

MINISTRY OF HEALTH OF UKRAINE  
KHARKIV NATIONAL MEDICAL UNIVERSITY

**Department of Biochemistry**

2021-2022

**SYLLABUS OF EDUCATION COMPONENT**

**BIOLOGICAL CHEMISTRY**

**Normative educational component**

Format of education	mixed
Field of knowledge	22 “Healthcare” (code and title of discipline)
Specialty	222 “Medicine” (code and title of discipline)
Education-professional programme	“Medicine” second (Master) level
Course	Second

Approved by the Department of Biochemistry

Protocol #18  
d.d. August 30, 2021

Head of the Department

OA Nakonechna

August 30, 2021

Approved by the KhNMU Methodical  
Committee on General and Preprofessional  
Training

Protocol #01  
d.d. August 31, 2021

Head

OY Vovk

August 31, 2021

Compilers:

Hanna Polikarpova, PhD, Associate Professor,  
Svitlana Stetsenko, PhD, Associate Professor.

**INFORMATION ABOUT LECTURERS WHO TEACH  
EDUCATIONAL COMPONENT**

***Nakonechna Oksana Anatoliivna*** - Doctor of Medical Sciences, Professor, Head of the Department of Biological Chemistry. Contact phone: 050 632 6387; E-mail: [Oksana.nakonechna69@gmail.com](mailto:Oksana.nakonechna69@gmail.com)

***Popova Liudmila Dmytrivna*** - Doctor of Biological Sciences, Professor of the Department of Biological Chemistry. Contact phone: 0984285463; Email: [popova\\_ld@ukr.net](mailto:popova_ld@ukr.net)

***Popova Tetyana Mykhailivna*** - Candidate of Medical Sciences, Associate Professor of the Department of Biological Chemistry. Contact phone: 0978136061; Email: [popovatatyanamikh@gmail.com](mailto:popovatatyanamikh@gmail.com)

***Denysenko Svitlana Andriivna*** - Candidate of Biological Sciences, Associate Professor of the Department of Biological Chemistry. Contact phone: 0962923473; Email: [svet.deni@ukr.net](mailto:svet.deni@ukr.net)

***Tkachenko Anton Sergeevich*** - Candidate of Medical Sciences, Associate Professor of Biological Chemistry. Contact phone: 0501094554; Email: [antontkachenko555@gmail.com](mailto:antontkachenko555@gmail.com)

***Polikarpova Hanna Valeriyivna*** - Candidate of Biological Sciences, Associate Professor of the Department of Biological Chemistry. Contact phone: 0632303792; Email: [h.polikarpova@yahoo.com](mailto:h.polikarpova@yahoo.com)

***Bondareva Alla Volodymyrivna*** - Candidate of Biological Sciences, Associate Professor of the Department of Biological Chemistry. Contact phone: 066 877 7345; Email: [bondareva.alla@i.ua](mailto:bondareva.alla@i.ua)

***Vasileva Iryna Mykhailivna*** - Candidate of Biological Sciences, Associate Professor of the Department of Biological Chemistry. Contact phone: 067 928 9666; Email: [vasilevaira@ukr.net](mailto:vasilevaira@ukr.net)

***Yarmysh Natalia Vasylivna*** - Candidate of Biological Sciences, Assistant of the Department of Biological Chemistry. Contact phone: 050 575 5709; Email: [biochimiyaforever@gmail.com](mailto:biochimiyaforever@gmail.com)

***Bezrodna Anastasia Igorivna*** - Candidate of Biological Sciences, Assistant of the Department of Biological Chemistry. Contact phone: 0932046754; Email: [bezrodnaya.ai@gmail.com](mailto:bezrodnaya.ai@gmail.com)

***Hoidina Valeriya Serhiivna*** - Assistant of the Department of Biological Chemistry. Contact phone: 093 535 8129; Email: [zampatriot1@gmail.com](mailto:zampatriot1@gmail.com)

**Contact phone and Email of the Department:** phone (057)707-73-71, [kaf.1med.biokhimii@kntmu.edu.ua](mailto:kaf.1med.biokhimii@kntmu.edu.ua)

**Offline consultations:** schedule and venue according to the schedule of the department.

**Online consultations:** schedule and venue by prior arrangement with the teacher.

**Location:** classes are held in the main building of KhNMU, Department of Biological Chemistry.

## INTRODUCTION

**The syllabus of "Biological Chemistry" discipline** is compiled in accordance with the Education professional programme (hereinafter – the EPP) “Medicine” and project of Standard of Higher Education of Ukraine (hereinafter - the Standard) for the second (Master's) level of higher education in the field of knowledge 22 "Healthcare" and specialty 222 "Medicine".

**Description of the discipline (abstract):** the academic discipline "Biological chemistry" is taught for second-year students in two semesters. To study the academic discipline 6.0 ECTS credits, i.e. 180 hours, is provided (122 hours for practical classes and 58 hours for self-study). The discipline programme is structured into four parts.

**The subject of the study of the discipline** is the chemical composition of living organisms (human body) and biochemical transformations of molecules that occur in living organisms.

**Interdisciplinary relationships:** biological chemistry as an educational discipline:

a) is based on the study of medical biology, biophysics, medical chemistry, morphological disciplines and integrates with these disciplines;

b) provides the basis for students to study molecular biology, genetics, physiology, pathology, general and molecular pharmacology, toxicology and propaedeutics of clinical disciplines, which involves the integration of teaching these disciplines and the formation of abilities to apply knowledge of biological chemistry, primarily biochemical processes taking place in the body of healthy and ill individuals in the process of further education and professional activity;

c) underlies the clinical diagnosis of the most common diseases, monitoring the course of the disease, monitoring the effectiveness of treatment and measures aimed at preventing pathological processes;

d) the obtained theoretical knowledge, practical skills in the discipline form the clinical thinking of students and will be used in the study of the elective course "Clinical Biochemistry" by fourth-year students.

**Prerequisites.** The study of the discipline involves the prior mastering of disciplines in medical biology, biophysics, medical and bioorganic chemistry, morphological disciplines.

**Postrequisites.** The main provisions of the discipline should be applied in the study of related disciplines during the next years of study, is the basis for preparation for the licensing exam EDKI, preparation for study in higher education institutions in the programs of the third educational and scientific level of higher education.

**Discipline page in Moodle system:**

<http://distance.knmu.edu.ua/course/view.php?id=2562>

## **1. AIM AND TASKS OF THE DISCIPLINE**

**1.1. The aim** of teaching the discipline "Biological chemistry" is a systematic study of the chemical composition, structural organization and properties of bioorganic compounds, which are components of cells, tissues and organs of the human body, patterns of metabolism and energy at the molecular level in healthy and diseased organisms and the formation on this basis biochemically - the scientific thinking necessary for successful training of specialists who possess a considerable volume of

theoretical and practical knowledge concerning the chemical bases of life: chemical composition of organic compounds and the nature of metabolic processes occurring in the human body and provision of theoretical basis for the study of other medical and biological disciplines.

**1.2 The main tasks** of studying the discipline "Biological Chemistry" are: to find out features of metabolic transformations in living organisms; to acquire knowledge of hallmarks of protein, nucleic acid, carbohydrate, lipid, enzyme, vitamin, hormone synthesis; to master the basic catabolic cycles of bioorganic molecules; to study the main regulatory mechanisms that carry out the integration of all metabolic pathways for the transformation of bioorganic molecules; to give students an idea of modern trends and directions of fundamental-scientific and applied researches in biochemistry and related sciences for future professional orientation.

**1.3 Competences and results of training** whose formation is facilitated by the discipline (interconnection with the normative content of the training of higher education graduates formulated in terms of the results of training in the Standard).

**1.3.1.** According to the requirements of the Standard, the discipline ensures acquisition of the following **competences**:

- *integral*: the ability to solve typical and complex specialized tasks and practical problems in the professional activity or in the process of learning, apply the acquired knowledge, skills, abilities and personal qualities, values to perform the task of any level of complexity during professional activity or training.

- *general*: the ability to apply knowledge in practical situations; knowledge and understanding of the subject and understanding of the profession; ability to self-regulate and lead a healthy lifestyle, ability to adapt and act in a new situation; ability to choose communication strategy; ability to work in a team; interpersonal skills; ability to speak native language both orally and in writing; ability to speak second language; skills of using information and communication technologies; ability to abstract thinking, analysis and synthesis, ability to learn and be modernly trained; ability to apply knowledge in practical situations; ability to evaluate and ensure the quality of work performed; determination and persistence in terms of tasks and responsibilities; ability to act socially responsibly and socially consciously; the desire to preserve the environment.

- *special (professional)*: ability to interpret the results of laboratory and instrumental research; ability to process state, social, economic and medical information; ability to assess the impact of the environment on the health of the population; ability to assess the impact of socio-economic and biological determinants on the health of the individual, family, population.

**1.3.2** The study of the discipline provides students with the acquisition of the following **program learning outcomes**:

PLO 1. Possess general and special fundamental and professionally-oriented knowledge, skills, abilities, competencies necessary to perform typical professional tasks related to activities in the medical field in the relevant position.

PLO 3. Apply the acquired knowledge, skills and understanding to solve typical problems of the doctor, the scope of which is provided by lists of syndromes and symptoms, diseases, emergencies, laboratory and instrumental research, medical manipulations.

PLO 5. Evaluate the results of surveys, physical examinations, laboratory and instrumental research data.

PLO 7. Determine the nature and principles of disease treatment.

PLO 16. Assess the impact of the environment on public health.

PLO 18. Assess and support human health, taking into account the impact of the environment and other health factors.

**1.3.3.** The study of this discipline forms **social skills** among applicants for education:

- communicativeness (implemented through: the method of working in groups and brainstorming in the analysis of biochemical cases, the method of presenting the results of independent work and their protection in a group)
- team work (implemented through: group work method and brainstorming in the analysis of biochemical cases),
- conflict management (implemented through: business games),
- time management (implemented through: the method of self-organization in classroom work in groups and independent work),
- leadership skills (implemented through: the method of presenting the results of independent work and their protection in a group).

