atoms, the energy effect.

51. The structure and operation of the electron transport chain (electron transport chain). How is its functioning related to the citrate cycle? FMN and FAD-dependent dehydrogenase. Cytochromes Ways of ATP synthesis. Substrate phosphorylation. Separation of oxidation and phosphorylation. The mechanism of oxidative phosphorylation and ATP synthesis (P. Mitchell's theory).

52. What is the amphibolic significance of common pathways for catabolism?

53. Genetic information and basic biosynthetic processes. The project "Human Genome", the structure of the genome, unique and repetitive sequences, coding and non-coding DNA genes. What is gene expression? What are matrix syntheses? Which matrix syntheses are parts of expression? What is the expression level?

54. The concept and mechanism of transcription. What is transcription? What is a transcription product? List the main "participants" of the process. Which of the DNA double helix chains is a transcription matrix? What is a promoter? What are consensus sequences where they are located? Give examples of elements of consensus sequences of prokaryotes and eukaryotes. What are strong and weak promoters? Draw (with the description of each stage) scheme of the process of transcription. In which direction does the growth of the replica occur, in which direction does the movement along the matrix occur?

What types of RNA polymerases do eukaryotes have? Specify which types of genes they transcribe.

55. Describe the differences in the structure of prokaryotic and eukaryotic genes. What is exon, intron, operon? Types of posttranscriptional modifications. Processing, splicing, alternative splicing.

56. What is the genetic code. List (with the decoding of each) its properties. What is a reading frame? What is an open reading frame?

57. Draw the secondary structure of tRNA. Specify the name of its sections. Specify the sites where "unusual" nucleotides are located. What is the anticodon and what is its function? Describe the features of its structure. The role of the 3`-

OH-group and the acceptor leg. Describe the features of ribosomes of prokaryotes and eukaryotes.

58. What is a broadcast? Describe the preparatory stage of the broadcast. Aminoacyl-tRNA synthetase.

59. Name the participants of the translation initiation and describe the events of this stage. Functional centers of the ribosome. What are the start codons?

60. The mechanism of elongation, its participants and its stages.

61. What are stop codons? Describe what happens at the translation termination stage. What happens to the broadcast product after it is completed?

62. Concepts of genomics, transcriptome, proteomics, lipidomics and metabolomics. Lipid metabolism, fatty acid oxidation and biosynthesis, cyclooxygenase and lipoxygenase pathways. Metabolism of cholesterol and bile acids. Hexose and glycogen metabolism. Metabolism of amino acids and proteins, nitrogen metabolism. Metabolism of porphyrins and bile pigments.

63. Mechanisms of regulation of biochemical processes. Regulation of enzyme activity. Regulation of gene activity. Activators and inhibitors. Steric and allosteric regulation. Competitive and noncompetitive inhibition, uncompetitive inhibition. Phosphorylation / dephosphorylation of Kinase.

64. The concept of communication between cells. Types and nature of the signals perceived by the cell. The concepts of signal-supplying cells and target cells. Concepts of ligand and receptor. Intracellular signal transduction mechanism (secondary messengers and effector molecules). Types of effector molecules and possible signaling results.

65. The general classification of signaling pathways depending on the distance of the ligand from the cell secreting the signal molecule. Contact-dependent signaling (signaling through integrins, ephrins, Notch signaling pathway, signaling through Toll receptors - NFκB pathway. Signaling through secreted molecules: through local mediators (paracrinic ¬– Wnt ligands, others); cells and ligand Hedgehog); through mediators working at a considerable distance from the secreted cell (via neurotransmitters and hormones)

66. Intracellular ligands. NO as a regulator of vascular smooth muscle contraction. Hydrophobic intracellular ligands (steroid and thyroid hormones, retinoids, vitamin D), a family of nuclear receptors (nuclear receptors superfamily).

67. Extracellular ligands. The main types of receptors that perceive extracellular ligands. Methods of activating signal transmitters when receptor is activated by ligand (phosphorylation / dephosphorylation; replacement of GTP with GDP - G proteins or monomeric GTPases - Ras and others; binding to other secondary messengers - large or small molecules - cAMP, Ca2 +, etc.). Ways of bringing together participants in the signaling process: the role of matrix proteins (scaffold-proteins) or adapter proteins, docking sites on other components, or lipid rafts.

