



SYLLABUS OF THE DISCIPLINE “BIOLOGICAL CHEMISTRY”

1. General information	
Name of the faculty	Faculty of the Foreign Students (General Medicine)
Educational program (branch, specialty, level of higher education, form of training)	22 Public Health, 222 Medicine, second (master's) level of the higher education, daily form
Academic year	2022-2023
Name of the discipline, code (<i>electronic address is on the web-site of the Danylo Halytsky Lviv National Medical University</i>)	Biological chemistry Code OK 12 https://new.meduniv.lviv.ua/kafedry/kafedra-biologichnoyi-himiyi/
Department (<i>name, address, tel, e-mail</i>)	Department of Biological Chemistry 79010, Lviv, 69, Pekarska Street tel. +38 (032) 275 76 02 Kaf_biochemistry@meduniv.lviv.ua
Head of the Department (<i>e-mail</i>)	Lesia Kobylinska Dr. sci., Professor kaf_biochemistry@meduniv.lviv.ua
Year of training (when the discipline is taught)	Second year of training (2)
Semester (when the discipline is taught)	III-IV
Type	Mandatory
Staff (<i>names, scholar degrees, e-mail</i>)	Lesya Kobylinska, PhD, Dr. biol. sci., Professor Iryna Fomenko, PhD, Dr. biol. sci., Professor irynafomenkolviv@gmail.com Natalya Denysenko, PhD, assistant professor denysenko.natalka@gmail.com
Erasmus yes/no (availability of the discipline for students in the framework of the Erasmus+)	No
A person, responsible for the syllabus (receiving comments regarding syllabus, e-mail)	Iryna Fomenko, PhD, Dr. biol. sci., Professor irynafomenkolviv@gmail.com

Number of ECTS credits	6.5
Number of hours (lectures/practical classes/students independent work)	195 h (18 lectures / 80 practical classes / 97 students individual work)
Language of training	English
Information on consultations	Consultations are carried out according to the approved plan once per week during the academical year. Consultations before exam are carried out according to the approved plan by lectors.
Address, telephone and working schedule of the Department	-

2. Short annotation to the course

General characteristics, short course description, peculiarities, advantages

Teaching of *Biological chemistry* at the medical faculty (for foreign students) in Danylo Halytsky Lviv National Medical University is provided during the second year of training.

General characteristics, short course description, peculiarities, advantages.

Biological chemistry belongs to the fundamental medical disciplines. Knowledge of biochemical processes occurring at different levels of the organization - cellular, organ, tissue and whole body - is necessary for medical students to understand the metabolic processes of metabolism, energy, the course of decomposition and synthesis reactions, transmission of hereditary information, processes that ensure the course of physiological functions, and for the interpretation of biochemical parameters for diagnostic or prognostic purposes in clinical practice.

Types of educational activities for students according to the curriculum are lectures, practical classes and students individual work (SIW).

Biological chemistry as a discipline:

a) is based on the study of medical biology, biophysics, medical chemistry (bioinorganic, physical and colloid chemistry), morphological disciplines by students and integrates with these disciplines;

b) lays the foundations 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 with these disciplines and the formation of skills to apply knowledge of biological chemistry, especially biochemical processes in the body of a healthy and sick person, in the process of further training and professional activities;

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

d) further improvement of skills to use theoretical and practical skills in pathobiochemistry should be carried out at a higher scientific and methodological level in a separate training course - "Clinical Biochemistry", which is taught as an elective course for 3 year students and which is desirable to be taught as mandatory at 5 - 6 courses, ie after completion of the study of the main clinical disciplines and therapeutic and surgical cycles.

3. Aim and scope of the course

1. The purpose of teaching the discipline "Biological Chemistry" is to master the results of biochemical research and changes, biochemical and enzymatic indicators used to diagnose human diseases; to analyze the biochemical processes of metabolism and its regulation in ensuring the functioning of organs and systems of the human body. The ultimate goal is to acquire practical skills.

2. The objectives of the discipline "Biological Chemistry" are to master the skills to detect biochemical components in biological fluids and analyze the results of biochemical investigations and changes in biochemical, in particular, enzymatic parameters used to

diagnose the most common human diseases.

3. Competences and learning outcomes, the formation of which provides the study of the discipline "Biological Chemistry" (general and special competencies).

General competencies, the formation of which provides the study of the discipline "Biological Chemistry":

- GC 1. Ability to abstract thinking, to analyze and synthesize.
- GC 2. Ability to learn and master modern knowledge.
- GC 3. Ability to apply knowledge in practical situations.
- GC 4. Ability to acquire basic general knowledge, as well as basic knowledge of the profession.
- GC 5. Ability to adapt and act in a new situation.
- GC 6. Ability to make grounded decisions.
- GC 7. Ability to work in a team.
- GC 8. Ability to interpersonal interaction.
- GC 9. Ability to communicate in a foreign language.
- GC 10. Ability to use information and communication technologies.
- GC 11. Improve the ability to manage information from various sources.
- GC 12. Certainty and persistence on the tasks and duties taken.
- GC 15. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on the understanding of history and development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, technics and technology, use different types and forms of activity for active recreation and leading a healthy lifestyle.

Professional (special, subject):

- PC1. Ability to collect medical information about the patient and analyze clinical data.
- PC2. Ability to determine the list of laboratory and instrumental studies necessary for patients and evaluate their results.
- PC 3. Ability to establish a preliminary and clinical diagnosis of the disease.
- PC 7. Ability to diagnose emergency conditions.
- PC 17. The ability to assess the impact of the environment, socio-economic and biological factors on the state of health of an individual, family, population.
- PC 21. Clearly and unambiguously convey one's own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists, in particular to people who are studying.
- PC 23. The ability to develop and implement scientific and applied projects in the field of health care.
- PC 24. Adherence to ethical principles when working with patients and laboratory animals.
- PC 25. Adherence to professional and academic integrity, to be responsible for the reliability of the obtained scientific results.

Integrative final program results of training (PRN), the formation of which is favored by the educational discipline:

- PRN1. To have thorough knowledge of the structure of professional activity. To be able to carry out professional activities that require updating and integration of knowledge. To be responsible for professional development, the ability for further professional training with a high level of autonomy.
- PRN2. Understanding and knowledge of fundamental and clinical biomedical sciences, at a level sufficient for solving professional tasks in the field of health care.
- PRN3. Specialized conceptual knowledge that includes scientific achievements in the field of health care and is the basis for conducting research, critical understanding of problems in the field of medicine and related interdisciplinary problems.
- PRN4. Highlight and identify leading clinical symptoms and syndromes (according to list 1); according to standard methods, using preliminary data of the patient's

history, data of the patient's examination, knowledge about the person, his organs and systems, establish a preliminary clinical diagnosis of the disease (according to list 2).

- PRN5. Collect complaints, anamnesis of life and illness, assess the psychomotor and physical development of the patient, the state of organs and systems of the body, based on the results of laboratory and instrumental studies, evaluate information regarding the diagnosis (according to list 4), taking into account the age of the patient.
- PRN6. To establish the final clinical diagnosis by making a reasoned decision and analyzing the received subjective and objective data of clinical, additional examination, carrying out differential diagnosis, observing the relevant ethical and legal norms, under the control of the head physician in the conditions of the health care institution (according to the list 2).
- PRN7. To assign and analyze additional (mandatory and optional) examination methods (laboratory, functional and/or instrumental) (according to list 4) of patients with diseases of organs and body systems for differential diagnosis of diseases (according to list 2).
- PRN8. To determine the main clinical syndromes or causes the severity of the victim/injured's condition (according to list 3) by making a reasoned decision and assessing the person's condition under any circumstances (in the conditions of a health care facility, outside its borders), including in the conditions of an emergency and hostilities, in field conditions, in conditions of lack of information and limited time.
- PRN21. To search for the necessary information in the professional literature and databases of other sources, analyze, evaluate and apply this information.
- PRN22. To apply modern digital technologies, specialized software, and statistical methods of data analysis to solve complex healthcare problems.
- PRN 23. Assess the impact of the environment on the state of human health in order to assess the state of morbidity of the population.
- PRN24. To organize the necessary level of individual safety (own and the persons he cares for) in case of typical dangerous situations in the individual field of activity.
- PRN25. It is clear and unambiguous to convey one's own knowledge, conclusions and arguments on health care problems and related issues to specialists and non-specialists.
- PRN27. Communicate freely in English language, both orally and in writing to discuss professional activities, research and projects.

4. Prerequisites of the course

(Indicates information on disciplines, basic knowledge and learning outcomes required by the student (enrolled) for successful study and acquisition of competencies in this discipline)

For successful training and mastering of key competencies in the discipline "Biological Chemistry" it is necessary to have basic knowledge in the following disciplines:

1. Medical biology - structure of viruses, prokaryotic cells, eukaryotes, subcellular structure of cells, structural and functional significance of organelles, basics of molecular biology, functional components and stages of replication, transcription, translation into prokaryotes and eukaryotes, transcription structure of the operon induction and repression by Jacob and Mono. Structure, properties, classification of simple and complex enzymes. Fundamentals of enzymatic kinetics. The concept of metabolism, stages of anabolism and catabolism. The main ways of metabolism of proteins, carbohydrates, lipids, nucleic acids.

2. Biophysics - osmolarity, osmolality, osmosis, turgor, active transport, diffusion, facilitated diffusion, electrolytes, rest and action potentials, optical activity, fluorescence, salinization, denaturation, electrophoresis, chromatography, gel filtration, enzyme-linked immunosorbent assay.

3. Organic chemistry - the structure and properties of organic acids, amino acids, proteins,

chromoproteins, nucleoproteins, monosaccharides, disaccharides, homopolysaccharides, heteropolysaccharides, heparin, glucosamine glycans, hyaluronic acid, hyaluronic acid, sialic acid, nucleosides, nucleotides, nucleic acids. Features of secondary, tertiary, quaternary structures of proteins and nucleic acids. Structure and properties of water-soluble and fat-soluble vitamins, vitamin-like substances, hormones derived from amino acids, protein-peptide, steroid, thyroid, hormone-like substances derived from arachidonic acid.

4. Anatomy - the structure of the nervous, endocrine, digestive, cardiovascular, excretory, circulatory, immune, connective, muscular, skeletal systems.

5. Physiology - structural and functional features of the nervous, endocrine, digestive, cardiovascular, excretory, circulatory, immune, connective, muscular, skeletal systems.

5. Program results of learning

List of learning results

Code of learning results	Contents of learning results	Reference to the code of the competency matrix
<i>Knowledge</i>		
<i>Kn-1</i>	To know the main biochemical parameters used for the diagnostics and assessment of the state of a patient	<i>PRL 1</i> <i>PRL 2</i> <i>PRL 3</i>
<i>Kn -2</i>	Know the necessary list of biochemical investigations and principles of evaluation of their results	<i>PRL 4</i> <i>PRL 5</i>
<i>Kn-3</i>	Know the correspondence between biochemical clinical parameters and the corresponding syndromes and diseases	<i>PRL 6</i> <i>PRL 7</i>
<i>Kn-7</i>	To know the biochemical parameters that indicate emergency conditions	<i>PRL 8</i> <i>PRL 21</i>
<i>Kn-17</i>	To the biochemical parameters indicating the influence of the environment, socio-economic and biological determinants on the state of health	<i>PRL 22</i> <i>PRL 23</i> <i>PRL 24</i>
<i>Kn-21</i>	To know the methods of familiarization with knowledge, conclusions, arguments on health care issues	<i>PRL 25</i> <i>PRL 27</i>
<i>Kn-23</i>	To know the main principles of of scientific and research projects development	
<i>Kn-24</i>	To know ethical principles when working with patients and laboratory animals	
<i>Kn-25</i>	To know the principles of professional and academic integrity	
<i>Skills</i>		
<i>Sk-1</i>	To be able to choose the necessary list of clinical and biochemical studies and evaluate their results	<i>PRL 1</i> <i>PRL 2</i>
<i>Sk-2</i>	To be able to establish preliminary and clinical diagnoses of the disease on the basis of clinical and biochemical parameters	<i>PRL 3</i> <i>PRL 4</i> <i>PRL 5</i>
<i>Sk-3</i>	To be able to diagnose emergency conditions using biochemical parameters	<i>PRL 6</i> <i>PRL 7</i>
<i>Sk-7</i>	To be able to assess the impact of the environment, socio-economic and biological determinants on the state of health according to biochemical parameters	<i>PRL 8</i> <i>PRL 21</i> <i>PRL 22</i>
<i>Sk-17</i>	To be able to clearly and unambiguously convey one's own knowledge, conclusions and arguments on health care problems and related issues	<i>PRL 23</i> <i>PRL 24</i> <i>PRL 25</i>
<i>Sk-21</i>	To be able to develop and implement scientific and applied projects in the field of health care.	<i>PRL 27</i>