## 2. INFORMATIONAL VOLUME OF DISCIPLINE

Parameters	Field of knowledge, specialty, educational and qualification level, EPP	Characteristics of discipline	
		Full day courses	
Number of credits 6.5	Field of knowledge 22 'Healthcare' (шифр і назва)	Normative	
Total number of hours – 180	Specialty 222 'Medicine' (шифр і назва)	<b>Course:</b>	
		2	
		<b>Semester</b>	
		3	4
Hours for full day (or part-time evening) courses: practical – 122 Self-study – 58	Educational and qualification level : Master  EPP "Medicine"	<b>Lectures</b>	
		16 hours	14 hours
		<b>Practical classes, seminars</b>	
		52 hours	40 hours
		<b>Self-study</b>	
37 hours	21 hours		
		<b>Control type:</b> <i>exam</i>	

## 2.1 Subject description

### 2.2.1 Lecture topics

№	Titles	Number of hours	Types of lectures
1.	Introduction to biochemistry. Biochemistry of enzymes.	2	Informational (thematic)
2.	General characteristics of vitamins. Fat-soluble and water-soluble vitamins. Vitamin-like substances. Antivitamins.	2	
3.	Bioenergetic processes: biological oxidation, oxidative phosphorylation, ATP synthesis. Basic features of metabolism regulation. Common catabolic pathways: pyruvate oxidative decarboxylation, tricarboxylic acid cycle.	2	
4.	Biochemistry of hormones.	2	
5.	Digestion and absorption of carbohydrates in the gastrointestinal tract. Glycogen metabolism. Anaerobic and aerobic glucose oxidation. Gluconeogenesis.	2	
6.	Pentose phosphate glucose oxidation pathway. Metabolism of fructose and galactose. Metabolism of glycosaminoglycans. Regulation and disorders of carbohydrate metabolism.	2	
7.	Digestion and absorption of lipids in the gastrointestinal tract. Transport forms of lipids. Metabolism of triacylglycerols and phospholipids.	2	
8.	Metabolism of fatty acids and ketone bodies. Glycerol metabolism. Cholesterol metabolism. Regulation and disorders of lipid metabolism.	2	
9.	Digestion and absorption of proteins in the gastrointestinal tract. Protein putrefaction in the intestine. Amino acid pool of tissues. Common pathways of amino acid metabolism. Decarboxylation of amino acids.	2	
10.	Deamination and transamination of amino acids. Ammonia metabolism. Specific metabolism of amino acids.	2	
11.	Functions and metabolism of nucleotides, its possible disorders. Analysis of endogenous nitrogen end products.	2	
12.	Biosynthesis of nucleic acids and proteins. Transfer of genetic information. Fundamentals of molecular genetics.	2	
13.	Blood functions. Physico-chemical properties and chemical composition of blood. Biochemical composition of blood under normal and pathological conditions.	2	
14.	Biochemistry of RBCs. Biochemistry and pathobiochemistry of Hb.	2	
15.	Water-salt and mineral metabolism. Regulation. Disorders. Biochemistry of kidneys and urine.	2	
<b>Total number of hours</b>		<b>30</b>	

### 2.2.2 Topics of seminars

Not included in the curriculum.

### 2.2.3 Topics of practical classes

№	Titles	Number of hours	Learning methods	Forms of control
1.	Introduction to biochemistry. Development of biochemistry as a science. Biochemical components of the cell. Safety rules in biochemical laboratory.	2	Verbal (lecture, conversation), visual (illustration), practical (independent work, case-method, brainstorming, pair work, group work, test tasks)..	Oral examination (individual and frontal); written survey; test control.
2.	Basics of biocatalysis. Structure, physical and chemical properties of enzymes. Classification and nomenclature of enzymes.	2		
3.	Mechanism of action and determination of activity of enzymes. Kinetics of enzymatic catalysis.	2		
4.	Regulation of enzymatic processes. Inhibitors and activators of enzymes. Medical enzymology.	2		
5.	General characteristics of hormones. Fat-soluble vitamins.	4		
6.	Water-soluble vitamins. Vitamin-like substances. Antivitamins.	4		
7.	Bioenergetic processes: biological oxidation, oxidative phosphorylation, ATP synthesis. Chemiosmotic theory of oxidative phosphorylation. Inhibitors and uncouplers of oxidative phosphorylation.	4		
8.	Basic principles of metabolism. Common catabolic pathways: pyruvate oxidative decarboxylation, tricarboxylic acid cycle.	2		
9.	<i>Control work on part I.</i>	2		
10.	General characteristics of hormones. Hypothalamic-pituitary hormones.	4		
11.	Protein-peptide hormones and amino acid derivatives.	2		
12.	Steroid hormones. Eicosanoids.	2		
13.	Digestion and absorption of carbohydrates in the gastrointestinal tract. Glycogen metabolism. Blood glucose level and its regulation.	2		
14.	Anaerobic and aerobic glucose oxidation. Gluconeogenesis.	2		
15.	Pentose phosphate glucose oxidation pathway. Metabolism of fructose and galactose. Metabolism of glycosaminoglycans. Regulation and disorders of carbohydrate metabolism.	4		
16.	Digestion and absorption of lipids in the gastrointestinal tract. Resynthesis of triacylglycerols in the intestine. Transport forms of lipids.	4		
17.	TAG and phospholipid metabolism.	2		
18.	Metabolism of fatty acids and ketone bodies.	2		



	Glycerol metabolism.		Verbal (lecture, conversation), visual (illustration), practical (independent work, case-method, brainstorming, pair work, group work, test tasks)..	Oral examination (individual and frontal); written survey; test control.
19.	Cholesterol metabolism. Regulation and disorders of lipid metabolism.	2		
20.	<i>Control work on part 2.</i>	2		
21.	Digestion and absorption of proteins in the gut. Protein putrefaction.	2		
22.	Tissue proteolysis. Amino acid pool. Common pathways of amino acid metabolism. Decarboxylation of amino acids.	2		
23.	Amino acid deamination and transamination.	2		
24.	Ammonia metabolism: sources, mechanisms of detoxification, transport forms. Ornithine cycle of urea synthesis (Krebs-Henseleit cycle). Biological role of urea synthesis in the liver. Disorders of ornithine cycle. Formation of ammonium salts in kidneys.	2		
25.	Specific metabolism of amino acids. Pathways of metabolism of amino acid carbon skeletons; relationships with the Krebs cycle. Glycogenic and ketogenic amino acids. Metabolism of phenylalanine, tyrosine and tryptophan.	4		
26.	Metabolism of glycine and serine, arginine, methionine and cysteine, dicarboxylic amino acids and branched-chain amino acids. Glutathione as a product of glycine, glutamate and cysteine metabolism. Nitric oxide as an arginine metabolism product. Creatine as a product of metabolism of arginine, glycine and methionine.	4		
27.	Functions and metabolism of nucleotides, its possible disorders. Analysis of nitrogen metabolism end products.	4		
28.	Biosynthesis of nucleic acids and proteins (template biosynthesis). Transfer of genetic information. Basics of molecular genetics.	2		
29.	<i>Control work on part 3.</i>	2		
30.	Blood functions. Physical and chemical properties and chemical composition of blood. Buffer systems, mechanism of action and role in maintaining the acid-base balance. Blood plasma proteins, their role.	4		
31.	Biochemical composition of blood under normal and pathological conditions. Blood plasma enzymes. Non-protein organic nitrogen-containing and nitrogen-free substances of blood plasma. Inorganic components of plasma blood. Kallikrein-kinin system.	2		
32.	Biochemistry of RBCs. Structure, features and role of Hb.	2		

33.	Metabolism of hemoglobin; its synthesis and breakdown. Iron metabolism, its role in the formation of heme. Porphyrins and hemoglobinoses (hemoglobinopathies, thalassemias). Jaundices.	2	Verbal (lecture, conversation), visual (illustration), practical (independent work, case-method, brainstorming, pair work, group work, test tasks)..	Oral examination (individual and frontal); written survey; test control.
34.	Water-salt and mineral metabolism. Regulation. Disorders.	2		
35.	Biochemistry of kidneys and urine. Physical and chemical properties and chemical composition of urine in normal conditions. Pathological components of urine. Biochemical study of urine.	2		
36.	Biochemistry of tissues (liver, muscles, connective tissue). Biotransformation of xenobiotics and endogenous toxins.	2		
37.	<i>Control work on part 4.</i>	2		
<b>Total number of hours</b>		<b>92</b>		

### 2.2.4 Topics of laboratory works

Not included in the curriculum.

### 2.2.5 Self-study

№ 3/П	Topics	Number of hours	Learning methods	Forms of control
<b><i>Part 1. General principles of metabolism.</i></b>				
1.	<b><i>Topic 1.</i></b> Connection of biochemistry with other medical and biological sciences. Clinical biochemistry. Biochemical laboratory diagnostics. History of biochemistry and development of biochemical research in Ukraine. Chemical composition of living organisms, its features compared with objects of inanimate nature. Chemical composition of the human body. Biochemical components of cells (biomolecules), their biochemical functions. Structure of prokaryotic and eukaryotic cells. Autotrophic and heterotrophic organisms.	2	Practical (self-study)	Oral examination (individual and frontal); written survey; test control.
2.	<b><i>Topic 2.</i></b> Oligomeric proteins, enzymes, multi-enzyme complexes and membrane-associated enzymes. Isoenzymes: features of the structure, localization of synthesis in the human body (for example, isoenzymes of lactate dehydrogenase, creatine phosphokinase); role in diagnosis of diseases.	2		
3.	<b><i>Topic 3.</i></b> Kinetics of enzymatic reactions: influence of the concentration of substrate and enzyme on the rate of enzymatic reaction (graphic dependence). Michaelis-Menten equation. Michaelis constant, its definition and meaning.	2		
4.	<b><i>Topic 4.</i></b> Enzymodiagnosics in cardiology, hepatology, nephrology, urology, oncology, pulmonology,	2	Practical (self-	Oral examination

	orthopedics, etc. Disorders of enzymatic processes: hereditary and acquired enzymopathies, inborn errors of metabolism, clinical and laboratory diagnostics. Enzyme therapy: pharmacological application of enzymes of the gastrointestinal tract, coagulant and fibronolytic blood systems, kallikrein-kinin and renin-angiotensin systems. Inhibitors of enzymes as medicines.		study)	on (individual and frontal); written survey; test control.
5.	<b>Topic 5.</b> The history of the discovery of vitamins, the role of scientists in the development of vitaminology. Exogenous and endogenous hypo- and avitaminosis. Clinical and biochemical aspects of avitaminosis. Vitamin F (complex of polyunsaturated fatty acids): the structure of the components of the complex, participation in the metabolism; sources, daily requirements, symptoms of insufficiency.	2		
6.	<b>Topic 6.</b> General characteristics of vitamin-like substances; the role of carnitine, ubiquinone and lipoic acid in metabolism. Antivitamins; features of structure and action; use in medicine.	2		
7.	<b>Topic 7.</b> ATP-synthetase in mitochondria, structure and principles of functioning. Chemiosmotic theory of oxidative phosphorylation. Pathways of ATP synthesis in cells. Tissue respiration. Respiratory control. Disorders of ATP synthesis under the influence of pathogenic factors of chemical, biological and physical origin.	3		
8.	<b>Topic 8.</b> Exergonic and endergonic biochemical reactions; the role of ATP and other macroergic phosphates in processes that occur with the release and storage of energy. Methods of studying metabolism.	2		
<b>Part 2. Biochemistry of hormones. Carbohydrate and lipid metabolism.</b>				
9.	<b>Topic 1.</b> Methods of studying hormones. Guanylate is a cyclic messenger system, the structure of GTP, and cyclic 3',5'-GMP. The role of hormones in the mechanisms of self-regulation, which support the dynamic constancy of the internal environment. The family of proopiomelanocortin (POMC) and products of POMC processing (adrenocorticotropin, lipotropin, endorphins).	2		
10.	<b>Topic 2.</b> Gastrointestinal hormones: gastrin, secretin, cholecystokinin. General characteristics of thymic hormones; their structure and role.	2		
11.	<b>Topic 3.</b> Clinical application of agonists and antagonists of sex hormones. Biological and pharmacological properties of eicosanoids, their clinical application; acetylsalicylic acid and other non-steroidal anti-inflammatory drugs as inhibitors of prostaglandin synthesis.	2		
12.	<b>Topic 4.</b> The role of carbohydrates in the life of the organism. The most important carbohydrate represen-	2	Practical (self-	Oral examinati