68. GPCR Signaling - G-protein coupled receptors. GPCR structure, possible ligands, general mechanism for signal activation and transmission. Signal processes triggered by GPCR. G-proteins. Structure, general principles of work. Secondary messengers activated by G-proteins: adenylyciclase and cAMP, phospholipase C, ion channels.

69. Phosphatidylinositol cleavage and calcium signaling. The path scheme. Functions of calcium in the cell.

70. Signaling through kinase-related receptors. The main classes of receptors that work through interaction with kinases. Tyrosine kinase receptor (RTKs). Ras / MAPK signaling path. Serine-threonine kinase receptors.

71. Signal pathways, depending on the inhibition of the complex degradation of the latent gene regulator. Ligands, receptors, latent regulators, effectors of the canonical Wnt pathway, Hedgehog pathways, NFκB pathways.

72. Signaling and morphogenesis. The concept of morphogen, examples of signal substances capable of performing the role of morphogens. Mechanisms of cell response to the launch of the signal path. Positive and negative feedback (negative and positive feedback loops). Positive feedback as a mechanism for committing cells and memorizing signaling in subsequent generations, as well as providing different cell responses in the morphogen gradient. Adaptation or desensitization of cells. Adaptation through chemical modification of signaling components or down-

regulation of receptors. Methods of down-regulation of receptors (endocytosis: sequestration = internalization or degradation in endosomes). Internalization of receptors as a mechanism for the continuation of signaling inside the cell on the example of neuronal growth factor (NGF).

Evaluation approaches for current studying students results
Test questions on topics:

I. Proteins.

1. The concepts of "amino acid", "peptide", "protein".
2. The elemental composition and function of proteins in the body.
3. Basic physicochemical properties of amino acids. Role
functional groups.
4. Classification of amino acids on the biological role and structure
radical (20 essential amino acids)
5. Formation of the peptide bond underlying the construction
peptides and the primary structure of the protein molecule. Be able to
build and name a peptide.
6. The levels of the structural organization of the protein molecule (primary, secondary, tertiary and quaternary).
7. Physical and chemical properties of proteins.
8. Functional properties of proteins.
9. Classification of proteins.
10. The exchange of proteins. General concepts about metabolism and energy.
11. Anabolism and catabolism.
12. Nutritional value of proteins.
13. Protein cleavage. Proteolytic enzymes.
14. Ways of decomposition and formation of amino acids.
15. Neutralization of ammonia.
16. Biosynthesis of proteins. The main stages of the broadcast.

17. Regulation of protein biosynthesis.

18. Posttranslational transformations of proteins.

II.Vitamins

1. What substances belong to vitamins?

2. How do vitamins regulate metabolic processes?

3. Classification and nomenclature of vitamins.

4. What substances belong to provitamins? Give examples
turning provitamins into vitamins.

5. What substances belong to antivitamins? Examples of the use of antivitamins as medicines.

6. Water-soluble vitamins.

7. Fat-soluble vitamins.

III. Enzymes.

1. Enzymes - biological catalysts. The difference of enzymes from chemical catalysts.

2. The structure of the enzyme molecule: one-component and two-component enzymes.

3. Catalytic, substrate, allosteric centers in the enzyme molecule.

4. The mechanism of action of enzymes. Stage of the enzymatic reaction.

5. Properties of enzymes. The dependence of enzyme activity on temperature, pH. Effect of inhibitors and activators on enzyme activity. Specificity of enzymes, types of specificity.

6. Nomenclature and classification of enzymes.

7. Characteristics of all classes of enzymes.

8. Representation of catalysis (energy barrier, activation energy, etc.). Specify the role of enzymes in catalysis.

9. Name and describe ways of regulation of enzymatic activity (allosteric mechanisms, covalent modification, etc.).

10. Name the types of inhibition of their features.

IV. Nucleic acids.

1. What are the concepts: nucleic acid, nucleotide, nucleoside.

2. What caused the diversity of nucleotides in the composition
nucleic acids?

3. What are the features of the chemical composition of DNA and RNA nucleotides?

4. Describe the primary structure of nucleic acids, its connections forming.

5. What are the features of the secondary structure of DNA, the type of stabilizing bond, the complementarity of the bases.

6. Specify the features of the tertiary structure of DNA, the structural organization of DNA in the chromatin of the cell nucleus.

