MINISTRY OF EDUCATION AND SCIENCE OF THE KYRGYZ REPUBLIC

Government-run Educational-Institution of Higher Professional Education
Kyrgyz-Russian Slavic University named after B.N. Yeltsin
School of medicine

ENDORSED BY
Director of the Institute of Clinical Medicine and Innovative Technologies
Abylova S.S.
4th of November
2026 year.

Biochemistry

Course Outline (Module)

Assigned to	**Base and Clinical Pharmacology, Chemistry and Biochemistry**
Academic Curriculum	560001_26_1LDi.pli.xml 560001 - KR General Medicine (for foreign student)
Qualification	**Specialist**
Mode of Study	**Intramural**
Total Credit Value	**8 credit points**

Course Hours	240
including:	
in-class learning	112
Individual work	97,7
exam	35,5

Scope of Testing Semesters:
exams 3
credits 2

Course Hours Scheduling (per semester)

Semester (Academic Year)	**2 (1.2)**		**3 (2.1)**		Total	
Weeks	18		16			
Type of Training	AC	CO	AC	CO	AC	CO
Lectures	16	16	32	32	48	48
Practical Session	32	32	32	32	80	80
Contact work during semester	0.3	0.3			0.3	0.3
Contact work during exam period			0.5	0.5	0.5	0.5
Including Interactive Session	3	3	3	3	6	6
Total In-class Session	48	48	64	64	112	112
Common contact work	48.3	48.3	64.5	64.5	112.8	112.8
Independent student work	71.7	71.7	26	26	97,7	97,7
Exam			29,5	29,5	29,5	29,5
Total	120	120	120	120	240	240

The Course outline developed by:

Kochkorova M.M., assistant of department, _____ and Ibraeva I.G., associate professor , CMS _____

Reviewers:

Internal: Makimbetova Ch.E., Associate Professor of the Department of Normal Physiology of KRSU named after B.N. Yeltsin, CMS _____

External: Dusheeva B.M., Associate Professor of the Department of Biochemistry with the course of General and Bioorganic Chemistry of KSMA KSMA named after I.K. Akhunbayev, CCS _____

Approved by head of educational programm, Jamankulova M. K.

The Course Outline

Biochemistry

in accordance with Academic Curriculum:

Speciality 560001 - KR General Medicine (for foreign students)

confirmed by KRSU Board of Academics in 26.06.2026, record № 11.

The Course Outline endorsed by **Base and Clinical Pharmacology, Chemistry and Biochemistry** Department Meeting.

Record of 07.09 2026. № 2

Valid for: 2026-2031 academic years.

The Head of Department Zurdinova A.A., associate professor, CPhS

RECORD OF REVISIONS
Of working program of discipline (module)

Biochemistry

_____ *Name of discipline*

№	Reasons of changes	Chapter/ topic	Description of changes
1.			
2.			
3.			
4.			
5.			

1. COURSE OUTLINE OBJECTIVES	
1.1	to acquire systemic knowledge of the main molecular mechanisms of biological systems functioning, their impact on human health and adaptation at the molecular, cellular and organ levels, to form theoretical basis for further study of medical biological and clinical disciplines in specialty 560001 General Medicine

2. PLACE OF THE COURSE IN THE EDUCATIONAL PROGRAM	
Cycle (section) CEP:	Б1.О
2.1	**Students' Preliminary Training Requirements:**
2.1.1	Medical informatics
2.1.2	Physiology
2.1.3	Histology, Embryology, Cytology
2.1.4	Anatomy
2.1.5	Biology
2.1.6	Physics, Mathematics
2.1.7	Chemistry
2.2	**Course Units and Practical Sessions imposing the prior Proficiency:**
2.2.1	microbiology, virology;
2.2.2	pathophysiology, clinical pathophysiology;
2.2.3	Propaedeutic of internal diseases
2.2.4	pharmacology;
2.2.5	immunology;
2.2.6	Faculty therapy
2.2.7	Faculty surgery
2.2.8	Clinic pharmacology;
2.2.9	Endocrinology
2.2.10	Hospital therapy
2.2.11	Hospital surgery
2.2.12	Infection diseases

3. THE STUDENT'S COMPETENCIES FORMED AS A RESULT OF MASTERING THE DISCIPLINE (MODULE)	
PC-6: In order to address professional tasks a student is capable and ready to assess the morphofunctional and physiological states and pathological processes in the human body in different age and gender groups.	
Knowledge:	
Level 1	To characterize biochemical processes in normal conditions and at during age and gender groups for the purpose of addressing professional tasks.
Skills:	
Level 1	To use biochemical methods to solve professional tasks, taking into account age and gender groups.
Expertise:	
Level 1	To understand the molecular mechanisms of disease pathogenesis; skills in assessing the diagnostic and prognostic significance of biochemical analysis results.

PC-7: Capable and ready to conduct and interpret patient interviews, physical examinations and clinical assessments, as well as the results of modern laboratory and instrumental tests and to complete outpatient and inpatient medical records.	
Knowledge:	
Level 1	The range of modern biochemical tests required for the examination of outpatients and inpatients.
Skills:	
Level 1	To Interpret the results of modern biochemical tests required for the assessment of outpatients and inpatients.
Expertise:	
Level 1	The Skills in the analysis and clinical-biochemical interpretation of laboratory tests.

DC-7: Capable of applying fundamental physicochemical, mathematical, and natural science concepts and methods to solve professional problems.	
Knowledge:	
Level 1	Fundamental physicochemical principles underlying the vital processes of the organism. Major pathways of protein, lipid, carbohydrate, and energy metabolism, and their interrelationships.
Skills:	
Level 1	Apply physicochemical and mathematical methods to solve biochemical problems. Explain the mechanisms of key metabolic processes using concepts from the natural sciences.
Expertise:	
Level 1	Skills in applying physicochemical methods to the study of biological systems. Skills in using knowledge from the natural sciences to explain the mechanisms of pathological changes in the body.

Final Students' Competences

3.1	**Knowledge:**
3.1.1	Fundamental and applied issues of modern biochemistry: chemical composition, structure, exchange and functions of molecular and supramolecular formations;
3.1.2	the main ways and mechanisms of regulation of metabolism of carbohydrates, lipids, proteins, amino acids, nucleotides;
3.1.3	mechanisms of energy exchange and tissue energy supply;
3.1.4	mechanisms of enzymatic catalysis, features of the enzymatic composition of organs; basic principles of diagnosis and treatment of diseases associated with impaired functioning of enzymes;
3.1.5	mechanisms of regulation and integration of metabolism, providing metabolic and physiological homeostasis of organs
3.1.6	principles of biochemical analysis, diagnostically significant indicators of the composition of blood, saliva, gastric juice, urine and ranges of their fluctuations in a healthy person.
3.2	**Skills:**
3.2.1	explain the molecular mechanisms of the structure and functional activity of the main organs and tissues;
3.2.2	perform laboratory work, fill out the research protocol, evaluate its results;
3.2.3	solve test tasks and situational tasks based on theoretical knowledge.
3.3	**Expertise:**
3.3.1	Using of Biochemical terminology;
3.3.2	in using laboratory instruments, laboratory chemical utensils and other laboratory equipment;
3.3.3	of performing biochemical laboratory tests in the presence of reagents and methodological materials;
3.3.4	Skills of independent work with biochemical literature: to search for data, turn what you read into a tool for solving biochemical, and in the future professional tasks.

