



Appendix 2
To the Procedure of development and
periodic revision of educational programs

A syllabus on the discipline "Biological chemistry"

1. General information	
Name of faculty	Pharmaceutical faculty
Educational program (area, specialty, level of higher education, form of studying)	22 "Healthcare" specialty 226 "Pharmacy, industrial pharmacy", the second (master's) level of higher education, full-time
Academic year	2020/2021
Name of discipline, code (email address on the site of Danylo Halytsky LNMU)	Biological chemistry OK 18
Department (name, address, phone, email)	Department of biological chemistry. 79010, Lviv, Pekarska street, 69 tel. +38(032)2757602, Kaf_biochemistry@meduniv.lviv.ua
Head of the department (contact email)	Sklyarov Oleksandr Yakovych – MD, Dr Sci, Honored Professor of Danylo Halytsky Lviv National Medical University Kaf_biochemistry@meduniv.lviv.ua
Year of study (year in which the study of the discipline is implemented)	3rd year of study
Semester (<i>semester in which the study of the discipline is implemented</i>)	5, 6 semesters
Type of discipline/module (<i>required/optional</i>)	Required
Teachers (<i>names, surnames, scientific degrees and ranks of teachers who teach discipline, contact email</i>)	Fomenko Iryna Stepanivna, PhD, Dr Sci, professor iryna.fomenko.lviv@gmail.com Nasadyuk Christina Myroslavivna, MD, PhD, associate professor nasadyukch@gmail.com Lozynska Iryna Ihorivna, PhD, assistant professor ira9ilkiv@gmail.com Denysenko Nataliya Valeriyivna, assistant professor denysenko.natalka@gmail.com
Erasmus yes/no (<i>availability of discipline for students within Erasmus+ program</i>)	No
The person responsible for the syllabus (<i>person supposed to receive the comments on syllabus, contact email</i>)	Denysenko Nataliya Valeriyivna, assistant professor denysenko.natalka@gmail.com Nasadyuk Christina Myroslavivna, MD, PhD, associate professor nasadyukch@gmail.com
Number of ECTS credits	6
Number of hours (<i>lectures/practical classes /individual work of students</i>)	30/70/80
Language of studying	English
Information about consultations	Held once a week during the school year. Pre-examination consultations are conducted by lecturers according to schedule
Address, telephone and regulations of work of the clinical base, bureau... (if necessary)	-

2. Short annotation to the course

General characteristics, brief description of the course, features, benefits.

The discipline "Biological Chemistry" is taught to the third-year students for two semesters. Each semester includes 3 credits and 2 sections. The total number of hours - 180 (100 in classroom and 80 hours of individual work of student). Discipline is structured into sections. The amount of training workload for student is 6 ECTS credits - credits that are credited to students if they successfully learn the relevant section (credit).

The discipline is structured in 2 sections:

Section 1. General patterns of metabolism. Metabolism of carbohydrates, lipids and its regulation.

Section 2. Biochemical bases of proliferation, intercellular communications of human organs and tissues. Fundamentals of pharmaceutical biochemistry.

The subject of study of the discipline: diagnosis and correction of pathological conditions associated with metabolic disorders with drugs.

Interdisciplinary links: Biological chemistry as a discipline is based on:

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 and bioorganic chemistry, especially biochemical processes, which take place in the body of healthy and sick humans, in the process of further training and professional activity;

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

d) further improve of the ability to use theoretical and practical skills with pathobiochemistry should be carried out at a higher scientific and methodological level in a separate training course - "Clinical Biochemistry", which is desirable to teach in 5-6 courses.

3. The aim and objectives of the course

The aim of teaching the discipline "Biological chemistry" is training pharmacists to get a significant amount of theoretical and practical knowledge on the chemical basis of life - the chemical composition of organic compounds and metabolic processes occurring in the human body.

The goals of studying the discipline "Biological chemistry" are to master the skills to investigate biochemical components in biological fluids and analyze the results of biochemical studies and changes in biochemical, in particular, enzymatic parameters, used to diagnose the most common human diseases.

Competences and learning outcomes, the formation of which provides the study of 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 act socially responsible and civic conscious.

GC 2. Ability to apply knowledge in practical situations.

GC 3. The desire to preserve the environment.

GC 4. Ability to abstract thinking, analysis and synthesis, learn and be modern trained.

GC 5. Ability to show initiative and entrepreneurship.

GC 6. Knowledge and understanding of the subject area and understanding of professional activity.

GC 7. Ability to adapt and act in a new situation.

GC 8. Ability to communicate in a foreign language (English) at a level that provides effective professional activity.

GC 9. Skills in the use of information and communication technologies.

GC 10. Ability to choose a communication strategy, the ability to work in a team and with experts from other fields of knowledge/types of economic activity.

GC 12. Ability to conduct research at the appropriate level.

Professional competencies, the formation of which provides the study of the discipline “Biological chemistry”:

PC 3. Ability to provide home care to patients and victims in extreme situations and emergencies.

PC 4. The ability to ensure the rational use of prescription and over-the-counter medicines and other pharmaceutical products according to physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a particular disease and pharmacotherapeutic regimens for its treatment.

PC 5. Ability to monitor the effectiveness and safety of use of drugs according to their clinical and pharmaceutical data characteristics, as well as taking into account subjective signs and objective clinical, laboratory and instrumental criteria for examination of the patient.

PC 6. The ability to identify drugs, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological research, to diagnose acute poisoning, drug and alcohol poisoning intoxication.

PC 11. Ability to analyze socio-economic processes in pharmacy, forms, methods and functions of the system of pharmaceutical supply of the population and its components in world practice, indicators of need, efficiency and availability of pharmaceutical assistance in terms of health insurance and reimbursement of the cost of medicines funds.

PC 13. Ability to demonstrate and apply in practice communication skills, fundamental principles of pharmaceutical ethics and deontology based on moral obligations and ethical values, norms of professional conduct and responsibility in accordance with the Code of Ethics for pharmaceutical workers of Ukraine and WHO guidelines.

PC 20. Ability to develop methods for quality control of medicines, including active pharmaceutical ingredients, medicinal plant raw materials and excipients using physical, chemical, physico-chemical, biological, microbiological, pharmacotechnological and pharmacoorganoleptic control methods.

Program learning outcomes:

PLO 1. Carry out professional activities in social interaction based on humanistic and ethical principles; identify future professional activity as socially significant for human health.

PLO 2. Apply knowledge of general and professional disciplines in professional activities.

PLO 4. Demonstrate the ability to independently search, analyze and synthesize information from different sources and use of these results to solve typical and complex specialized tasks of professional activity.

PLO 7. Perform professional activities using creative methods and approaches.

PLO 8. Carry out professional communication in English, use skills, oral communication in a foreign language, analyzing texts of professional orientation and translate foreign information sources.

PLO 9. Carry out professional activities using information technology, information databases, navigation systems, Internet resources, software and other information and communication technologies.

PLO 10. Adhere to the norms of communication in professional interaction with colleagues, management, consumers, work effectively in a team.

PLO 12. Analyze the information obtained as a result of scientific research, generalize, systematize and use it in professional activities.

PLO 15. Provide home care to patients in emergencies and victims of extreme situations.

PLO 16. Determine the influence of factors influencing the processes of absorption, distribution, deposition, metabolism and excretion of the drug and due to the condition, features of the human body and physicochemical properties of drugs.

PLO 17. Use data from clinical, laboratory and instrumental studies to monitor the effectiveness and safety of medicines.

PLO 18. Select biological objects of analysis, determine xenobiotics and their metabolites in biological media and evaluate the results obtained with taking into account their distribution in the body.

PLO 25. To promote the preservation of health, including disease prevention, rational appointment and use of drugs. Perform your professional responsibilities conscientiously, comply promotion and advertising of medicines with the law. Possess psychological communication skills to gain trust and mutual understanding with colleagues, doctors, patients, consumers

4. Prerequisites of the course

For successful learning and mastering key competencies in the discipline “Biological chemistry” requires basic knowledge of the following disciplines:

1. Medical biology - the 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 in prokaryotes and eukaryotes, structure of transcription (operon), regulation of translation by induction and repression by Jacob and Mono. Structure, properties, classification of simple and complex enzymes. Foundations of enzymatic kinetics. The concept of metabolism, stages of anabolism and catabolism. Basic 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, salting out, 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, glucoaminglycans, hyaluronic acid, sialic acids, neutral fats, phospholipids, glycolipids, sphingolipids, cholesterol, nitrogenous bases, 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 derivatives arachidonic acid.