7. Characterize the secondary and tertiary structures of RNA, its functional types (m-RNA, t-RNA, r-RNA).

8. Name the physical and chemical properties of nucleic acids.

9. Replications. Transcription. The enzymes involved in these processes.

10. The exchange of nucleic acids.

11. Disintegration of nucleic acids to nucleotides. Enzymes that accelerate the breakdown of DNA and RNA.

12. Metabolism of mononucleotides. Disintegration of nitrogenous bases.

13. General idea about the mechanism of pyrimidine and purine-containing nucleotides biosynthesis.

14. The mechanism of biosynthesis of polynucleotide chains of nucleic acids and reproduction of their primary structure.

15. DNA replication. Its principles, mechanism. Types of replication.

sixteen. . Reverse transcription.

17. Biosynthesis of RNA. Transcription. Principles, transcription unit, transcription stages, Jacob and Mono operon.

V. Carbohydrates.

1. The elemental composition of carbohydrates.

2. Monosaccharides. General characteristics of monosaccharides. Aldoz, ketozy. Tautomeric transformations of monosaccharides. Pyranose, furanose. Stereoisomers. Monosaccharides used in the food industry. Derivatives of monosaccharides: esters, sugar alcohols, sugar acids, amino sugars. Oligosaccharides. General characteristics of oligosaccharides. Glycoside-glucose, glycoside glycosides: representatives, properties. Oligosaccharides used in the food industry.

3. Polysaccharides. General characteristics. Representatives, properties. Polysaccharides used in the food industry.

4. Functions of carbohydrates in the body of plants, animals, microorganisms, humans.

5. Fermentation. Breath.

6. Carbohydrate exchange.

7. Enzymatic cleavage of carbohydrates (hydrolase, phosphorylase).

8. Anaerobic and aerobic breakdown of carbohydrates. Glycolysis. Fermentation (lactic acid, alcohol).

9. CTK, energy, biological role (Krebs cycle).

10.Pentozny way of splitting carbohydrates and its biological significance.

11. The primary synthesis of carbohydrates. Gluconeogenesis.

12. Synthesis of polysaccharides.

VI. Lipids.

1. General lipid characteristics. Lipid functions

2. Classification of lipids.

3. Fats: the general formula, saturated, unsaturated fatty acids that make up fats, vegetable fats, animal fats. Simple and mixed fats. Rancid fats. Causes of rancid fats.

4. Wax. Chemical structure. Properties, functions in the body. Vegetable wax. Animal wax. The use of waxes in industry.

5. Steroids. Chemical composition, properties, main representatives.

6. Phospholipids (glycerophospholipids, sphingophospholipids, inositol phospholipids). Chemical composition, properties, functions. Application in industry.

7. Glycolipids. Chemical composition, properties, functions. Key representatives.

8. Lipid metabolism: hydrolysis of triglycerides, β-oxidation of fatty acids, biosynthesis of fatty acids (the main enzymes involved in these processes).

9. Lipid exchange.

10 Hydrolysis of fats in humans and animals. Hydrolysis enzymes. Fat storage.

11. The exchange of glycerol. The energy effect of glycerol oxidation.

12. Oxidation of higher fatty acids (α- and β-oxidation).

13. Acetyl – CoA exchange. Glyoxyl cycle, synthesis of acetoacetic acid and other processes.

13. The mechanism of biosynthesis of higher fatty acids.

14. Synthesis of triglycerides and phospholipids.

VII. Biological oxidation.

1. The concept of metabolism, catabolic and anabolic pathways.

2. Specify the relationship of metabolism and energy metabolism.

3. In what form does the energy enter the human body?

4. Name the stages of catabolism of nutrients in the body.

5. Name the role of ATP in cell metabolism and function. What is called the ATF-ADP cycle?

6. Name the concept of biological oxidation, its features and value of the process.

7. Specify the structure of mitochondria.

8. Describe the specific and non-specific stages of biological oxidation, their localization.

9. What enzymes play the role of primary hydrogen acceptors in the oxidation of substrates. Indicate the mechanisms of their functioning.

10. Name the forms of transformation of free energy: the formation of active forms of hydrogen (NADH-H +, etc.), the synthesis of "high-energy" compounds (ATP, 1,3-diphosphoglycerate, creatine phosphate, acyl-S-CoA, etc.).

11. Name the methods of phosphorylation (ATP synthesis) in biological oxidation.

12. Indicate the structure and functioning of the mitochondrial respiratory chain, the magnitude of the redox potential of electron carriers.

VIII. Blood biochemistry.

1. Compound blood components.
2. Biochemical features of blood cells.
3. Biochemical functions of blood.
4. Blood as a source of drugs.