<i>Sk-24</i>	To be able to follow ethical principles when working with patients and laboratory animals.	
<i>Sk-25</i>	To be able to carry out professional activities, observing professional and academic integrity, to be responsible for the reliability of the obtained scientific results	
<i>Competencies</i>		
<i>C-1</i>	Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results.	<i>PRL 1</i> <i>PRL 2</i>
<i>C-2</i>	Ability to establish a preliminary and clinical diagnosis of the disease.	<i>PRL 3</i> <i>PRL 4</i>
<i>C-3</i>	Ability to diagnose emergency conditions.	<i>PRL 5</i> <i>PRL 6</i>
<i>C-7</i>	The ability to assess the impact of the environment, socio-economic and biological determinants on the state of health of an individual, family, population.	<i>PRL 7</i> <i>PRL 8</i> <i>PRL 21</i>
<i>C-17</i>	To convey one's own knowledge clearly and unambiguous, conclusions and arguments on health care problems and related issues to specialists and non-specialists, in particular to people who are studying.	<i>PRL 22</i> <i>PRL 23</i> <i>PRL 24</i> <i>PRL 25</i> <i>PRL 27</i>
<i>C-21</i>	The ability to develop and implement scientific and applied projects in the field of health care.	
<i>C-24</i>	Adherence to ethical principles when working with patients and laboratory animals.	
<i>C-25</i>	Adherence to professional and academic integrity, to be responsible for the reliability of the obtained scientific results.	
<i>Autonomy and responsibility</i>		
<i>AR-1</i>	Be responsible for knowledge of basic clinical and biochemical indicators Be responsible for assessing the environmental impact of socio-economic and biological determinants on the state of health according to biochemical parameters	<i>PRL 2</i> <i>PRL 3</i> <i>PRL 21</i> <i>PRL 22</i> <i>PRL 23</i>
<i>AR-2</i>	Be responsible for the ability to choose the necessary list of clinical and biochemical studies and evaluate their results	<i>PRL 24</i> <i>PRL 25</i>
<i>AR-3</i>	Be responsible for establishing preliminary and clinical diagnoses	
<i>AR-7</i>	Be responsible for the ability to diagnose emergency conditions based on biochemical indicators	
<i>AR-17</i>	Be responsible for conveying one's own knowledge, conclusions and arguments on health care problems and related issues	
<i>AR-21</i>	To be responsible for the development of scientific and research projects	
<i>AR-24</i>	Be responsible for observing ethical principles when working with patients and laboratory animals	
<i>AR-25</i>	Be responsible for carrying out professional activities, observing professional and academic integrity, for the reliability of the obtained scientific results	
6. Format and contents of the course		
Format of the course (classroom)	<i>Classroom</i>	

Type of classes	Number of hours	Number of groups
lectures	18	
practical	80	
seminars	-	-
Individual students work	97	

7. Topics and contents of the course

Code of classes type	Topic	Contents of learning	Code of the results of the teaching	Lecturer
L-1	Biochemistry as a science. Enzymes: structure, properties, classification. Regulation of metabolic processes. Coenzymes and cofactors.	<p>History of biochemistry. Subject and purpose of biochemistry. History and achievements of the Department of Biochemistry of Danylo Halytsky LNMU. Biological chemistry (biochemistry) as a science. Objects of study and tasks of biochemistry. Enzymes: definition; properties of enzymes as proteins; common and different properties of enzymes and inorganic catalysts.</p> <p>Classification, nomenclature, enzyme code. Characteristics of six classes of enzymes. The structure of enzymes. Definition and role of active and allosteric (regulatory) centers. Mechanisms of action of enzymes. Types of classifications of coenzymes. The role of metals in the functioning of enzymes. Structure, properties, participation in chemical reactions of coenzymes - derivatives of water-soluble vitamins, vitamin-like substances, non-vitamin coenzymes. Isoenzymes. Activators and enzyme inhibitors. Regulation of enzymatic processes. Medical enzymology.</p>	<i>Kn-1, 3, 17, 25</i>	Prof. L.I. Kobylinska
L-2	Bioenergetics : general ways of catabolism of carbohydrates , lipids, amino acids. Krebs cycle. Biological oxidation and oxidative phosphorylation	<p>Metabolism (metabolism). Tricarboxylic acids cycle (TCA). Types of biological oxidation reactions; their biological significance. Tissue respiration. Definition, localization in the cell. Respiratory chain of mitochondria. Chemiosmotic theory of oxidative phosphorylation. Electron transport inhibitors and oxidative phosphorylation disconnectors.</p>	<i>Kn-7, 17,25</i>	Prof. L.I. Kobylinska

	on. Electron transport chain in mitochondria.			
L-3	Carbohydrate metabolism. General characteristics of the processes of glycolysis, aerobic oxidation of glucose, glycogen metabolism, gluconeogenesis, PPP. Diabetes.	Digestion of carbohydrates Glycolysis. Oxidative decarboxylation of pyruvate. Energy effect of complete oxidation of glucose. Shuttle mechanisms of NADH transport across membranes. Phosphorolytic pathway of glycogen breakdown in liver and muscles, glycogen biosynthesis. Gluconeogenesis. Pentose phosphate pathway (PFS) of glucose oxidation. Glucose-lactate (Corey cycle) and glucose-alanine cycles. Regulation of blood glucose concentration. Diabetes mellitus is a pathology of glucose metabolism. Types of diabetes mellitus, causes, metabolic disorders, biochemical criteria of diabetes mellitus. Present and explain the sugar load curve.	<i>Kn-1, 2, 3, 17, 25</i>	Prof. Fomenko I.S.
L-4	Lipid metabolism. Characteristics of the metabolism of triacylglycerols, fatty acids, glycerol, ketone bodies, cholesterol. Regulation and pathology of lipid metabolism.	Digestion of lipids. Catabolism of triacylglycerols in adipocytes of adipose tissue: Biosynthesis of triacylglycerols and phosphoglycerides. Oxidation of fatty acids (β -oxidation). Biosynthesis of higher fatty acids. Metabolism of ketone bodies. Metabolism of sphingolipids. Genetic abnormalities of sphingolipid metabolism. Cholesterol biosynthesis. Ways of cholesterol biotransformation. Plasma lipoproteins: lipid and protein (apoproteins) composition. Hyperlipoproteinemia. Classification of dyslipoproteinemias according to the WHO. Atherosclerosis. Characteristics of changes in lipid metabolism in obesity and diabetes. Pathologies of lipid metabolism. Characteristics of the processes of lipid peroxidation and antioxidant protection in normal and pathological conditions. Oxidative stress. Give examples of the formation of reactive oxygen species and fatty acid radicals.	<i>Kn-1, 2, 3, 7, 17, 25</i>	Prof. L.I.Kobylińska
L-5	Amino acid metabolism. General ways	Transamination of amino acids. Types of direct and indirect deamination of free amino acids in tissues. Decarboxylation of	<i>Kn-1, 2, 3, 7, 17, 25</i>	Prof. I.S. Fomenko

	<p>of conversion of amino acids.</p> <p>Ammonia metabolism: urea biosynthesis and its disorders.</p> <p>Specialized ways to convert amino acids; hereditary enzymopathy associated with them.</p> <p>Heme synthesis.</p>	<p>L-amino acids in the human body. Ways of formation and neutralization of ammonia in the body. Urea biosynthesis.</p> <p>Metabolism of sulfur-containing amino acids. Specialized pathways of cyclic amino acids - phenylalanine and tyrosine.</p> <p>Hereditary enzymopathies of cyclic amino acid metabolism - phenylalanine and tyrosine, their manifestations, diagnosis, consequences. The metabolism of the cyclic amino acid tryptophan is normal and in pathologies. Metabolism of porphyrins.</p> <p>Hereditary disorders of porphyrin biosynthesis, types of porphyria.</p>		
L -6	<p>Features of nucleotide metabolism in normal and in pathology.</p> <p>General characteristics of matrix syntheses and their regulation.</p> <p>Molecular mechanisms of mutations.</p>	<p>Metabolism of purine nucleotides.</p> <p>Metabolism of pyrimidine nucleotides.</p> <p>Biosynthesis of deoxyribonucleotides.</p> <p>Formation of thymidyl nucleotides; inhibitors of dTMP biosynthesis as antitumor agents; give examples.</p> <p>DNA replication. RNA transcription. Stages and mechanisms of translation. Types of posttranslational modification of proteins.</p> <p>Broadcast regulation. Antibiotics.</p> <p>Regulation of gene expression. Mutations.</p> <p>Biological significance and mechanisms of DNA repair: reparation.</p>	<i>Kn-1, 2, 3, 7, 17, 25</i>	Prof. I.S. Fomenko
L-7	<p>Hormones.</p> <p>Structure and classification of hormones.</p> <p>Membrane and membrane-cytosolic mechanisms of hormone action.</p> <p>Regulation of metabolism by hormones of protein-peptide, steroid and thyroid nature.</p>	<p>Hormones: definition, general characteristics. Classifications of hormones and hormone-like substances.</p> <p>The reaction of target cells to the action of hormones. Membrane and cytosolic receptors; their role and structure.</p> <p>Biochemical cascade systems of intracellular transmission of hormonal signals.</p> <p>Molecular-cellular mechanisms of action of hormones of protein, peptide nature and amino acid derivatives. Hypothalamic hormones - liberins and statins. Tropic hormones of the anterior pituitary gland.</p> <p>Hormones of the posterior pituitary gland</p> <p>Hormones of the pineal gland. Pancreatic hormones. Catecholamines. Hormonal regulation of calcium homeostasis in the</p>	<i>Kn-1, 2, 3, 7, 17, 25</i>	Prof. L.I.Kobylińska

	Hormone-like substances.	body. The mechanism of action of the corresponding hormones and hormone-like substances. Molecular-cellular mechanisms of action of steroid and thyroid hormones. Thyroid hormones. Steroid hormones of the adrenal cortex (C21-steroids) - glucocorticoids and mineralocorticoids. Female and male sex hormones. Hormone-like substances. Eicosanoids.		
L-8	Blood biochemistry. Hemoglobin, its structure, properties, types, derivatives, biological role. Regulation of acid-base state. Blood pathochemistry. General characteristics of coagulation and fibrinolytic blood systems.	Hemoglobin: structure, mechanisms of participation in gas transport. Hemoglobin derivatives, their significance. Physiological and abnormal types of hemoglobin. Hemoglobinopathy and thalassemia. Blood buffer systems. Types of acid-base imbalance in the body. Hypoxia, its types. Biochemical composition of human blood. Blood plasma proteins. Electrophoregram of human serum proteins in normal and pathological conditions. Hyper-, hypo-, dysproteinemia, paraproteinemia. Their causes and clinical and diagnostic value. Acute phase proteins. Blood plasma enzymes. Kallikrein-kinin, renin-angiotensin blood system. Non-protein organic compounds of blood plasma: nitrogen-containing and nitrogen-free. Residual blood nitrogen. Coagulation, anticoagulation, fibrinolytic blood system. Immunoglobulins: structure, classes, biochemical characteristics of separate classes of human immunoglobulins. Characteristics of mediators and hormones of the immune system.	<i>Kn-1, 2, 3, 7, 17, 25</i>	Prof. Fomenko I.S.
L-9	Biochemical functions of the liver. Heme catabolism, biochemistry of jaundice; biotransformation of endogenous substances and xenobiotics	Characteristics of biochemical functions of the liver in normal and in pathology. Detoxification function of the liver: characteristics of the phases of biotransformation; types of biotransformation reactions of xenobiotics and endogenous toxins. Microsomal oxidation reactions. Cytochrome P-450. Conjugation reactions. Catabolism of hemoglobin and heme. The role of the liver in the metabolism of bile pigments.	<i>Kn-1, 2, 3, 7, 17, 25</i>	Prof. L.I.Kobylińska