4. Histology and cytology - cell structure (components of the nucleus, mitochondria, ribosomes, biological membranes).

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

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

5. Program learning outcomes

List of learning outcomes

Learning outcome code	The content of the learning outcome	Reference to the competency matrix code
<i>The code is created when filling the syllabus (category: GC - general competencies, PC-professional competencies)</i>	<i>Learning outcomes determine that the student must know, understand and be able to perform, after completing the discipline. Learning outcomes follow from the set learning goals. To enroll in the discipline, it is necessary to confirm the achievement of each learning outcome.</i>	Symbol of the Program learning outcome code in the higher education Standard
<i>Knowledge</i>		
<i>Kn-1</i>	Know biochemical terminology, nomenclature and classification of organic substances.	<i>PLO 2</i>

<i>Kn-2</i>	Know the principles of laboratory biochemical research.	<i>PLO 4</i>
<i>Kn-3</i>	Know the basic biochemical and molecular basics of physiological functions of cells, organs and systems in human body.	<i>PLO 8</i> <i>PLO 16</i>
<i>Kn-4</i>	Know the principles of biochemical mechanisms of the development of pathological processes in the human body and the principles of their correction.	<i>PLO 18</i>
<i>Kn-5</i>	Know the requirements for processing the results of biochemical investigation and changes of biochemical and enzymatic indicators.	
<i>Kn-6</i>	Know the biochemical processes of metabolism and its regulation in ensuring the functioning organs and systems of the human body.	
<i>Skills</i>		
<i>Sk-1</i>	Be able to apply in practice acquired theoretical knowledge of biochemical terminology, namely: correctly used in the process of collection of anamnesis, diagnosis, assessment of the course diseases.	<i>PLO 2</i> <i>PLO 4</i> <i>PLO 8</i>
<i>Sk-2</i>	Be able to justify the laboratory results of biochemical research.	<i>PLO 16</i>
<i>Sk-3</i>	Be able to apply the acquired knowledge during research of biochemical and molecular bases of physiological functions of cells, organs and systems of human body.	<i>PLO 18</i>
<i>Sk-4</i>	Be able to interpret the origin of pathological processes in the human body and the principles of their correction.	
<i>Sk-5</i>	Be able to process biochemical results of research and changes of biochemical and enzymatic indicators.	
<i>Sk-6</i>	Be able to apply knowledge of biochemical metabolic processes and its regulation in ensuring the functioning of organs and systems in human body.	
<i>Competences</i>		
<i>C-1</i>	Ability to analyze the conformity of the structure of bioorganic substances to physiological functions, performed in a living organism.	<i>PLO 2</i> <i>PLO 4</i>
<i>C-2</i>	Ability to interpret the features of physiological state of the organism and the development of pathological processes according to the results of laboratory tests.	<i>PLO 8</i> <i>PLO 16</i>
<i>C-3</i>	The ability to explain biochemical and molecular basis of physiological functions of cells, organs and systems of human body.	<i>PLO 18</i>
<i>C-4</i>	The ability to explain biochemical and molecular basis of physiological functions of cells, organs and systems of the human body.	
<i>C-5</i>	Ability to process the biochemical results of research and changes of biochemical and enzymatic indicators used to diagnose the most common human diseases.	
<i>C-6</i>	Ability to analyze the biochemical processes of metabolism and its regulation in ensuring the functioning of organs and systems of human body.	
<i>Autonomy and responsibility</i>		
<i>AR-1</i>	Be responsible for literacy in professional communication.	<i>PLO 2</i>

AR-2	Be responsible for competent conduction of the laboratory biochemical studies.	PLO 4		
AR-3	Be responsible for the correct interpretation of the origin of pathological processes in the human body and principles of their correction.	PLO 8 PLO 16		
AR-4	Be responsible for the correct interpretation of biochemical results of research and changes of biochemical and enzymatic indicators.	PLO 18		
6. Format and scope of the course				
Course format (specify full-time or part-time)	Full-time			
Kind of classes	Number of hours		Number of groups	
lectures	80		1	
practical classes	70		1	
seminars	-		-	
individual work	80		1	
7. Topics and content of the course				
Code of the kind of classes	Topic	Learning content	Learning outcome code	Teacher
L-1	Enzymes: structure, properties and classification. Mechanism of action and regulation of enzymatic activity. Kinetics of enzymatic reactions.	Enzymes: definition; properties of enzymes as proteins; common and different properties of enzymes and inorganic catalysts. Classification, nomenclature, code of enzymes. Characteristics of six classes of enzymes with examples. The structure of enzymes. Definition and role of active and allosteric (regulatory) centers. Mechanisms of action of enzymes.	Kn-1 Kn-2 Kn-3	Prof. Fomenko I. S.
L-2	Role of cofactors in catalytic activity of enzymes. Regulation of enzymatic processes and analysis of enzymopathias appearance. Medical enzymology.	Classifications of coenzymes. The role of metals in 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 Inhibitors of enzymes. Regulation of enzymatic	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5	Prof. Fomenko I. S.

		processes. Medical enzymology.		
L-3	General principles of turnover of biomolecules and energy. Tricarboxylic acid cycle. Molecular principles of bioenergetics. Biological oxidation. Oxidative phosphorylation and its regulation.	Metabolism. Tricarboxylic acid (TCA) cycle. Types of reactions of biological oxidation; their biological significance. Tissue respiration - definition, localization in cell. Respiratory chain of mitochondria. Chemiosmotic theory of oxidative phosphorylation. Inhibitors of electron transport and uncouplers of oxidative phosphorylation.	Kn-1 Kn-3 Kn-4 Kn-6	Prof. Fomenko I. S.
L-4	Carbohydrates: structure, classification, functional significance. Metabolism of monosaccharides, anaerobic and aerobic oxidation of glucose.	Glycolysis. Oxidative Decarboxylation of pyruvate. Energy effect of complete oxidation of glucose. Shuttle mechanisms of NADH transfer through membranes.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Prof. Fomenko I. S.
L-5	Regulation of carbohydrate metabolism and its disorders.	Glucose-lactate (Cori cycle) and glucose-alanine cycles. Regulation of glucose concentration in blood. Diabetes - pathology of glucose metabolism. Types of diabetes, causes, metabolic disorders, biochemical criteria for diabetes. Glucose tolerance test.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Prof. Fomenko I. S.
L-6	Lipids: structure, classification and functional significance. Transport forms of lipids in blood. Metabolism of simple lipids.	Catabolism of triacylglycerols in adipocytes of fat tissues. Biosynthesis of triacylglycerols. Oxidation of fatty acids (β -oxidation). Biosynthesis of higher fatty acids. Metabolism of ketone bodies. Lipoproteins of blood plasma: lipid and protein (apoproteins) composition.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Assoc. prof. Kobylinska L. I.
L-7	Metabolism of complex lipids and its regulation. Correction of disorders of lipid metabolism by drugs.	Metabolism of sphingolipids. Genetic abnormalities of sphingolipids metabolism. Biosynthesis of cholesterol. Ways of cholesterol	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Assoc. prof. Kobylinska L. I.

		<p>biotransformation. Hyperlipoproteinemia. The WHO classification of dyslipoproteinemias. Atherosclerosis. Characteristics of changes of lipid metabolism during obesity and diabetes mellitus. Pathologies of lipid metabolism. Characteristics of processes of lipid peroxidation and antioxidant protection in normal and pathological conditions. Oxidative stress. Reactions of reactive oxygen species and fatty acid radicals formation.</p>		
L-8	<p>General pathways of amino acid metabolism (deamination, transamination, decarboxylation of amino acids). Urea biosynthesis and alternative pathways of ammonia detoxification.</p>	<p>Transamination of amino acids. Types of direct and indirect deamination of free amino acids in tissues. Decarboxylation of L-amino acids in the human body. Ways of formation and neutralization of ammonia in human body. Biosynthesis of urea.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6</p>	<p>Assoc. prof. Nasadyuk Ch. M.</p>
L-9	<p>Specific metabolic pathways of selected amino acids and their disorders. Glutathion and creatine, structure and physiological significance.</p>	<p>Metabolism of sulfur-containing amino acids. Metabolism of glycine and serine. Specialized pathways of cyclic amino acids metabolism - phenylalanine and tyrosine. Hereditary enzymopathy of cyclic amino acids metabolism – phenylalanine and tyrosine, tryptophan, their manifestations, diagnosis, consequences.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6</p>	<p>Assoc. prof. Nasadyuk Ch. M.</p>
L-10	<p>Biosynthesis and catabolism of purine and pyrimidine nucleotides and its regulation. Hereditary disorders of nucleotide metabolism.</p>	<p>Metabolism of purine nucleotides. Metabolism of pyrimidine nucleotides. Biosynthesis of deoxyribonucleotides. Formation of thymidyl nucleotides; inhibitors of dTMP biosynthesis as antitumor drugs.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6</p>	<p>Prof. Fomenko I. S.</p>
L-11	<p>Biosynthesis of nucleic acids, mechanisms of replication and transcription. Biosynthesis of proteins and</p>	<p>DNA replication. RNA transcription. Stages and mechanisms of translation. Types of post-translational</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4</p>	<p>Prof. Fomenko I. S.</p>

	their post translational modification.	Modification of protein. Regulation of translation. Antibiotics. Regulation of gene expression. Mutations. Biological significance and mechanisms of DNA reparation.	Kn-5 Kn-6	
L-12	Modern classification of hormones and molecular mechanisms of their effects. Hormones of central and peripheral glands.	Hormones: definition, general characteristics. Classifications of hormones and hormone-like substances. The response of target cells to action of hormones. Membrane and cytosolic receptors; their role and structure. Biochemical cascade systems of intracellular hormonal transmission of signals. Molecular-cellular mechanisms of action of hormones of protein, peptide nature and amino acid derivatives. Hypothalamic hormones - liberins and statins. Hormones of anterior lobe of pituitary gland. Hormones of posterior lobe of the pituitary gland. Hormones of pineal gland. Hormones of pancreas. Catecholamines. Hormonal regulation of calcium homeostasis in human body. The mechanism of action of the appropriate hormones and hormone-like substances. Molecular-cellular mechanisms of action of steroid and thyroid hormones. Thyroid hormones. Steroid hormones of adrenal gland cortex (C ₂₁ steroids) - glucocorticoids and mineralocorticoids. Female and male sex hormones. Hormone-like substances. Eicosanoids.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Prof. Sklyarov A. Ya.
L-13	Role of blood in mechanisms of homeostasis of human organism. Respiratory function of red blood cells; regulation of acid-base balance. Pathobiochemistry	Hemoglobin: structure, mechanisms of participation in gas transport. Derivatives of hemoglobin, their significance. Physiological and abnormal types of	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Prof. Fomenko I. S.