Ix. Liver biochemistry.

1. Regulatory homeostatic function.
2. Urinary function.
3. Biliary function and excretory function.
4. Neutralizing function.
5. Disorders of the liver.

X. Biochemistry of the kidneys.

1. The mechanism of urine formation in different parts of the nephron.
2. Regulatory homeostatic function.
3. Neutralizing function.
4. Intra-secretory function.
5. Characteristics of urine components in health and disease.

Criteria for grading a student in the pass / exam

on discipline "Biochemistry":

Ponts	Score (standart)	Requirements for the generated competencies
85-100	«pass» / «exelent»	The grade "excellent" is given to the student, if he deeply and firmly mastered the program material, exhaustively, consistently, clearly and logically slender outlines him, is able to closely link theory with practice, freely copes with tasks, questions and other uses of knowledge, and not It is difficult to answer when modifying tasks uses in the response material monographic, correctly justifies the decision, owns versatile skills and techniques perform practical tasks.
76-85	«pass» / «good»	A grade of “good” is given to the student if he is firmly knows the material, correctly and essentially sets it out, not allowing significant inaccuracies in answering the question correctly applies theoretical positions when solving practical issues and tasks, owns necessary skills and techniques for their implementation.
61-75	«pass» / "satisfactory"	The grade "satisfactory" is given to the student if he has knowledge of only the basic material, but not assimilated its details, inaccurate, not enough correct formulations, logical violations sequences in the presentation of software material, is having difficulty doing practical work.
< 61	"not pass" / "not satisfactory"	A grade of "unsatisfactory" is given to a student who does not know much of the material, allows significant errors hesitantly, with great difficulty practical work.

Evaluation approuches for current student studing

Tasks:

THEME "PROTEINS AND ENZYMES"

Task 1.

Proteins that transport molecules or ions across the membrane are often classified as transmembrane proteins. Such proteins have, in their structure, a region enclosed in the lipid bilayer of the membrane, and regions that are turned inside the cell (into the cytoplasm) and into the extracellular space. Based on the classification of amino acids by the polarity of the radical, suppose which amino acids should prevail in different parts of this transmembrane protein.

Task 2.

Find what zone of pH (neutral, acidic or alkaline) is the IEP of the polypeptide consisting of the following amino acid residues: arg-gis-glucis. In

what direction will this peptide move when peptides are separated by electrophoresis in a buffer solution with a neutral pH? How will the charge and direction of movement of a peptide in an electric field change if arginine is replaced with leucine in the composition of the peptide?

Task 3.

It is known that eating raw eggs can cause vitamin H hypovitaminosis. The eggs contain avidin protein, which is able to interact with vitamin H and prevent its absorption in the gastrointestinal tract. Explain why boiled eggs do not have this effect?

THEME "NUCLEOPROTEIN EXCHANGE. PROTEIN SYNTHESIS"

Task 1.

The patient complains of repeated bouts of acute inflammation of the joints (most often small). Under the skin of the patient revealed education in the form of gouty nodes and the formation of stones in the urinary system.

a) Indicate the possible cause of the symptoms caused, the name of the disease. b) What biochemical parameters need to be determined to clarify the dignosis?

c) What are the causes of this disease and ways to correct it?

Task 2.

There is an enzyme in the rat liver, the polypeptide chain of which contains 192 amino acid residues. This enzyme is encoded by a gene comprising 1440 base pairs. Explain the relationship between the number of base pairs in the corresponding gene and the number of amino acids in the protein-enzyme.

Task 3.

There is no DNA in the composition of RNA-containing viruses; they contain only RNA, which acts as a viral chromosome. This means that in such viruses the genes are in the RNA, and not in the DNA. Does this refute the central dogma of molecular genetics? Justify your answer.

THEME “BIOLOGICAL OXIDATION. CYCLE CREBS”

Task 1.

Explain why during intensive physical work the rate of citrate cycle reactions is activated? Write the reaction, the rate of which increases. Explain why?

Task 2.

Directly in the reactions of the Krebs cycle, oxygen is not involved. However, the citrate cycle is an aerobic process. Explain why it is inhibited in the absence of oxygen.

Task 3.

In the experiment, acetyl CoA was added to the homogenate containing all the enzymes of the citrate cycle and the respiratory chain. What will measurement of the quantitative content of oxaloacetate and acetyl CoA show before and after incubation?

a) Did an increase in oxaloacetate occur? Explain the role of oxaloacetate in this process.

b) Has the acetyl CoA content changed? What happens to him in the Krebs cycle?