	in the liver.	Pathobiochemistry of jaundice; types of jaundice; hereditary (enzymatic) jaundice. Biochemical diagnosis of jaundice.		
P-1	Control of the initial level of knowledge. Subject and tasks of biochemistry. Purpose and methods of biochemical research; their substantiation and clinical and diagnostic value.	<ol style="list-style-type: none"> 1. Subject and tasks of biochemistry. Main directions and sections of biochemistry: static, dynamic, functional biochemistry, medical and clinical biochemistry. 2. Biochemistry as a fundamental medical - biological science. History of development, scientific biochemical schools, importance in the system of higher medical education. 3. The contribution of scientists of the Department of Biochemistry of Lviv National Medical University named after Danylo Halytsky in the development of biological chemistry. 4. Chemical composition of a living organism. Biomolecules (proteins, carbohydrates, lipids, nucleic acids, hormones, vitamins, etc.), their biochemical functions. Characteristic features of living matter: metabolism and energy and their relationship with the environment. 5. Structural elements of prokaryotic and eukaryotic cells. The main functions of subcellular organelles, their fractional separation by ultracentrifugation. 6. Principles of basic methods of biochemical research. (Informativeness of enzyme-linked immunosorbent assays and PCR in the diagnosis of COVID-19). 7. The purpose of conducting biochemical laboratory tests and criteria for evaluating the methods used in laboratory tests. 8. Material for laboratory diagnostic tests, principles of collection and storage of material for laboratory tests. 9. Characteristics of errors that occur during laboratory tests. 	<i>Kn-1, 2, 3, 21, 25</i> <i>Sk-1, 2, 3, 17, 21, 23,24,25</i> <i>C- 1, 2, 3, 17,21,23,24, 25</i> <i>AR-1, 2,3, 17,21,23,24, 25</i>	According to the time-table
P-2	Study of the structure and physicochemical properties of enzymes. Determination of enzyme activity, study of the mechanism of their action and kinetics of enzymatic	<ol style="list-style-type: none"> 1. Enzymes: definition; properties of enzymes as biological catalysts of metabolic reactions and as proteins (electrochemical properties, solubility, thermodynamic stability, ability to deposition, denaturation, interaction with ligands). 2. Levels of structural organization of enzymes. Simple enzymes. Complex enzymes, their structure (cofactors, coenzymes, prosthetic groups). The role of metal ions in the functioning of enzymes. Multienzyme complexes, enzymatic 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C- 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

	catalysis.	<p>ensembles, polyfunctional enzymes, their advantages. Give examples.</p> <p>3. The structure of enzymes: active, regulatory (allosteric) centers, their importance.</p> <p>4. Nomenclature, classification, enzyme code. Types of reactions that catalyze certain classes of enzymes.</p> <p>5. Basic kinetic properties of enzymes.</p> <p>6. Units of enzymatic activity. Principles of quantitative determination of enzyme activity (by the amount of product formed under the action of the enzyme; by the amount of substrate used; by the change in the amount of coenzyme (redox transformations for NAD and FAD)).</p> <p>7. Formation of the enzyme-substrate complex and the process of substrate transformation. Mechanisms of action of enzymes (effects of convergence and orientation; effects of acid-base catalysis; effects of nucleophilic and electrophilic catalysis). Give examples.</p> <p>8. Specificity of enzymes. Types of specificity (absolute, relative, stereospecificity). Give examples.</p> <p>9. Intracellular localization and tissue (organ) specificity of enzymes. Give examples.</p>		
P -3	Research of regulation of enzymatic processes and analysis of mechanisms of enzymopathies. Medical enzymology.	<p>1. Activation and inhibition of enzymes. Enzyme activators (examples). Inhibition of enzymes: reversible, irreversible, competitive, non-competitive (give examples).</p> <p>2. Regulation by changing the catalytic activity of enzymes: allosteric enzymes; covalent modification of enzymes; proteolytic activation of enzymes (limited proteolysis); action of regulatory proteins; cyclic nucleotides in the regulation of enzymatic processes.</p> <p>3. Regulation by changing the number of enzymes (constitutive and adaptive enzymes).</p> <p>4. Isoenzymes (definition, structure on the example of lactate dehydrogenase and creatine phosphokinase). The use of isoenzymes for diagnosis.</p> <p>5. Enzyme diagnostics (determination). Changes in the activity of plasma and serum enzymes as diagnostic (marker) indicators of the development of pathological processes (myocardial infarction, liver disease, pancreas, muscle</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>C - 1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>tissue).</p> <p>6. Enzymopathology (definition). Congenital (hereditary) and acquired metabolic defects (examples, their clinical and laboratory diagnosis).</p> <p>7. Enzymotherapy (definition). The use of enzymes, cofactors and enzyme inhibitors (acetylsalicylic acid, allopurinol, contrikal, trasilol, sulfonamides and others) as drugs.</p>		
P -4	Investigation of the role of cofactors and coenzyme vitamins. The role of water- and fat-soluble vitamins in the metabolism of living organisms.	<p>1. Vitamins as essential biologically active components of nutrition that are necessary for the human body. History of the discovery of vitamins. Development of vitaminology in Ukraine.</p> <p>2. Exo- and endogenous hypo- and avitaminosis, their causes and consequences. Hypervitaminosis: possible causes and consequences.</p> <p>3. Vitamins B₁ and B₂, their structure, coenzyme role, sources for humans, daily requirement. Signs of hypovitaminosis; application in medicine.</p> <p>4. Structure, properties of vitamin H and pantothenic acid. The role of coenzymes of carboxybiotin and CoASH in metabolic processes. The main sources, daily needs. Signs of hypovitaminosis; application in medicine.</p> <p>5. Antianemic vitamins (B₁₂, folic acid), their structure, the participation of coenzymes in metabolism, sources for humans, daily requirement, signs of hypovitaminosis, use in medicine.</p> <p>6. Vitamins B₆ and PP, their structure, coenzyme role, sources for humans, daily requirement, signs of hypovitaminosis, use in medicine.</p> <p>7. Vitamins C and P, their structure, biological role, participation in metabolism, sources for humans, daily requirement. Functional relationship between vitamin P and vitamin C (synergistic effect of vitamins). Manifestations of insufficiency in the human body, use in medicine.</p> <p>Будова, властивості, участь в хімічних реакціях хінонових і карнітинових коферментів. Написати структурні формули убіхінону/убіхінолу і ацилкарнітину.</p> <p>Будова, властивості, участь в хімічних реакціях невітамінних коферментів. Написати структурні формули УДФ-глюкози, ЦПФ-холіну, глутатіону (окислена і відновлена форми).</p> <p>8. Vitamins of group D, structure,</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sk-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>C - 1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>AR- 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>biological role, mechanism of action, daily requirement, sources for the person, signs of hypo - and hypervitaminosis, avitaminosis.</p> <p>9. Vitamin A, structure, biological role, mechanism of action, daily requirement, sources for humans, signs of hypo-, hypervitaminosis.</p> <p>10. Vitamins E, F, structure, biological role, mechanism of action, sources for humans, mechanism of action, daily requirement, signs of hypo-, hypervitaminosis, use in medicine.</p> <p>11. Antihemorrhagic vitamins (K₂, K₃) and their water-soluble forms, structure, biological role, sources for humans, mechanism of action, daily requirement, signs of insufficiency, use in medicine.</p> <p>12. Vitamin-like substances: definition, structure and biological role.</p>		
P -5	<p>Metabolism and energy. Study of the functioning of the tricarboxylic acid cycle.</p>	<p>1. The concept of metabolism and energy. Characteristics of catabolic, anabolic and amphibolic pathways of metabolism, their significance.</p> <p>2. Extragonic and endergonic biochemical reactions; the role of ATP and other macroergic phosphates in their conjugation.</p> <p>3. Intracellular localization of metabolic pathways, compartmentalization of metabolic processes in the cell. Isolation of subcellular structures by differential centrifugation.</p> <p>4. Stages of catabolism of biomolecules: proteins, carbohydrates, lipids; their characteristics.</p> <p>5. The most important metabolites of the metabolic pathways of proteins, carbohydrates, lipids (pyruvate, acetyl-S-CoA); their role in integrating cell metabolism.</p> <p>6. Tricarboxylic acid cycle (TCA): intracellular localization of TCA enzymes; the sequence of TCA reactions; characteristics of enzymes and coenzymes of TCA; substrate phosphorylation reactions in CTC; the effect of allosteric modulators on the regulation of TCA; energy balance of the tricarboxylic acid cycle.</p> <p>7. Mechanisms of regulation of TCA. Give examples.</p> <p>8. Anaplerotic reactions of TCA. Give definitions and give examples.</p>	<p><i>Kn-1</i>, 2, 3, 17, 21, 23, 24, 25 <i>Sk-1</i>, 2, 3, 17, 21, 23, 24, 25 <i>C - 1</i>, 2, 3, 17, 21, 23, 24, 25 <i>AR- 1</i>, 2, 3, 17, 21, 23, 24, 25</p>	According to the time-table

P-6	Investigation of the processes of biological oxidation, oxidative phosphorylation and ATP synthesis. Investigation of the action of oxidative phosphorylation inhibitors and disconnectors .	<ol style="list-style-type: none"> 1. Biological oxidation of substrates in cells. Biological oxidation reactions and their functional significance. Characteristics of dehydrogenases, oxidases, oxygenases (mono- and dioxygenases). 2. Pyridine-dependent dehydrogenases. The structure of NAD⁺ and NADP⁺. Their importance in oxidation and reduction reactions. Flavin-dependent dehydrogenases. Structure of FAD and FMN. Their role in oxidation and reduction reactions. 3. Ubiquinone, structure and its role in oxidation and reduction reactions. 4. Cytochromes and their role in tissue respiration. The structure of their prosthetic group. 5. Molecular organization of the electron transport chain (respiratory chain) of mitochondria. The principle of arrangement of components of a respiratory chain according to indicators of redox potential. The sequence of electron carriers in the complete and shortened respiratory chain. 6. Supramolecular complexes of the respiratory chain of the inner membranes of mitochondria. Regulation of tissue respiration (respiratory control): dependence of tissue respiration on the concentration of ADP; the value of the ratio of ATP / ADP in tissues. 7. Oxidative phosphorylation is a molecular mechanism of ATP generation in the process of biological oxidation. The main provisions of Mitchell's chemiosmotic theory. Scheme of the chemiosmotic mechanism of conjugation of electron transport in the respiratory chain with ATP synthesis. Molecular structure and principle of action of ATP synthase. 8. Conjugation points of electron transport and phosphorylation. Oxidative phosphorylation coefficient. 9. Inhibitors of electron transport in the respiratory chain of mitochondria, their effect on ATP synthesis. 10. Uncouplers of electron transport and oxidative phosphorylation in the respiratory chain of mitochondria, their influence on ATP synthesis. Free, non-phosphorylating oxidation. 	<i>Kn-1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>Sk-1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 7, 17, 21, 23, 24, 25</i>	According to the time-table
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		11. Reactive forms of oxygen (hydrogen peroxide, superoxide anion radical, hydroxyl radical, singlet oxygen); mechanism of their formation and inactivation.		
P -7	Study of glycolysis - anaerobic oxidation of carbohydrates .	<ol style="list-style-type: none"> 1. Biochemical mechanisms of carbohydrate digestion processes in the digestive tract. Specificity of digestive enzymes, optimal conditions of their action. Absorption of carbohydrates in the small intestine. 2. Hereditary enzymopathies of carbohydrate digestion processes (insufficiency of disaccharidases: lactase, sucrase and isomaltase, violation of membrane transport of hexoses, absorption of glucose and galactose). 3. Glucose as an important metabolite of carbohydrate metabolism: a general scheme of sources and ways of conversion of glucose in the body. 4. Anaerobic oxidation of glucose. Contribution of the works of H. Embden, O. Meyerhoff, and Ya. Parnas to the study of glycolysis. Chemical reactions and characteristics of anaerobic and aerobic glycolysis enzymes. 5. Lactate dehydrogenase reaction in glycolysis, mechanism and features of its course, regulation of activity in various tissues. 6. LDH isoenzymes, definition, structure and clinical-diagnostic value of determination in blood. 7. Mechanisms of regulation of activity of reactions of anaerobic oxidation of glucose. Pasteur effect, its molecular basis. 8. Energy value of anaerobic oxidation of glucose. 9. Alcohol fermentation, enzymatic reactions. 	<i>Kn-1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>Sk-1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 7, 17, 21, 23, 24, 25</i>	According to the time-table
P -8	Investigation of aerobic oxidation of glucose and alternative pathways of monosaccharide metabolism.	<ol style="list-style-type: none"> 1. Characteristics of the stages of aerobic oxidation of glucose. 2. Oxidative decarboxylation of pyruvic acid. 3. Energy value of aerobic (complete) oxidation of glucose to CO₂. Comparative characteristics of bioenergy of aerobic and anaerobic oxidation of glucose. 4. Pentose phosphate cycle (PFC) of glucose oxidation. 5. Enzymatic reactions of fructose conversion in the human body. Hereditary 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