	of blood. Blood coagulation.	<p>hemoglobin.</p> <p>Hemoglobinopathy and thalassemia. Blood buffer systems. Types of acid-base imbalance of human body. Hypoxia, its types. Biochemical composition of blood. Blood plasma proteins. Electrophoregram of proteins of human blood serum in normal and pathological conditions.</p> <p>Hyper-, hypo-, dysproteinemia, paraproteinemia. Their reasons and clinical and diagnostic value. Proteins of acute phase. Plasma enzymes of blood. Kallikrein-kinin, renin-angiotensin systems. Non-protein organic plasma compounds: nitrogen-containing and nitrogen-free. Residual nitrogen of blood. Coagulant, anticoagulant, fibrinolytic systems of blood. Immunoglobulins: structure, classes, biochemical characteristics of individual classes of immunoglobulins. Characteristic of mediators and hormones immune system.</p>		
L-14	Biochemical functions of liver. End products of heme catabolism, pathobiochemistry of jaundices. Role of liver in biotransformation and detoxification of xenobiotics and endogenous toxic substances. Metabolism of drugs.	<p>Characteristics of biochemical function of liver in normal and pathological conditions. Detoxification function of liver: characteristics of two phases of biotransformation; types of biotransformation reactions. Reactions of microsomal oxidation. Cytochrome P-450. Reactions of conjugation. Metabolism of hemoglobin and heme. Role of liver in metabolism of bile pigments. Pathobiochemistry of jaundice; types of jaundice; hereditary (enzymatic) jaundice. Biochemical</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Assoc. prof. Kobylnska L. I.

		diagnostics of jaundice		
L-15	Biochemistry muscle tissue. Biochemistry of nerve tissue: specific features of metabolism in brain, neuromediators	Biochemical composition of muscles. Characteristics of proteins in myofibrils. Non-protein nitrogenous, nitrogen-free organic compounds, mineral elements of muscles. Molecular mechanisms of muscle contraction. Bioenergetics in muscles, sources of ATP, the role of creatine phosphate in energy supply of muscle contraction. General characteristics of amino acids and proteins in nervous tissue. Bioenergetics of nervous tissue. Characteristics of neurotransmitters and mechanism of their action. Metabolic disorders in the nervous tissue. Medicines for correction of disturbances in nervous system.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6	Assoc. prof. Nasadyuk Ch. M.
P-1	Introduction to biochemistry. Methods of biochemical investigation. Amino acid composition, structure, physico-chemical properties, classification and functions of simple and conjugated proteins.	1. The objectives and assignments of biochemistry and its principal trends and parts. 2. A short history of biochemistry and its main periods. 3. Methods of biochemichemical analysis: optical methods in biochemical investigations; electrophoresis; chromatography; radioisotopic methods; enzyme immunoassays (ELISA). 4. General characterization of amino acids. Classification of amino acids (due to their structural, electrochemical, biological properties). 5. Biologically active peptides, their significance and employment in medicine (glutathione, hormones of	Kn-1 Kn-2 Kn-5 Sk-1 Sk-2 Sk-5 AR-1 AR-2	According to the schedule

		<p>hypophysis and hypothalamus, insulin etc.).</p> <p>6. Modern concept of structural levels in organization of protein molecule and types of chemical bonds in protein molecule. Physical and chemical properties of proteins. Isoelectric point, proteins as amphoteric electrolytes.</p> <p>7. Classification of proteins. Characterization of simple proteins.</p> <p>8. Conjugated proteins, their characteristics.</p>		
P-2	<p>Enzymes: structure, physico-chemical properties, classification and mechanism of action of enzymes. Methods of detection of enzymes in biological material.</p>	<p>1. Enzymes: definition, properties of enzymes as biological catalysts, difference between enzymes and inorganic catalysts.</p> <p>2. Nomenclature and classification of enzymes.</p> <p>3. Physico-chemical properties of enzymes.</p> <p>4. Simple and conjugated enzymes. Role of non-protein part of conjugated enzymes.</p> <p>5. Structure of enzymes: active centres and allosteric sites.</p> <p>6. Levels of structural organization of enzymes. Multi-enzyme complexes, their advantages.</p> <p>7. Specificity of enzymes.</p> <p>8. The localization of enzymes in cells and organs.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-6 Sk-1 Sk-2 Sk-5 AR-1 AR-2</p>	<p>According to the schedule</p>
P-3	<p>Kinetics of enzymatic reactions. Regulation of enzymatic activity, determination of enzymatic activity.</p>	<p>1. Enzyme kinetics. Factors affecting enzymatic activity: concentration of enzyme; concentration of substrate; effect of temperature; effect of pH.</p> <p>2. Michaelis-Menten constant and equation;</p> <p>3. Lineweaver-Burk double-reciprocal plot.</p> <p>4. Mechanism of enzyme action: substrate-enzyme complex formation and dissociation; lock and key</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2</p>	<p>According to the schedule</p>

		<p>model or Fisher's template theory; induced fit theory or Koshland's model; substrate strain theory.</p> <p>5. Units of enzymatic activity.</p> <p>6. Methods of enzymatic activity assays.</p>	<p>AR-3 AR-4</p>	
P-4	<p>Regulation of enzymatic processes enzymopathias and mechanisms of their development. Application of enzymes as drugs.</p>	<p>1. Enzyme inhibition (reversible, irreversible, competitive, non-competitive).</p> <p>2. Regulation of enzyme activity in the living system: allosteric regulation; feedback regulation; covalent modification of enzymes; activation of latent enzymes by limited proteolysis; cyclic nucleotides in regulation of enzymatic processes.</p> <p>3. Control of enzymes synthesis (constitutive and adaptive enzymes).</p> <p>4. Application of enzymes: enzymes as therapeutic agents; enzymes as analytic agents; immobilized enzymes.</p> <p>5. Diagnostical importance of enzymes (plasma specific and non-plasma specific enzymes).</p> <p>6. Changes in enzymatic activity of blood plasma and serum as diagnostic indexes (markers) of pathological processes in distinct organs – myocardial infarction, acute pancreatitis, liver disease, pathology of muscle tissue.</p> <p>7. Isoenzymes, their role in enzymodiagnosics.</p> <p>8. Inborn (hereditary) and acquired metabolic defects, their clinical and laboratory diagnostics.</p> <p>9. Application of enzyme inhibitors as medicinal and drugs – acetylsalicylic acid, allopurinol, sulfonamides.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

P-5	The role of cofactors, vitamins and their coenzyme forms in enzyme catalysis.	<p>1. Cofactors, coenzymes and prosthetic groups of enzymes.</p> <p>2. Role of metal ions in function of enzymes.</p> <p>3. Classification of coenzymes due to their chemical nature and type of catalytic reaction.</p> <p>4. Coenzymes as transporters of hydrogen atoms and electrons (examples of distinct reactions): NAD⁺, NADP⁺; coenzymes – derivatives of vitamin PP; FAD, FMN coenzymes – derivatives of vitamin B₂ – riboflavin; role of vitamin C in oxidative-reductive reactions; metalloporphyrins.</p> <p>5. Coenzymes as transporters of chemical groups (examples): pyridoxal phosphate; HS-CoA – coenzyme of acylation; lipoic acid; THF – derivatives of folic acid.</p> <p>6. Coenzymes of isomerisation, synthesis and cleavage of C-C bonds (examples): thiamine pyrophosphate – coenzyme form of vitamin B₁; biocytin – coenzyme form of vitamin H – biotin; methylcobalamin and deoxyadenosylcobalamin – coenzyme forms of vitamin B₁₂.</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-6 Sk-1 Sk-2 Sk-3 Sk-5 Sk-6 AR-1 AR-2 AR-4	According to the schedule
P-6	Metabolic pathways and bioenergetics. Tricarboxylic acid cycle and its regulation.	<p>1. Conception of turnover of material and energy (metabolism). Characteristics of catabolic, anabolic and amphibolic reactions and their significance.</p> <p>2. Exergonic and endergonic biochemical reactions, role of ATP and other macroergic phosphate containing compounds in their coupling.</p> <p>3. Intracellular location of</p>	Kn-1 Kn-3 Kn-4 Kn-6 Sk-1 Sk-2 Sk-3 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		<p>metabolic pathways, compartmentalization of metabolic reactions in the cell. Methods of investigation of metabolism.</p> <p>4. Catabolic transformation of biomolecules: proteins, carbohydrates, lipids, its characteristics.</p> <p>5. The most important metabolites of amphibolic pathways in turnover of proteins, carbohydrates, lipids, their significance for integration of metabolism in the cell.</p> <p>6. Tricarboxylic acid (TCA) cycle: cellular location of TCA cycle enzymes; sequence of TCA cycle reactions; characteristics of enzymes and coenzymes participating TCA cycle; reactions of substrate phosphorylation in TCA cycle; the effect of allosteric modulators upon TCA cycle reactions; energetic effect of TCA cycle.</p> <p>7. Anaplerotic and amphibolic reactions of TCA cycle.</p>		
P-7	<p>Biological oxidation. Molecular basis of bioenergetics. Enzymes of biological oxidation.</p>	<p>1. Biological oxidation of substrates in cells. Reactions of biological oxidation and their functional significance.</p> <p>2. Pyridine dependent dehydrogenases, structure of NAD and NADP, their role in reactions of oxidation and reduction.</p> <p>3. Flavine dependent dehydrogenases. Structure of FAD and FMN, their role in reactions of oxidation and reduction.</p> <p>4. Cytochromes and their role in tissue respiration. Structure of their prosthetic group.</p> <p>5. Molecular organization of electron transport chain of mitochondria.</p> <p>Supramolecular complexes</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