THEME "HORMONES"

Task 1.

The patient is treated with prednisone related to glucocorticoids. How will the metabolic processes in this patient?

Task 2.

The patient has a dramatically increased blood pressure, basal metabolic rate, sugar content, level of free fatty acids in the blood. The amount of adrenaline and norepinephrine in the blood plasma increased 500 times. Which organ pathology can you think of?

Task 3.

The pharmaceutical industry produces anabolic steroids - synthetic derivatives of androgens, almost devoid of androgenic properties, but stimulating oxidative phosphorylation, protein biosynthesis. Is it advisable for athletes to use to stimulate the development of muscles? Give us your opinion.

THEME "CARBON EXCHANGE"

Task 1.

What disaccharides can be formed from glycogen during its digestion in the gastrointestinal tract. List the enzymes that act on glycogen in the gastrointestinal tract. Give disaccharide formulas.

Task 2.

With hard work, muscle tissue consumes much more ATP than at rest. It is known that in white skeletal muscles, for example, in the muscles of the legs in a rabbit or turkey, almost all of this ATP is formed during anaerobic glycolysis. A muscle could work hard, i.e. with high speed to form ATP by glycolysis, if it lacked the enzyme lactate dehydrogenase? Argue your answer.

Task 3.

The graph in the figure shows the relationship between ATP concentration and phosphofructokinase activity, which is an allosteric enzyme. The activity of phosphofructokinase increases with increasing ATP concentration, but at some point a fracture occurs - a further increase in ATP concentration causes inhibition of the enzyme. Write the reaction equation catalyzed by this enzyme. Explain how ATP can be both a substrate and a phosphofructokinase inhibitor? How is the activity of this enzyme regulated by ATP? How is glycolysis regulated depending on ATP level?

THEME "LIPID EXCHANGE"

Task 1.

Symptoms of steatorrhea, characterized by an excess of lipids in the feces, can be due to two reasons: either insufficient secretion of bile acids, or lack of pancreatic secretion. Why do these causes lead to the appearance of lipids in the

feces? How can one distinguish which of these two causes underlies the disease based on stool analysis? Give an explanation.

Task 2.

In the patient's blood after it is stored in the refrigerator for 16 to 24 hours, a cream-like layer appears above the transparent serum. The blood has significantly increased triglycerides, the concentration of cholesterol is slightly increased. There are no clinical signs of atherosclerosis. To what type can this hyperlipoproteinemia be attributed? What is the mechanism of detected disorders in lipid metabolism?

Task 3.

Carbon dioxide is a mandatory participant in the biosynthesis of fatty acids. Explain what is the specific role of CO2? Will the palmitic acid formed during the incubation of the soluble fraction with 14CO2 and other components necessary for the biosynthesis of fatty acids contain 14C? Prove it.

THEME "EXCHANGE OF PROTEINS"

Task 1.

Healthy rats for a long time were kept on an artificial protein diet excluding TRIPTOFAN.

Will the nitrogen balance change in these animals? If it changes, HOW and WHY? Give a description of the nitrogen balance.

Task 2.

Healthy rats for a long time were kept on an artificial protein diet, excluding ALANIN and ASPART.

Will the nitrogen balance change in these animals? If it changes, HOW and WHY? Give a description of the nitrogen balance.

Task 3.

After administration of the amino acid SERINE containing the labeled atom (N15) in the α-position to the mice, it was found that the label quickly appears in the α-amino group of other amino acids of the liver.

Explain why this happens, arguing the answer with the appropriate scheme.

THEME: "LIVER BIOCHEMISTRY"

Task 1.

A patient with liver disease was admitted to the hospital. A study was made of urea in the blood.

a) What was the purpose of this analysis?

b) What enzymes can be detected in the blood to make sure that the liver is the disease?

c) What can be the definition of total bilirubin and its fractions?

d) What urine tests should be performed to confirm the diagnosis?

Task 2.

A young woman with a short period of pregnancy turned to the antenatal clinic for advice. A history of - transferred Botkin's disease. Among the recommendations of the doctor were the following: beware of taking smoked food, canned food, reduce intake of various medications, limit the use of cosmetics. Explain from a biochemical position the recommendations of the doctor.

Task 3.