		<p>enzymes of fructose metabolism.</p> <p>6. Enzymatic reactions of galactose conversion in the human body. Hereditary enzymes of galactose metabolism.</p> <p>7. Malate-aspartate route of glycolytic NADH₂ transfer in mitochondria.</p> <p>8. Glycerol phosphate shuttle mechanism of glycolytic NADH₂ transfer in mitochondria.</p>		
P-9	<p>Studies of glycogen catabolism and biosynthesis. Regulation of glycogen metabolism, glucose biosynthesis – gluconeogenesis.</p>	<p>1. Features of the course and mechanism of enzymatic reactions of glycogenesis.</p> <p>2. Glycogenolysis, reactions common and different with glycolysis.</p> <p>3. Cascade mechanisms of ATP-dependent regulation of glycogen phosphorylase and glycogen synthetase activities.</p> <p>4. Features of hormonal regulation of glycogen metabolism in muscles and liver.</p> <p>5. Hereditary disorders of glycogen synthesis and breakdown enzymes. Glycogenesis, aglycogenesis, their characteristics, causes.</p> <p>6. Features of metabolism of carbohydrate components of glycoconjugates.</p> <p>7. Genetic disorders of glycoconjugate metabolism (glycosidosis).</p> <p>8. Gluconeogenesis. Determination, substrates, compartmentalization of enzymes, sequence of reactions, biological significance of the process.</p> <p>9. Mechanisms of regulation of gluconeogenesis in the human body.</p> <p>10. Irreversible glycolysis reactions and their bypasses.</p> <p>11. Relationship between glycolysis and gluconeogenesis. Glucose-lactate (Corey cycle), glucose-alanine cycles.</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table
P-10	<p>Investigation of mechanisms of metabolic and hormonal regulation of carbohydrate metabolism. Diabetes.</p>	<p>1. Biochemical processes that ensure a constant level of glucose in the blood. The role of different pathways of carbohydrate metabolism in the regulation of blood glucose levels.</p> <p>2. The role of the liver in carbohydrate metabolism.</p> <p>3. Endocrine regulation of carbohydrate metabolism:</p> <ul style="list-style-type: none"> • insulin, structure, mechanism of action, role in carbohydrate metabolism; • epinephrine and glucagon, mechanisms of their regulatory action on carbohydrate metabolism; • glucocorticoids, their effect on 	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>carbohydrate metabolism;</p> <ul style="list-style-type: none"> • somatotropin, features of influence on carbohydrate metabolism. <p>4. Characteristics of hyper-, hypoglycemia and glucosuria.</p> <p>5. Insulin-dependent and non-insulin-dependent forms of diabetes. Biochemical criteria of diabetes mellitus.</p> <p>6. Characteristics of disorders of hydrocarbon, lipid, protein metabolism in diabetes.</p> <p>7. Biochemical tests to assess diabetes mellitus (blood and urine sugar, blood and urine ketone bodies, urine protein, glycosylated hemoglobin, C-peptide). Glucose tolerance test. Present the sugar load curve, explain its features for people with normal and impaired glucose tolerance.</p>		
P-11	<p>Studies of catabolism and biosynthesis of triacylglycerols and phospholipids . Intracellular lipolysis and molecular mechanisms of its regulation.</p>	<p>1. Biological functions of simple and complex lipids in the human body (spare, energy, participation in thermoregulation, biosynthetic).</p> <p>2. Biochemical mechanisms of lipid digestion processes in the digestive tract. Specificity of digestive enzymes, optimal conditions of their action. The value of emulsification processes.</p> <p>3. Violation of digestion and absorption of lipids. Steatorrhea, its types and diagnosis.</p> <p>4. Participation of lipids in the construction and functioning of biological cell membranes. Liquid-mosaic model of biomembranes. Liposomes. The use of liposomes in medicine.</p> <p>5. Adipocytes of adipose tissue and their role in lipid metabolism and bioenergetic processes in the body.</p> <p>6. Catabolism of triacylglycerols: characteristics of intracellular lipolysis, its biological significance; enzymatic reactions; mechanisms of regulation of triacylglycerol lipase activity; neurohumoral regulation of lipolysis with the participation of adrenaline, noradrenaline, glucagon, insulin; energy of oxidation of triacylglycerols.</p> <p>7. Biosynthesis of triacylglycerols and phospholipids, the value of phosphatidic acid.</p> <p>8. Metabolism of sphingolipids. Genetic abnormalities of sphingolipid metabolism - sphingolipidosis. Lysosomal</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	<p>According to the time-table</p>

		diseases.		
P-12	β - Oxidation and biosynthesis of fatty acids. Studies of the metabolism of fatty acids and ketone bodies.	<ol style="list-style-type: none"> 1. β-Oxidation of higher fatty acids (FFA). 2. The mechanism of glycerol oxidation, the energy of this process. 3. Biosynthesis of higher fatty acids. 4. Metabolism of ketone bodies. 	<i>Kn-1, 2, 3, 17, 21,25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
P-13	Cholesterol biosynthesis and biotransformation. Pathologies of lipid metabolism: steatorrhea, atherosclerosis, obesity. Transport forms of lipids - plasma lipoproteins.	<ol style="list-style-type: none"> 1. Cholesterol biosynthesis in the human body. 2. Ways of biotransformation of cholesterol (esterification, formation of bile acids and steroid hormones, synthesis of vitamin D₃, excretion from the body). 3. The structure of blood lipoproteins. Characteristics of the main classes of blood lipoproteins. 4. Features of blood lipoprotein metabolism. 5. Pathologies of lipid metabolism. 6. Processes of lipid peroxidation and mechanisms of action of antioxidant protection enzymes. 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
P-14	Investigation of proteins digestion in digestive system/ General pathways of amino acid metabolism (transamination, deamination, decarboxylation).	<ol style="list-style-type: none"> 1. Digestion of proteins in the stomach: the mechanism of activation and the specific action of enzymes (pepsin, gastrin, renin). Biochemical aspects of activation and stimulation of enzyme secretion. The mechanism of formation and the role of hydrochloric acid. 2. Acidity of gastric juice and forms of its expression; quantitative indicators in normal and under conditions of pathology (by the method of pH-metry). 3. Digestion of proteins in the small intestine: proteolytic enzymes of the pancreas and small intestine, the mechanism of their activation and specificity of action. 4. Mechanisms of absorption of protein hydrolysis products. 5. Characteristics of protein putrefaction processes in the colon. 6. Ways of formation and maintenance of a pool of free amino acids in the human body. General ways of conversion of free amino acids. 7. Deamination of amino acids. 8. Transamination of amino acids. 9. Decarboxylation of amino acids. 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

P-15	Investigation of ammonia detoxification and urea biosynthesis processes. biosynthesis of glutathione and creatine.	<ol style="list-style-type: none"> 1. General pathways of metabolism of nitrogen-free skeleton of amino acids in the human body. Glucogenic and ketogenic amino acids. 2. Ways of ammonia formation. Ammonia toxicity and mechanisms of its neutralization. Circulatory transport of ammonia (glutamine, alanine). 3. Urea biosynthesis: enzymatic reactions; genetic defects of enzymes (enzymopathy) of urea synthesis. 4. Glutathione, structure and role in the metabolism of organic peroxides. 5. Formation of creatine and creatinine, clinical and biochemical significance of disorders of their metabolism. 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
P-16	Specific pathways of amino acid metabolism. Investigation of intermediates of porphyrin biosynthesis and their accumulation in porphyrias.	<ol style="list-style-type: none"> 1 Specialized ways of metabolism of acyclic amino acids. 2. Features of amino acid metabolism with branched chains. 3. Specific pathways of metabolism of cyclic amino acids phenylalanine and tyrosine, the sequence of enzymatic reactions. 4. Hereditary enzymopathy of cyclic acyclic amino acids phenylalanine and tyrosine - phenylketonuria, alkaptonuria, albinism.. 5. Metabolism of sulfur-containing amino acids; methylation reactions. The role of S - adenosylmethionine in transmethylation reactions. 6. Coenzymes of vitamins H and B₁₂ in the metabolism of sulfur-containing and branched-chain amino acids. 7. Metabolism of arginine; biological role of nitric oxide, NO - synthase. 8. Tryptophan metabolism: kinurenin and serotonin pathways. 9. Pathologies of nitrogen metabolism: kwashiorkor, aminoaciduria, cystinosis, cystinuria. 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
P-17	Investigation of purine and pyrimidine nucleotide metabolism. Determination of the end products of their exchange. Hereditary disorders of	<ol style="list-style-type: none"> 1. Structure and nomenclature of nitrogenous bases, nucleosites and nucleotides. Minor nitrogenous bases and nucleotides. 2. Biosynthesis of purine nucleotides. 3. Biosynthesis of pyrimidine nucleotides: reactions; regulation. Clinical and biochemical characteristics of orotaciduria. 4. Biosynthesis of deoxyribonucleotides. Formation of thymidyl nucleotides; inhibitors of dTMP 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

	their exchange.	<p>biosynthesis as antitumor agents (structural analogues of dTMP, pterin derivatives).</p> <p>5. Catabolism of purine nucleotides; hereditary disorders of uric acid metabolism. Clinical and biochemical characteristics of hyperuricemia, gout, Lesch-Nihan syndrome.</p> <p>6. Catabolism of pyrimidine nucleotides; metabolism of their breakdown products.</p>		
P-18	<p>DNA replication and RNA transcription studies.</p> <p>Analysis of mechanisms of mutations, DNA repairs. Assimilation of the principles of obtaining recombinant DNA, transgenic proteins.</p>	<p>1. Nucleic acids: structure, properties, historical stages of study. Primary, secondary and tertiary structure of DNA.</p> <p>2. Structure, properties and biological functions of RNA. RNA types: mRNA, tRNA, rRNA; features of structural organization.</p> <p>3. DNA replication: biological significance; semi-conservative mechanism of replication (experimental scheme of M. Meselson and F. Stahl).</p> <p>4. General scheme of DNA biosynthesis. Enzymes of DNA replication in prokaryotes and eukaryotes (unwinding proteins, primase, DNA polymerase, DNA ligase). Stages of synthesis of daughter chains of DNA molecules (values of antiparallelism of DNA chains; Okazaki fragments).</p> <p>5. RNA transcription. RNA polymerases of prokaryotes and eukaryotes. The structure of the transcripton (operon). Transcription signals: promoter, initiator, terminator regions of the genome. Stages of RNA synthesis. The value of reverse transcriptase. Antibiotics are transcription inhibitors.</p> <p>6. Processing - posttranscriptional modification of RNA; stages of processing.</p> <p>7. Regulation of prokaryotic gene expression: a scheme of regulation by F. Jacob and J. Mono. Structure of Lac-operon of E. coli, principles of its functioning (repression, induction).</p> <p>8. Regulation of eukaryotic gene expression at the level of transcription; system of transcription signals - promoter sequences, enhancers, attenuators, silencers.</p> <p>9. Features of molecular organization and genome expression in eukaryotes. Nuclear chromatin of eukaryotes; covalent modification of histones as one of the</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>C - 1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>mechanisms of gene expression control.</p> <p>10. Genetic recombination; transposons. Recombinations of the prokaryotic genome (transformation, transduction, conjugation). Recombination processes in eukaryotes on the example of gene formation of H- and L-chains of immunoglobulin molecules.</p> <p>11. Amplification of genes (metallothionein genes, dihydrofolate reductase): definition, biological significance.</p> <p>12. Mutations: genomic, chromosomal, genetic (point); role in the occurrence of enzymopathy and hereditary human diseases. Biochemical mechanisms of action of chemical mutagens - analogues of nitrogenous bases, deaminating, alkylating agents, ultraviolet and ionizing radiation.</p> <p>13. Biological significance and mechanisms of DNA repair. Repair of UV-induced gene mutations; xeroderma pigmentosum; repair of cytosine deamination.</p>		
P-19	<p>Protein biosynthesis on ribosomes. Investigation of the processes of initiation, elongation and termination in the synthesis of a polypeptide chain. Inhibitory effect of antibiotics. Assimilation of the principles of genetic engineering and gene cloning, their application in modern medicine.</p>	<p>1. Genetic (biological) code; its properties. Characteristics of the genetic code table.</p> <p>2. Ribosomal protein synthesis system. Components of the protein-synthesizing system of ribosomes.</p> <p>3. The structure of transport RNA and the mechanism of amino acid activation. [Aminoacyl-tRNA synthetase.]</p> <p>4. Stages and mechanisms of translation: initiation, elongation, termination. Initiating and terminating codons of mRNA; the role of ribosome protein factors in translation.</p> <p>5. Regulation of broadcasting. Molecular mechanisms of translation control on the example of globin biosynthesis.</p> <p>6. Mechanisms of posttranslational modification of peptide chains.</p> <p>7. Influence of physiologically active compounds on translation processes. Antibiotics - inhibitors of transcription and translation in prokaryotes and eukaryotes, their biomedical use.</p> <p>8. Biochemical mechanisms of antiviral action of interferons. Blocking protein biosynthesis by diphtheria toxin (ADP-ribosylation of translation factors).</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>9. Genetic engineering, or recombinant DNA technology: general concepts, biomedical significance. Technology of gene transplantation and production of hybrid DNA molecules; use of restriction endonucleases. Gene cloning in order to obtain biotechnological drugs and diagnostics (hormones, enzymes, antibiotics, interferons, etc.).</p> <p>10. Polymerase chain reaction; its biomedical application in the diagnosis of infectious and hereditary human diseases, individual identification ("DNA diagnosis").</p>		
P -20	<p>Investigation of molecular cellular mechanisms of action of hormones of protein-peptide nature on target cells. Mechanism of action of hormones - derivatives of amino acids and biogenic amines. Hormonal regulation of calcium homeostasis.</p>	<p>1. Hormones and other bioregulators in the system of intercellular integration of human body functions. Definitions, properties. Classification of hormones by chemical structure, place of synthesis.</p> <p>2. Regulation of hormonal secretion by direct and feedback in the human body (give examples). Factors affecting the secretion and nature of hormones.</p> <p>3. Targets of hormonal action; types of cell responses to hormones. Hormone receptors: membrane (ionotropic, metabotropic) and cytosolic receptors, their molecular organization. Proteins are transducers.</p> <p>4. Membrane and membrane-cytosolic mechanisms of action of hormones (derivatives of amino acids, peptide, protein) with the participation of the following messenger systems.</p> <p>5. Hormones of the hypothalamus (liberins and statins, the value of neurophysins) and the pineal gland (melatonin). The mechanism of their action.</p> <p>6. Tropic hormones of the anterior pituitary gland.</p> <p>7. Hormones of the posterior pituitary: vasopressin (antidiuretic hormone) and oxytocin. The mechanism of their action. Pathology associated with impaired ADH production. The use of oxytocin in medical practice.</p> <p>8. Characteristics of pancreatic hormones.</p> <p>9. Catecholamines: adrenaline, norepinephrine, dopamine. Chemical nature, synthesis reactions, biological action, receptors. Their role in the realization of stress.</p> <p>10. The mechanism of action of parathyroid hormone and calcitonin.</p>	<p><i>Kn-1</i>, 2, 3, 17, 21, 23, 24, 25 <i>Sc-1</i>, 2, 3, 17, 21, 23, 24, 25 <i>C - 1</i>, 2, 3, 17, 21, 23, 24, 25 <i>AR - 1</i>, 2, 3, 17, 21, 23, 24, 25</p>	According to the time-table