		of respiratory chain in inner membrane of mitochondria.		
P-8	Oxidative phosphorylation and ATP synthesis. Inhibitors and uncouplers of tissue respiration and oxidative phosphorylation in respiratory chain of mitochondria	<ol style="list-style-type: none"> 1. Oxidative phosphorylation. Sites of oxidative phosphorylation. P/O ratio. 2. Mechanisms of oxidative phosphorylation: chemical coupling hypothesis, chemiosmotic theory. The scheme of chemiosmotic mechanism of coupling of electron transport in respiratory chain with ATP synthesis. Molecular structure and principles of functioning of ATP-synthetase. 3. Inhibitors of electron transport in a respiratory chain of mitochondria. 4. Uncouplers of electron transport and oxidative phosphorylation in a respiratory chain of mitochondria. 5. Microsomal oxidation. 	Kn-1 Kn-2 Kn-3 Kn-4 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule
P-9	Glycolysis – anaerobic oxidation of glucose, alternative pathways of carbohydrate metabolism.	<ol style="list-style-type: none"> 1. Glucose as an important metabolite in carbohydrate metabolism: general scheme of sources and turnover of glucose in the organism. 2. Anaerobic oxidation of glucose: the sequence of reactions in glycolysis; enzymatic reactions of anaerobic and aerobic glycolysis; characterization of glycolytic reactions, which occur with utilization of energy; characterization of enzymatic reactions of substrate phosphorylation in glycolysis; mechanism of glycolytic oxido-reduction and reactions, which provide this process. 3. The contribution of works of Embden, Meyerhoff and Parnas in detection of sequence of enzymatic glycolysis reactions. 4. The role of lactate dehydrogenase (LDH) in 	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		glycolysis, mechanism of reaction and its peculiarities. Isoenzymes of LDH and their clinical diagnostic significance. 6. Energetic effect of anaerobic oxidation of glucose. 7. Alcohol fermentation, common and different reactions in glycolysis and fermentation.		
P-10	Glucose oxidation under aerobic conditions and alternative metabolic pathways of monosaccharides metabolism.	1. Stages of aerobic oxidation of glucose. 2. Oxidative decarboxylation of pyruvic acid: structure of multienzyme pyruvate dehydrogenase complex; peculiarities of function of pyruvate dehydrogenase complex; mechanism of oxidative decarboxylation of pyruvate; role of vitamins and coenzymes in transformation of pyruvate to acetyl-CoA. 3. Energetic effect of aerobic oxidation of glucose. 4. Pentose phosphate pathway (PPP) of glucose utilization: scheme of reactions in oxidative and nonoxidative stages of PPP; enzymes and coenzymes of PPP reactions; biological significance of PPP; disorders of PPP in red blood cells; enzymopathias of glucose-6-phosphate dehydrogenase. 5. Enzymatic reactions of fructose turnover in human body. Hereditary enzymopathias of fructose metabolism. 6. Enzymatic reactions of galactose metabolism in human body. Hereditary enzymopathias of galactose metabolism.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule
P-11	Catabolism and biosynthesis of glycogen. Regulation of glycogen metabolism.	1. Mechanism and peculiarities of enzymatic reactions of glycogenesis.	Kn-1 Kn-2 Kn-3	According to the schedule

	<p>Biosynthesis of glucose – gluconeogenesis.</p>	<p>2. Glycogenolysis, common and different reactions with glycolysis. 3. Cascade mechanisms of ATP-dependent regulation of glycogen phosphorylase and glycogen synthase activities. 4. Peculiarities of hormonal regulation of glycogen metabolism in liver and muscles. 5. Hereditary disorders in enzymes of glycogen synthesis and breakdown. Glycogenoses, aglycogenoses. 6. Metabolic pathways and substrates of gluconeogenesis, mechanisms of regulation, compartmentalization of enzymes, biological significance of the process. 7. Relations between glycolysis and gluconeogenesis (Cori cycle). Irreversible reactions of glycolysis and their shunt pathways. Glucose-lactate and glucose-alanine cycles. 8. Regulation of gluconeogenesis in human organism.</p>	<p>Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	
<p>P-12</p>	<p>Mechanisms of metabolic and humoral regulation of carbohydrate metabolism. Disorders of carbohydrate metabolism.</p>	<p>1. Biochemical processes which provides the constant blood glucose level. Role of different pathways of carbohydrate metabolism in regulation of blood glucose level. 2. Hormonal regulation of carbohydrate metabolism: insulin, its structure, mechanism of action, role in carbohydrate metabolism; adrenalin and glucagone, mechanism of their regulatory effects on carbohydrate metabolism; glucocorticoids, their effect on carbohydrate metabolism. 3. Characterization of hypo-</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

		<p>and hyperglycemia, glucosuria.</p> <p>4. Insulin dependent and noninsulin dependent forms of diabetes mellitus.</p> <p>5. Characterization of metabolic disorders in diabetes mellitus.</p> <p>6. Biochemical tests for evaluation of conditions of patients with diabetes mellitus. Glucose tolerance test and its alteration in diabetes mellitus. Biochemical criteria of diabetes mellitus.</p>		
P-13	Catabolism and biosynthesis of triacylglycerols and phospholipids. Intracellular lipolysis and molecular mechanisms of its regulation.	<p>1. Classification of lipids. Biological functions of simple and complex lipids in human body (reserve, energetic, thermoregulatory, production of biologically active substances).</p> <p>2. Involvement of lipids in formation of structure and function of biological membranes. Liposomes. Application of liposomes in medical practice.</p> <p>3. Circulatory transport of lipids and their deposition in adipose tissue. Lipoproteinlipase of blood.</p> <p>4. Catabolism of triacylglycerols: characteristics of intracellular lipolysis, its biological significance; enzymatic reactions; neurohumoral regulation of lipolysis: role of epinephrine, norepinephrine, glucagone, insulin; energetic balance of triacylglycerol oxidation.</p> <p>5. Biosynthesis of triacylglycerols, the significance of phosphatidic acid as a precursor.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	According to the schedule
P-14	Metabolism of complex lipids and ketone bodies.	<p>1. Biosynthesis of phospholipids from phosphatidic acid.</p> <p>2. Metabolism of sphingolipids. Genetic</p>	<p>Kn-1 Kn-3 Kn-4 Kn-5 Kn-6</p>	According to the schedule

		<p>anomalies of sphingolipid metabolism – sphingolipidoses. Lysosomal diseases.</p> <p>3. Metabolism of ketone bodies: enzymatic reactions of ketone bodies biosynthesis (ketogenesis); reactions of ketone bodies utilization (ketolysis), energetic effect; metabolism of ketone bodies in pathology. Mechanism of excessive accumulation of ketone bodies in diabetes mellitus and in starvation.</p>	<p>Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	
P-15	<p>β-Oxidation and biosynthesis of fatty acids. Studies on metabolism of fatty acids and ketone bodies.</p>	<p>1. β-Oxidation of long chain fatty acids: localization of the process of β-oxidation of fatty acids; activation of fatty acids, the role of carnitin in transport of fatty acids into mitochondria; the sequence of enzymatic reactions in β-oxidation of fatty acids; energetic balance of β-oxidation of fatty acids;</p> <p>2. Mechanism of glycerol oxidation, bioenergetics of this process.</p> <p>3. Biosynthesis of long chain fatty acids: localization of biosynthesis of long chain fatty acids; metabolic sources for biosynthesis of fatty acids; stages in synthesis of saturated fatty acids; characteristic of the synthetase of long chain fatty acids, the significance of acyl transporting protein and biotin; sources of NADPH₂ for biosynthesis of long chain fatty acids; the sequence of enzymatic reactions in biosynthesis of long chain fatty acids; regulation of biosynthetic process on level of acetyl-CoA-carboxylase and fatty acid synthetase; elongation of carbon chain of fatty acids.</p>	<p>Kn-1 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

P-16	<p>Biosynthesis and biotransformation of cholesterol. Pathology of lipid metabolism: steatorrhea, atherosclerosis, obesity. Transport forms of lipids: lipoproteins of blood plasma.</p>	<ol style="list-style-type: none"> 1. Biosynthesis of cholesterol in human body: localization of the process and its significance; stages of cholesterol biosynthesis; enzymatic reactions of biosynthesis of mevalonic acid; regulation of cholesterol synthesis. 2. Pathways of cholesterol biotransformation (esterification, production of bile acids and steroid hormones, synthesis of vitamin D₃, excretion from the body). 3. Atherosclerosis, mechanism of its development, role of genetic factors, hypercholesterolemia. Hypercholesterolemia in diabetes mellitus, myxoedema, obstructive jaundice, nephritic syndrome. Control of hypercholesterolemia. 4. Lipoproteins: structure, classification, characteristics of apolipoproteins. 5. Metabolism of lipoproteins – a general view. 6. Disorders of plasma lipoproteins (classification of hyperlipoproteinemias, characteristics of hypolipoproteinemias). 7. Fatty liver (steatosis), lipotropic factors. 8. Pathological processes which leads to the development of obesity. 9. Lipid peroxidation and mechanisms of antioxidant enzymatic system action: lipid peroxidation under normal conditions and in pathology; regulation of free radical reactions in human body; characteristics of prooxidants and antioxidants, their significance in peroxide 	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>
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		oxidation of lipids.		
P-17	General pathways of amino acid metabolism (deamination, transamination, decarboxylation of amino acids). Glutathion and creatine, structure and physiological significance.	<p>1. Pathways of formation and maintainance of free amino acid pool in human body. General pathways of free amino acid turnover.</p> <p>2. Transamination of amino acids, substrates for transamination reaction. Mechanism of transamination. Reaction. Aminotransferases, their localization in tissues and organs. Clinical diagnostic significance of determination of aminotransferases activity.</p> <p>3. Types of reactions of amino acid deamination their final products. Mechanism of oxidative deamination, oxidases of D- and L- amino acids, their enzymatic activity and specificity.</p> <p>4. Decarboxylation of amino acids, decarboxylases. Production of biogenic amines (GABA, histamine, setrotonin, dopamine). Decarboxylation of amino acids in putrifaction of proteins in intestines. Oxidation of biogenic amines.</p> <p>5. Glutathion, structure and role in metabolism of organic peroxides.</p> <p>6. Production of creatine and creatinine, clinical and diagnostic significance of disorders in their metabolism.</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule
P-18	Urea biosynthesis and alternative pathways of ammonia detoxification. Specific metabolic pathways of selected amino acids and their disorders.	<p>1. General metabolic pathways of nitrogen free residues of amino acids in human body. Glucogenic and ketogenic amino acids.</p> <p>2. Pathways of ammonia production. Toxicity of ammonia and mechanisms of its detoxification. Circulatory transport of ammonia (glutamine,</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5	According to the schedule