The patient has 12 mmol / l of bilirubin in the blood, stercobilin was found in the feces, in the urine - traces of stercobilinogen, no bilirubin. a) What is the normal total bilirubin content?

b) What is the ratio of direct and indirect bilirubin normal?

c) What pigments are normally found in the urine?

d) Why is there no bilirubin in the urine?

Criteria for evaluation:

86-100 points are awarded to a student if he has successfully completed the assignment, had no difficulty in analyzing the work, made logically reasoned conclusions; Demonstrated knowledge and proficiency in independent research; did not make factual errors.

76-85 points are awarded to a student if he has successfully completed the work; made no more than 1 error in the analysis; Demonstrated knowledge and proficiency in independent research; did not make factual errors.

75-61 points are awarded to a student, if he, with the help of a teacher, coped with the task, had difficulty in analyzing work, made no more than 2 errors in analyzing work.

60-50 points are awarded to a student, if the work is performed without analysis, three or more than three mistakes are made in the analysis of work.

Test

INTRODUCTION TO BIOCHEMISTRY.

1.1 The amino group is found in:
1. proteins;
2. neutral fats;
3. carbohydrates;
4. amino acids;
5. nitrogenous bases.

1.2 Which of these compounds contain phosphorus?
1. simple proteins;
2. glycogen;
3. DNA;
4. mRNA;
5. amino acids;
6. nucleotides.

1.3 What is the structural element of simple proteins?
1. mononucleotides;
2. glucose;
3. amino acids;
4. glycerin.

1.4 The structural elements of nucleic acids are:
1. mononucleotides;
2. glucose;
3. glycerin;
4. amino acids.

1.5 Which of these compounds is hydrophobic?
1. simple protein;

2. neutral fat;
3. glycogen;
4. amino acids.

PROTEINS. STRUCTURE, PROPERTIES, FUNCTIONS.

2.1 Compare the solubility of the three pentapeptides at pH = 7. Arrange them in ascending order.

hydrophilic properties:

1) Leu - Phe - Lle - Gly - Val;

2) Glu - Asp - Ser - Phe - Lle.

3) Arg - Lys - Thr - His - Cys.

2.2 Arrange the elements of the structure of the protein molecule in the sequence in which they occur during protein synthesis and the formation of its native conformation.

1. Combining protomers into oligomeric protein.

2. The formation of α-helices and β-folded sections.

3. Formation of peptide bonds.

4. The formation of hydrophobic, hydrogen and ionic bonds between amino acid radicals.

2.3 Write the structural formula of the pentapeptide of the following structure:

His - Glu - Pro - Phe - Ser.

PROTEIN SYNTHESIS.

4.1. Specify the sequence of protein synthesis steps:

1. initiation of the ribosomal cycle;

2. post-translational processing;

3. transcription;

4. elongation of the ribosomal cycle;

5. termination of the ribosomal cycle;

6. posttranscriptional processing.

4.2. Specify the sequence of numbers of the processes going at the initial stage elongation of eukaryotic ribosomal cycle:

1. peptide bond is formed with the participation of peptidyl transferase, a dipeptide is formed;

2. A-site contains methionyl-tRNA;

3. the first aminoacyl-tRNA joined to the FE-1 and GTP is added to the P-site;

4. tRNA loses its connection with the amino acid radical and leaves the P-site;

5. peptidyl translocase, FE-2 and GTP energy is involved in the movement of the ribosome by 1 triplet;

6. The second aminoacyl-tRNA is added to the A site;

7. A-site becomes free.

Criteria for evaluation:

86-100 points are awarded to a student if he made no more than 1 error.

76-85 points are awarded to the student if he made 2-3 mistakes.

75-61 points are awarded to a student if he has made 4-5 mistakes.

60-50 points are awarded to a student if he has made more than 5 mistakes.

Interview Questions

Test questions on topics:

I. Proteins

1. The concepts of "amino acid", "peptide", "protein".

2. The elemental composition and function of proteins in the body.

3. Basic physicochemical properties of amino acids. Role
functional groups.

4. Classification of amino acids on the biological role and structure
radical (formula 20 essential amino acids)

5. Formation of the peptide bond underlying the construction
peptides and the primary structure of the protein molecule. Be able to
build and name a peptide.