		<p>Parathyroid hormone - structure, mechanism of hypercalcemic action. Calcitriol: biosynthesis; effect on the absorption of Ca²⁺ and phosphates in the intestine. Calcitonin - structure, effect on the metabolism of calcium and phosphates.</p> <p>11. Clinical and biochemical characteristics of disorders of calcium homeostasis (rickets, osteoporosis). Hyperparathyroidism and hypoparathyroidism. Distribution of Ca²⁺ in the body; molecular forms of calcium in human blood plasma. The role of bone tissue, small intestine and kidneys in calcium homeostasis.</p>		
P-21	Investigation of molecular cellular mechanisms of action of steroid and thyroid hormones on target cells.	<ol style="list-style-type: none"> 1. Mechanism of action (cytosolic) of thyroid hormones and steroid hormones (cytosolic and nuclear receptors). 2. Thyroid hormones of the thyroid gland: 3. Steroid hormones: nomenclature, classification. Scheme of genesis of steroid hormones from cholesterol. 4. Steroid hormones of the adrenal cortex (C₂₁-steroids). 5. Steroid hormones of the gonads. 6. General characteristics of hormone-like substances. Biochemical bases of hormonal regulation of digestive processes: GEP hormones (acute - entero - pancreatic) - tract systems. Gastrin. Cholecystokinin. Secretin. 7. Biogenic amines with hormonal and mediator properties: structure, biosynthesis, physiological effects, biochemical mechanisms of action (serotonin, melatonin, histamine). Receptors of biogenic amines; receptor action of drugs, histamine receptor antagonists. 8. Eicosanoids: general characteristics; nomenclature (prostanoids - prostaglandins, prostacyclins, thromboxanes, leukotrienes). 	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table
P-22	Study of intermediate products of heme biosynthesis and their accumulation in porphyrias. The structure and properties of	<ol style="list-style-type: none"> 1. Blood - the internal environment of the body. Composition of blood, plasma, blood serum. Shaped elements of blood: erythrocytes, leukocytes, thrombocytes. Blood volume, blood pH. 2. Homeostatic, physicochemical and biological properties of blood. 3. Porphyrins. The structure of porphyrins. 4. Synthesis of porphyrins, scheme of enzymatic reactions of heme synthesis. Regulation of porphyrin synthesis. 	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	

	hemoglobin and its derivatives. Pathological forms of hemoglobin - hemoglobinopathies, thalassemia	<p>5. Hereditary disorders of porphyrin metabolism (enzymopathy). Clinical manifestations of porphyria: photosensitivity, neurological disorders; Classification of porphyria - erythropoietic (Gunther's disease), hepatic porphyria, photodermatitis.</p> <p>6. Hemoglobin, its structure (features of the primary, secondary, tertiary and Quaternary levels of structural organization, the structure of heme) and properties.</p> <p>7. Physiological types of hemoglobin at different stages of development of the organism. Hemoglobin derivatives, their significance.</p> <p>8. Pathological forms of hemoglobin. Hemoglobinosis: hemoglobinopathy (for example, sickle cell anemia) and thalassemia.</p> <p>9. Respiratory function of erythrocytes (oxygen binding, its transport, gas exchange in tissues, CO₂ transport). The effect of cooperation. Dependence of the degree of oxygenation on the partial pressure of oxygen. Oxyhemoglobin and myoglobin dissociation curve.</p> <p>10. Acid-base state. Regulation of fluid pH in the body: acid-base disorders: metabolic and respiratory acidosis; metabolic and respiratory alkalosis. Mechanisms of their occurrence. Hormonal mechanisms of acid-base regulation and osmotic pressure.</p> <p>11. Buffer blood systems, their types: the role of buffer blood systems in maintaining blood pH.</p>		
P-23	Investigation of blood plasma proteins: proteins of acute phase of inflammation Non-protein nitrogen-containing and nitrogen-free components of blood.	<p>1. The main groups of plasma proteins, their composition and content are normal and in pathology. Factors influencing the content of proteins in blood plasma: hyper-hypo-, dysproteinemia. Paraproteinemia. Give examples.</p> <p>2. Albumins and globulins. The essence of the method of electrophoresis of blood plasma proteins. Electrophoregrams in various diseases.</p> <p>3. Proteins of the acute phase of inflammation: C-reactive protein, ceruloplasmin, haptoglobin, cryoglobulin, α1-antitrypsin, α2-macroglobulin, interferon, fibronectin. Their diagnostic value.</p> <p>4. Blood plasma enzymes: own (secretory), excretory and indicator (tissue) enzymes.</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>Their clinical and diagnostic value.</p> <p>5. Kalikrein-kinin and renin-angiotensin systems, their biological role in normal and in pathology.</p> <p>6. Diagnostic value of research of activity of enzymes and isoenzymes of blood plasma: creatine phosphokinase, LDH, AST, ALT, amylase, lipase, cholinesterase of blood serum.</p> <p>7. The concept of total and residual blood nitrogen. Non-protein nitrogen-containing components of blood. Diagnostic value of their definition.</p> <p>8. Nitrogen-free organic and inorganic blood compounds, their metabolic origin. Molecules of average mass (average molecules), their metabolic origin. Clinical and diagnostic value of their definition.</p> <p>9. Azotemia, its types and causes, their differentiation in the clinic.</p>		
P-24	Investigation of coagulation, anticoagulation and fibrinolytic blood systems.	<p>1. General characteristics of the hemostasis system in the human body: vascular-platelet and coagulation hemostasis.</p> <p>2. Blood coagulation system; characteristics of components (coagulation factors). Mechanisms of activation and functioning of the cascade system of blood coagulation; internal and external coagulation pathways.</p> <p>3. The role of vitamin K in coagulation reactions (carboxylation of glutamic acid, the role in the binding of calcium ions). Drugs - agonists and antagonists of vitamin K.</p> <p>4. Hereditary and acquired disorders of vascular-platelet and coagulation hemostasis.</p> <p>5. Changes in blood coagulation in patients with COVID-19.</p> <p>6. Anticoagulant blood system, characteristics of anticoagulants.</p> <p>7. Fibrinolytic blood system: stages and components of fibrinolysis. Drugs that affect the processes of fibrinolysis. Plasminogen activators and plasmin inhibitors.</p> <p>8. Disseminated intravascular coagulation syndrome. Blood clotting, thrombosis and fibrinolysis in atherosclerosis and hypertension.</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>C - 1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table
P -25	Investigation of biochemical basics of the	<p>1. Immunoglobulins: structure, biological functions, mechanisms of regulation of immunoglobulin synthesis. Biochemical characteristics of certain classes of human</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sc-1, 2, 3, 17, 21, 23,</i></p>	According to the time-table

	<p>implementation of immune processes. Immunodeficiency states.</p>	<p>immunoglobulins.</p> <p>2. Mediators and hormones of the immune system: interleukins, interferons, protein-peptide factors regulating cell growth and proliferation.</p> <p>3. Biochemical components of the human complement system; classical and alternative (properdin) activation mechanisms.</p> <p>4. Biochemical mechanisms of immunodeficiency states: primary (hereditary) and secondary immunodeficiencies.</p> <p>5. The role of ACE-2 receptors, VEGF / VPF factors, "cytokine storm" in the pathogenesis of COVID-19.</p> <p>5. Initiation of a "cytokine storm" involving T lymphocytes and transcription factor IRF-5.</p>	<p>24, 25</p> <p>C - 1, 2, 3, 17, 21, 23, 24, 25</p> <p>AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	
P -26	<p>Study of metabolism of end products of heme catabolism. Pathobiochemistry of jaundice.</p>	<p>1. Homeostatic role of the liver in the metabolism of the whole organism. Biochemical functions of hepatocytes. The role of the liver in the metabolism of carbohydrates, lipids, proteins, urea synthesis, pigment metabolism, bile synthesis. Biochemical composition of bile.</p> <p>2. Violation of biochemical processes in the liver in certain diseases (cytolytic, cholestatic and other syndromes). Diagnosis of biochemical syndromes.</p> <p>3. The role of the liver in the metabolism of bile pigments. Chemistry of reactions of rupture of tetrapyrrole ring of heme, decomposition of verdoglobin, conversion of biliverdin to bilirubin, formation of bilirubin diglucuronide. Catabolism of hemoglobin to the final products.</p> <p>4. Pathobiochemistry of jaundice: hemolytic (prehepatic), parenchymal (hepatic), obstructive (posthepatic), their diagnosis. Physiological jaundice of newborns, methods of its correction.</p> <p>5. Hereditary jaundice: Kriegler-Nayar syndrome ("conjugative jaundice"), Gilbert's disease ("abscessive jaundice"), Dabin-Johnson syndrome ("excretory jaundice"); their causes and manifestations.</p>	<p>Kn-1, 2, 3, 17, 21, 23, 24, 25</p> <p>Sc-1, 2, 3, 17, 21, 23, 24, 25</p> <p>C - 1, 2, 3, 17, 21, 23, 24, 25</p> <p>AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	<p>According to the time-table</p>
P-27	<p>Research of biotransformation processes of xenobiotics and</p>	<p>1. Detoxification function of the liver; biotransformation of xenobiotics and endogenous toxins.</p> <p>2. Types of biotransformation reactions of foreign chemical compounds in the liver.</p> <p>3. Microsomal oxidation reactions;</p>	<p>Kn-1, 2, 3, 17, 21, 23, 24, 25</p> <p>Sc-1, 2, 3, 17, 21, 23, 24, 25</p> <p>C - 1, 2, 3,</p>	<p>According to the time-table</p>