		alanine). 3. Biosynthesis of urea: enzymatic reactions, hereditary defects of enzymes involved in urea synthesis (enzymopathias of urea synthesis). 4. Metabolism of sulfur containing amino acids, reactions of methylation. 5. Metabolism of arginine. Biological significance of nitric oxide, NO-synthase.	Sk-6 AR-1 AR-2 AR-3 AR-4	
P-19	Metabolism of cyclic amino acids. Disorders of cyclic amino acids metabolism.	1. Specific pathways of metabolism of aromatic amino acids phenylalanine and tyrosine, sequence of enzymatic reactions. 2. Hereditary enzymopathies of phenylalanine and tyrosine metabolism - phenylketonuria, alkaptonuria, albinism. 3. Turnover of tryptophan: kynurenine and serotonin pathways. Hereditary enzymopathias.	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule
P-20	Biochemical functions of nucleotides and nucleic acids.	1. Biochemical functions of nucleic acids and nucleotides. Formation of nucleic acid chain from nucleotides. 2. Constituents of nucleotides and nucleosides. Minor nitrogenous bases and nucleotides. 3. Nucleic acids: structure, properties, stages of investigation. Primary structure of nucleic acids, polarity of polynucleotides, specific features of DNA and RNA structure. 4. Structure, properties and biological significance of DNA. Experimental proof of DNA significance in heredity (phenomenon of transformation). 5. Secondary structure of DNA, role of hydrogen	Kn-1 Kn-3 Kn-6 Sk-1 Sk-2 Sk-5 AR-1 AR-2	According to the schedule

		<p>bonds in stabilization of secondary structure (Chargaff rules, Watson-Crick model), antiparallelism of chains.</p> <p>6. Tertiary structure of DNA. Physical-chemical properties of DNA: denaturation and renaturation of DNA.</p> <p>7. Structure, properties and biological functions of RNA. Types of RNA: mRNA, tRNA, rRNA, snRNA; specific features of structure (secondary and tertiary) of different RNA types.</p>		
P-21	Catabolism of purine and pyrimidine nucleotides. Hereditary disorders of nucleotide metabolism.	<p>1. Biosynthesis of purine nucleotides; scheme of reactions of IMP synthesis; synthesis of AMP, GMP, ATP, GTP. Regulation of purine nucleotides synthesis on a principle of feedback inhibition.</p> <p>2. Biosynthesis of pyrimidine nucleotides: reactions, regulation.</p> <p>3. Biosynthesis of deoxyribonucleotides. Formation of thymidyl nucleotides; inhibitors of dTMP biosynthesis as antitumor drugs.</p> <p>4. Catabolism of purine nucleotides; hereditary disorders of uric acid metabolism. Biochemical background of hyperuricemia, gout, Lesch-Nyhan syndrome.</p> <p>5. Catabolism of pyrimidine nucleotides.</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule
P-22	DNA replication and transcription of RNA. Mutations and their types, reparations of damaged DNA.	<p>1. Biological significance of DNA replication. The sense of J. Watson and F. Crick discovery. Semiconservative mechanism of replication, the scheme of Meselsohn's and Stahl's experiment.</p> <p>2. General scheme of DNA synthesis. Mechanisms of DNA replication in</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4	According to the schedule

		<p>prokaryotes and eukaryotes.</p> <p>3. General scheme of transcription. Stages and enzymes of RNA synthesis in prokaryotes and eukaryotes.</p> <p>4. Posttranscriptional modifications of RNA.</p> <p>5. Inhibitors of replication and transcription as medical drugs; their mechanisms of action.</p> <p>6. Regulation of gene expression in prokaryotes. Structure of Lac-operon of <i>Escherichia coli</i>: structural and regulatory genes, promoter, operator, regulator; repression and induction of Lac-operon function.</p> <p>7. Mutations: genomic, chromosomal, gene (point mutations), their significance in appearance of enzymopathias and human hereditary diseases.</p> <p>8. Biological significance and mechanisms of DNA repair. Repair of UV-induced mutations. Xeroderma pigmentosum.</p>	<p>Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	
P-23	<p>Biosynthesis of proteins, initiation, elongation and termination steps. Post-translational modification of proteins. Principles of gene engineering and production of transgenic proteins of medical significance.</p>	<p>1. Features of genetic code; triplet structure, its properties.</p> <p>2. Protein synthesis on the ribosomes. Components of protein synthesis system.</p> <p>3. Transfer RNA and amino acid activation, aminoacyl-tRNA synthetase.</p> <p>4. Stages and mechanisms of translation: initiation, elongation, termination. Initiating and terminating codons of mRNA.</p> <p>5. Post-translational modification of polypeptide chains. Regulation of translation. Molecular mechanisms of translation control on example of globin synthesis.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

		<p>6. The influence of biologically active compounds on translation. Antibiotics as inhibitors of transcription and translation in prokaryotes and eukaryotes, their biomedical application.</p> <p>7. Biochemical mechanisms of antiviral activity of interferon. Block of protein synthesis by diphtheria toxin (ADP-ribosylation of translation factors).</p> <p>8. Gene engineering or recombinant DNA technology: general principles, biomedical significance. The employment of enzymes. Gene cloning for obtaining of medicinals and diagnostic tools using methods of biotechnology (hormones, enzymes, antibiotics, antigens, interferons etc.).</p> <p>9. Polymerase chain reaction, its biomedical application in diagnostics of contagious and hereditary diseases, identification of a person (DNA-diagnostics).</p>		
P-24	Functional role of water soluble vitamins.	<p>1. Vitamins as essential nutritional components. History of vitamins discovery and development of vitaminology.</p> <p>2. Vitamin B₁ and B₂: structure, biological function, sources, daily requirement. Symptoms of hypovitaminosis.</p> <p>3. Structure and properties of vitamin H and pantothenic acid. Their involvement in metabolism, sources, daily requirement. Metabolic significance of CoA.</p> <p>4. Antianemic vitamins (B₁₂, folic acid): structure, biological function, sources, daily requirement. Symptoms of hypovitaminosis.</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		<p>5. Vitamins B₆ and PP, structure, biological function, sources, daily requirement. Symptoms of hypovitaminosis.</p> <p>6. Vitamin C and P: structure, biological function, sources, daily requirement. Functional interrelations between vitamin C and P, manifestations of insufficiency in human organism.</p> <p>7. Provitamins, antivitamins, mechanism of action and application in practical medicine.</p> <p>8. Modern vitamin drugs, their application in treatment and prevention of diseases. Biologically active supplements.</p>		
P-25	Functional role of fat soluble vitamins.	<p>1. Vitamins of D group: structure, biological function, nutritional sources, daily requirement. Symptoms of hypo- and hyper-vitaminosis, avitaminosis.</p> <p>2. Vitamin A: structure, biological function, sources, daily requirement. Symptoms of hypo- and hypervitaminosis.</p> <p>3. Vitamins E, F: structure, biological role, nutritional sources, mechanism of action, daily requirement. Symptoms of insufficiency, application in medicine.</p> <p>4. Antihemorrhagic vitamins (K₂, K₃) and their water soluble forms: structure, biological function, nutritional sources, mechanism of action, daily requirement, symptoms of insufficiency, application in medicine.</p> <p>5. Provitamins, antivitamins, mechanism of action and application in practical medicine.</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		<p>6. Vitaminoids: structure and biological activity.</p> <p>7. Modern vitamin drugs, their application in treatment and prevention of diseases. Biologically active supplements.</p>		
P-26	<p>Molecular mechanisms of action of hormones of protein and peptide nature, as well biogenic amines upon target cells. Humoral regulation of calcium homeostasis in human body.</p>	<p>1. Hormones in a system of intercellular integration of physiological functions in human organism. Classification of hormones.</p> <p>2. Mechanisms of hormonal action – amino acid derivatives, peptide and protein hormones, steroid hormones. Regulatory sites in DNA, which interacts with hormone-receptor complexes. Messenger function of cyclic nucleotides, Ca/calmodulin system, phosphoinositides. Serine, threonine and tyrosine proteinkinases in effector response of the cell.</p> <p>3. Hormones of hypothalamus. Mechanism of their action.</p> <p>4. Tropic hormones of the anterior pituitary: group "growth hormone (somatotropin) - prolactin – chorionic somatomamotropin"; pathological processes associated with impaired growth hormone, somatomedin, prolactin; a group of glycoproteins – pituitary trophic hormones (TSH, gonadotropins, FSH, LH), chorionic gonadotropin; POMK hormones– processing products of POMK (adrenokortykotropin, lipotropin, endorphins).</p> <p>5. Hormones of the posterior pituitary: vasopressin (antidiuretic hormone) and oxytocin. Mechanism of action. The use of oxytocin</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