6. The levels of the structural organization of the protein molecule (primary, secondary, tertiary and quaternary).

7. Physical and chemical properties of proteins.

8. Functional properties of proteins.

9. Classification of proteins.

10. The exchange of proteins. General concepts about metabolism and energy.

11. Anabolism and catabolism.

12. Nutritional value of proteins.

13. Protein cleavage. Proteolytic enzymes.

14. Ways of decomposition and formation of amino acids.

15. Neutralization of ammonia.

16. Biosynthesis of proteins. The main stages of the broadcast.

17. Regulation of protein biosynthesis.

18. Posttranslational transformations of proteins.

II.Vitamins

1. What substances belong to vitamins?

2. How do vitamins regulate metabolic processes?

3. Classification and nomenclature of vitamins.

4. What substances belong to provitamins? Give examples
turning provitamins into vitamins.

5. What substances belong to antivitamins? Examples of the use of antivitamins as medicines.

6. Water soluble vitamins.

7. Fat-soluble vitamins.

III. Enzymes.

1. Enzymes - biological catalysts. The difference of enzymes from chemical catalysts.

2. The structure of the enzyme molecule: one-component and two-component enzymes.

3. Catalytic, substrate, allosteric centers in the enzyme molecule.

4. The mechanism of action of enzymes. Stage of the enzymatic reaction.

5. Properties of enzymes. The dependence of enzyme activity on temperature, pH. Effect of inhibitors and activators on enzyme activity. Specificity of enzymes, types of specificity.

6. Nomenclature and classification of enzymes.

7. Characteristics of all classes of enzymes.

8. Representation of catalysis (energy barrier, activation energy, etc.). Specify the role of enzymes in catalysis.

9. Name and describe ways of regulation of enzymatic activity (allosteric mechanisms, covalent modification, etc.).

10. Name the types of inhibition of their features.

IV. Nucleic acids.

1. What are the concepts: nucleic acid, nucleotide, nucleoside.

2. What caused the diversity of nucleotides in the composition
nucleic acids?

3. What are the features of the chemical composition of DNA and RNA nucleotides?

4. Describe the primary structure of nucleic acids, its connections forming.

5. What are the features of the secondary structure of DNA, the type of stabilizing bond, the complementarity of the bases.

6. Specify the features of the tertiary structure of DNA, the structural organization of DNA in the chromatin of the cell nucleus.

7. Characterize the secondary and tertiary structures of RNA, its functional types (m-RNA, t-RNA, r-RNA).

8. Name the physico-chemical properties of nucleic acids.

9. Replications. Transcription. The enzymes involved in these processes.

10. The exchange of nucleic acids.

11. Disintegration of nucleic acids to nucleotides. Enzymes that accelerate the breakdown of DNA and RNA.

12. Metabolism of mononucleotides. Disintegration of nitrogenous bases.

13. General idea about the mechanism of pyrimidine and purine-containing nucleotides biosynthesis.

14. The mechanism of biosynthesis of polynucleotide chains of nucleic acids and reproduction of their primary structure.

15. DNA replication. Its principles, mechanism. Types of replication.

sixteen. . Reverse transcription.

17. Biosynthesis of RNA. Transcription. Principles, transcription unit, transcription stages, Jacob and Mono operon.

V. Carbohydrates.

1. The elemental composition of carbohydrates.

2.Monosaccharides. General characteristics of monosaccharides. Aldoz, ketozy. Tautomeric transformations of monosaccharides. Pyranose, furanose. Stereoisomers. Monosaccharides used in the food industry. Derivatives of monosaccharides: esters, sugar alcohols, sugar acids, amino sugars. Oligosaccharides. General characteristics of oligosaccharides. Glycoside-glucose, glycoside glycosides: representatives, properties. Oligosaccharides used in the food industry.

3. Polysaccharides. General characteristics. Representatives, properties. Polysaccharides used in the food industry.

4. Functions of carbohydrates in the body of plants, animals, microorganisms, humans.

5. Fermentation. Respiration.

6. Carbohydrate exchange.

7. Enzymatic cleavage of carbohydrates (hydrolase, phosphorylase).

8. Anaerobic and aerobic breakdown of carbohydrates. Glycolysis. Fermentation (lactic acid, alcohol).

9. CTK, energy, biological role (Krebs cycle).

10.Pentozny way of splitting carbohydrates and its biological significance.

11. The primary synthesis of carbohydrates. Gluconeogenesis.

12. Synthesis of polysaccharides.

VI. Lipids.

1. General lipid characteristics. Lipid functions

2. Classification of lipids.

3. Fats: the general formula, saturated, unsaturated fatty acids that make up fats, vegetable fats, animal fats. Simple and mixed fats. Rancid fats. Causes of rancid fats.