	endogenous metabolites. Microsomal oxidation, cytochrome P-450.	<p>inducers and inhibitors of microsomal monooxygenases.</p> <p>4. Electronic transport chains of the endoplasmic reticulum. Genetic polymorphism and inducibility of cytochrome P-450 synthesis.</p> <p>5. Conjugation reactions in hepatocytes: biochemical mechanisms of reactions with glucuronic acid, sulfuric acid, glycine, methylation, acetylation; their functional significance.</p> <p>6. The origin and nature of the development of tolerance to drugs.</p>	<p>17, 21, 23, 24, 25</p> <p>AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	
P -28	Study of water-salt and mineral metabolism	<p>1. The biological role of water and its distribution in the human body. Endogenous water. Water balance, its types.</p> <p>2. Regulation of water-salt metabolism, its violation. Dehydration and hyperhydration (hypervolemia and hypovolemia), biochemical mechanisms of occurrence.</p> <p>3. Mineral metabolism. Classification of mineral elements, ways of their receipt in a human body. Biological role of organogenic, macro-, micro- and ultramicroelements.</p> <p>4. Metabolic role of Na⁺, K⁺; hormonal regulation of their metabolism. Mechanism of action of Na⁺, K⁺-ATPase and its regulation.</p> <p>5. Biological functions of individual macronutrients: calcium, phosphorus, chlorine, magnesium.</p> <p>6. Biological functions of individual trace elements: iron, manganese, iodine, bromine, fluorine, copper, zinc, cobalt, molybdenum, selenium. Manifestations of micronutrient deficiency.</p> <p>7. Human microelements: endogenous and exogenous (technogenic, iatrogenic, etc.). Oligotherapy.</p> <p>8. The role of heavy metals and radioactive elements in the development of pathological processes.</p>	<p>Kn-1, 2, 3, 17, 21, 23, 24, 25</p> <p>Sc-1, 2, 3, 17, 21, 23, 24, 25</p> <p>C - 1, 2, 3, 17, 21, 23, 24, 25</p> <p>AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	According to the time-table
P-29	Urinary function of the kidneys. Normal and pathological components of urine.	<p>1. The role of the kidneys in regulating the volume, electrolyte composition and pH of body fluids. Biochemical mechanisms of urinary function of the kidneys (filtration, reabsorption, secretion and excretion). Biochemical characteristics of renal clearance and renal threshold, their diagnostic value.</p> <p>2. Hormonal mechanisms of regulation of water-salt metabolism and kidney function;</p>	<p>Kn-1, 2, 3, 17, 21, 23, 24, 25</p> <p>Sc-1, 2, 3, 17, 21, 23, 24, 25</p> <p>C - 1, 2, 3, 17, 21, 23, 24, 25</p> <p>AR - 1, 2, 3, 17, 21, 23,</p>	According to the time-table

		<p>antidiuretic hormone; aldosterone.</p> <p>3. Renin-angiotensin system. Natriuretic factors of the atria and other tissues. Biochemical mechanisms of renal hypertension. Antihypertensive drugs are angiotensin-converting enzyme inhibitors.</p> <p>4. Physico-chemical properties of urine: quantity, color, odor, transparency, reaction (pH), its dependence on the composition of food. The role of the kidneys and lungs in maintaining the acid-base state of the body. Ammonium genesis.</p> <p>5. The chemical composition of urine is normal (organic and mineral components); reasons for possible deviations. Involvement of the kidneys in the excretion of inorganic and organic substances. Clinical and diagnostic value of determination of separate components of urine.</p> <p>6. Pathobiochemistry of the kidneys. Clinical and biochemical changes in acute and chronic renal failure.</p> <p>7. Characteristics of the conditions of formation of kidney stones, their chemical composition and prevention measures.</p> <p>8. Pathological components of urine - blood, hemoglobin, creatine. Ways of their penetration into urine; reasons for their appearance.</p> <p>9. Clinical and diagnostic value of their detection in the urine of carbohydrates. Characteristics of glucosuria, galactosuria, fructosuria, pentosuria, the causes of their appearance.</p> <p>10. Clinical and diagnostic value of detection and determination in urine: indican, phenylpyruvic, and homogentisic acids.</p> <p>11. Clinical and diagnostic value of determination of ketone bodies, bile acids and bile pigments in urine.</p>	24, 25	
P-30	<p>Research of the nervous system.</p> <p>Pathobiochemistry of mental disorders.</p>	<p>1. Features of biochemical composition and metabolism of nervous tissue.</p> <p>2. Energy metabolism in the human brain.</p> <p>3. Neurotransmitters (acetylcholine, norepinephrine, dopamine, serotonin, excitatory and inhibitory amino acids).</p> <p>4. Molecular basis of bioelectrical processes on the membranes of neurons.</p> <p>5. Receptors for neurotransmitters and physiologically active compounds</p> <p>6. Peptidergic system of the brain. Opioid</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>C - 1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		<p>peptides (enkephalins, endorphins, dinorphins).</p> <p>7. Disorders of metabolism of mediators and modulators of the brain in mental disorders.</p> <p>8. Neurochemical mechanisms of action of psychotropic drugs (neuroleptics, antidepressants, anxiolytics, nootropics).</p> <p>9. Enzymes that provide biosynthesis and cleavage of neurotransmitters (amino acid decarboxylase, acetylcholinesterase, monoamine oxidase, diamine oxidase).</p>		
P-31	Study of muscle contraction processes.	<p>1. Ultrastructure and biochemical composition of myocytes; structural organization of sarcomeres. Myofibril proteins: myosin, actin, tropomyosin, troponin. Molecular organization of thick and thin filaments.</p> <p>2. Muscle extracts, nitrogenous and nitrogen-free, their chemical nature and role. The role of Ca²⁺ ions in the regulation of contraction and relaxation of skeletal and smooth muscle.</p> <p>3. Molecular mechanisms of muscle contraction: modern ideas about the interaction of muscle filaments. Features of skeletal muscle contraction. Features of smooth muscle contraction.</p> <p>4. Modern ideas about the energy of contraction and relaxation of muscle fibers. Macroergic muscle compounds. Structure, formation and role of ATP, creatine phosphate, creatine phosphokinases, sources of ATP in muscles.</p> <p>5. Cellular organization and peculiarities of heart muscle metabolism. Features of bioenergetic processes in the myocardium and regulation of cardiomyocyte contraction.</p> <p>6. The heart as an endocrine organ. Cardiopeptides, their role.</p> <p>7. Biochemical changes in myocardial infarction. Changes in the activity of blood plasma enzymes and other markers in acute myocardial infarction in the dynamics.</p> <p>8. Metabolic changes in chronic heart disease.</p> <p>9. Biochemical changes and diagnosis of muscular dystrophies.</p> <p>10. Pathobiochemistry of muscles - myopathy. Metabolic myopathies. Metabolic disorders in skeletal muscle with aging.</p>	<p><i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>C - 1, 2, 3, 17, 21, 23, 24, 25</i></p> <p><i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i></p>	According to the time-table

		11. Pathobiochemistry of hypertension. Changes in biochemical parameters at different stages of hypertension and their evaluation. Symptomatic hypertension.		
P-32	Research of biochemical components of connective tissue.	<p>1. General characteristics of the biochemical composition of the intercellular substance of connective tissue: fibers (collagen, reticular, elastic) and the main amorphous substance.</p> <p>2. Proteins of connective tissue fibers: collagen, elastin, glycoproteins and proteoglycans.</p> <p>3. Biosynthesis of collagen and the formation of fibrillar structures.</p> <p>4. Structure and role of complex carbohydrates of the main amorphous matrix of connective tissue - glycosaminoglycans (mucopolysaccharides). Mechanisms of participation of glycosaminoglycan molecules (hyaluronic acid, chondroitin-, dermatan-, keratan sulfates, heparin) in the construction of the main substance of connective tissue. Distribution of various glycosaminoglycans in human organs and tissues.</p> <p>5. Pathobiochemistry of connective tissue: biochemical mechanisms of mucopolysaccharidosis and collagenosis, their clinical and biochemical diagnosis.</p>	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-1	Modern biochemical research methods. The contribution of scientists of the Department of Biochemistry of Lviv National Medical University named after Danylo Halytsky in the development of biological chemistry.	Characteristics of the main physicochemical research methods used in biochemistry: optical methods in biochemistry (photoelectrocolorimetry, spectrometry, spectrophotometry, luminescence analysis, fluorescent in situ hybridization); electrophoresis (horizontal, disk electrophoresis, isoelectric focusing, immunoelectrophoresis); chromatography (affinity, ion exchange, thin layer, gas, exclusion or displacement); radioisotope methods; enzyme-linked immunosorbent assays; blotting; polymerase chain reaction (PCR).	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-2	Characteristic	1. The structure and significance of	<i>Kn-1, 2, 3,</i>	According

	<p>s of peroxisome enzymes in metabolic processes of the human body. Catalase activity under conditions of oxidative stress development in diseases of different genesis.</p>	<p>peroxisomes in cell metabolism. Characteristics of peroxisome enzymes. Peroxisome enzyme activity and normal conditions and pathologies.</p> <p>2. The use of determining the activity of antioxidant enzymes under conditions of oxidative stress in diseases of different genesis. Catalase activity under conditions of oxidative stress in diseases of different genesis.</p>	<p>17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	<p>to the time-table</p>
SIW-3	<p>Prognostic and diagnostic value of determination of enzymes in the blood of patients with myocardial infarction. Diagnostic value of the analysis of changes of activity of isoforms of NO-synthase at pathological conditions.</p>	<p>1. Prognostic and diagnostic value of determination of enzymes in the blood of patients with myocardial infarction.</p> <p>2. The structure and value of NO-synthase. See NO synthase. Diagnostic value of the analysis of changes of activity of isoforms of NO-synthase at pathological conditions.</p>	<p>Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	<p>According to the time-table</p>
SIW-4	<p>Modern vitamin preparations and their preventive and therapeutic use in medical practice. Biologically active supplements. The use of lipoic acid as a hepatoprotective agent in</p>	<p>1. The role of vitamin-like substances in the metabolism of the human body. The use of lipoic acid as a hepatoprotective agent in liver pathologies.</p> <p>2. The role of vitamin-like substances in the metabolism of the human body. The use of carnitine in medical practice.</p>	<p>Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25</p>	<p>According to the time-table</p>

	liver pathologies. Use of carnitine in medical practice.			
SIW-5	The role of the most important metabolites of amphibolic pathways (glucose-6-phosphate, pyruvate, α -ketoglutarate, acetyl-S-CoA, succinyl-S-CoA, etc.) in the integration of metabolism. The use of succinate (succinic acid) in medical practice.	1. The importance of amphibolic pathways in metabolism. The role of the most important metabolites of amphibolic pathways (glucose-6-phosphate, pyruvate, α -ketoglutarate, acetyl-S-CoA, succinyl-S-CoA, etc.) in the integration of metabolism. 2. Succinate as a metabolite of energy metabolism. The use of succinate (succinic acid) in medical practice.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-6	Violation of ATP synthesis under the influence of pathogenic factors of chemical, biological and physical origin on the human body. The role of cytochromes and coenzyme Q in the processes of cell metabolism.	1. Violation of ATP synthesis under the influence of pathogenic factors of chemical, biological and physical origin on the human body. Ways of correction. 2. The role of cytochromes and coenzyme Q in the processes of cell metabolism. The role of individual components of the respiratory chain in metabolic processes in normal and in pathology.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-7	Features of regulation of glycolysis metabolism in normal and	1. Особливості регуляції обміну гліколізу в нормі та при патології. Діагностика, шляхи корекції. 2. Молекулярна основа ефекту Пастера та Крептрі. Ефект Крептрі при	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