		<p>in medical practice.</p> <p>6. Characteristics of pancreatic hormones: endocrine function of the pancreas (insulin, glucagon, somatostatin, pancreatic polypeptide); insulin – structure, biosynthesis and secretion; characteristics of insulin receptors, molecular mechanisms of action (effect on metabolism of carbohydrates, lipids, amino acids and proteins); glucagon – the chemical nature and the biological effect of the hormone;</p> <p>7. Catecholamines: epinephrine, norepinephrine, dopamine. Chemical nature, biological effect, receptors. Their role in the stress response.</p> <p>8. The mechanism of action of parathyroid hormones and calcitonin. Parathyroid hormone – structure, mechanism of action. Calcitriol: biosynthesis; effects on the absorption of Ca^{2+} and phosphate in the intestine. Calcitonin - structure, effect on calcium and phosphate.</p> <p>9. Clinical and biochemical characteristics of disorders of calcium homeostasis (rickets, osteoporosis). The distribution of Ca^{2+} in the body; molecular forms of calcium in the blood plasma. The role of bone, small intestine and kidney in calcium homeostasis.</p>		
P-27	Molecular mechanisms of action of steroid and thyroid hormones upon target cells.	<p>1. The mechanism of action of thyroid and steroid hormones (cytosolic and nuclear receptors).</p> <p>2. Thyroid hormones: structure and biosynthesis of thyroid hormones; biological effects of T4 and T3; thyroid pathologies; disorders of metabolism under conditions</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4	According to the schedule

		<p>of hyper- and hypothyroidism; endemic goiter and its prevention.</p> <p>3. Steroid hormones: nomenclature, classification. Biosynthesis of steroid hormones from cholesterol.</p> <p>4. Steroid hormones of the adrenal cortex (C21-steroids): structure, physiological and biochemical effects of glucocorticoids (cortisol, corticosterone), the role of cortisol in the regulation of metabolism (carbohydrates, proteins, lipids); biochemical basis of glucocorticoid anti-inflammatory properties; structure, physiological and biochemical effects of mineralokortykoids (aldosterone); role of aldosterone in regulation of water-salt metabolism; Cushing's disease, Addison's disease (bronze), aldosteronism, Kron's disease.</p> <p>5. Steroid hormones of gonads: female hormones: estrogen - estradiol, estrone (C18-steroids), progesterone (C21-steroids); physiological and biochemical effects; connection with the phases of the menstrual cycle; regulation of synthesis and secretion; male sex hormones (androgens) - testosterone, dihydrotestosterone (C19-steroids); physiological and biochemical effects, regulation of synthesis and secretion;</p> <p>6. General characteristics of hormone-like substances. Biochemical basis of hormonal regulation of digestion. Gastrin. Cholecystokinin. Secretin.</p>	<p>Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	
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P-28	Biochemistry of blood. Proteins of blood plasma, nonprotein nitrogen containing and nitrogen free components of blood plasma. Acid-base equilibrium of blood and its regulation.	<p>1. Principal groups of blood proteins, their composition and content in normal conditions and in pathology.</p> <p>2. Albumins and globulins. Resolution of blood plasma proteins by method of protein electrophoresis.</p> <p>3. Glycoproteins: their structure, biological role, changes in diseases.</p> <p>4. Proteins of acute phase of inflammation: C-reactive protein (CRP), ceruloplasmin, haptoglobin, cryoglobulin, α-1 antitrypsin, α-2 macroglobulin, interferon, fibronectin, their diagnostic validity.</p> <p>5. Enzymes of blood plasma: genuine (secretory),</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		<p>excretory, indicatory (tissue) enzymes. Kallikrein-kinine and renin-angiotensin systems, their biological significance.</p> <p>6. Diagnostic value of investigation of enzyme and isoenzyme activity in blood plasma: creatine kinase (CK), LDH, AST, ALT, amylase, lipase, cholinesterase.</p> <p>7. Definition of total and rest nitrogen in blood. Nonprotein nitrogen containing compounds of blood, their diagnostic significance.</p> <p>8. Nitrogenemia, its kinds and causes of development, differentiation in clinical conditions.</p> <p>9. Hemoglobin: derivatives, mechanisms of the transport of oxygen and carbon dioxide. Pathological types of hemoglobin in humans.</p> <p>10. Acid-base equilibrium of blood. Regulation of pH in biological fluids, disorders of acid-base equilibrium: metabolic and respiratory acidosis, metabolic and respiratory alkalosis, mechanisms of their development.</p> <p>11. Buffer systems of blood, their types, role of different buffer systems in providement of constant pH of blood.</p>		
P-29	Coagulation, anticoagulation and fibrinolytic systems of blood.	<p>1. Functional and biochemical characteristics of intrinsic and extrinsic blood coagulation pathways.</p> <p>2. Blood coagulation system; characteristics of coagulation factors. Cascade mechanism of activation and function of blood coagulation; intrinsic and extrinsic blood coagulation pathways. Role of vitamin K in reactions of</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1</p>	According to the schedule

		<p>hemocoagulation (carboxylation of glutamic acid residues, its role in Ca binding). Medical preparations as vitamin K agonists and antagonists.</p> <p>3. Hereditary disorders of hemocoagulation.</p> <p>4. Anticoagulation system of blood, functional characteristics of its components – heparin, antithrombin III, citric acid, prostacycline. Role of vascular endothelium. Changes in biochemical characteristics of blood in prolong treatment with heparin.</p> <p>5. Fibrinolytic system of blood: stages and factors of fibrinolysis. Pharmacological modulation of fibrinolytic process. Activators and inhibitors of plasmin.</p>	<p>AR-2 AR-3 AR-4</p>	
P-30	<p>Biological role and metabolism of hemoglobin. Patobiochemistry of porphyria and jaundice.</p>	<p>1. Biosynthesis of heme, precursors and scheme of enzymatic reactions. Regulation of porphyrin/heme synthesis.</p> <p>2. Hereditary disorders of porphyrin metabolism (porphyrias).</p> <p>3. Hemoglobin catabolism: production of bile pigments, biliverdin, its transformation to bilirubin, synthesis of bilirubin diglucuronide and excretion with bile.</p> <p>4. Pathobiochemistry of jaundices; hemolytic (prehepatic), parenchimatous (hepatic), occlusive (posthepatic).</p> <p>5. Enzymatic congenital jaundices: Crigler-Najjar syndrome, Gilbert disease, Dubin-Johnson.</p> <p>6. Diagnostic significance of determination of total bilirubin and its fractions in blood plasma.</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

P-31	<p>Detoxification function of liver, microsomal oxidation, role of cytochrome P-450 system and flavine containing monooxygenases. Biotransformation of xenobiotics and endogenous toxins.</p>	<ol style="list-style-type: none"> 1. Homeostatic role of liver in human body. Involvement of liver in glucose turnover (glycogenesis and glycogen breakdown, gluconeogenesis), proteins and lipid metabolism. 2. Detoxification function of liver; biotransformation of xenobiotics and endogenous toxins. 3. Types of reactions of biotransformation of foreign substances in liver. 4. Reactions of microsomal oxidation; inducers and inhibitors of microsomal monooxygenases. 5. Conjugation reactions in hepatocytes: biochemical mechanisms, functional significance. 6. Electron transport chains of endoplasmic reticulum. Genetic polymorphism and induction of biosynthesis of cytochrome P-450. 7. Development of tolerance to medicinal and drugs and its causes. 	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>
P-32	<p>Investigation of water and mineral metabolism.</p>	<ol style="list-style-type: none"> 1. Biological role of water and its distribution in human body. Water balance, its types. 2. Regulation of water and mineral metabolism, its disorders. Dehydration and rehydration, biochemical mechanisms of their development. 3. Mechanism of Na, K-ATP-ase action and its regulation. 4. Biogenic elements, their classification, pathways of their providement. 5. Biological role of macroelements, trace elements and ultramicroelements. 6. Human microelementoses: endogenous and exogenous 	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

		causes (technogenic, yatrogenic, etc.). Oligotherapy.		
P-33	Renal function. Biochemical composition of human urine in norm and pathology.	<p>1. Role of kidneys in regulation of volume, composition of electrolytes and acid-base equilibrium of biological fluids. Biochemical mechanisms of urine production (filtration, reabsorption, secretion and excretion). Characterization of renal clearance and renal threshold, their diagnostic significance.</p> <p>2. Humoral mechanisms of regulation of water and mineral metabolism and kidney function; antidiuretic hormone; aldosteron.</p> <p>3. Renin-angiotensine system. Natriuretic factors of heart atrium and other tissues. Biochemical mechanisms of development of renal hypertonia.</p> <p>4. Physical and chemical properties of urine: volume, color, odor, transparency, acidity (pH), its dependence from diet. Role of kidneys and lungs in regulation of acid-base equilibrium. Ammoniogenesis.</p> <p>5. Chemical composition of urine in health (organic and mineral components), their diagnostic significance and causes of changes of stable indices of urine analysis.</p> <p>6. Pathological constituents of urine – blood, protein, sugar, bile pigments, ketone bodies. Causes and pathways of their appearance in urine.</p> <p>7. Glucosuria, galactosuria and pentosuria, causes of their development. Clinical significance of their detection.</p> <p>8. Clinical significance of detection and determination of indican, phenylpyruvic and homogentisinic acids in</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		<p>urine.</p> <p>9. Clinical significance of detection and determination of ketone bodies in urine.</p> <p>10. Differentiation of jaundices on the appearance of bile acids and bile pigments in urine</p>		
P-34	<p>Biochemistry of nervous and muscle tissues.</p> <p>Pathochemistry of psychotic disorders.</p>	<p>1. Fine structure and biochemical composition of myocytes; structural organization of sarcomers. Myofibril proteins: myosine, actin, tropomyosine, troponine complex. Molecular organization of thick and thin filaments.</p> <p>2. Nitrogen containing and nitrogen free water soluble organic compounds, their structure and functional significance. Molecular mechanisms of muscle contraction: modern data on interaction of muscle filaments. Role of Ca^{2+} ions in regulation of contraction and relax of striated and smooth muscles.</p> <p>3. Modern ideas on energetics of muscle contraction and relaxation. Macroergic compounds of muscles. Structure, production and role of ATP, creatine phosphate, creatine phosphokinases, sources of ATP in muscle cell; role of creatine phosphate in energetic supply of contraction. Pathobiochemistry of muscles - myopathias.</p> <p>4. Metabolic changes in muscles in certain disorders.</p> <p>5. Biochemical composition and metabolism in brain: neurospecific proteins and lipids (gangliosides, cerebroside, cholesterol), peculiarities of amino acid composition of brain tissue, role of glutamate system.</p> <p>6. Energetic metabolism in</p>	<p>Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4</p>	<p>According to the schedule</p>