4. COURSE (MODULE) STRUCTURE AND CONTENT

Class code	Subject Name /Type of Class/	Semester / Academic Year	Hours	Competencies	Literature	Interactive Sessions	Others	Notes
	Section 1. Molecular basics of structural cellular organization							
1.1	Classification of proteins. Simple proteins and natural peptides. Complex proteins. /Lec/	2	2	PC-6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
1.2	Levels of structural organization and physical chemical properties of proteins. Laboratory work No.1 Dialysis	2	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			

	of proteins; No.2 Sedimentation of proteins by boiling; No.3 Sedimentation of proteins by heavy metal salts. Methods of separation and quantitative determination of proteins and amino acids. Laboratory work No.1 Determination of total protein in serum by refractometric method; No.2 Quantitative determination of total protein concentration in blood serum by the biuret reaction on a photocolorimeter. /Pr/							
1.3	Levels of structural organization and physical chemical properties of proteins. /IW/	2	4	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
1.4	Simple and conjugated proteins. Laboratory work No.1 Preparation of hemin crystals; No.2 Determination of blood hemoglobin concentration. /Pr/	2	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
1.5	Simple and complex proteins. /IW/	2	4	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
1.6	Complex proteins - supramolecular protein complexes. Laboratory work: Hydrolysis of yeast nucleoproteins. /Pr/	2	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
1.7	Supramolecular protein complexes: nucleoproteins, lipoproteins, glycoproteins. /IW/	2	4	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
	Section 2. Neuroendocrine regulation of cellular activity							
2.1	Biochemical basics of structural and functional organization of biological membranes of subcellular structures, functions of biomembranes. Transmembrane transport of substances. /Lec/	2	2	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
2.2	Biological membranes. Structure, functional organization of the cell. /Pr/	2	2	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
2.3	Biological membranes Mechanisms of active transport of substances across membranes. Ca2+-, Na+-, K+-dependent ATPases. /IW/	2	4	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
2.4	Mechanisms of transfer of hormonal signals inside the cell. /Pr/	2	4	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
2.5	Biological membranes. Mechanisms of transfer of external signals inside the cell. /IW/	2	5	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.

2.6	Neuroendocrine regulation of cell functions. /Pr/	2	2	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2	1		Reports on the topic "Mechanisms of actions of pituitary and hypothalamus
2.7	Hypothalamic-pituitary hormones. Parathyroid hormone and Calcitonin as main regulators of Ca-Ph exchange. /IW/	2	5	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
	Section 3. Molecular basics of vital functions and pathology							
3.1	Enzymes are proteins - catalysts../Lec/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
3.2	Nomenclature and classification of vitamins. Water-soluble and fat-soluble vitamins. /Lec/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
3.3	Enzymes, structure, mechanism of action. Kinetics of enzymatic reactions. Laboratory work "Enzymatic hydrolysis of starch by saliva amylase at room Temperature. No.2 Influence of pH on enzyme. activity of saliva amylase; No.3 Specificity of salivary amylase action; No.4 Influence of activators and inhibitors on salivary amylase activity./Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
3.4	Properties of enzymes. Kinetics of enzymatic reactions. Regulation of enzyme activity. /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
3.5	Nomenclature and classification of enzymes. Laboratory work Quantitative determination of amylase activity using the Wohlgemuth method. /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
3.6	Classification and nomenclature of enzymes /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
3.7	Water-soluble vitamins. Laboratory work No.1 Qualitative reactions for vitamin B1; No.2 Qualitative reactions for vitamin B2; No.3 Fluorescence of thiochrome and riboflavin (demonstration); No.4 Quantitative determination of vitamin C in plant products /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2	1		Discussion on situational problems
3.8	Water-soluble vitamins and their derivatives are essential coenzymes and prosthetic groups of enzymes. Their role in catalysis. /IW/	2	5,7	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
3.9	Biological role of fat-soluble vitamins. Laboratory work No.1 Qualitative reactions for vitamins A, D, E, Vicasol; No.2 Chromatographic separation of carotenoids. /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
3.10	Biological role of fat-soluble vitamins. /IW/	2	5	PC -6 PC -7	L1.1, L1.2, L1.3, L1.4,			Complete tables,

				DC -1	L2.1, E1, E2			diagrams, tests and situational prolems.
	Section 4. Biological oxidation, cell energetics and carbohydrate metabolism							
4.1	Introduction to metabolism. Energy resources of our body. Specific and general (common) pathways of catabolism /Lec/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.2	Tissue respiration – terminal stage of biological oxidation. Regulation of tissue respiration. /Lec/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.3	Exchange of charbohydrates. /Lec/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.4	Specific and general pathways of catabolism. Laboratory work: Qualitative reactions of Krebs cycle substrates. /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.5	Integration function of tricarboxylic acid cycle in cellular metabolism - catabolic and anabolic functions. /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
4.6	Tissue respiration – terminal stage of biological oxidation. Laboratory work: Qualitative determination of blood catalase /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.7	Energy exchange. Biological oxidation. /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
4.8	Carbohydrates. Digestion, absorption, transport to cells. Glycolytic pathway of oxidation of carbohydrates. Synthesis and mobilization of glycogen in body cells. Laboratory work: Determination of glucose concentration in blood by glucose oxidase test. /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.9	Glycolysis. Metabolism of glycogen. Glycogen store diseases. /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
4.10	Pentose phosphate pathway of glucose transformation. Stages of pentose phosphate pathway of glucose-6-phosphate oxidation. Gluconeogenesis. /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.11	Pentose phosphate pathway of glucose transformation. Gluconeogenesis. /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
4.12	Regulation of carbohydrate metabolism and energy production in body cells. Carbohydrate metabolism disorders. /Pr/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2	1		Discussion on situational problems