	in pathology. Molecular basis of the Pasteur and Creptri effect.	ОНКОЛОГІЧНИХ ЗАХВОРЮВАННЯХ.	<i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	
SIW-8	Causes, manifestations of congenital and acquired disorders of the pentose phosphate cycle Disorders of galactose and fructose metabolism Molecular basis, clinical manifestations.	1. Causes, manifestations of congenital and acquired disorders of the pentose phosphate cycle. Ways of correction. 2. Disorders of galactose and fructose metabolism Molecular basis, clinical manifestations. Diagnosis, ways of correction.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-9	Features of regulation of glycogen metabolism Hereditary disorders of glycoconjugate metabolism.	1. Features of regulation of glycogen metabolism. Causes of impaired regulation of glycogen metabolism. Glycogenosis, aglycogenosis. 2. Hereditary disorders of glycoconjugate metabolism. Diagnosis of glycoconjugate metabolism disorders.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-10	Methods, diagnostics and principles of biochemical correction of diabetes mellitus. WHO criteria for impaired glucose tolerance.	1. Methods, diagnostics and principles of biochemical correction of diabetes mellitus. Modern methods of biochemical diagnosis and treatment. 2. WHO criteria for impaired glucose tolerance. Types of sugar load curves.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-11	Metabolism of sphingolipids in normal and in pathology; clinical significance, disorders of sphingolipid	1. Metabolism of sphingolipids in normal and in pathology; clinical significance, disorders of sphingolipid metabolism. Diagnosis, ways of correction of metabolic disorders. 2. Biological functions of polyunsaturated fatty acids, sources and their application in clinical practice. Cyclooxygenase. Cyclooxygenase inhibitors.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

	metabolism. Biological functions of polyunsaturated fatty acids, sources and their application in clinical practice.		<i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	
SIW-12	Congenital and acquired disorders of lipid metabolism. Primary and secondary carnitine deficiency, causes, main symptoms and treatment.	1. Congenital and acquired disorders of lipid metabolism. Diagnosis, ways of correction. 2. Primary and secondary carnitine deficiency, causes, main symptoms and treatment. Myopathies as a consequence of carnitine deficiency.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-13	Implementation of the biochemical role of nitric oxide. Oxidative stress, its causes, manifestations and the possibility of correction.	1. Nitric oxide - mediator functions. Implementation of the biochemical role of nitric oxide. The value of nitric oxide formation in normal and in pathology. 2. Oxidative stress, its causes, manifestations and the possibility of correction. Estimation of oxidative stress intensity as a diagnostic and prognostic parameter.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-14	Synthesis and decomposition of biogenic amines in normal and pathological conditions. Clinical and diagnostic value of transaminases.	1. Synthesis and decomposition of biogenic amines in normal and in pathology. 2. Transaminases - structure and significance. Clinical and diagnostic value of blood transaminases. De Ritis coefficient in the diagnosis of inflammatory and necrotic diseases.	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-15	Features of the functioning of the ornithine cycle in normal and in	1. Features of the functioning of the ornithine cycle in normal and in pathology. The value of individual components of the ornithine cycle in metabolic processes. 2. Ways of phenylalanine metabolism; hereditary enzymopathy of phenylalanine metabolism. Biochemical diagnosis and	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23,</i>	According to the time-table

	pathology. Phenylalanine metabolism pathways; hereditary enzymopathy of phenylalanine metabolism.	compensatory therapy of phenylketonuria. Alkaptonuria. Albinism.	24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	
SIW-16	Porphyria metabolism is normal and in pathology. Disorders of sulfur-containing amino acid metabolism - cystinuria, cystinosis. Homocystinuria.	1. Metabolism of porphyrins is normal and in pathology. Types of porphyria. 2. The role of sulfur-containing amino acids. Disorders of sulfur-containing amino acid metabolism - cystinuria, cystinosis. Homocystinuria.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-17	Phases of the cell cycle of eukaryotes. Biochemical mechanisms of control of cell entry into mitosis; cds2-kinase, cyclin.	1. Phases of the normal cell cycle 2. The duration of the cell cycle 3. Regulation of the cell cycle in mammals 4. Role in the regulation of the cell cycle of cyclin-dependent kinases and cyclones.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-18	Biochemical mechanisms of apoptosis and necrosis.	1. Determination of apoptosis (necrosis) and the causes of their occurrence. 2. Mechanisms of apoptosis. Stages of apoptosis. 3. Functions of cytokines in the regulation of apoptosis. 4. The role of caspases in proteolysis reactions.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-19	Congenital and acquired disorders of DNA repair mechanisms.	1. Mechanisms of DNA repair. 2. Repair of UV-induced gene mutations. 3. Repair of cytosine deamination. 4. The cause of impaired DNA repair in xeroderma pigmentosum. Manifestations of xeroderma pigmentosum. 5. UV-induced melanoma.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23,	According to the time-table

			24, 25	
SIW-20	Genetic engineering. Cloning. Application of genetic engineering methods in modern medicine.	<ol style="list-style-type: none"> 1. The use of DNA technology for the cultivation of microorganisms as producers of hormones - insulin, growth hormone, somatostatin. 2. The use of DNA technologies for the synthesis of biologically active peptides, blood coagulation factors 3. The use of DNA technology for the treatment of hereditary diseases. 	<i>Kn-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>Sc-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>C-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>AR-1</i> , 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-21	Endocrine functions of the pancreas are normal and in pathology.	<ol style="list-style-type: none"> 1. Hormones synthesized by the pancreas (place of synthesis and hormonal action). 2. Etiological (WHO, 1999) and clinical classification of diabetes mellitus. 3. Diabetes is associated with hormonal disorders. 4. Diabetes is caused by toxic substances and pharmacological agents. 	<i>Kn-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>Sc-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>C-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>AR-1</i> , 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-22	Transformation of arachidonic acid in the human body and the influence of its products on biochemical processes.	<ol style="list-style-type: none"> 1. Sources of arachidonic acid in the human body. 2. Ways to use arachidonic acid: <ol style="list-style-type: none"> 1) cyclooxygenase 2) lipoxygenase 3) oxidative with the participation of cytochrome P450 	<i>Kn-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>Sc-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>C-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>AR-1</i> , 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-23	Disorders of metabolism of mediators and modulators of the brain in mental disorders.	<ol style="list-style-type: none"> 1. Disorders of metabolism of mediators and modulators of the brain in schizophrenia. 2. Disorders of neurotransmitter metabolism in Parkinson's disease. 3. Features of serotonin metabolism in manic-depressive state 	<i>Kn-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>Sc-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>C-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>AR-1</i> , 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-24	Modern requirements for the components of nutrition. The role of food additives.	<ol style="list-style-type: none"> 1. Define the concept of nutrition and requirements for it. 2. The ratio of nutrients in the diet. 3. Functions of food additives. 4. Negative consequences of the use of food additives. 	<i>Kn-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>Sc-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>C-1</i> , 2, 3, 17, 21, 23, 24, 25 <i>AR-1</i> , 2, 3, 17, 21, 23, 24, 25	According to the time-table

			17, 21, 23, 24, 25	
SIW-25	Endogenous hypovitaminosis. Causes and mechanisms of development in diseases of the digestive and cardiovascular systems.	Endogenous hypovitaminosis. Causes and mechanisms of development in diseases of the digestive and cardiovascular systems.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-26	Assessment of the state of the blood system and its biochemical functions.	1. The concept of the blood system, its humoral regulation, homeostasis and homeokinesis. 2. Analysis of homeostasis parameters: blood volume, acid-base balance, osmotic pressure, quantitative and qualitative composition of plasma and blood cells, hemoglobin concentration, hematocrit, color index, erythrocyte sedimentation rate. 3. Biochemical basis of methods for studying the functions of the blood system: the amount of hemoglobin, ESR, osmotic stability of erythrocytes, blood clotting time, determination of blood group in the ABO system.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-27	The main types of hypoxia. The mechanism of their occurrence, diagnostic methods	Causes and consequences of hypoxia. Ways of correction. Exogenous and endogenous hypoxia. Features of respiratory (pulmonary), circulatory (cardiovascular), blood (hemic), tissue (histotoxic), mixed hypoxia.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-27	Estimation of indicators of nitrogen metabolism and changes in the content of nitrogen-containing non-protein components of blood.	1. The concept of nitrogen metabolism and nitrogen balance. 2. Clinical and diagnostic value of determining the content of urea, nitrogen, amino acids, uric acid, creatine, creatinine and ammonia in the serum. 3. Biochemical basis of methods for determining the content of urea, nitrogen, amino acids, uric acid, creatine, creatinine and ammonia in the serum.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-28	Blood glycoproteins	Composition of blood glycoproteins. Biological role. Clinical and diagnostic	Kn-1, 2, 3, 17, 21, 23, 24, 25	According to the

	, their structure, biological role, change in composition in diseases.	value of individual blood glycoproteins.	<i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	time-table
SIW-29	AIDS and COVID-19 - molecular mechanism of occurrence, pathochemical changes.	<ol style="list-style-type: none"> 1. Morphology of HIV, criteria for diagnosis of HIV and AIDS, molecular mechanism of occurrence. 2. Laboratory diagnosis of AIDS and diagnosis of HIV infection. 3. Mechanisms of hematopoietic dysregulation and cytopenia in HIV infection. 4. The role of ACE-2 receptors, VEGF / VPF factors, "cytokine storm" in the pathogenesis of COVID-19. 5. Initiation of a "cytokine storm" involving T lymphocytes and transcription factor IRF-5. 6. Changes in blood coagulation in patients with COVID-19. 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-30	Changes in biochemical parameters in chronic hepatitis, cirrhosis, gallstones, dyskinesia and cholecystitis, their diagnostic evaluation. Association of excretory liver function disorders with digestive disorders in the intestine, diagnosis of these disorders.	<ol style="list-style-type: none"> 1. Biochemical syndromes in diseases of the hepatobiliary system 2. Biochemical parameters of blood and urine in diseases of the hepatobiliary system 3. Disorders of digestive processes in diseases of the hepatobiliary system 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table
SIW-31	Microsomal oxidation and conjugation reactions	<ol style="list-style-type: none"> 1. The role of microsomal oxidation reactions in the biotransformation of drugs and other substances. 2. The role of conjugation reactions in the biotransformation of drugs and other substances. 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3,</i>	According to the time-table

	in the biotransformation of xenobiotics and endogenous toxins.	3. The mechanism of development of tolerance to drugs by induction of enzymes of I and II phases of biotransformation.	17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	
SIW-32	Human trace elements.	1. Microelementosis: definition, causes. 2. Characteristics of the main groups of microelementosis (natural endogenous and exogenous, technogenic, iatrogenic). 3. Oligotherapy.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-33	Biochemical mechanisms of regulation of water-salt metabolism and the role of the kidneys in the formation of urine.	1. The role of vasopressin, aldosterone and natriuretic hormone of the atria in the regulation of water-electrolyte metabolism. 2. The mechanism of urine formation: filtration, reabsorption, secretion and excretion. 3. Clearance as an indicator of glomerular filtration.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-34	Characterization of the conditions for the formation of stones in the kidneys, their chemical composition, preventive measures.	Chemical composition of kidney stones. Characteristics of formation conditions and properties of stones of organic and inorganic origin. Properties of stones deposited in conditions of acidosis, alkalosis, inflammatory processes, infectious processes.	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table
SIW-35	Heart damage and biochemical diagnosis of some diseases (thyrotoxicosis, hypothyroidism, hypercortisolism, diabetes mellitus, parathyroid	1. Influence of endocrine diseases on myocardial function. 2. The effect of radiation on muscle protein synthesis. 3. Heart damage as a consequence: a) eating disorders; b) alcohol intoxication	Kn-1, 2, 3, 17, 21, 23, 24, 25 Sc-1, 2, 3, 17, 21, 23, 24, 25 C - 1, 2, 3, 17, 21, 23, 24, 25 AR - 1, 2, 3, 17, 21, 23, 24, 25	According to the time-table

	disease, radiation exposure, porphyria, gout, eating disorders, alcohol heart disease).			
SIW-37	Pathochemistry of connective tissue: biochemical mechanisms of mucopolysaccharidosis and collagenosis, their clinical and biochemical diagnosis.	<ol style="list-style-type: none"> 1. The composition of connective tissue is normal. 2. The main causes and prerequisites for pathological changes in the composition and structure of connective tissue. 3. Characteristics of the main biochemical parameters used for the diagnosis of connective tissue diseases (mucopolysaccharides and collagenosis). 	<i>Kn-1, 2, 3, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 17, 21, 23, 24, 25</i> <i>AR - 1, 2, 3, 17, 21, 23, 24, 25</i>	According to the time-table

It is necessary to provide the system of the classes organization, the use of interactive methods, educational technologies that are used for the transfer of knowledge and skills.

8. Verification of learning results

Current control

is carried out during training sessions and aims to check the assimilation of students of educational material (it is necessary to describe the forms of current control during training sessions). Forms of assessment of current educational activities should be standardized and include control of theoretical and practical training. The final grade for the current educational activity is set on a 4-point (national) scale.