	tatives, their chemical structure, properties, biological significance. The energy value of carbohydrates. Daily human need in carbohydrates. Blood glucose. Regulation of blood glucose level. Methods of determining the content of glucose in blood and urine, their significance.		study)	on (individual and frontal); written survey; test control.
13.	<b>Topic 5.</b> Alcoholic and other types of fermentation. Relationship of anaerobic and aerobic ways of glucose oxidation in cells. Pasteur effect. Interconnection and reciprocal regulation of glycolysis and gluconeogenesis in the body. Glucose-lactate and glucose-alanine cycles.	2		
14.	<b>Topic 6.</b> Glycosaminoglycans: structure, role; general understanding of metabolism. Effects of glucagon, adrenaline, glucocorticoids, somatotropin and insulin on the level of glucose in the blood. Changes in carbohydrate metabolism in hypoxic states. Hypoglycemia in newborns. Disorders of carbohydrate metabolism associated with insufficiency of disaccharides (lactase, maltase, sucrase). Hereditary disorders of glycogen metabolism (glycogen storage diseases).	2		
15.	<b>Topic 7.</b> Lipids: biological role, classification, structure and function of simple lipids, structure and function of complex lipids (phospholipids and glycolipids). Resynthesis of fats in the epithelial cells of the intestine; its significance; the role of $\beta$ -MAG in this process.	2		
16.	<b>Topic 8.</b> Metabolism of phosphoglycerols and sphingolipids. Genetic abnormalities of sphingolipid metabolism - sphingolipidoses. Lysosomal diseases: Niemann-Pick disease, Tay-Sax disease, Gaucher disease.	2		
17.	<b>Topic 9.</b> Biosynthesis of monounsaturated fatty acids in the human body. Glycerol metabolism: oxidation to $\text{CO}_2$ and $\text{H}_2\text{O}$ ; conversion to carbohydrates.	2		
18.	<b>Topic 10.</b> Regulation of lipid metabolism. Pathology of lipid metabolism: steatorrhea, obesity, atherosclerosis, hyperlipoproteinemia. Abnormal lipid metabolism in obesity, diabetes mellitus.	2		
<b>Part 3. Metabolism of proteins and nucleic acids.</b>				
19.	<b>Topic 1.</b> Clinical and diagnostic significance of gastric juice analysis. Risk factors for the development of gastric ulcers and tumors. Diagnostic significance of qualitative determination of lactic acid in gastric juice.	1		
20.	<b>Topic 2.</b> Scheme of major pathways of replenishment and use of amino acid pool; the main classes of organic compounds formed from amino acids.	1		
21.	<b>Topic 3.</b> Deamination of serine, threonine, cysteine and histidine.	1		
22.	<b>Topic 4.</b> Role of alanine in ammonia transport. Formation of ammonium salts in the kidneys, its significance.	1		
23.	<b>Topic 5.</b> Physiological significance and regulation of gluconeogenesis from amino acids. Ketogenic and	1		

	glycogenic amino acids.			
24.	<b>Topic 6.</b> Scheme of arginine metabolic pathways; Nitric oxide as a product of arginine metabolism, its role in the body. Metabolism of dicarboxylic amino acids.	1	Practical (self-study)	Oral examination (individual and frontal); written survey; test control.
25.	<b>Topic 7.</b> Nucleotides, their structure and role in the body. Digestion and absorption of nucleoproteins. Synthesis of deoxyribonucleotides. Interconnection between metabolism of proteins and nucleic acids. End products of purine and complex protein (nucleoproteins) catabolism. Nitrogen balance, its types.	4		
26.	<b>Topic 8.</b> Regulation of gene expression in prokaryotes. Features of the molecular organization of DNA and genome expression in eukaryotes. Genetic recombinations in prokaryotes. Biological significance and mechanisms of DNA repair. Repair of UV-induced gene mutations; xeroderma pigmentosum. Gene engineering or recombinant DNA technology: general concepts, biomedical significance. Technology of gene transplantation and obtaining hybrid DNA molecules. Gene cloning. Mutations: genomic, chromosomal, genetic; role in enzymopathies and hereditary diseases.	4		
<b>Part 4. Functional biochemistry.</b>				
27.	<b>Topic 1.</b> Immunoglobulins, structure, function. Acute phase proteins, clinical and diagnostic significance of their determination.	1		
28.	<b>Topic 2.</b> Inorganic blood components: content, role. Kallikrein-kinin system, its role in the body; drugs as inhibitors of kallikrein and kinin formation.	1		
29.	<b>Topic 4.</b> Iron. Its role and metabolism in the body, daily requirements. Hemoglobinoses: hemoglobinopathies and thalassemia; causes. Physiological neonatal jaundice.	1		
30.	<b>Topic 5.</b> Humoral regulation of water-salt metabolism. Phosphate-calcium metabolism, role of hormones and vitamins in its regulation.	1		
31.	<b>Topic 6.</b> Functions of kidneys and features of metabolism. Biochemical mechanisms of kidney function regulation.	1		
32.	<b>Topic 7.</b> Role of the liver in metabolism of carbohydrates, lipids, proteins, pigments. Types of conjugation of xenobiotics in hepatocytes: biochemical mechanisms, functional significance. Elimination of the products of xenobiotic biotransformation from the body. Bioenergy of muscle tissue; ATP sources; role of creatine phosphate in providing muscle contraction energy. Changes in muscles in muscular dystrophy, hypodynamia, avitaminosis E. Major classes of glycosaminoglycans, their structure and functions.	2		
<b>Total number of hours</b>		<b>58</b>		

### 3. EVALUATION CRITERIA

**3.1.** Evaluation of educational success of students is carried out on the basis of the current "Instructions for evaluating the educational activities of students of KhNMU".

***Evaluation of current control (PC)***

The assessment is carried out in each class (except lectures). According to the results of mastering of each theme is set evaluation using a 4-point scale

***Evaluation of concluding class (CC)***

1. Solving basic tests that cover the content of educational material to one outcome (90.% correctly solved tasks). 2. Evaluation development of practical skills (evaluation criteria - "fulfilled" or "not fulfilled"); 3. Solution theoretical issues included in the concluding classes (CC) (evaluation using a 4-point scale is set). If there are unsatisfactory marks in the CC themes the teacher must provide the possibility for the student to answer some additional question from the topic of these classes with following put this mark to the "Register of the work of the academic group" and ER.

***Evaluation of current educational activity (CEA)***

CEA is the educational activity of students during semester. CEA is suggested to be performed if the student worked off all missed classes and lectures and the middle score for all practice classes is 3 scores and more in the current semester. In this case the mark "worked off" and the middle score by the 4-point scale (**calculated automatically by ER**) or "unworked" if the student has unworked classes or his middle score is less than 3 are put into the grade sheet.

***Evaluation of student self-work (SSW)***

Studying of themes to be submitted only on self-work is checked during the concluding class and exam.

***Total educational activity (TEA)***

TEA is the educational activity of students during all period of the subject studying to be finished by the mark with the form of control "exam". TEA is suggested to be performed if all missed classes and lectures are worked off and the middle score for all topics of CC and PC is 3 scores and more. The scores for TEA are calculated as the all scores for all topic per all semester average (accurate to hundredths) by the table "Conversion of the average mark for the current control to the multi-score scale (for the subjects finished by DC or exam)" **automatically by ER**. TEA is evaluates from 70 till 120 scores.

4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale
5	120	4.45-4,49	107	3.91-3,94	94	3.37-3,4	81
4.95-4,99	119	4.41-4,44	106	3.87-3,9	93	3.33- 3,36	80
4.91-4,94	118	4.37-4,4	105	3.83- 3,86	92	3.29-3,32	79
4.87-4,9	117	4.33-4,36	104	3.79- 3,82	91	3.25-3,28	78
4.83-4,86	116	4.29-4,32	103	3.74-3,78	90	3.21-3,24	77
4.79-4,82	115	4.25- 4,28	102	3.7- 3,73	89	3.18-3,2	76
4.75-4,78	114	4.2- 4,24	101	3.66- 3,69	88	3.15- 3,17	75
4.7-4,74	113	4.16- 4,19	100	3.62- 3,65	87	3.13- 3,14	74
4.66-4,69	112	4.12- 4,15	99	3.58-3,61	86	3.1- 3,12	73
4.62-4,65	111	4.08- 4,11	98	3.54- 3,57	85	3.07- 3,09	72
4.58-4,61	110	4.04- 4,07	97	3.49- 3,53	84	3.04-3,06	71
4.54-4,57	109	3.99-4,03	96	3.45-3,48	83	3.0-3,03	70

4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale	4-point scale	200-point scale
4.5-4,53	108	3.95- 3,98	95	3.41-3,44	82	Less than 3	Insufficiently

### *Evaluation of individual tasks (IT)*

IT is evaluated in scores (no more 10) to be added to the scores for TEA after subject finishing. Sum of scores for TEA and IT can not exceed 120 points.

### *Evaluation of discipline*

Admission to the exam as the mean scores for TEA and IT from 70 till 120, in condition of absence of missed classes or lectures. The missed classes must be worked off obligatory. Exam is marked from 50 till 80 scores. The mark for discipline is the sum score for TEA, IT and exam and count 120-200 scores.

### *Exam*

1. Solving a package of tests on the penultimate lesson (criterion evaluation - 90% correctly solved problems, "passed - filled"). 2. Evaluation of practical skills (according to the criteria "fulfilled", "not fulfilled"). 3. Evaluation of theoretical knowledge by the table

Number of questions	«5»	«4»	«3»	Oral answer for question cards including theoretical part of discipline	Each student answer receives from 10 to 16 points, corresponding to: «5» - 16 points; «4» - 13 points; «3» - 10 points.
1	16	13	10		
2	16	13	10		
3	16	13	10		
4	16	13	10		
5	16	13	10		
	80	65	50		

The correspondence of the marks between the 200-point and four-point (national) scales and the ECTS scale:

Mark in a 200-point scale	ECTS-based mark	National four-scale-based mark
180-200	A	Excellent
160-179	B	Good
150-159	C	Good
130-149	D	Satisfactory
120-129	E	Satisfactory
Below 120	F, Fx	Unsatisfactory

## **3.2. THE LIST OF QUESTIONS FOR EXAM**

### **A. Theoretical questions.**

1. Enzymes: role, chemical nature, general properties, classification, nomenclature, mechanisms of action and activity regulation.