4.13	Carbohydrate metabolism disorders. /IW/	2	5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
4.14	/Control of Theoretical education/	2	0,3	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
4.15	Credit	2		PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
	Section 5. Metabolism and functions of lipids							
5.1	Chemistry and metabolism of lipids /Lec/	2	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
5.2	Intermediary metabolism of lipids, intracellular lipolysis. Beta- oxidation of fatty acids. Metabolism of ketone bodies. Their biological role. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
5.3	Biosynthesis of lipids. Regulation of lipid metabolism. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
5.4	Chemistry and metabolism of lipids. Laboratory work No.1 Kinetics of lipase action. No.2 Qualitative reactions of acetone and acetacetic acid. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
5.5	Cholesterol, its biochemical functions and transport. /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
5.6	Peroxide oxidation of unsaturated fatty acids. Formation of endoperoxides: prostaglandins, thromboxanes, prostacyclins, leukotriens. Natural antioxidants. /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
5.7	Intermediary metabolism of lipids. Laboratory work No.1 Determination of beta lipoproteins concentration in blood serum. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
5.8	Intermediary metabolism of lipids. /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
	Section 6. Metabolism of proteins and amino acids							
6.1	Dynamic state of proteins in the body. Biological value of food proteins. Digestion. Proteolytic enzymes. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
6.2	Main pathways of amino acids metabolism in our body. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
6.3	Exchange of specific amino acids. Hereditary disorders of	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4,			

	amino acid exchange. /Lec/				L2.1, E1, E2			
6.4	Protein nutrition. Digestion, absorption of protein hydrolysis products. Laboratory work No.1 Quantitative determination of gastric acidity. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
6.5	Protein nutrition. Digestion, absorption of products of protein hydrolysis. /IW/	3	1	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
6.6	Intermediary amino acid exchange. Laboratory work No.1 Determination of activity of aspartate aminotransferase and alanine aminotransferase of blood serum. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
6.7	Intermediary of amino acid exchange /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
6.8	Exchange of specific amino acids. Features of specific amino acids exchange: a) exchange of phenylalanine and tyrosine; b) exchange of tryptophan; c) exchange of serine and glycine. Formation of one-carbon groups. Role of tetrahydrofolic acid; d) exchange of methionine and cysteine; e) dicarboxylic amino acids and their amides. Hereditary disorders of amino acid exchange. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2	1		Discussion on situational problems
6.9	Biogenic amines. Their synthesis. Biological role. /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
	Section 7. Molecular mechanisms of transfer of genetic information							
7.1	Exchange and functions of nucleotides. Biosynthesis of nucleotides. Catabolism of nucleotides, products of catabolism. Disorders of nucleotide metabolism. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
7.2	Biosynthesis of nucleic acids (replication and transcription). /Lec/	3	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
7.3	Biosynthesis of proteins. Regulation of protein sythesis and molecular mechanisms of variability. /Lec/	3	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
7.4	Exchange of nucleotides. Laboratory work No. 1 Determination of uric acid in urine /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
7.5	Biological role of nucleotides in body cells /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4,			Complete tables,

					L2.1, E1, E2			diagrams, tests and situational prolems.
7.6	Biosynthesis of nucleic acids (replication and transcription). Components required for replication. Stages of replication. Mechanism of replication. Transcription - biosynthesis of RNA. Components required for transcription. DNA-dependent RNA polymerase. Biogenesis of mRNA. Splicing. Biogenesis of tRNA and rRNA. Biological significance of replication and transcription. /Pr/	3	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
7.7	Biosynthesis of nucleic acids (replication and transcription). /IW/	3	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
7.8	Biosynthesis of proteins. Components of protein synthesis system - ribosomes, mRNA, tRNA, amino acids, enzymes, protein factors. Genetic code. Post-translational protein modification. Regulation of protein biosynthesis. /Pr/	3	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
7.9	Biosynthesis of proteins. Regulation of protein synthesis and molecular mechanisms of variability. /IW/	3	2	PC -6	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
	Section 8. Functional biochemistry of organs and tissues.							
8.1	Biochemistry of liver. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			
8.2	Biochemistry of blood. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			
8.3	Exchange of water and mineral compounds. Functional biochemistry of kidneys /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			
8.4	Biochemistry of connective tissue. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			
8.5	Biochemistry of muscles. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			
8.6	Biochemistry of nerve tissue. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			
8.7	Hormones. Hormonal regulation of metabolic processes. Regulation of carbohydrate, protein, lipid and mineral metabolism. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			

8.8	Biochemistry of liver. Laboratory work No.1 Sublimate-phosphate test No.2 Qualitative reaction to bilirubin presence in blood serum. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2	1		Discussion on situational problems
8.9	Biochemistry of liver. /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.10	Biochemistry of blood. Laboratory work No.1 Determination of inorganic phosphates of blood serum /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
8.11	Biochemistry of blood /IW/	3	1	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.12	Biochemistry of kidneys. Laboratory work No.1 Qualitative reaction for protein in urine; No.2 Qualitative reaction for glucose in urine using Fehling's reagent; No.3 Qualitative reaction for bile acids; No.4 Qualitative reaction for blood pigments - benzidine test. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
8.13	Functional biochemistry of kidneys /IW/	3	1	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.14	Biochemistry of connective tissue. Laboratory work No.1 Quantitative determination of free oxyproline in urine /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
8.15	Biochemistry of connective tissue /IW/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.16	Biochemistry of muscles. Laboratory work No.1 Quantitative determination of creatinine in urine. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
8.17	Biochemistry of muscles. /IW/	3	1	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.18	Biochemistry of nerve tissue. /Pr/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
8.19	Biochemistry of nerve tissue. /IW/	3	1	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.20	Integration of metabolism. /Lec/	3	2	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			

8.21	Hormonal regulation of metabolism, processes of biochemical adaptation, reproduction, growth and development of the body. Disorders of hormonal regulation of metabolism, growth and development of the body. /Pr/	3	4	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2	1		Reports on the topic "Hormonal regulation of metabolism"
8.22	Hormonal regulation of metabolic processes. /IW/	3	1	PC -6 PC -7 DC -1	L1.1, L1.2, L2.1, E1, E2			Complete tables, diagrams, tests and situational prolems.
8.23	/Control/	3	0,5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			
8.24	/Exam/	3	35,5	PC -6 PC -7 DC -1	L1.1, L1.2, L1.3, L1.4, L2.1, E1, E2			

5. ASSESSMENT FUND

5.1. Advancement Questions and Assignments

Questions of midterm examination for semester I:

Questions to check students' competence « Knowledge»:

1. Write the structure of the following polypeptides:
Gly-Ala-Val-Leu-Ile, Thre-Asp-Lys-Tyr-Gly-His.
What is the main charge of each of these compounds?
2. Write the structure of the following polypeptides:
Thre-Asp-Lys-Tyr-Glu; Ser-Cys-Ala.
Which type of coloration do these substances demonstrate when color reactions for proteins are used?
3. Do You known the mechanism of color reactions for proteins?
4. What is protein hydrolysis of and what types of hydrolysis do You know?
5. What happens to amino acids and proteins in water solution and in the presence of excess acids or alkalis?
6. What is the isoelectric point of protein? What is the range of Ip of animal proteins?
7. What factors determine protein solubility? What factors stabilize proteins in solution?
8. What are the common mechanisms of protein sedimentation?
9. Do You know how to precipitate proteins without their denaturation?
10. What is the salting out of proteins?
11. What is the denaturation of proteins? What substances can cause protein denaturation?
12. How to separate albumin and globulin of muscle tissue?
13. What method can determine the amount of protein in solution?
14. How to build the calibration curves for the quantitative determination of proteins using the biuret method?
15. What kinds of chromatographic method for separation of substances do you know?
16. What is paper partition chromatography of amino acids?
17. What substances are called enzymes? What is their chemical nature?
18. What main criteria used to characterize inorganic catalysts could be applied to enzymes?
19. How does the activity of enzymes depend on temperature?
20. How does the pH environment influence enzyme activity?
21. What is the specificity of enzyme action and how is it determined?
22. What substances are called activators and inhibitors of enzymes? Give examples.
23. What qualitative methods are used to investigate the action of enzymes?
24. What quantitative methods are used to study the action of enzymes?
25. What units of enzyme activity do You know?
26. Why do structural analogues of substrates inhibit the appropriate enzymes?
27. What are the consequences of introducing any inhibitors for a particular enzyme?
28. List the types of specificity. Give examples of enzymes for these types of specificity?
29. How to verify the specificity of the enzyme in the experiment?
30. Name the type of specificity of the following enzymes: arginase, amylase, sucrase, urease?
31. What are vitamins and why are they so called?
32. How are vitamins classified?
33. What is avitaminosis and hypovitaminosis and what are their causes?
34. What are the specific symptoms of vitamins B1, B2, B6 deficiency?
35. What are the specific symptoms of vitamins PP and C deficiency?
36. What diseases are caused by lack of vitamins A, D and K?
37. What is the relationship between vitamins and enzymes?
38. What are some qualitative reactions for vitamins? Give examples.
39. Write the formula for coenzyme of vitamin B1.
40. Write the formula for coenzyme of vitamin B2.
41. Write the formula for coenzyme of vitamin B6.
42. Write the formula for coenzymes of oxidoreductases.
43. What is the chemical nature of oxidoreductases?
44. What properties of Riboflavin are related to its biological activity?
45. What is thevbiological role of Niacin?
46. What is the biological oxidation? What are its main stages?
47. Write the chemical reaction that occurs in muscle tissue with the enzyme succinate dehydrogenase.
48. What is the principle of detecting the activity of succinate dehydrogenase based on?
49. Which substances serve as a source of energy in working muscles?

Tasks for checking students' competence «Skills»:

1. What is the difference between sedimentation and denaturation of proteins?
2. What is the clinical and diagnostic significance of quantitative determination of total protein in serum?
3. Compare the types of secondary structure of proteins. Give examples.
4. Compare the structure of globular and fiber proteins.
5. Compare the Quaternary structure of globular and fiber proteins.
6. Compare the methods of salting-out and denaturation.
7. What is the structure of enzymes? What is the difference between the structure of simple and complex enzymes?
8. What main criteria for inorganic catalysts could be applied to enzymes?
9. What methods are used to separate proteins from low molecular weight compounds?
10. What is the principle of determining the amylase activity and what is the diagnostic value of this analysis?
11. How to determine the catalase activity in blood?
12. Explain the clinical significance of determination of enzymes in biological fluids.
13. What is the relationship between vitamins and enzymes?
14. Compare the mechanism of action of water-soluble and fat-soluble vitamins.
15. Why does hemeralopy develop through lack of vitamin A?
16. What is pellagra, lack of which vitamin causes this condition?
17. What is Beri-Beri, lack of which vitamin causes this condition?
18. What biochemical changes develop through lack of vitamin D?

Tasks for checking students' competence «Expertise»:

Task 1

Cirrhosis of the liver and edema developed in the individuals who had been consuming ethanol for a long time.

1. What is the reason for edema development?
2. What are the functions of albumins?
3. What are the domains and what is their role in the formation of proteins?
4. What methods are used to determine albumin?
5. How does the ratio of protein fractions of blood change in different diseases?

Task 2

Proteins transport molecules or ions across the membrane and are often classified as transmembrane proteins. Such proteins are embedded in the membrane lipid bilayer, upper-membrane and down-membrane part. Using the classification of amino acids according to polarity of radicals suggest which amino acids should be located in different parts of this transmembrane protein.

Task 3

There are 19 natural proteins and 7 functions which they perform in the body. Name the function performed by each of these proteins.

Proteins:

1. Ribonuclease, 2. Antibodies 3. Hemoglobin, 4. Actin, 5. Serum albumin, 6. Insulin 7. Casein (milk), 8. Keratin 9. Ferritin, 10. Trypsin, 11. Thrombin, 12. Growth hormone, 13. Collagen, 14. Myosin, 15. Egg albumin, 16. Elastin, 17. Tubulin, 18. Glucagon 19. Pepsin

Functions: I.Enzyme, II. Transport, III. Digestion and storage, IV. Contractive, motor, V. Structural, VI. Protective, VII. Regulatory

Task 4

Find at which pH (neutral, acidic or alkaline) is the IEP of the polypeptide located if this polypeptide consists of the following amino acid residues: Arg-His-Glu-Cys. In what direction will this peptide move using the separation by electrophoresis in a buffer solution with neutral pH? How does the charge and the direction of movement of the peptide change in the electric field, if arginine is replaced by leucine in this peptide?

Task 5

Why does not fresh milk coagulate on boiling but sour milk is denaturated? What can be done to avoid denaturation of sour milk?

Task 6

Skin burns caused by acids or alkalis heal more slowly than mechanical injuries of the skin. Explain possible reasons for these differences.

Task 7

To perform chemical curling thiol groups of hair protein "α-keratin" at first are restored (the first bottle is a reducing agent) and then they are oxidized (the second bottle is an oxidizer). Explain mechanisms of changes in hair shape based on the characteristics of the spatial structure of α-keratin.

Task 8

Explain why the biuret method cannot be used for determining the protein content of amino acids in solution. How is the presence of individual amino acids determined? Will the color of the biuret reagent will be the same for 1000 molecules of albumin and 1000 molecules of gamma globulin? Explain your answer.

Task 9

How to explain possible decreasing in solubility of proteins during the cleavage of peptides from them (as in the case of pepsinogen)? Keep in mind the following: 1. Define the isoelectric point of the protein.

2. How do the properties of proteins change at the isoelectric point?
3. What is the solubility of proteins, what is it caused by?