		<p>human brain.</p> <p>7. Biochemistry of neuromediators (acetylcholine, norepinephrine, dopamine, serotonin, excitory and calming amino acids), their role in nerve impulse transduction and memory regulation.</p> <p>8. Receptors for neuromediators and physiologically active compounds.</p> <p>9. Peptidergic system of brain.</p> <p>10. Opioid receptors (enkephalins, endorphins, dinorphins) and their receptors.</p> <p>11. Biochemical mechanisms of the development of human neuro-psychic disorders (alcoholism, narcomany, Alzheimer's disease, multiple sclerosis, Parkinson's disease, epilepsy).</p>		
P-35	Principles of pharmaceutical biochemistry.	<p>1. Homeostatic role of the liver in the metabolism of the whole organism. Biochemical functions of hepatocytes. Glucogenic and lipid-regulating functions of liver, protein and urea synthesis.</p> <p>2. Detoxification function of the liver. The concept of the biochemistry of foreign compounds - "xenobiochemistry"; mechanisms of biotransformation of xenobiotics and endogenous toxins.</p> <p>3. Types of reactions of biotransformation of foreign compounds in the liver.</p> <p>4. Reactions of microsomal oxidation, inducers and inhibitors of microsomal monooxygenases.</p> <p>5. The biological role of cytochrome P-450. Electron</p>	Kn-1 Kn-2 Kn-3 Kn-4 Kn-5 Kn-6 Sk-1 Sk-2 Sk-3 Sk-4 Sk-5 Sk-6 AR-1 AR-2 AR-3 AR-4	According to the schedule

		<p>transport chain in the membranes of endoplasmic reticulum of hepatocytes.</p> <p>6. Reactions of conjugation in hepatocytes: biochemical mechanisms, functional significance.</p> <p>7. The origin and nature of the development of drugs tolerance.</p>		
IW-1	Methods of separation and purification of protein mixtures.	<p>1. Characteristics of the main physico-chemical methods of research that are used in biochemistry to separate and purify protein mixtures; electrophoresis (horizontal, disk electrophoresis, isoelectric focusing, immunoelectrophoresis); chromatography (affinity, ion exchange, thin layer, gas, exclusive or displacement); radioisotope methods; enzyme-linked immunosorbent assays; blotting.</p>	<p>Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4</p>	According to the schedule
IW-2	The role of vitamins in mechanism of action of conjugated enzymes	<p>1. Structure and role of vitamins in functioning of enzymes and metabolism in cells. Characteristic of the structure of the active center enzymes. Mechanism and role of vitamins in functioning enzymes.</p> <p>2. Examination of activity of antioxidant enzymes under the conditions of oxidative stress at diseases of various genesis.</p>	<p>Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4</p>	According to the schedule
IW-3	The use of isoenzymes in diagnostics of diseases.	<p>1. Prognostic and diagnostic value of determination of enzymes in the blood of patients with myocardial infarction and pathologies of liver and muscles.</p>	<p>Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4</p>	According to the schedule
IW-4	The use of enzymes and their inhibitors as drugs.	<p>1. The use of enzymes as drugs.</p> <p>2. The use of inhibitors of enzymes in diseases of digestive system.</p> <p>3. Systemic enzyme therapy</p>	<p>Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3</p>	According to the schedule

		and modern drugs (Wobenzyme, flobenzyme, etc). Application of drugs in the treatment of pathological states.	AR-4	
IW-5	Composition, localization and function of multi-enzyme complexes in aerobic oxidation of substrates.	1. The role of metabolic pathways in metabolism. 2. Pyruvate dehydrogenase and α -ketoglutarate dehydrogenase complexes as examples of multi-enzyme complexes. The structure, role and significance in processes of aerobic oxidation.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-6	Structure, conditions of action and regulation of ATP synthases on inner membranes mitochondria.	1. The structure of ATP-synthase and its role in the processes of ATP synthesis. 2. Disorders of ATP synthesis under the conditions of action of pathogenic factors of chemical, biological and physical origin. on the human body. Ways of correction.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-7	Modern drugs used in treatment of disorders of carbohydrate metabolism.	1. Modern drugs used in correction of violations of carbohydrate metabolism. 2. Mechanism of action and practical application of these drugs. 3. Hereditary disorders of glycoconjugate metabolism. Diagnostics of disorders of glycoconjugate metabolism. Pharmaceutical drugs.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-8	Antihyperlipidemic drugs in regulation of disorders of lipid metabolism.	1. Modern drugs used in correction of violations of lipid metabolism. 2. Mechanism of action and practical application of these drugs. 3. Statins. Mechanism of action.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-9	Aminoaciduria: the causes of development and their pharmacological correction	1. Peculiarities of amino acid metabolism. 2. Causes of violations of amino acid metabolism. Enzymopathies. Mechanism of development. 3. Methods and drugs that are used for correction of aminoaciduria.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule

IW-10	General concepts and the importance of technology of recombinant DNA (gene engineering).	1. Use of DNA technology for growing of microorganisms as producers of biologically active compounds (vitamins, hormones, etc). 2. Perspectives of use of DNA technologies for treatment of hereditary pathological states.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-11	The effect of antibiotics and other drugs on matrix synthesis in the cell. Application of medicines in symptomatic treatment of COVID 19.	1. Mechanisms of action of modern antibiotics. 2. Perspective inhibitors of matrix syntheses and their application as drugs.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-12	Using of RIA method in quantitative determination of hormones.	1. The principle of the RIA method. 2. Use of RIA method in determination of hormones.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-13	Protein-peptide factors of growth and tissue proliferation.	1. Modern classification and nomenclature of protein-peptide factors of growth and tissue proliferation. 2. Mechanisms of action of protein-peptide factors on regulation of metabolism in human body.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-14	Antioxidant function of vitamins in human body.	1. Vitamins with antioxidant properties. Current data on their antioxidant function. 2. The mechanism of implementation of their antioxidant properties.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-15	Complex vitamin drugs in treatment of hypovitaminosis and other pathological states.	1. Modern complex vitamin drugs and their role in correction of pathological states. 2. The mechanism of their effects on metabolism under pathological states.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-16	Fractional composition of blood plasma proteins in normal conditions and pathology.	1. Modern methods applied for blood plasma protein fractionation. Their characteristics. 2. Changes in fractional composition of blood plasma proteins under the conditions of viral	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule

		pathologies.		
IW-17	Hormonal mechanisms in regulation of water and mineral metabolism and functions of kidney.	1. Hormones affecting regulation and homeostasis of water-mineral metabolism in the human body. 2. The mechanism of action of hormones, affecting water-mineral metabolism.	Kn-1 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
IW-18	The influence of drugs kidney functions and physico-chemical properties of urine.	1. Modern drugs used in correction of kidney function and water-mineral metabolism. 2. The mechanism of action of modern drugs on water-mineral metabolism.	Kn-1 Kn-2 Sk-1 Sk-3 Sk-6 AR-3 AR-4	According to the schedule
<i>It is necessary to present a system of organization of classes, the use of interactive methods, learning technologies used to transfer and assimilate knowledge and skills.</i>				
8. Verification of learning outcomes				
Current control				
<i>is carried out during training sessions and aims to check the mastery of educational material of students (it is necessary to describe the forms of the current control during training sessions). Forms of assessment of current educational activity should be standardized and include theoretical and practical training control.. The final grade for the current educational activity is set for 4 point (national) scale</i>				
Learning outcome code	Code of type of lessons	Method of verification of learning outcomes	Enrollment criteria	
		Types of training activities of students are: a) lectures b) practical classes c) individual work Thematic plans of lectures, practical classes, individual work ensure the implementation of all topics included in the content of the program in the educational process.		
Kn-1-6 C-1-6	L-1-15	Lecture course consists of 15 lectures. Topics of lecture course reveal problematic questions relevant to sections of biochemistry. During lectures in students is formed theoretical basic knowledge, provided motivational component and general approximate stage of mastery of scientific knowledge during independent work. In lecture course diverse didactic instruments are used - multimedia presentations, slides.	During the assessment of learning of each topic for the current curriculum student gets scores by 4-point (traditional) scale based on approved evaluation criteria for the relevant discipline. All types of work provided by the training program are taken into account. The student must receive score on each topic. A student gets an " excellent " grade if he took an active part in discussing the most difficult issues on lesson topics, gave at least 90% correct answers to standardized test tasks (19-20 of 20),	