2. Isoenzymes, features of structure and functions, their importance in diagnostics.

3. Common features of vitamins. Role of vitamins in the body. Classifications based on physical and chemical properties, clinical and physiological effects. Provitamins, structures of the most common provitamins. Common features of hypo- and avitaminoses, their classification, causes.

4. Vitamin A and  $\beta$ -carotene: structures, participation in metabolism; sources, daily requirements; hypo- and hypervitaminosis.
5. Vitamin E: structure, participation in metabolism; sources, daily requirements, symptoms of deficiency.
6. Group K vitamins: structure, participation in blood coagulation system; sources, daily requirements. Analogues and antagonists of vitamin K as drugs.
7. Group D vitamins: structure, mechanism of action in metabolism of calcium and phosphates; sources, daily requirements. Hypovitaminosis in children and adults. Symptoms of hypervitaminosis.
8. Vitamin F (polyunsaturated fatty acid complex): structure of the components of the complex, participation in metabolism; sources, daily requirements, symptoms of deficiency.
9. Vitamin B<sub>1</sub> (thiamine): structure, biological properties, mechanism of action in metabolism, sources, daily requirements, symptoms of deficiency. TPP structure.
10. Vitamin B<sub>2</sub> (riboflavin): structure, role in metabolism, sources, daily requirements, symptoms of deficiency. FAD and FMN structures.
11. Vitamin B<sub>3</sub> (pantothenic acid): structure, role in metabolism, sources, daily requirements, symptoms of deficiency. Describe the structure of HS-CoA.
12. Vitamin PP (nicotinic acid, nicotinamide): structure, role in metabolism, sources, daily requirements, symptoms of deficiency. NAD and NADP structures.
13. Vitamin B<sub>6</sub> (pyridoxine): structure, role in metabolism, sources, daily requirements, symptoms of deficiency. Pyridoxal phosphate structure.
14. Vitamin H (biotin): structure, biological properties, mechanism of action in metabolism, sources, daily requirements, symptoms of deficiency.
15. Vitamin B<sub>9</sub> (folic acid): structure, role in metabolism, sources, daily requirements, symptoms of deficiency.
16. Vitamin B<sub>12</sub> (cobalamin): structure, role in metabolism, sources, daily requirements, symptoms of deficiency.
17. Vitamin C (ascorbic acid): structure, role in metabolism, sources, symptoms of deficiency. Prophylactic and therapeutic doses.
18. Vitamin P (flavonoids): structure, biological properties, deficiency manifestations, sources, daily requirements.
19. General characteristics of vitamin-like substances and antivitamin.
- Common stages of intracellular catabolism of biomolecules: proteins, carbohydrates, and lipids.
20. TCA cycle: localization, sequence of enzymatic reactions, importance in metabolism. Its energy balance.
21. Reactions of biological oxidation; types of reactions (dehydrogenases, oxidases, oxygenases) and their role.
22. The modern theory of biological oxidation. Sequence of components of respiratory chain in mitochondria. Molecular complexes of mitochondrial inner membranes.
23. Oxidative and substrate-level phosphorylation. Structure and role of ATP.
24. Inhibitors of electron transport chains and oxidative phosphorylation uncouplers.
25. Formation of final products of metabolism - water and carbon dioxide.
26. Microsomal oxidation, cytochrome P-450; molecular organization of electron transport chain.
27. Lipid peroxidation: biological significance and role in development of pathological conditions.
28. Hormones: general description, classification, role, mechanism of action.
29. Hormones of hypothalamus: structure, role, mechanism of action, changes in production.
30. Hormones of the anterior pituitary: somatotropin (GH) and prolactin. Pathological processes associated with dysfunction of these hormones.
31. Vasopressin and oxytocin: synthesis site, structure, biological functions, abnormal synthesis and secretion.



32. Insulin: structure, biosynthesis, secretion; effects on metabolism of carbohydrate, lipids, amino acids, and proteins. Growth-stimulating effects of insulin. Disorders of synthesis and secretion.
33. Glucagon: structure, role in metabolism, secretion disorders.
34. Thyroid hormones: structure, biological effects, mechanism of action. Hypo- and hyperthyroidism.
35. Catecholamines: structure, biosynthesis, physiological effects, biochemical mechanisms of action.
36. Steroid hormones of the adrenal cortex (C21-steroids) - glucocorticoids and mineralocorticoids; structure, properties, mechanism of action. Abnormal functions of glands
37. Female sex hormones: estrogens, progesterone. Physiological and biochemical effects; connections with the phases of the menstrual cycle.
38. Male sex hormones (C19-steroids). Physiological and biochemical effects of androgens; regulation of synthesis and secretion.
39. General characteristics of intestinal hormones.
40. Structure and role of melatonin, synthesis site, mechanism of action, disorders.
41. Eicosanoids: structure, biological and pharmacological properties. Aspirin and other nonsteroidal anti-inflammatory drugs as inhibitors of prostaglandin synthesis.
42. Basic dietary carbohydrates. Daily requirements for carbohydrates. Their structure, digestion, and absorption in the gastrointestinal tract.
43. Anaerobic glucose oxidation: localization, general scheme of reactions, role, regulation. Glycolytic oxidoreduction and its role.
44. Aerobic glucose oxidation: localization, general scheme of reactions, role, regulation. Mitochondrial shuttles.
45. Oxidative decarboxylation of pyruvate. Enzymes, coenzymes, and sequence of reactions in the multi-enzyme complex.
46. Phosphorylytic pathway of glycogen breakdown in the liver and muscle. Regulation of glycogen phosphorylase. Disorders.
47. Biosynthesis of glycogen: enzymatic reactions, physiological significance. Regulation of glycogen synthase. Disorders.
48. Gluconeogenesis: substrates, localization, general scheme of reactions, role, regulation.
49. Glucose-lactate (Cori cycle) and glucose-alanine cycle.
50. Blood glucose (glycemia): normoglycemia, hypo- and hyperglycemia, glucosuria. Diabetes mellitus is a pathology of glucose metabolism. Hormonal regulation of glucose concentration and blood glucose metabolism.
51. Pentose phosphate pathway of glucose oxidation: localization, scheme of reactions, biological significance.
52. Pathways of fructose and galactose metabolism; inherited enzymopathies of their metabolism.
53. Basics of glycosaminoglycan metabolism and its disorders.
54. Regulation of carbohydrate metabolism and its disorders (diabetes mellitus, changes in carbohydrate metabolism under hypoxic conditions, hypoglycemia of newborns, hereditary disorders of glycogen metabolism, as well as fructose and galactose metabolism, deficiency of disaccharidases, mucopolysaccharidoses).
55. Basic dietary lipids. Daily requirements for lipids. Their structure, digestion, and absorption in the gastrointestinal tract. Resynthesis of TAGs in the intestinal epithelial cells.
56. Catabolism of triacylglycerols in adipocytes of adipose tissue: role, sequence of reactions. Neurohormonal regulation of lipolysis by adrenaline, noradrenaline, glucagon, and insulin.
57. Oxidation of fatty acids ( $\beta$ -oxidation): localization, scheme of reactions, role. The role of carnitine. Energy value of  $\beta$ -oxidation of fatty acids in cells.
58. Glycerol metabolism: localization, general scheme of reactions, role.
59. Ketogenesis and ketolysis: localization, scheme of reactions, regulation.
60. Biosynthesis of fatty acids: localization, scheme of reactions, regulation.

61. Biosynthesis of triacylglycerols and phosphoglycerols: localization, scheme of reactions, role, regulation.
62. Metabolism of sphingolipids. Genetic abnormalities of sphingolipid metabolism - sphingolipidoses.
63. Cholesterol biosynthesis: localization, scheme of reactions, regulation. Transport forms of cholesterol. Pathways of cholesterol biotransformation. Disorders.
64. Plasma lipoproteins: lipid and protein (apoproteins) composition. Hyperlipoproteinemia.
65. Pathologies of lipid metabolism: atherosclerosis, obesity, diabetes mellitus, steatorrhea.
66. The main stages of enteral protein metabolism. Enzymes involved in the digestion of proteins. Mechanisms of activation. Mechanisms of absorption of amino acids in the intestine. Abnormal protein digestion in the gastrointestinal tract.
67. Putrefaction, detoxification mechanisms of protein putrefaction products.
68. Tissue proteolysis. Action, properties and classification of cathepsins.
69. Scheme of the basic pathways of replenishment and use of the amino acid pool. The main classes of organic compounds that are formed from amino acids.
70. Decarboxylation of amino acids, enzymes, physiological significance. Biogenic amines: reactions of their formation, role. Catabolism of biogenic amines.
71. The main pathways of amino acid deamination in human tissues. Transamination. Mechanism of action of aminotransferases, their role in metabolism of amino acids, clinical significance of their determination in the blood.
72. Pathways of ammonia formation, its action. Transport of ammonia from tissues to the liver and kidney. Reactions of glutamine and asparagine formation and their role. Role of alanine in ammonia transport.
73. Formation of ammonium salts in kidneys, its significance.
74. Ornithine cycle of urea formation in the liver: enzymatic reactions, role. Genetic defects of enzymes of urea cycle (enzymopathies).
75. Metabolism of carbon skeletons of amino acids in the body, relation to Krebs cycle.
76. Metabolism of phenylalanine and tyrosine, disorders, ways of treatment.
77. Metabolism of tryptophan, disorders, ways of treatment.
78. Metabolism of glycine and serine. Glutathione as a product of amino acid metabolism, its structure, role.
79. Metabolism of arginine. Nitric oxide as a product of arginine metabolism, its role.
80. Metabolism of sulfur-containing amino acids.
81. Metabolism of dicarboxylic amino acids.
82. Metabolism of valine, leucine, isoleucine. Maple syrup urine disease.
83. Metabolism of creatine, its role, disorders. Creatine phosphokinase, isoforms, clinical and diagnostic significance of its determination in serum.
84. Synthesis and breakdown of pyrimidine and purine nucleotides. Regulation. Disorders and their treatment.
85. Steps and enzymes of DNA and RNA synthesis.
86. Stages and mechanisms of translation. Posttranslational modification of peptide chains.
87. Biological significance and mechanisms of DNA repair. Repair of UV-induced gene mutations; xeroderma pigmentosum.
88. Mutations: genomic, chromosomal, gene. Their role in enzymopathies and hereditary diseases.
89. Biological significance of water, its content, distribution, daily requirements. Exogenous and endogenous water. Water balance. Neurohormonal regulation of water-salt metabolism.
90. Functions of minerals in the body. Electrolyte composition of body fluids, its regulation.
91. Biogenic elements: role, classification, pathological conditions associated with disorders of their metabolism.
92. Acid-base balance of blood, its regulation, disorders.
93. Blood proteins: content, properties, role. Hyper-, hypo-, dys- and paraproteinemia, causes.