Task 10
Find the linear sequence of atoms connected by a covalent bond in a peptide chain?
1. –N–C–C–N–C–C–N–C–C–
2. –N–C–O–N–C–ON–C–O–
3. –N–C–C–ON–C–C–ON–C–C–O–
4. –N–H–C–C–N–H–C–C–N–H–C–C–
5. –N–H–C–O–H–N–H–C–O–H–N–H–C–C–
Task 11
The enzyme pepsin cleaves peptide bonds of proteins. Why does the effect of pepsin lead to inactivation of many enzymes? To justify the answer recall the following:
1. What is an enzyme?
2. In which class of enzymes is pepsin included?
3. What are the amino acids (peptide bonds) attacked by?
Task 12
Protein kinases phosphorylate proteins only of certain hydroxyl groups in radicals of amino acids. Which of the following groups of amino acids contain the hydroxyl group in the radical?
1. Asp, Glu, Ser
2. Ser, Thre, Tyr
3. Thre, Phe, Arg
4. Lis, Arg, Pro
5. Ala, Asn, Ser
Problem 13
Proteolytic enzymes and deoxiribonucleases are used for treatment of septic wounds. Explain their application. Before answering keep in mind the following:
1. Which reactions are catalyzed by these enzymes?
2. How does the viscosity of septic content change, if it depends on the concentration of macromolecules in its composition?
3. Is it possible to use pepsin, collagenase and hyaluronidase?
Problem 14
Although coenzymes are the main compounds for catalyzing reactions without enzymes they do not have catalytic activity. Why?
Problem 15
The inhibitor reduces the enzyme activity to 30% from the original level. Increasing the concentration of substrate restores 80% of the enzyme activity. What type of inhibitor is this?
Before answering make sure you remember:
1. Types of inhibition.
2. The effect of which inhibitor depends on the concentration of substrate?
Problem 16.
The poultry farm worker consuming 5 or more raw eggs daily experiences lethargy, drowsiness, muscle pain, hair loss, seborrhea.
1. Deficiency of which vitamin is associated with this condition?
2. What is the coenzyme of this vitamin?
3. Why is it dangerous to eat raw eggs?
4. What is the biological role of this vitamin?
5. Give examples of reactions involving this coenzyme.
Problem 17
After a long period of the synthetic diet rats stopped growing, lost their body weight, suffered hair loss. Autopsy revealed degenerative changes in the adrenals, heart, kidneys.
1. Deficiency of which vitamin is associated with this condition?
2. What is the coenzyme of this vitamin?
3. Name composition of this coenzyme.
4. How does this coenzyme perform the integral role, i.e. connects all types of exchanges?
5. Give an example of reactions with this coenzyme.
Task 18
A 44 year old man with a long history of alcohol abuse complains of a poor appetite. After drinking a large amount of alcohol on an empty stomach he felt very bad. He was examined in the hospital: pulse – 104, low blood pressure, chronic heart failure, disorientation in time and space. Deficiencyof which vitamin can be the cause?
Task 19
During the Battle of Britain British aircraft attacked and managed to resist superior forces of the enemy, mostly due to the skills of the British pilots. However, many pilots experienced difficulties when they flew at night because of problems with vision.
When the amount of milk, butter, eggs and carrots were increased in their diet this problem was completely solved. Explain, why?

Questions of midterm examination for semester II:
Questions to check students' competence «Knowledge»:
1. Classification of lipids. Characteristic of classes.
2. Structure, properties and functions of human tissues lipids.
3. Digestion and absorption of dietary lipids. The role of bile acids. Resynthesis of lipids.
4. Formation of chylomicrons and transport of lipids, lipoproteinlipase of blood.
5. Intermediary metabolism of lipids: intracellular lipolysis.
6. Metabolism of ketone bodies.
7. Functions and the transformation of polyene fatty acids in endoperoxide: prostaglandins, thromboxanes, prostacyclins, leukotrienes. Their role.

8. Carnitine acyltransferase and transport of fatty acids into the mitochondria.
9. Features of oxidation of the fatty acids with an odd number of carbon atoms. The metabolism of propionyl -CoA
10. Synthesis of fatty acids in the body. The multienzyme complex of fatty acid synthesis.
11. Biosynthesis of cholesterol. The role of cholesterol in the body.
12. Hormonal regulation of lipid metabolism.
13. Nutritional significance of dietary proteins. Sources of amino acids. Nitrogen balance.
14. Digestion of proteins. Proteolytic enzymes of the digestive system.
15. Digestion of proteins in the stomach. The role of hydrochloric acid.
16. Digestion of proteins in the intestine. Parietal digestion.
17. Transformations of amino acids by the intestinal bacteria. Products of protein putrefaction - biologically active amines and toxic substances.
18. Transamination reactions. Aminotransferases, their coenzymes.
19. Deamination reactions of. Enzymes and coenzymes. Oxidative deamination of glutamic acid.
20. Indirect deamination of amino acids (scheme). The role of the reactions.
21. Neutralization of ammonia in the body cells. Its transport to the liver and kidneys.
22. Ornithine cycle of urea formation in the liver.
23. The reaction of reductive transamination is the synthesis of amino acids.
24. Decarboxylation of amino acids, formation of biogenic amines. Examples.
25. Formation of polyamines: spermidine, spermine, putrescine and cadaverine. Write their formulas. Their role in the body cells.
26. The role of monoaminooxidases (MAO) and diaminoxidases in the inactivation of biogenic amines.
27. Exchange of serine and glycine. Formation of one-carbon groups. The role of THFA (tetrahydrofolic acid).
28. Write the reaction for the synthesis of creatine-phosphate. Its role in cells.
29. Exchange of phenylalanine and tyrosine. Formation of catecholamines.
30. Exchange of tryptophan and histidine.
31. Hereditary disorders of amino acid metabolism.

Questions to check students' competence « Skills»:
1. Disorders of protein digestion in the stomach related to the decreased and increased secretion of hydrochloric acid.
2. Disorders of protein digestion in the small intestine due to the disorders of the pancreas functions.
3. Comparative characteristics of lipoproteins in blood: chylomicrons, VLDL, LDL, HDL. Their composition and functions. Lipoproteinlipase of blood.
4. β-oxidation of fatty acids, the relationship with Krebs cycle and ETC.
5. Energy balance of palmitate oxidation.
6. Natural antioxidants-inhibitors of lipid peroxidation and their application in medicine.
7. Diagnostic value of determination of lipids and products of their metabolism in blood and urine.
8. Intermediary products of carbohydrate and protein metabolism as building material for lipids synthesis.
9. Formation of phosphoglycerol. Connection with glycolysis. Biosynthesis of triacylglycerides.
10. Synthesis of phospholipids. The role of the CTP, ATP, methionine, choline. The role of phospholipids in the body.
11. The relationship between carbohydrate and lipid metabolism.
12. Disorders of lipid metabolism: the role of LDL and VLDL in the development of atherosclerosis and obesity.
13. Neutralization mechanisms for toxic products of amino acid metabolism in the liver, their clinical significance.
14. Pathological changes of gastric juice acidity. Diagnostic value of their determination.
15. Diagnostic value of determination of the paired sulphuric acids and glucuronides in the urine.
16. Positive and negative nitrogen balance. Significance of its determination.
17. Diagnostic value of determination of aspartat – and alaninaminotransferases in the blood.
18. The fate of nitrogen free residues of amino acids, five items of their inclusion in the TCA (scheme).
19. Gluconeogenesis from nitrogen free residues of amino acids (scheme).
20. Explain the function of ornithine cycle of urea formation.
21. Write the reactions of amino acids synthesis.
22. Transport of amino acids through cell membranes. The fate of the absorbed amino acids in the body.
23. The role of biogenic amines in the body, their formation.
24. The role of S-adenosylmethionine in the synthesis of creatine, choline, epinephrine.
25. Metabolic disorders of phenylalanine and tyrosine. Explain the mechanism of their development.