Code of the learning result	Code of classes type	Mode of verification of the learning results	Criteria of acceptance
		Types of educational activity of the students: a) lectures б) practical classes в) students independent work Thematic plans of lectures, practical classes, ISW ensure the implementation in the educational process of all topics included in the content of the program.	
<i>Kn-1,2, 3, 7, 17, 25</i>	<i>L 1-9</i>	The lecture course consists of 15 lectures. The topics of the lecture course reveal the problematic issues of the relevant sections of	During the assessment of mastering each topic for the current educational activity of the student, grades are set on a 4-point (traditional) scale, taking into account the approved evaluation criteria for the relevant

		<p>biochemistry. During lectures, students develop theoretical basic knowledge, provides a motivational component and a general-indicative stage of mastering scientific knowledge during independent work. In the lecture course various didactic means are used as much as possible - multimedia presentations, slides.</p>	<p>discipline. This takes into account all types of work provided by the curriculum. The student must receive a grade for each topic.</p> <p>A grade of "excellent" is given to a student who took an active part in discussing the most difficult questions on the topic of the lesson, gave at least 90% correct answers to standardized test tasks (19-20 out of 20), answered written tasks without errors, did practical work and drew up a protocol.</p> <p>A grade of "good" is given to a student who took part in the discussion of the most difficult questions on the topic, gave at least 75% of correct answers to standardized test tasks (17-18 of 20), made some minor mistakes in answering written tasks, did practical work and drew up a protocol.</p> <p>A grade of "satisfactory" is given to a student who did not participate in the discussion of the most difficult questions on the topic, gave at least 60% correct answers to standardized test tasks (15-16 of 20), made significant mistakes in answering written tasks, did practical work and drew up a protocol.</p> <p>A grade of "unsatisfactory" is given to a student who did not participate in the discussion of the most difficult questions on the topic, gave less than 60% of correct answers to standardized test tasks (14 or less), made gross errors in answering written tasks or did not answer them at all, did not perform practical work and did not draw up a protocol.</p>
<p><i>Kn-1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>Sc-1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>C - 1, 2, 3, 7, 17, 21, 23, 24, 25</i> <i>AR 1, 2, 3, 7, 17, 21, 23, 24, 25</i></p>	<p><i>P 1-32</i></p>	<p>Practical classes are aimed at controlling the assimilation of theoretical material, the formation of practical skills and abilities, as well as the ability to analyze and apply the acquired knowledge to solve practical problems. Each lesson begins with a test control (20 tests) to assess the initial level of knowledge and determine the degree of readiness of students for the lesson. Students who have passed the test control perform a test containing 3 theoretical tasks.</p> <p>The teacher determines the purpose of the lesson and creates a positive cognitive motivation; answers questions from students who arose during the ISW on the topic of the lesson.</p> <p>The main stage of the lesson is to perform practical work.</p> <p>Assessment is carried out during practical classes, taking into account the oral examination, oral reports, case assignments, the quality of the practical task.</p> <p>The teacher summarizes</p>	

		the lesson, gives students tasks for independent work, points out the main issues of the next topic and offers a list of recommended reading. The duration of the practical lesson is 3 academic hours.	
3H-1, 2, 3, 7, 17, 21, 23, 24, 25 YM-1, 2, 3, 7, 17, 21, 23, 24, 25 K - 1, 2, 3, 7, 17, 21, 23, 24, 25 AB - 1, 2, 3, 7, 17, 21, 23, 24, 25	SIW-1 - 38	Independent work of students is performed in the form of abstracts, designed in a notebook of independent work using the recommended literature. Can be presented in the form of oral reports, presentations during the lesson. Tests and theoretical questions related to the questions taken in the VTS are evaluated in practical classes and exams.	
Summary control			
General system of evaluation	Working during semester/ exam – 60%/40% according to 200-grade scale		
Scales of evaluation	traditional 4-grade scale, multigrade (200-grade) scale, rating scale ECTS		
Conditions of permission to take a summary control	A student visited all practical classes and obtained not less than 72 grades for current excellence.		
A kind of summary control	Method of summary control	Criteria of “pass”	
Criteria of examination evaluation			
Exam	<p>The semester exam is a form of final control of mastering by the student of theoretical and practical material on academic discipline. The final control is carried out in writing, using the Misa training platform, according to the schedule.</p> <p>The duration of the exam is 2 academic hours.</p> <p>The procedure for the biochemistry exam includes the following steps:</p> <p>1) Compilation of a test control, which</p>	<p>Evaluation of exam</p> <p>The grade for the exam consists of the assessment of test tasks and the assessment of theoretical tasks (including practical skills).</p> <p>Criteria of evaluation of the examination test tasks:</p> <p>Evaluation of exam</p> <p>The grade for the exam consists of the assessment of test tasks and the assessment of theoretical tasks</p>	

contains 40 tasks with one correct answer. This stage - 40 minutes (1 test - 1 minute). 10 options.

2) Compilation of a theoretical task, which contains 5 tasks: 4 tasks from different sections of the discipline "Biological Chemistry", 5th task - reflects the level of mastery of practical skills.

(including practical skills).

Criteria of evaluation of the examination test tasks:

Less than 25 tests - "**unsatisfactory**";

25 - 30 tests - "**satisfactory**";

31 - 36 tests - "**good**";

37 - 40 tests - "**excellent**".

The correct answer to 1 test is 1 point.

The minimum number of points for 40 tests is 25 points.

The maximum number of points for 40 tests is 40 points.

Criteria for evaluating theoretical tasks:

Each of the five theoretical tasks is evaluated from 5 to 8 points:

Less than 5 points - "unsatisfactory";

5 points - "satisfactory";

7 points - "good";

8 points - "excellent".

The minimum number of points for 5 theoretical tasks is 25 points. The maximum number of points for 5 theoretical tasks is 40 points.

For theoretical questions the student receives:

Assessment "excellent", if without errors he answered written theoretical tasks (including practical skills), substantiated the results, ie: comprehensively and deeply mastered the curriculum; has full theoretical knowledge and practical skills

Assessment of "**good**" if you made some minor mistakes in answering written theoretical tasks (including practical skills), but did not fully substantiate the data obtained

Assessment "**satisfactory**" if significant errors were made in answering written theoretical tasks (including practical skills).

Assessment "**unsatisfactory**" if you made gross mistakes in answering written tasks or did not answer them at all.

For the exam the student receives:

A grade of "**excellent**" (75 - 80 points) is given to a student who gave correct answers to 37 - 40 standardized tests, without errors answered written theoretical tasks (including practical skills), substantiated the results (38 - 40 points), ie: comprehensively and deeply mastered the curriculum; has full theoretical knowledge and practical skills

A grade of "**good**" (62 - 74 points) is given to a student who gave correct answers to 31 - 36 standardized tests, made some minor mistakes in answering written theoretical tasks (including practical skills), but did not fully substantiate the data obtained (31 - 37 points).

A grade of "**satisfactory**" (50 - 61 points) is given to a student who gave correct answers to 25 - 31 standardized tests, made significant mistakes in answering written theoretical tasks (including practical skills) (25 - 30 points).

A grade of "**unsatisfactory**" is given to a student who gave correct answers to less than 25 standardized tests, made gross errors in answering written tasks or did not give answers to them at all.

The maximum number of points that a student can score when taking the exam is 80.

The minimum number of points in the exam - not less than 50.

The grade for the exam consists of the assessment of test tasks and the assessment of theoretical tasks (including practical skills).

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

The **minimum number** of points in the exam - not less than **50**.

The maximum number of points that a student can score for the current academic activity for admission to the exam (differentiated test) is **120 points**.

The minimum number of points that a student must score for the current academic activity for admission to the exam (differentiated test) is **72 points**.

The calculation of the number of points is based on the grades obtained by the student on a 4-point (national) scale during the study of the discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The resulting value is converted into points on a multi-

point scale as follows:
$$x = \frac{CA \times 120}{5}$$

**Criteria for assessing an objective structured practical (clinical) exam /
Complex of practice-oriented exam
Master's thesis**

9. Policy of the course

The policy of the course is determined by the system of requirements for the student in the study of the discipline "Biological Chemistry" and is based on the principles of academic integrity. Students are explained the value of acquiring new knowledge, the need for independent performance of all types of work, tasks provided by the work program of this discipline. Lack of references to used sources, fabrication of sources, writing off, interference in the work of other students are examples of possible academic dishonesty. Detection of signs of academic dishonesty in the student's work is the basis for its non-enrollment by the teacher, regardless of the extent of plagiarism or deception. Literary sources may be provided by the teacher exclusively for educational purposes without the right to transfer to third parties. Students are encouraged to use other literature sources not provided by the recommended list.

10. Literature

Mandatory

Main:

1. Gubsky Yu. Bioorganic and biological chemistry. Book 2. Biological chemistry. Second edition. Medicine 2021. 544p.
2. Harper's Illustrated Biochemistry 30th edition. V. W. Rodwell et al.; NY: McGraw-Hill Education, 2015. 817 p.
3. Satyanarayana U., Chakrapani U. Biochemistry. Fifth edition, N.Delhy: Elsevier, co-published with Book and Allied, 2017. 788 p.
4. Lippincott Illustrated Reviews: Biochemistry. 7th edition. D.R.Ferrier; Wolters Kluwer, 2017. 565 p.
5. Gubsky Yu. Biological Chemistry. Nova Knyha, Vinnytsia, 2017. 487 p.
6. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. 8-th edition. W.H. Freeman and Company, New York, 2021. 1328 p.
7. Swanson T. A., Kim S. I., Glucksman M. J. Biochemistry, Molecular Biology, and Genetics 5th edition / Lippincott Williams & Wilkins, 2010. 380 p.
8. McKee T., McKee J.R.. Biochemistry. The molecular basis of life. Seventh edition. Oxford University Press, 2019. 448 p.
9. MCQs in biochemistry 2nd edition / A. Ya. Sklyarov et al.: Lviv: Danylo Halytsky Lviv National Medical University Press, 2020. 319 p.
10. MCQs in biochemistry / A. Ya. Sklyarov et al.: Lviv: Danylo Halytsky Lviv National Medical University Press, 2012. 308 p.

Optional:

1. Vasudevan D.M., Sreekumari S., Kannan Vaidyanathan. Textbook of Biochemistry for Medical Students.. Jaypee Brothers Medical Pub, Seventh edition 2013. 791 p.
2. Chatterjea M.N., Rana Shinde. Textbook of Medical Biochemistry. Eighth edition. Jaypee Brothers Medical Pub, 2012. 894 p.
3. Ronner P.. Netter's Essential Biochemistry. Elsevier, 2018. 482 p
4. Tymoczko J.L., Berg J.M., Stryer L. Biochemistry: A Short Course. W. H. Freeman; Third edition, 2015. 896 p.

5. Lieberman M.. Marks' Basic Medical Biochemistry: A Clinical Approach. LWW; 5th edition. 2017. P. 1008
6. Lorch M.. Biochemistry: A Very Short Introduction. Oxford University Press. 2021. 160 p.
7. Oraby S. Biochemistry for medical students and postgraduates. Twelfth Edition. – 2013. – Part 1. – 248 p.
8. Copeland R. A. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. - Wiley-VCH, Inc. – 2000. – 412 p.
9. Toy E.C., Seifert W. E., Strobel H.W., Harms K.P. “Case Files in Biochemistry. 2nd edition” – 2008. – 488 p.
10. Moore J.T., Langley R.H. Biochemistry For Dummies. For Dummies; 3rd edition. 2022. 368 p.
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12. Pratt Ch., Cornely K. Essential Biochemistry. Wiley; 5th edition. 2021. 816 p
13. Combs G.F., McClung J.P. The Vitamins: Fundamental Aspects in Nutrition and Health. Academic Press; 6th edition.2022. 774 p.

Information resources:

1. Centre of testing – base of licenced test tasks
Krock-1 <http://testcentr.org.ua/>

1. Equipment, material and technical supply

Methodical supply:

1. Working educational program of the discipline;
2. Multimedia lectures supply;
3. Lectures theses;
4. Methodical recommendations for the lecturers;
5. Educational platform Misa;
6. Study guides;
7. Methodical guides to the practical classes for students;
8. Methodical instruction for the students independent work;
9. Test and control tasks to practical classes;
10. Questions and tasks for the summary control (exam);
11. Laboratory equipment (PEC, SP, centrifuges, laboratory utensils, biochemical analyzers)

12. Optional information

Responsible for the educational work with foreign students – Prof. Iryna Fomenko
 Practical classes and lectures are delivered in the Department classrooms at the address: Lviv, 69, Pekarska Street, Chemical building, ground floor.
 Web-site of the Department - *e-mail*: Kaf_biochemistry@meduniv.lviv.ua

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