94. Acute phase proteins. Clinical and diagnostic significance of their determination.
95. Blood enzymes, their origin, clinical and diagnostic significance of their determination.
96. Non-protein nitrogen-containing compounds. Total and rest nitrogen levels. Clinical significance of their determination. Azotemia: types, causes, methods of determination.
97. Non-protein nitrogen-free blood components. Clinical significance of their determination.
98. Inorganic compounds of blood: their content and role.
99. Structure, role, and properties of hemoglobin. Types of hemoglobin. Heme, its structure and role in hemoglobin. Mechanisms of hemoglobin participation in the transport of O<sub>2</sub> and CO<sub>2</sub>. Pathological forms of hemoglobin.
100. General scheme of hemoglobin synthesis. Regulation of this process. Porphyrrias: causes, types. Hemoglobinopathies and thalassemias. Their causes.
101. General scheme of hemoglobin breakdown. Bile pigments, their transformation, significance of their determination. Pathobiochemistry of jaundices. Enzymatic, hereditary jaundices. Neonatal jaundice.
102. Functions of kidneys and their metabolic features.
103. General properties and chemical composition of normal urine. Significance of its investigation in practice.
104. Physical and chemical properties of urine: diuresis, specific gravity, pH, odor, color, transparency. Significance of their determination. Possible deviations from the normal ranges. Clinical and diagnostic significance of quantitative and qualitative analysis of urine.
105. Protein as a pathological component of urine. Possible causes of its appearance. Methods of its determination.
106. Glucose as a pathological component of urine. Causes of glucosuria. Methods of its determination.
107. Creatine as a pathological component of urine. Possible causes of its appearance. Methods of its determination.
108. Ketone bodies as pathological components of urine. Possible causes of ketonuria. Methods of its determination.
109. Blood pigments (hemoglobin, methemoglobin) as pathological components of urine. Possible causes of their appearance. Methods of their determination.
110. Bile pigments (biliverdin, bilirubin, urobilinogen, urobilin) as pathological components of urine. Possible causes of their appearance. Methods of their determination.
111. Indican as a pathological component of urine. Possible causes of its appearance. Methods of its determination.
112. Biochemical functions in the bof the liver. Role of the liver in metabolism of carbohydrates, lipids, proteins, and pigments.
113. Chemical composition of the muscle tissue. Features of chemical composition and metabolism in cardiac and smooth muscles. Bioenergy of the muscle tissue. Changes in muscles in patients with muscular dystrophy, low physical inactivity, vitamin E deficiency.
114. Features of the connective tissue. Changes in the connective tissue with aging. Diseases of the connective tissue.

### **B. Required practical skills**

1. Quantitative determination of blood glucose by glucose oxidase method. Principle. Clinical and diagnostic value.
2. Qualitative reaction on bile scids. Principle. Clinical and diagnostic value.
3. Qualitative reactions for ketone bodies in the urine. Principle. Clinical and diagnostic value.
4. Enzymatical determination of the cholesterol concentration in serum by a kit. Principle. Clinical and diagnostic value.
5. Analysis of gastric juice. Principle. Clinical and diagnostic value.
6. Determination of the presence of lactic acid (Uffelmann's reaction). Principle. Clinical and diagnostic value.

7. Determination of aspartate aminotransferase activity (AsAT) in blood serum by King's method. Principle. Clinical and diagnostic value.
8. Quantitative determination of urea and ammonia in biological fluids. Principle. Clinical and diagnostic value.
9. Qualitative reaction to phenylpyruvate in urine (Fehling's test). Principle. Clinical and diagnostic value.
10. Determination of creatinine content in biological fluids. Principle. Clinical and diagnostic value.
11. Determination of uric acid content in blood serum by the method of Muller and Seifert. Principle. Clinical and diagnostic value.
12. Determination of total nitrogen in the urine by the Kjeldahl method. Principle. Clinical and diagnostic value.
13. Quantitative determination of calcium and inorganic phosphorus in blood serum. Principle. Clinical and diagnostic value.
14. Quantitative determination of total protein in blood serum by biuret method. Principle. Clinical and diagnostic value.
15. Quantitative determination of residual nitrogen in the blood. Principle. Clinical and diagnostic value.
16. Quantitative determination of hemoglobin in the blood by hemoglobin cyanide method. Principle. Clinical and diagnostic value.
17. Quantitative determination of bilirubin and its fractions in the blood serum by the method of Jendrassik, Cleghorn and Groff. Principle. Clinical and diagnostic value.
18. The study of physical and chemical properties and chemical composition of normal urine. Principle. Clinical and diagnostic value.
19. Qualitative reactions for protein in urine. Principle. Clinical and diagnostic value.
20. Determination of glucose in urine. Principle. Clinical and diagnostic value.
21. Qualitative reactions for blood in urine. Principle. Clinical and diagnostic value.
22. Qualitative reactions for bile pigments in urine. Principle. Clinical and diagnostic value.
23. Qualitative reaction for indican in urine. Principle. Clinical and diagnostic value.
24. Determination of the index of thymol test in the serum. Principle. Clinical and diagnostic value.

### **3.3. Control questions**

#### **PART 1 "GENERAL FEATURES OF METABOLISM"**

1. Biological chemistry as a science. Place of biochemistry among other biomedical disciplines.
2. The objects of study and biochemistry tasks. The leading role of biochemistry in determining the molecular mechanisms of human diseases pathogenesis.
3. Connection of biochemistry with other biomedical sciences. Medical biochemistry. Clinical biochemistry. Laboratory diagnostics.
4. History of biochemistry, development of biomedical research in Ukraine.
5. Biochemical components of cells and their functions. Classes of biomolecules. Hierarchy of biomolecules and their origin.
6. Enzymes: definition, properties as biological catalysts.
7. Classification and nomenclature of enzymes, characteristic of some classes of enzymes.
8. Structure and mechanisms of enzyme action. Active and allosteric (regulatory) sites.
9. Cofactors and coenzymes. Structure and properties of coenzymes, vitamins as precursors in the biosynthesis of coenzymes.

10. Coenzymes. Types of reactions that are catalyzed by separate classes of coenzymes.

11. Isoenzymes: structural features and functioning, the significance in the diagnosis of diseases.

12. The mechanism of action and kinetics of enzymatic reactions: the dependence of reaction velocity on substrate concentration, pH and temperature.

13. Mechanisms of enzyme activity regulation. Allosteric enzymes, covalent modification of enzymes. Activators and inhibitors of enzymes: examples and mechanisms of action.

14. Types of enzyme inhibition: reversible (competitive, non-competitive) and irreversible.

15. General understanding of enzymopathies and their causes.

16. Enzyme diagnostics of pathological processes and diseases.

17. Enzyme therapy. The use of enzymes, their activators and inhibitors in medicine.

18. Principles and methods of enzyme detection in biological objects. Units of enzyme activity.

19. History of discovery of vitamins, Lunin's and Funk's role in the development of vitaminology.

20. General characteristics of vitamins. The role of vitamins in the body. Classifications based on physical and chemical properties and clinical and physiological effect. Provitamins, their structures.

21. General characteristics of hypo- and avitaminosis, their classification, causes.

22. Vitamin A and  $\beta$ -carotene: structure, role in metabolism, sources, daily requirement for retinol and  $\beta$ -carotene, hypo- and hypervitaminosis.

23. Vitamin E: structure, role in metabolism, sources, daily requirement, deficiency symptoms

24 Vitamin K: structure, role in blood coagulation system; sources, daily requirement. Vitamin K analogues and antagonists as drugs.

25. Vitamin D: structure, mechanism of action, role in the metabolism of calcium and phosphate, sources, daily requirement. Hypovitaminosis in children and adults. Symptoms of hypervitaminosis.

26. Vitamin F (complex of polyunsaturated fatty acids): the structure of the components of the complex, role in metabolism, sources, daily requirement, deficiency symptoms.

27. Vitamin B<sub>1</sub> (thiamine): structure, biological properties, role in metabolism, sources, daily requirement, deficiency symptoms. Structure of TPP.

28. Vitamin B<sub>2</sub> (riboflavin): structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms. Structure of FAD, FMN.

29. Pantothenic acid: structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms. Structure of HS-CoA.

30. Vitamin PP (nicotinic acid, nicotinamide): structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms. Structure of NAD and NADP.

31. Vitamin B<sub>6</sub> (pyridoxine): structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms. Structure of PALP.

32. Vitamin B<sub>7</sub> (biotin): structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms.

33. Vitamin B<sub>9</sub> (folic acid): structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms.

34. Vitamin B<sub>12</sub> (cobalamin): structure, biological properties, mechanism of action in metabolism, sources, daily requirement, deficiency symptoms.

35. Vitamin C (ascorbic acid): structure, biological properties, mechanism of action in metabolism, sources, deficiency symptoms. Prophylactic, protective and therapeutic doses.

36. Vitamin P (flavonoids): structure, biological properties, mechanism of action, the manifestations of deficiency, sources, daily requirement.

37. General characteristics of the vitamin-like substances. Role of carnitine, ubiquinone and lipoic acid in metabolism.

38. Antivitamins: specificity of structure and action, use in medicine.

39. Metabolism: the general features of catabolic and anabolic processes.

40. General stages of intracellular catabolism of biomolecules: proteins, carbohydrates, lipids.

41. Citric acid cycle (TCA cycle): localization, sequence of enzymatic reactions, importance in metabolism.

42. Energy balance of TCA cycle.

43. Amphibolic function of TCA cycle.

44. Biological oxidation reactions; types of reactions (dehydrogenase, oxidase, oxygenase reactions) and their biological significance.

45. Tissue respiration: stages, localization in the cell.

46. Enzymes of biological oxidation in mitochondria: pyridine and flavin-dependent dehydrogenases, cytochromes.

47. Sequence of components of respiratory chain in mitochondria. Molecular complexes of mitochondrial inner membranes.

48. Oxidative phosphorylation: electron transport and oxidative phosphorylation coupling points, the coefficient of oxidative phosphorylation.