4. Wax. Chemical structure. Properties, functions in the body. Vegetable wax. Animal wax. The use of waxes in industry.

5. Steroids. Chemical composition, properties, main representatives.

6. Phospholipids (glycerophospholipids, sphingophospholipids, inositol phospholipids). Chemical composition, properties, functions. Application in industry.

7. Glycolipids. Chemical composition, properties, functions. Key representatives.

8. Lipid metabolism: hydrolysis of triglycerides, β-oxidation of fatty acids, biosynthesis of fatty acids (the main enzymes involved in these processes).

9. Lipid exchange.

10 Hydrolysis of fats in humans and animals. Hydrolysis enzymes. Fat storage.

11. The exchange of glycerol. The energy effect of glycerol oxidation.

12. Oxidation of higher fatty acids (α- and β-oxidation).

13. Acetyl – CoA exchange. Glyoxyl cycle, synthesis of acetoacetic acid and other processes.

13. The mechanism of biosynthesis of higher fatty acids.

14. Synthesis of triglycerides and phospholipids.

VII. Biological oxidation.

1. The concept of metabolism, catabolic and anabolic pathways.

2. Specify the relationship of metabolism and energy metabolism.

3. In what form does the energy enter the human body?

4. Name the stages of catabolism of nutrients in the body.

5. Name the role of ATP in cell metabolism and function. What is called the ATF-ADP cycle?

6. Name the concept of biological oxidation, its features and value of the process.

7. Specify the structure of mitochondria.

8. Describe the specific and non-specific stages of biological oxidation, their localization.

9. What enzymes play the role of primary hydrogen acceptors in the oxidation of substrates. Indicate the mechanisms of their functioning.

10. Name the forms of transformation of free energy: the formation of active forms of hydrogen (NADH-H +, etc.), the synthesis of "high-energy" compounds (ATP, 1,3-diphosphoglycerate, creatine phosphate, acyl-S-CoA, etc.).

11. Name the methods of phosphorylation (ATP synthesis) in biological oxidation.

12. Indicate the structure and functioning of the mitochondrial respiratory chain, the magnitude of the redox potential of electron carriers.

VIII. Blood biochemistry.

1. Compound blood components.

2. Biochemical features of blood cells.

3. Biochemical functions of blood.

4. Blood as a source of drugs.

IX. Liver biochemistry.

1. Regulatory homeostatic function.

2. Urinary function.

3. Biliary function and excretory function.

4. Neutralizing function.

5. Disorders of the liver.

X. Biochemistry of the kidneys.

1. The mechanism of urine formation in different parts of the nephron.
2. Regulatory homeostatic function.
3. Neutralizing function.
4. Intra-secretory function.
5. Characteristics of urine components in health and disease.

Criteria for evaluation.

100-85 points - if the answer shows a solid knowledge of the main processes of the subject area being studied, it is distinguished by the depth and completeness of the topic disclosure possession of terminological apparatus; the ability to explain the essence, phenomena, processes, events, draw conclusions and generalizations, give reasoned answers, give examples; fluency in monologue speech, consistency and consistency of response; ability to give examples of current problems of the studied area.

85-76 - points - the answer that reveals a solid knowledge of the basic processes of the studied subject area, is distinguished by the depth and completeness of the disclosure of the topic; possession of terminological apparatus; the ability to explain the essence, phenomena, processes, events, draw conclusions and generalizations, give reasoned answers, give examples; fluency in monologue speech, consistency and consistency of response. However, one or two inaccuracies in the response are allowed.

75-61 point - the answer is evaluated, which testifies mainly about the knowledge of the processes of the studied subject area, which is characterized by insufficient depth and completeness of the topic disclosure; knowledge of the main issues of the theory; poorly formed skills of analyzing phenomena, processes, insufficient ability to give reasoned answers and give examples; not enough fluency in monologue speech, logic and consistency of response. Several errors in the content of the response are allowed; inability to give an example of the development of a situation, to connect with other aspects of the studied area.

60-50 points - the answer that reveals the ignorance of the processes of the studied subject area, characterized by a shallow disclosure of the topic; ignorance of the main issues of the theory, unformed skills of analyzing phenomena, processes; the inability to give reasoned answers, poor knowledge of monologic speech, lack of consistency and consistency. Serious errors are made in the content of the response; ignorance of modern problems of the studied area.