Questions to check the training level «Expertise»:
1. Calculate the energy balance in ATP from complete oxidation of 1g.of palmitate to CO_2 and H_2O.
2. Name the enzymes catalyzing the following reactions:
aspartate + alpha-Ketoglutarate → Oxaloacetate+ glutamate
alanine + alpha-Ketoglutarate → Piruvate+ glutamate
What is the clinical value of increasing activity of these enzymes in blood serum?
3. What are the substrates for formation of glycerophosphate in adipose tissue and muscles, which processes are connected by this reaction? Write the scheme of the reaction.
4. What is the role of Krebs cycle metabolites in fatty acid synthesis?
5. Write the reaction of biogenic amines formation: histamine, serotonin, gamma-aminobutyric acid/GABA/ dopamine. Their role.
6. What is the role of glutamic and aspartic acids in the neutralization of NH_3 in the body? Write these reactions.
7. Give the scheme of glucose-alanine cycle. What is its role?
8. Which amino acid is the source for adrenaline formation? Write the reactions including intermediary products and explain their role in the body?

9. Five moles of ATP and one mole of CO2 were produced after alanine oxidation. To which product are these reactions related?
10. What happens with glucose-alanine cycle if a patient with diabetes takes physical exercise or relaxes?
11. What could the differences be between in the content of cholesterol in vegetarians and non- vegetarians?
12. Explain why ketonemia occurs in the patient with diabetes?
13. Increased concentrations of ammonia and citrulline are detected in the patient's blood and urine. Specify the possible causes. How to prove your answer?
14. The immediate precursor of ketone bodies is beta-hydroxy-beta-methylglutaryl CoA which is synthesized from acetyl-CoA. Acetyl-CoA is formed from glucose and fatty acids. However, acetyl-CoA derived from fatty acids is used for the ketone bodies synthesis. Give a scheme of ketone bodies synthesis. Explain your answer.
15. What are the compounds needed for the body's synthesis of phosphotidylserine, phosphotidylethanolamine, phosphotidylcholine?
16. Explain the mechanism of activation of pepsinogen, trypsinogen and chymotrypsinogen. Explain the mechanism of activation of these proenzymes?
17. The amount of indican, paired sulfuric and glucuronic acids, is increased in the sick child's urine. Explain why?
18. Explain the expression "Lipids burn in the flame of carbohydrates". What is the biochemical meaning of this expression?
19. The patient has the gallbladder removed. What problems with assimilation of proteins, carbohydrates or lipids could he have? Why?
20. The enzymes involved in the digestion of proteins in the stomach and intestines, have a wide range of substrate specificity. Is it possible to assume that they are not perfect enzymes?

5.2. Course Papers Themes

Discipline does not involve writing a term paper.

5.3. Assessment Fund

Report.

LIST OF THEMES OF ABSTRACTS FOR INDIVIDUAL STUDENTS' WORK:

1. Directions and perspectives of biochemistry development.
2. Essential dietary sources for nutrition of healthy and sick people (essential amino acids, unsaturated fatty acids).
3. Amino acids as drugs.
4. Pathology related to lack of amino acids in the body.
5. The specific role of proteins in the phenomenon of life.
6. Characteristics of peptide bonds.
7. Chemiosmotic theory of oxidative phosphorylation associated with tissue respiration.
8. Glycogen synthesis and its mechanism.
9. Tricarboxylic acid cycle, the consequence of reactions.
10. Oxidation of fatty acids.
11. Resynthesis of triacylglycerols in the intestinal epithelium, phosphatidic and beta – monoglycerides pathways of resynthesis.
12. Coenzyme A and its role in the metabolism of fatty acids.
13. The fate of foreign compounds in the body, detoxification, increase of their activity or toxicity.
14. Antagonism and synergism of antioxidants. Methods of research of antioxidant properties.
15. Chemistry of neutralization of toxic substances in the liver.
16. Parenteral protein nutrition: advantages and disadvantages.
17. Dietary proteins: chemical composition, structure, biological role.
18. Proteins of blood plasma.
19. Disintegration of tissue proteins. The role of lysosomal enzymes.
20. Activators and mechanism of proteases activation in the gastrointestinal tract.
21. Disorders of urea cycle. The hyperammonemia.
22. Disorders of metabolism of sulphur-containing amino acids.
23. The fate of phenylalanine in the body.
24. Disorders of phenylalanine metabolism.
25. Disorders of tryptophan metabolism.
26. Disorders of metabolism of glutamic and aspartic acids.
27. Types of mononucleotides and their role.
28. The role of nucleic acids in protein biosynthesis.
29. The breakdown of hemoglobin. Differential diagnosis of jaundice.
30. Inhibitors of enzymes and antienzymes as therapeutic agents.
31. Isoenzymes and their role in medicine.
32. Digestive enzymes in replacement enzyme therapy.
33. Enzymes of blood plasma.
34. Enzymopathies: hereditary, toxic and nutritional.
35. Biocatalytic function of water-soluble vitamins.
36. Vitamin-like compounds and their role in metabolism.
37. The biological role of vitamin C.
38. The history of the development of hormone theories.
39. The role of second messengers in the transmission of the hormonal signal.
40. Tissue hormones and their role.
41. Prostaglandins as drugs.
42. Mechanism of insulin action.