49. Chemiosmotic theory of oxidative phosphorylation, mitochondrial ATP-synthase.

50. Inhibitors and uncouplers of electron transport and oxidative phosphorylation.

51. Microsomal oxidation: cytochrome P-450 and b<sub>5</sub>; molecular organization of electron transport chain.

52. Lipid peroxidation: biological significance and role in the occurrence of pathological conditions.

## **PART 2 «BIOCHEMISTRY OF HORMONES. METABOLISM OF CARBOHYDRATES AND LIPIDS»**

1. Hormones: general characteristics, role in intercellular integration of functions of the human body.

2. Classification of hormones.

3. Response of target cells to hormones. Membrane (ionotropic, metabotropic) and cytosolic receptors.
4. Biochemical systems of intracellular transmission of hormonal signals.
5. Molecular and cellular mechanisms of action for steroid and thyroid hormones.
6. Hormones of hypothalamus.
7. Pituitary hormones: growth hormone, lactotropin. Pathological processes associated with dysfunction of these hormones.
8. Vasopressin and oxytocin: structure, biological functions.
9. Insulin: structure, biosynthesis and secretion, influence on metabolism of carbohydrates, lipids, amino acids, and proteins.
10. Glucagon: regulation of carbohydrate and lipid metabolism.
11. Thyroid hormones: structure, biological effects of T<sub>3</sub> and T<sub>4</sub>. Changes in metabolic processes in patients with hypo- and hyperthyroidism.
12. Catecholamines (epinephrine, norepinephrine, dopamine): structure, biosynthesis, physiological effects, and biochemical mechanisms of action.
13. Steroid hormones of the adrenal cortex - glucocorticoids and mineralocorticoids: structure, properties, biological effects, disorders.
14. Female sex hormones. Physiological and biochemical effects, connection with phases of the ovulation cycle.
15. Male sex hormones. Physiological and biochemical effects of androgens, regulation of synthesis and secretion.
16. Hormonal regulation of calcium homeostasis in the body.
17. Eicosanoids: structure, biological and pharmacological properties. Aspirin and other non-steroidal anti-inflammatory drugs as inhibitors of prostaglandin synthesis.
18. Carbohydrates. Biological role. Classification. Structure and functions of mono-, oligo- and polysaccharides.
19. Classification of carbohydrates. Structure and functions of polysaccharides.
20. Glycosaminoglycans: structure and role.
21. Major dietary carbohydrates: daily requirements, structure, digestion, and absorption in the gastrointestinal tract.
22. Aerobic and anaerobic glucose oxidation.
23. Anaerobic glucose oxidation: reactions and enzymes.
24. Aerobic glucose oxidation; steps and final products.
25. Glycolytic oxidoreduction: substrate-level phosphorylation and shuttles that transfer NADH.
26. Comparison of bioenergy balance of aerobic and anaerobic glucose oxidation, Pasteur effect.
27. Glycogen in the liver.
28. Glycogen. Its structure and functions.
29. Phosphorylative pathway of glycogen breakdown in the liver and muscles. Regulation of glycogen phosphorylase.
30. Glycogen biosynthesis: enzymatic reactions, physiological significance. Regulation of glycogen synthase.
31. Mechanisms of reciprocal regulation of glycogenolysis and glycogenesis.

32. Role of adrenaline, glucagon and insulin in hormonal regulation of glycogen metabolism in the liver and muscles.
33. Genetic disorders of glycogen metabolism.
34. Gluconeogenesis: substrates, enzymes, physiological significance.
35. Glucose-lactate (Cori cycle) and glucose-alanine (Cahill cycle) cycles.
36. Blood glucose (glucosemia): normo-, hypo- and hyperglycemia, glycosuria. Diabetes mellitus as a pathology of glucose metabolism.
37. Hormonal regulation of carbohydrate metabolism and blood glucose concentration.
38. Pentose phosphate pathway of glucose oxidation: scheme and biological significance.
39. Pathways of fructose and galactose metabolism; hereditary enzymopathies.
40. General understanding of glycosaminoglycan metabolism. Mucopolysaccharidoses. Genetic disorders of glycosaminoglycan metabolism.
41. Regulation of carbohydrate metabolism.
42. Disorders of carbohydrate metabolism.
43. Lipids. Biological role. Classification. Structure and functions of simple lipids.
44. Lipids. Structure and functions of complex lipids.
45. Basic dietary lipids and their structure. Daily requirements for lipids. Digestion and absorption in the gastrointestinal tract.
46. Bile acids and their role in digestion and absorption of lipids.
47. Lipases of the gastrointestinal tract. Role of pancreatic lipase.
48. Resynthesis of fats in intestinal epithelial cells: its importance, role of  $\beta$ -MAG.
49. Catabolism of triacylglycerols in adipose tissue: reactions, regulation.
50. Neurohumoral regulation of lipolysis.
51. Oxidation of fatty acids, role of carnitine.
52. Energy balance of  $\beta$ -oxidation of fatty acids.
53. Glycerol oxidation: enzymatic reactions, energy balance.
54. Ketone bodies: reactions of biosynthesis and utilization, physiological significance. Disorders.
55. Metabolism of ketone bodies under pathological conditions (diabetes mellitus, starvation).
56. Biosynthesis of fatty acids. Reactions of saturated fatty acid (palmitate) synthesis and regulation.
57. Biosynthesis of mono- and polyunsaturated fatty acids in humans.
58. Biosynthesis of triacylglycerols and phosphoglycerols.
59. Metabolism of sphingolipids. Sphingolipidoses.
60. Cholesterol biosynthesis. Reactions. Regulation.
61. Pathways of cholesterol biotransformation.
62. Blood plasma lipoproteins: lipid and protein composition. Hyperlipoproteinemiae.
63. Disorders of lipid metabolism: atherosclerosis, obesity, diabetes mellitus, steatorrhea.
- 64. Relations between carbohydrate metabolism and lipid metabolism. Regulation and disorders**



### **PART 3 «METABOLISM OF PROTEINS AND NUCLEIC ACIDS»**

1. Role of proteins in the vital activity of organism.
2. Protein norms in the nutrition. Complete and incomplete proteins. Non-essential, essential, conditionally essential and semiessential amino acids.
3. Nitrogen balance, its types.
4. The biological meaning of protein digestion in the gastrointestinal tract. Enzymes of protein digestion. The mechanism of proteolytic enzymes activation.
5. The chemical composition of gastric juice. Forms of gastric juice acidity, the methods of determination. Role of HCl.
6. Mechanisms of amino acids absorption in the intestine.
7. Biochemical mechanisms of protein digestion regulation. Hormones of gastrointestinal tract.
8. Disorders of protein digestion in the gastrointestinal tract. Parenteral nutrition.
9. Chemical conversions of amino acids in large intestine. Mechanisms of detoxification of protein putrefaction products in the large intestine.
10. Amines formed in the large intestine during the putrefaction from diaminomono-carboxylic acids, their detoxification.
11. Toxic substances formed in the large intestine during the putrefaction from tyrosine and phenylalanine, their detoxification.
12. The toxic substances formed in large intestine during the putrefaction from tryptophan, their detoxification.
13. Tissue proteolysis. Action, properties and classification of cathepsins.
14. Scheme of the basic pathways of formation and using the amino-acid pool of tissues. Basic classes of the organic compounds formed from the amino acids.
15. General pathways of the amino acid metabolism.
16. Decarboxylation of amino acids: enzymes, physiological significance.
17. Biogenic amines: reactions of formation, role. Mechanisms of inactivation of biogenic amines.
18. Major types of deamination of amino acids in organism.
19. Direct and indirect deamination of L-amino acids. Mechanism of action and role of amino acid oxidases and glutamate dehydrogenase.
20. Transamination of amino acids. Mechanism of aminotransferase action. Role of aminotransferases in metabolism of amino acids. Clinical value of determination of aminotransferases in blood.
21. Reaction of reductive amination of  $\alpha$ -ketoglutarate, its role.
22. The pathways of ammonia formation in the body, its toxic action.
23. Transport of ammonia from tissues to liver and kidneys. Reactions of formation of glutamine and asparagine, their role. Role of alanine in transport of ammonia.
24. Mechanisms of temporary and final detoxification of ammonia.
25. Formation of ammonia salts in kidneys, the significance of process.
26. Ornithine cycle of urea formation in the liver: reactions, role. Genetic defects of ornithine cycle enzymes (enzymopathies).
27. Hyperammonemia: its causes, manifestation, consequences.

28. Scheme of metabolic pathways of nitrogen-free amino acid residues. Their interrelation with Krebs cycle.
29. Glucogenic and ketogenic amino acids.
30. Physiologic meaning and regulation of gluconeogenesis processes from amino acids.
31. Metabolism of phenylalanine and tyrosine, disturbances, ways of correction.
32. Metabolism of tryptophan, disturbances, ways of correction.
33. Metabolism of glycine and serine. Glutathione as a product of amino acid metabolism; its structure and role.
34. Arginine metabolism. Nitric oxide as a metabolite of arginine, its role.
35. Metabolism of sulfur-containing amino acids.
36. Metabolism of dicarboxylic amino acids.
37. Metabolism of valine, leucine, isoleucine. Maple syrup urine disease.
38. Creatine synthesis, its role, disorders. Creatine kinase: isoforms, clinical and diagnostic significance of its determination in blood serum and urine.
39. Congenital defects of amino acids metabolism, biochemical methods of their diagnostics, possibilities of their correction.
40. Nucleotides, their structure and role in the body.
41. Digestion and absorption of nucleoproteins.
42. Synthesis of pyrimidine nucleotides. Regulation. Disorders.
43. Synthesis of purine nucleotides. Regulation. Disorders.
44. Synthesis of deoxyribonucleotides.
45. Role of carbamoyl phosphate in metabolism of proteins and nucleotides.
46. Breakdown of pyrimidine nucleotides.
47. Degradation of purine nucleotides. Hyperuricemia, its causes, biochemical mechanisms of correction.
48. Correlation between metabolism of proteins and nucleic acids.
49. DNA replication, the biological significance; semiconservative replication mechanism. Discovery of DNA double helix by Watson and Crick.
50. General scheme of biosynthesis of DNA strands. Enzymes of DNA replication in prokaryotes and eukaryotes, scheme of DNA replication.
51. Molecular mechanisms of DNA replication. Stages of synthesis of daughter strands of DNA molecules.
52. Total RNA transcription scheme. RNA-polymerases of prokaryotes and eukaryotes.
53. Stages and enzymes of RNA synthesis. Signals of transcription: promoter, initiator and terminator sequences of genome.
54. Processing (posttranscriptional modification of RNA). Antibiotics, which are inhibitors of transcription.
55. Genetic (biological) code; triplet structure of the code and its properties.
56. Ribosomal protein-synthesizing system: its components. The structure of eukaryotic ribosomes.
57. Transfer RNAs and activation of amino acids. Aminoacyl-tRNA synthetases.

58. Stages and mechanisms of translation: initiation, elongation, termination. Codon of initiation and termination, the role of protein factors of ribosomes in translation.