<p>Kn-1-6 Sk-1-6 C-1-6 AR-1-4</p>	<p>P-1-34</p>	<p>Practical classes are aimed to control assimilation of theoretical material, formation of practical skills and abilities, as well as skills to analyze and apply acquired knowledge to resolve practical tasks. Every lesson starts with test control (20 tests) in order to evaluate the initial level of knowledge and definition the degree of readiness of students to practical class. Students who passed the test control can perform the control work that contains 3 theoretical tasks. Teacher determines the purpose of classes and creates a positive cognitive motivation; responds to questions of students which arose during individual work on the topic. The main stage of the practical lesson is the performance of practical work. Evaluation is held during the practical classes with taking into account oral discussion, oral reports, case studies tasks, quality of implementation of practical task.</p> <p>Teacher fails result of classes, gives tasks for independent work for students, points to main issues of next topic and offers a list of recommended literature. Duration of practical lesson is 2 academic hours.</p>	<p>responded to writing tasks without errors, performed practical work and wrote the protocol.</p> <p>The grade "good" is received by the student, who took part in the discussion of the most difficult questions on the topic, gave no less than 75% correct answers to standardized test tasks (17-18 of 20), assumed some minor errors in answers on written tasks, performed practical work and wrote a protocol. Student receives a "satisfactory" grade if he did not participate in discussing of the most difficult issues in topics, gave at least 60% correct answers to standardized tests task (15-16 of 20), assumed significant errors in responses to written assignments, performed practical work and wrote a protocol.</p> <p>Student receives a "unsatisfactory" grade if he did not participate in discussing the most difficult issues with topics, gave less than 60% correct answers to standardized tests task (14 or less), assumed gross errors in responses to written assignments or not given at all answers to them, did not perform practical work and did not write a protocol.</p>
<p>Kn-1-6 Sk-1-6 C-1-6 AR-1-4</p>	<p>IW-1-34</p>	<p>Individual work of students is performed in the form of abstracts, decorated in notebooks for individual work with using of recommended literature. They can be introduced in the form of oral reports, presentations during practical class time. Tests and theoretical questions which apply to issues rendered in individual work, are valued at practical classes and exams.</p>	
Final control			
<p>General evaluation system</p>	<p>Participation in the work during the semester / exam - 60% / 40% by a 200-point scale</p>		
<p>Scales of evaluation</p>	<p>Traditional 4-point scale, multi-point (200-point) scale, rating ECTS scale</p>		

Terms of admission to final control	The student attended all practical classes and received at least 72 points on current performance	
Kind of final control	Methods of conducting of final control	Criteria of enrollment
Exam evaluation criteria		
Exam	<p>The semester exam is a form of final control of assimilation of theoretical and practical material on academic discipline by a student. Final control is conducted in writing form, with using training platform MISA, according to schedule.</p> <p>The duration of the exam is 2 academic hours.</p> <p>The procedure for the exam on biochemistry includes the following stages:</p> <ol style="list-style-type: none"> 1. Passing of test control, which contains 40 tasks with one correct answer. This stage lasts 40 minutes (1 test - 1 minute). 10 variants. 2. Passing of the theoretical part, which contains 5 tasks: 4 tasks from different sections of discipline "Biological chemistry", 5th task - displays the level of mastering of practical skills. 	<p>Exam evaluation</p> <p>The score for the exam consists of a score on test tasks and theoretical assessments tasks (including practical skills).</p> <p>Criteria for evaluation of test tasks: Less than 25 tests - "unsatisfactory"; 25 - 30 tests - "satisfactory"; 31 - 36 tests - "good"; 37 - 40 tests - "excellent".</p> <p>The correct answer on 1 test is 1 point. The minimum number of points for 40 tests – 25 points. The maximum number of points for 40 tests – 40 points.</p> <p>Criteria for evaluation of the theoretical tasks: Each of the five theoretical tasks is estimated from 5 to 8 points: Less than 5 points - "unsatisfactory"; 5 points - "satisfactory"; 7 points - "good"; 8 points - "excellent".</p> <p>The minimum number of points for 5 theoretical tasks - 25 points. The maximum number of points for 5 theoretical tasks - 40 points.</p> <p>For theoretical questions the student receives: Score "excellent", if without errors responded to written theoretical tasks (including practical skills), substantiated the obtained results, ie: comprehensively and deeply mastered the curriculum; fully possesses theoretical knowledge and practical skills. Score "good", if assumed some minor errors in answers to written theoretical tasks (including practical skills), but not fully substantiated findings. Score "satisfactory" if made significant mistakes in answers to written theoretical tasks (including practical skills).</p>

		<p>The score is "unsatisfactory" if made gross mistakes in answers to written assignments or did not give answers to them at all.</p> <p>For the exam the student receives: Score "excellent" (75 - 80 points) gets the student who gave the correct answers to 37-40 standardized tests, without errors answered on writing theoretical problems (including practical skills), justified the obtained results (38-40 points), that is: comprehensively and deeply mastered curriculum material; fully possesses theoretical knowledge and practical skills. Student receives a score "good" (62-74 points) if he gave the correct answers to 31-36 standardized tests, assumed some minor errors in written answers on theoretical tasks (including practical skills), but not fully substantiated the obtained data (31-37 points). Assessment "satisfactory" (50-61 points) gets the student who gave the correct answers to 25-31 standardized tests, made significant errors in answers to written theoretical tasks (including practical skills) (25-30 points). Student receives a grade "unsatisfactory" if he gave the correct answers to less than 25 standardized tests, made gross mistakes in answers to written assignments or did not give answers to them at all.</p> <p>The maximum number of points that can be received by the student during passing the exam is 80. The minimum number of points at passing the exam - not less than 50.</p>
<p>The maximum number of points that a student can score for the current educational activity for admission to the exam (differentiated test) is 120 points. The minimum number of points that a student must score for the current educational activity for admission to the exam (differentiated test) is 72 points. The calculation of the number of points is based on the student's grades by 4 point (national) scale during the study of the discipline, by calculation arithmetic mean (AM), rounded to two decimal places. The resulting value is converted into points on a multi-point scale as follows:</p> $x = (AM \times 120) / 5$		
<p>Criteria for assessing an objective structured practical (clinical) exam / Complex of practice-oriented exam Master's thesis</p>		
<p>9. Course policy</p>		

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. The value of acquiring new knowledge, the need for independent implementation of all types of works, tasks provided by the working program of this discipline is explained to the students. Absence of references to used sources, fabrication of sources, writing off, interference in work of other students are examples of possible academic dishonesty. Detection of signs of academic dishonesty in the work of the student is the basis for its non-enrollment by teacher, regardless of the extent of plagiarism or deception. Literary sources can 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 in recommended list.

10. Literature

1. Biological and Bioorganic Chemistry: textbook: in 2 books. Book 2. Biological Chemistry / Yu. I. Gubsky, I. V. Nizhenkovska, M. M. Korda et al.; edited by Yu. I. Gubsky, I. V. Nizhenkovska – 2nd ed. – Kyiv: AUS Medicine Publishing, 2021. – 544 p.
2. Satyanarayana U., Chakrapani U. Biochemistry. Fifth edition, N.Delhy: Elsevier, co-published with Book and Allied, 2017. 788 p.
3. Harper's Illustrated Biochemistry 30th edition / V. W. Rodwell et al.; NY: McGraw-Hill Education, 2015. 817 p.
4. Trudy McKee, James R. McKee. Biochemistry. The molecular basis of life. Sixth edition. Oxford University Press, 2015. 928 p.
5. Nelson D.L., Cox M.M. Lehninger Principles of Biochemistry. Fifth edition. NY: W.H. Freeman and Company, 2005. 1010 p.
6. Swanson T. A., Kim S. I., Glucksman M. J. Biochemistry, Molecular Biology, and Genetics 5th edition / Lippincott Williams & Wilkins, 2010. 380 p.
7. Devlin T. M. ed. Textbook of Biochemistry with Clinical Correlations, 7th edition. Hoboken: Wiley-Liss, 2010. 1240 p.
8. MCQs in biochemistry 2nd edition / A. Ya. Sklyarov et al.: Lviv: Danylo Halytsky Lviv National Medical University Press, 2020. 319 p.
9. MCQs in biochemistry / A. Ya. Sklyarov et al.: Lviv: Danylo Halytsky Lviv National Medical University Press, 2012. 308 p.

Information resources:

1. www.meduniv.lviv.ua
2. <https://new.meduniv.lviv.ua/kafedry/kafedra-biologichnoyi-himiyi/>

Test center – database of licensed test tasks:

3. www.testcentr.org.ua
4. Website of the department:
<https://new.meduniv.lviv.ua/kafedry/kafedra-biologichnoyi-himiyi/>
email: Kaf_biochemistry@meduniv.lviv.ua

11. Equipment, logistics and software of the discipline "Biological chemistry"

Methodical support:

1. Working curriculum of the discipline;
2. Multimedia support of lectures,
3. Abstracts of lectures on the discipline;
4. Methodical recommendations and developments for the teacher;
5. MISA studying platform;
6. Textbooks;
7. Methodical instructions for practical classes for students;
8. Methodical materials that provide independent work of students;
9. Test and control tasks for practical classes;
10. Questions and tasks for the final control (exam);

11. Laboratory equipment (PEC, SF, centrifuges, laboratory glassware, biochemical analyzers etc.)

12. Additional information

Responsible for the educational process at the department - associate professor O. P. Havrona.
There is a scientific circle at the department. Responsible is assist. prof. L. P. Biletska.
Practical classes and lectures are held in the classrooms of the department, lecture hall by address Pekarska str., 69, chemical building, I floor.

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