43. Mechanisms of memory. Tissue hormones: neurotransmitters, derivatives of arahidonic acid, cyclic nucleotides, active peptides and their role in the regulation of metabolism.
44. P.Mitchell received the Nobel prize in chemistry in 1978 for his chemiosmotic theory of oxidative phosphorylation.
45. Hormones that regulate blood sugar level. The place of their synthesis and mechanism of their action.
46. Biochemical features of diabetes mellitus.
47. Hereditary metabolic diseases of glycogen (glycogenosis).
48. Non-enzymatic glycosylation of proteins.
49. Catabolism of glucose in anaerobic and aerobic conditions.
50. Biosynthesis of glucose (gluconeogenesis).
51. Metabolism of fructose and galactose, disorders of their metabolism.
52. Biological membranes, structure, role of phospholipids and cholesterol.
53. Hormonal regulation of lipid metabolism.
54. Metabolism of cholesterol in the body.
55. Plasma lipoproteins.
56. Hyperlipoproteinemia, types, symptoms.
57. Biochemistry of atherosclerosis.
58. Change of metabolism during starvation.
59. Biochemical features of nerve tissue.
60. Characteristic of muscle proteins.
61. Pathology of biochemical changes in muscles.
62. Biochemical changes in the connective tissue due to pathology and aging.
63. Biochemical changes in muscles due to muscular dystrophy and coronary heart disease.

Situational tasks are given in Appendix 1.
Tests are presented in Appendix 2.
Control work. Each examinational card includes three questions of the category "KNOWLEDGE", one question of the category "SKILLS" and one questions of the category “EXPERTISE”.

5.4. List of Assessment Tools

Reports
Situational tasks
Tests
Oral answer
Exam
Grading scales are given in Appendix 3.

6. COURSE (MODULE) METHODOLOGICAL AND INFORMATIONAL SUPPORT

6.1. Recommended Reading

6.1.1. Required Reading List

	Authors, Compliers	Title	Book publisher, Year
L1.1	Robert K. Murray, David A. Bender, Kathleen M. Botham et all	Harper’s illustrated biochemistry, 28th edition	The McGraw-Hill Company, 2009
L1.2	Richard A. Harvey	Lippincott’s Illustrated Reviews: Biochemistry	Baltimore, 2014
L1.3	Satyanarayana	Biochemistry, 4th edition	2013
L1.4	Victor W. Rodwell, David A. Bender, Kathleen M. Botham and others	Harper’s Illustrated Biochemistry, 31st edition	McGraw-Hill Education / Medical; 31 edition (May 28, 2018)

6.1.2. Advanced Reading

	Authors, Compliers	Title	Book publisher, Year
L2.1	E. A. Stroev	Biochemistry	Mir, Moscow, 1989

6.2. Online Resources

E1	High Wire Press: http://highwire.stanford.edu/

E2	National Library of Medicine: http://www.nlm.nih.gov/
6.3 List of Information and Education Technologies	
6.3.1 Competence-based Educational Technologies	
6.3.1.1	The biology Project: http://www.biology.arizona.edu/default.html
6.3.1.2	Harvard University Department of Molecular and Cellular Biology Links: http://mcb.harvard.edu/BioLinks.html
6.3.2 Перечень информационных справочных систем и программного обеспечения	
6.3.2.1	The following software is used for students: Electronic library website https://www.krsu.kg/library KRSU Integrated Automated Information System https://krsu.kg Microsoft Teams platform, Microsoft Office suite
6.3.2.2	Carbohydrate Chemistry and Glycobiology: http://sciencemag.org/feature/data/carbohydrates.dtl
6.3.2.3	European Bioinformatics Institute: http://ebi.ac.uk/
6.3.2.4	Genes and Disease: http://www.ncbi.nlm.nih.gov/disease/
6.3.2.5	Karolinska Institute: Diseases and Disorders: http://www.mic.ki.se/Diseases/C18.html
6.3.2.6	Lipids Online: http://lipidsonline.org/
6.3.2.7	Society for Neuroscience: http://www.sfn.org

7. COURSE (MODULE) LOGISTICS	
7.1	For successful studying of disciplines students are given:
7.2	Rooms should be special classrooms for lectures (main lecture room in Alamedin-1 campus), seminars, group and individual consultations, midterm examination and evaluation as well as rooms for individual work, for storage facilities and maintenance of training equipment.
7.3	Rooms should be equipped with specialized furniture and technical tools for education which are used for presentation of educational information to a large audience.
7.4	Classroom of lecture type is used for lectures and has demo tools (projection screen, audio-visual and educational visual equipment), to provide thematic illustrations for corresponding subjects (modules) and course disciplines. Set of presentations for lectures is developed using multimedia tools: laptop, multimedia projector, screen.
7.5	Laboratory auditorium is equipped with laboratory equipment and supplies.
7.6	Equipment: a distiller, cabinets for storage of reagents and materials, refrigerator. Dry boxes, thermostats, water bath, laboratory universal centrifuge CLU-1 (2pcs), fridge.
7.7	Instruments and devices are used for practical training: photoelectrocolorimeter (PEC-2, PEC-1), electronic balance, refractometer, installation s for titration, glucometer, pH-meter, microscopes, gas analyzers, spectrophotometer, technical scales, apparatus for vertical gelelectrophoresis, AVGE-2, electric sterilizers, dry-air sterilizer.
7.8	Supplies: chemicals, glassware, measuring glassware (burettes, pipettes, volumetric flasks, cylinders, graduated test tubes), chemical test tubes; chemical and physical stands, Bitter's forceps, burning tubes, porcelain ware (crucibles, cups, mortars, pestles).

8. COURSE (MODULE) PROFICIENCY METHODICAL GLUIDELINES (FOR STUDENT)

The planning sheet of discipline is in Appendix 4.
Recommendations for organization of individual students' extracurricular work to study the theoretical part of "Biochemistry".
- Studying the theoretical part of the discipline is intended not only to extend and consolidate the knowledge gained in the auditorium classes, but also to develop students' creative skills, initiative, ability to organize and manage their time.
- First it is necessary to read recommended literature for each topic and to make a brief summary of key terms, regulations, laws, information that requires memorization and which is fundamental to studying the topic with the aim of developing subsequent course material. Students are encouraged to use Internet to expand knowledge in the discipline.
- Time management planning is needed for the course study and students should implement this planning during the semester with regular repetition of course material.
During the laboratory classes students achieve the following aims:
- deepening and consolidation of theoretical knowledge of the course, using practical tasks;
- skills in scientific experimentation, the analysis of the obtained results;
- formation of primary skills of organization, planning and research;
- preparation for each lab performed individually before the lesson.
Recommendations for preparation of laboratory and practical exercises:
- review the content of the laboratory work;
- make sure you understand the purpose and objectives of this work;
- consolidate the theoretical material and independently solve the problem of the appropriate part of IW;
- check the implementation of the work (principles of the work, clinical significance, how to use devices);
- review the safety precaution for the work and rules of the workplace organization;
- prepare charts, tables, graphs which are necessary for the work performance;
- write reaction equations to explain the expected outcome of the laboratory work;
- perform the corresponding laboratory activity tasks under teacher's or lab assistant's guidance;
- after the experiment fix the obtained results in the form of diagrams, tables, charts;
- process the results, analyze data, formulate conclusions is performed by students induvidualy;
register and protect data.