59. Posttranslational modification of peptide chains. Regulation of translation. Molecular mechanisms controlling translation on the example of the globin biosynthesis.

60. Effects of physiologically active substances on the process of translation. Antibiotics, which are inhibitors of translation in prokaryotes and eukaryotes, their application in medicine.

61. Regulation of gene expression in prokaryotes. Scheme of structural and control genes according to F. Jacob and J. Monod: promoter, regulatory genes.

62. Features of the molecular organization of DNA and expression of eukaryotic genome (exons, introns, repeated sequences).

63. Genetic recombinations in prokaryotes (transformation, transduction, conjugation).

64. The biological significance and mechanisms of DNA repair. Repair of UV-induced gene mutations, xeroderma pigmentosum.

65. Genetic engineering or recombinant DNA technology: general concepts, biomedical importance.

66. Technology of genes transplantation and making hybrid DNA molecules. Cloning of genes to obtain biotechnology drugs (hormones, enzymes, antibiotics, interferon).

67. Mutations: genome, chromosome and gene mutations. Role of mutations in the development of enzymopathies and inherited diseases in humans.

#### **PART 4 « FUNCTIONAL BIOCHEMISTRY »**

1. The biological significance of water and its content, the daily requirement. Exogenous and endogenous water.
2. Properties and biochemical functions of the water. The distribution and state of water in the body.
3. Metabolism of water in the body, age features, regulation.
4. Water balance of organism and its types.
5. Neurohumoral regulation of water-salt metabolism. Role of vasopressin, aldosterone and renin-angiotensin system.
6. Functions of mineral salts in the body.
7. Electrolite composition of body liquids, its regulation.
8. Minerals of the human body, their content, role.
9. Classification of biogenic elements, their role.
10. Phosphate-calcium metabolism. Inorganic and organic phosphates. Phosphates of urine. Regulation.
11. Role of sodium, potassium, chlorine in vital processes.
12. Iron: role and metabolism in organism, daily requirement.
13. Pathological conditions associated with disorders of metabolism of mineral substances.
14. Role of the blood in the vital functions.

15. Physico-chemical properties of blood, serum, lymph: pH, osmotic and oncotic pressure, relative density, viscosity.
16. Acid-base balance of the blood, its regulation, disorders. Modern methods for the determination of acid-base balance of the blood.
17. Buffer systems of the blood. Their role in maintenance of the acid-base balance. Disorders: acidosis, alkalosis. Their causes.
18. The main fractions of blood plasma proteins. Methods of investigation.
19. Blood proteins: content, functions, content changes in pathological states.
20. Albumins, physical and chemical properties, the role.
21. Globulins, physical and chemical properties, the role.
22. Immunoglobulins of blood, structure, and functions.
23. Hyper-, hypo-, dys- and paraproteinemias; the causes of their appearance.
24. Acute phase proteins. Clinical and diagnostic significance of their determination.
25. Enzymes of blood, clinical and diagnostic significance of their determination.
26. Non-protein nitrogen-containing components. Total and residual nitrogen of blood. Clinical significance of determination.
27. Azotemia: types, causes, methods of determination.
28. Nitrogen-free blood components. Clinical significance of determination.
29. Inorganic components of blood.
30. Kallikrein-kinin system and its role in the body.
31. Structure, role and properties of hemoglobin.
32. Types of hemoglobin.
33. Heme, its structure and role in the hemoglobin functioning.
34. Mechanism of hemoglobin participation in the transport of O<sub>2</sub> and CO<sub>2</sub>.
35. Abnormal forms of hemoglobin.
36. The general scheme of the hemoglobin synthesis. Regulation of process.
37. Porphyria: causes, types.
38. Hemoglobinoses: thalassemia and hemoglobinopathies.
39. The general scheme of the hemoglobin breakdown. Bile pigments, their conversion, the value of research in the blood, urine, and feces.
40. Direct and indirect bilirubin of blood. Significance of determination.
41. Pathobiochemistry of jaundices. Enzymatic, hereditary jaundices. Jaundices of newborns.
42. Renal functions and features of metabolism in kidneys.
43. General properties and chemical composition of normal urine. Significance of urine analysis in clinical practice.
44. Physical and chemical indices of urine. The significance of their investigation. Possible deviations from the norm.
45. Clinical and diagnostic significance of quantitative and qualitative analysis of urine.
46. Protein as a pathological component of urine. Possible causes of its occurrence. Methods of determination.
47. Glucose as a pathological component of urine. The causes and types of glycosuria. Methods of determination.

48. Creatine as a pathological component of urine. Possible causes of its occurrence. Methods of determination.
49. Ketone bodies as pathological components of urine. Possible causes of ketonuria. Methods of determination.
50. Blood pigments (hemoglobin, methemoglobin) as pathological components of urine. Possible causes of their occurrence. Methods of determination.
51. Bile pigments (biliverdin, bilirubin, urobilinogen) as pathological components of urine. Possible causes of their occurrence. Methods of determination.
52. Indican as a component of urine. Possible causes of the increased urinary excretion. Methods of determination.
53. Biochemical functions of liver in the body.
54. Role of liver in carbohydrate metabolism.
55. Role of liver in lipid metabolism.
56. Role of liver in protein metabolism.
57. Role of liver in pigment metabolism.
58. Bile formation function of liver. Chemical composition of bile.
59. Detoxification function of liver. Types of reactions of xenobiotics and endogenous toxins biotransformation.
60. Systems of conjugation for detoxification of toxic substances in liver.
61. Disorder of liver functions in diseases. Liver tests.
62. Xenobiotics: concept, principle of classification, pathways of entering to the body, transport through cellular membranes.
63. Microsomal oxidation. Characteristic of microsomal monooxygenase chains. Cytochromes P-450 and b<sub>5</sub>.
64. Types of conjugation of xenobiotics in hepatocytes: biochemical mechanisms, functional value.
65. Ways of the removal of xenobiotics biotransformation products from organism.
66. The main classes of substances of nervous tissue, their ratio in different regions of nervous system.
67. Features of structure of muscle fiber, thick and thin filaments.
68. Chemical composition of muscular tissue. Features of chemical composition and metabolism of substances in cardiac and smooth muscles.
69. Characteristics of muscle proteins, main non-protein nitrogen-containing substances.
70. Bioenergetics of muscular tissue; sources of ATP; role of creatine phosphate in providing of muscle contraction with energy.
71. Changes in muscles in muscular dystrophy, hypodynamia, avitaminosis E.
72. Features of connective tissue structure.
73. Fibronectin: features of structure and role.
74. Elastin: features of amino acid composition and physico-chemical properties.
75. Collagen: structure, role, biosynthesis.
76. Main classes of proteo- and glycosaminoglycans, structure, role.
77. Changes in connective tissue in aging.
78. Diseases of connective tissue. Molecular pathology of connective tissue (Marfan's syndrome, Menke's disease, Ehlers–Danlos syndrome).

### 3.4. Individual tasks

1. Prepare the abstract on the theme: "The occurrence of hyperamylasemia and hyperamylasuria in disturbance of the functioning pancreas."
2. Prepare the abstract on the topic: "The ribozymes - biological catalysts of non-protein nature."
3. Prepare the abstract on the theme: "Peculiarities of the structure, kinetics and regulation of the activity of allosteric enzymes."
4. Prepare the review of the scientific literature on the topic: "Serine proteinase. The use of proteolysis inhibitors in medicine. "
5. Prepare an abstract on the theme: "Toxic effects of vitamins A and D hypervitaminosis."
6. Prepare a presentation on the topic: "The absorption of fat-soluble vitamins in the gastrointestinal tract."
7. Prepare a presentation on the topic: "Vitamin B12 - history of discovery, participation in metabolism, malabsorption and formation of coenzyme forms."
8. Review the scientific literature on the topic: "The role of ascorbic acid in metabolism of connective tissue."
9. Prepare the abstract on the topic "Bioflavonoids (vitamin P) are plant antioxidants."
10. Prepare the abstract on the topic: "Uncouplers of oxidative phosphorylation and tissue respiration, regulation of thermogenesis ."
11. Prepare a presentation on the topic: "The development of conceptions about biological oxidation."
12. Review the scientific literature on the topic: "The regulation of oxidative phosphorylation."
13. Prepare the abstract on the topic: "Mechanisms of regulation of common pathways of catabolism".
14. Prepare a presentation on the topic: "Citric acid cycle is a common metabolic pathway of carbohydrate, lipid and amino acid metabolism."
15. Prepare a presentation in accordance with the following topic: "History of endocrinology".
16. Prepare a brief review in accordance with the following topic: "Hypothalamus is a site of interconnection between neuroreflectory and humoral mechanisms of metabolism regulation."
17. Prepare a presentation in accordance with the following topic: "Features of the receptor system and intracellular insulin signaling."
18. Prepare a brief review in accordance with the following topic: "Iodinated thyroid hormones. Role of iodine in the interaction of TSH and iodine-containing thyroid hormones."
19. Prepare a brief review in accordance with the following topic: "Catecholamines: receptors and mechanism of action, role in carbohydrate and lipid metabolism."
20. Prepare a brief review in accordance with the following topic: "Osteoporosis is a manifestation of sex hormone deficiency".

21. Prepare a presentation in accordance with the following topic: "Molecular mechanisms of glucocorticoid signaling. Effects of glucocorticoids on the genetic apparatus."
22. Prepare a review in accordance with the following topic: "Mechanisms of transmembrane monosaccharide transport into the cells. Glucose transporters."
23. Prepare a presentation in accordance with the following topic: "Sugar loading tests: procedure, types of glycemic curves, diagnostic significance."
24. Prepare a brief review in accordance with the following topic: "Glucuronic pathway of glucose metabolism."
25. Draw a scheme of the hormonal regulation for carbohydrate metabolism.
26. Prepare a brief review in accordance with the following topic: "Carbohydrate metabolism in Cushing's disease."
27. Prepare a review in accordance with the following topic: "Mucopolysaccharidoses and possible ways of their treatment."
28. Prepare a review in accordance with the following topic: "Biochemical aspects of obesity."
29. Prepare a presentation in accordance with the following topic: "Hormones of the adipose tissue. Their structures and functions."
30. Prepare a brief review in accordance with the following topic: "Disorders of fatty acid oxidation in the body."
31. Prepare a presentation in accordance with the following topic: "Molecular mechanisms of atherosclerosis pathogenesis."
32. Prepare a scheme for assessing disorders of lipid metabolism using biochemical parameters for various pathological conditions.
33. Prepare a brief review in accordance with the following topic: "Steatohepatitis: causes, biochemical manifestations."
34. Prepare a report "Mechanisms of activation and inhibition of proteolytic enzymes of the gastrointestinal tract."
35. Prepare a review "Regulation of secretion of gastrointestinal juices."
36. Prepare a report "Clinical significance of aminotransferases."
37. Create a scheme: 1) interrelation of urea synthesis and deamination, transamination of amino acids and energy metabolism; 2) interrelation of both Krebs cycles (citric acid cycle and ornithine cycle).
38. Prepare a presentation "Nitric oxide (II): formation and biological functions."
39. Prepare a review "Protein and amino acid metabolism disorders."
40. Prepare a presentation "Pyrimidine derivatives as drugs."
41. Create a scheme of nucleic acid structural organization.
42. Explain a mechanism of formation of tRNA hairpins.
43. Compare erythropoietic and hepatic porphyrias.
44. Make a table "Differential diagnosis of jaundice."
45. Make a review of researches: "Renal insufficiency, biochemical changes in blood and urine."
46. Prepare a report: "Modern biochemical methods for the assessment of kidney function."

47. Prepare a presentation: "Methods for determining the detoxification function of the liver."

48. Prepare a report: "Changes in parameters of the urine in diabetes mellitus."

49. Prepare a presentation: "Non-collagen proteins of the intercellular matrix. Structure, biological role."

50. Prepare a review: "Biochemical basis of muscle fatigue. The problem of ammonia detoxification and lactate excretion from muscular tissues."

51. Present stages of collagen biosynthesis.

### **3. Rules for appealing the assessment**

Applicants for higher education who are dissatisfied with the assessment of the discipline may contact the teacher of their academic group. The teacher explains to the student the evaluation criteria for the discipline. If the applicant of higher education after the explanation of the teacher is not satisfied with the assessment, he applies to the dean's office. The Dean's Office informs the applicant of higher education about the Regulations on the appeal of the results of the final control of applicants for education of KhNMU. The student submits an application for appeal in person in writing no later than the next day after the announcement of the results of the final control of the discipline. The dean registers the application in the educational and methodical department and submits it for the signature of the rector, prepares a draft order on the composition of the appeal commission, informs the student of the date and place of the meeting of the appeal commission. The application must be considered at a meeting of the Appeals Commission no later than the next two working days after its submission.

### **4. DISCIPLINE POLICY.**

In order to successfully complete the relevant course, it is necessary to regularly attend practical classes; to have theoretical preparation for practical classes according to the subject; not to be late and not to miss classes; perform all necessary tasks and work in each lesson; be able to work with a partner or in a group; to address to teachers of a course on various questions on subjects of employment and to receive it when you need it.

Students can discuss different tasks, but their performance is strictly individual. It is not allowed to write off, use various software, tips, use a mobile phone, tablet or other electronic gadgets during classes for purposes other than the educational process. Students are not allowed to be late for practical classes.

Students with special needs can meet with the teacher or warn him before the start of classes, at the request of the student it can be done by the head of the group. If you have any questions, please contact the teacher.

Students' participation in research and conferences on this topic is encouraged.

All students of KhNMU are protected by the Regulations on Prevention, Prevention and Settlement of Cases Related to Sexual Harassment and Discrimination at Kharkiv National Medical University, designed to define an effective mechanism for resolving conflict situations related to discrimination and sexual harassment. This Regulation is developed on the basis of the following normative legal acts of Ukraine: the Constitution of Ukraine; Law of Ukraine "On Education"; Law of Ukraine "On



Higher Education"; Law of Ukraine "On Principles of Preventing and Combating Discrimination in Ukraine"; Law of Ukraine "On Ensuring Equal Rights and Opportunities for Women and Men"; Convention for the Protection of Human Rights and Fundamental Freedoms; Convention for the Suppression of Discrimination in Education; Convention on the Elimination of All Forms of Discrimination against Women; General Recommendation № 25 to paragraph 1 of Article 4 of the Convention on the Elimination of All Forms of Discrimination against Women; Cultural Rights; UN Committee on Economic, Social and Cultural Rights); Recommendations on education in the spirit of international understanding, cooperation and peace and education in the spirit of respect for human rights and fundamental freedoms (UNESCO); The concept of the State social program to ensure equal rights and opportunities for women and men for the period up to 2021. Kharkiv National Medical University provides education and work that is free from discrimination, sexual harassment, intimidation or exploitation. The University recognizes the importance of confidentiality. All persons responsible for the implementation of this policy (staff of deans' offices, faculties, institutes and the Center for Gender Education, members of the student government and ethics committee, vice-rector for research and teaching) are confidential about those who report or accuse of discrimination. or sexual harassment (except when the law requires disclosure of information and / or when disclosure by the University is necessary to protect the safety of others).

KhNMU creates a space of equal opportunities free from discrimination of any national, racial or ethnic origin, sex, age, disability, religion, sexual orientation, gender, or marital status. All rights, privileges, programs and activities granted to students or staff of the University apply to all without exception, provided they are properly qualified. The anti-discrimination policy and the policy of counteracting sexual harassment of KhNMU are confirmed by the Code of Corporate Ethics and the Charter of KhNMU.

### ***Behavior in the audience***

It is important for students to follow the rules of good behavior at the university. These rules are common to all, they also apply to all faculty and staff, and are not fundamentally different from the generally accepted norms.

During classes it is allowed:

- leave the audience for a short time if necessary and with the permission of the teacher;

- drink soft drinks;
- take photos of presentation slides;
- take an active part in the class

Forbidden:

- eat (except for persons whose special medical condition requires another - in this case, medical confirmation is required);

- smoking, drinking alcohol and even low-alcohol beverages or drugs;
- use obscene language or use words that offend the honor and dignity of colleagues and faculty;
- gambling;

- damage the material and technical base of the university (damage inventory, equipment; furniture, walls, floors, litter the premises and territories);
- shouting, shouting or listening to loud music in classrooms and even in corridors during classes.

### ***Occupational Health***

The first lesson of the course will explain the basic principles of labor protection by conducting appropriate training. It is expected that everyone should know where the nearest evacuation exit to the audience, where the fire extinguisher is, how to use it, and so on.

## **5. ACADEMIC INTEGRITY**

Applicants must adhere to the principles of academic integrity set forth in the Code of Academic Integrity of Kharkiv National Medical University, which is designed to support the idea of integrity and a dignified relationship between participants in the academic process; promoting the importance of academic integrity; resolved issues related to raising the quality of higher education; promoting the development of a positive reputation; raising the rating of teachers and the competitiveness of university graduates; development of skills of conscientious and correct work with sources of information; compliance with the requirements of scientific ethics and respect for the intellectual property of others; activation of independence and individuality in the creation of their own works, as well as increasing the responsibility for violating the generally accepted rules of citation.

The main tasks of implementing the policy of academic integrity at the University are: prevention and elimination of cases of academic fraud among students and teachers of the University, education of negative attitudes to plagiarism, carrying out constant purposeful work on the development of academic integrity. Teachers, researchers and students who show a desire for academic integrity should be a role model and raise the standard of educational and research activities in general. Violations of the rules of academic integrity should not adversely affect the reputation of the University and reduce the value of educational and scientific degrees obtained at the University.

## **6. References**

### **Basic**

1. Harper's Illustrated Biochemistry / V.W. Rodwell, D.A. Bender, K.M. Botham et al. – Mc Graw Hill Education, 2015. – 817 p.
2. Popova L. Biochemistry / Popova L., Polikarpova A. – Kharkiv: KNMU, 2021. – 540 p.
3. Harper's Biochemistry / Murray R.K., Granner D.K., Mayes P.A. et al. – Prentice-Hall Int. Inc., 1998 – 1014 p.

### **Extra**

1. Halkerston I.D.K. Biochemistry: 2nd edition / Halkerston I.D.K. – The National medical series for independent study, 1988. – 522 p.
2. Stryer L. Biochemistry / Stryer L. – W.H. Freeman and Company, New York. – 1995. – 1064 p.
3. Molecular Cell Biology / H. Lodish et al. - W.H. Freeman and Company, N. York. – 2016. – 1170 p.

## 7. INFORMATION RESOURCES

1. Link to the discipline page in MOODLE:  
<http://distance.knmu.edu.ua/course/view.php?id=2562>
2. Educational portal: <http://www.osvita.org.ua>.
3. Website of the National Library of Ukraine named after VI Vernadsky:  
<http://nbuv.gov.ua>
4. Site of Kharkiv State Scientific Library named after VG Korolenko  
<http://korolenko.kharkov.com>.
5. Official site of the Ministry of Education and Science of Ukraine:  
<http://www.education.gov.ua>.
6. Website of the department: <http://www.knmu.kharkov.ua/>.
7. The site of the library of KhNMU: <http://libr.knmu.edu.ua>.
8. Provisions on prevention, prevention and settlement of cases related to sexual harassment and discrimination in KhNMU:  
[http://files.knmu.edu.ua:8181/upload/redakt/doc\\_uchproc/polog-sex.doc](http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog-sex.doc)
9. Regulations on Academic Integrity and Ethics of Academic Relations at Kharkiv National Medical University:  
[http://files.knmu.edu.ua:8181/upload/redakt/doc\\_uchproc/polog\\_ad\\_etyka\\_text.pdf](http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog_ad_etyka_text.pdf)
10. The procedure for conducting classes on in-depth study by students of Kharkiv National Medical University of certain disciplines beyond the scope of the curriculum: [http://files.knmu.edu.ua:8181/upload/redakt/doc\\_uchproc/nak-poriad-pogl-vyv-dysc.docx](http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/nak-poriad-pogl-vyv-dysc.docx)
11. Regulations on the Commission for Academic Integrity, Ethics and Conflict Management of KhNMU: [http://files.knmu.edu.ua:8181/upload/redakt/doc\\_uchproc/polog\\_komis\\_ad\\_text.pdf](http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog_komis_ad_text.pdf).
12. Regulations on the recognition of the results of non-formal education at Kharkiv National Medical University:  
[http://files.knmu.edu.ua:8181/upload/redakt/doc\\_uchproc/polog\\_neform\\_osv.pdf](http://files.knmu.edu.ua:8181/upload/redakt/doc_uchproc/polog_neform_osv.pdf)
13. INCLUSIVE EDUCATION: [http://www.knmu.kharkov.ua/index.php?option=com\\_content&view=article&id=7108%3A2021-03-10-14-08-02&catid=12%3A2011-05-10-07-16-32&Itemid=33&lang=uk](http://www.knmu.kharkov.ua/index.php?option=com_content&view=article&id=7108%3A2021-03-10-14-08-02&catid=12%3A2011-05-10-07-16-32&Itemid=33&lang=uk)
14. ACADEMIC INTEGRITY:  
[http://www.knmu.kharkov.ua/index.php?option=com\\_content&view=article&id=2520%3A2015-04-30-08-10-46&catid=20%3A2011-05-17-09-30-17&Itemid=40&lang=uk](http://www.knmu.kharkov.ua/index.php?option=com_content&view=article&id=2520%3A2015-04-30-08-10-46&catid=20%3A2011-05-17-09-30-17&Itemid=40&lang=uk)