Individual work in studying discipline includes:
- study lecture notes; lecture material should be regularly studied and information from basic and additional literature added;
- read the recommended literature and learn the theoretical material;
- search for information in the Internet sources;
- prepare for various forms of control;
- prepare and write reports;
- answers for questions on the discipline topics, solving tasks of IW;

Preparation for midterm examination and control includes:
- review of lecture notes;
- notes of practical classes;
- protocols of laboratory works;
- consolidation of the material including the tasks from relevant section of IW;
- use of basic and additional literature.

Individual student's work for writing a report (abstract) includes:
- review of theoretical material, using literature sources, periodics, online sites;
- creative work with selected material;
- presentation of material in the form of a report, illustrated by charts, graphs, photographs and drawings.
- report written in a clear and simple language.

Guidelines for the report (abstract) preparation:
- choose the theme;
- prepare the report outline;
- work with literature;
- work with Internet resources;
- write the text in accordance with the plan;
- consult the teacher;
- prepare a report;
- present a report;
- answer the questions.

Recommendations for students working with literature:
- be familiar with the theme of laboratory-practical class (according to the methodological guidelines);
- carefully read the questions of target class tasks to identify the section of scientific literature for this topic;
- compose a list of books, including electronic resources for this topic.
- conduct a preliminary review of selected books, find necessary chapter.
- read all titles of chapters, introduction, paragraphs, diagrams, charts, graphs and drawings. Chose and read the required section or chapter;
- select from the text or notes of educational material passages, abstracts explaining the basic idea of the title or target questions;
- abstracts should be strictly organized in accordance with the order of the targets;
- develop the ability to summarize in your own words the author's point of view;
- systematize the received information in the form of definitions, laws;
- write mathematical expressions of the laws, the estimated equations, graphs by heart;
- if the text is difficult for understanding, read it using the techniques of "slow reading." To understand unfamiliar words and phrases you need to refer to the glossary, reference books, dictionaries.
- it is advisable to use an index at the end of the books, which shows the pages where you can find explanations for some key words.
- to check memorized material it is necessary to discuss issues with group mates using not only the author's thoughts but your own;
- for deepening and expanding theoretical knowledge it is necessary to use additional information;
- if questions are not clear ask the teacher for explanation.

Appendix 1

Situational tasks.

1. Calculate the balance of energy in ATP at complete oxidation of 1g of palmitic acid to CO_2 and H_2O.
2. Name the enzymes which catalyze the following reactions:
aspartate + alpha-Ketoglutarate →oxalacetate + glutamate
alanine + alpha-Ketoglutarate →pyruvate + glutamate
What is the clinical value of increasing the activity for each of these enzymes in the blood serum?
3. What substrates are needed to form glycerophosphate in adipose tissue and in muscles, what processes do they connect? Write the reaction scheme.
4. What is the role of Krebs cycle metabolites in fatty acid synthesis?
5. Name the main components of VLDL, LDL and HDL. Explain the synthesis of lipoproteins.
6. Write the nucleotide sequence of DNA fragment synthesized by DNA polymerase according to the following DNA matrix: AGC - GCG - AGA - GGA.
7. What will the amino acid composition from m-RNA be, if the gene contains the nucleotides GTT-CCT-TCA-AAA?
8. Most of the amino acids have more than one code and more than one t-RNA. Write all variants of anticodons for four histidin codons: GGU-GGC-GGA-GGG.
9. What changes in the nucleotide composition in the sixth codon of m-RNA are responsible for the synthesis of beta chains of hemoglobin in a patient with sickle cell anemia?
10. Write the reaction of formation for the following biogenic amines: histamine, serotonin, gamma-aminobutyric acid/GABA/, dopamine. Explain their role.
11. What is the role of glutamic, aspartic acid in the neutralization of NH_3 in the body? Write these reactions.
12. Give the scheme of glucose-alanine cycle. What is its role?
13. Which amino acid is the source for adrenaline formation? Write the reaction with intermediary products and explain their role in the body?
14. Explain the regulation of calcium metabolism in the body. The role of calcium in cells.
15. Protein consists of 60-70% of aspartic and glutamic acids, the other protein contains a significant quantity of arginine and lysine. What is their direction of movement relative to the anode and cathode during electrophoresis?
16. How is the activity of enzymes in cells regulated? What units express enzyme activity?
17. A patient suffers from poor vision at twilight, slow adapts to the changes from light to dark. Name the hypovitaminosis, what is the mechanism of participation of vitamin in photoreception?
18. A patient has small hemorrhages in the skin, bleeding gums. Lack of which vitamin could he have? Explain the mechanism of bleeding.
19. In the process of alanine oxidation five moles ATP and one mole of CO_2 are formed. Which product formation are these reactions associated with?
20. How does the function of glucose-alanine cycle change in a patient with diabetes taking physical exercise or being at rest?
21. Catabolism of glycogen increases in stressful situations and after injections of adrenaline. Explain the mechanism of hormone action?
22. There are two runners in a race: the sprinter completes the 100^{th} meter, the stayer – the 10^{th} kilometer. Specify the differences in the energy supply for muscle work of these runners.
23. What could the differences in cholesterol content be for vegetarians and non-vegetarians?
24. Explain why does ketonemia occur in patient with diabetes?
25. Increases concentrations of ammonia and citrulline are found in the blood and urine of the patient. Specify the possible cause. How to check your assumption?
26. Why does lack of folic acid and vitamin B_{12} lead to anemia?
27. Why and how is the glucose tolerance determined?
28. The immediate precursor of ketone bodies is beta-hydroxy-beta-methylglutaryl CoA which is synthesized from acetyl-CoA. Acetyl-CoA is formed from glucose and fatty acids. However, acetyl-CoA derived from fatty acids is used for the ketone bodies synthesis. Give a scheme of ketone bodies synthesis. Explain your answer.
29. Biotin is involved in activation and transport of a certain group. Specify which: a) acetyl, b) methyl, c) CO_2, d) phosphoryl, d) adenosyl.
30. Deficiency of which vitamin causes of xerophthalmia, keratomalacia, chicken blindness: a) vitamin C b) B_1, c), D, d) A, e) E. Explain the mechanism of disorders.
31. What is the role of ubiquinone in the enzymic reactions of the following classes: 1. Oxidoreductases; 2. Transferases; 3. Hydrolases; 4. Lyases; 5. Isomerases; 6 Ligases (synthetases).

32. How many ATP molecules are formed during the oxidation of two moles of pyruvate to acetyl-CoA and transport of hydrogen in the respiratory chain?
33. What ion is required for kinase activation which catalyzes the formation of ortho-phosphoric esters? a) Mo^{2+}, b) Ca^{2+}, b) Na^{+}, d) K^{+}, Mn^{2+}.
34. A person gains weight due to excessive carbohydrate nutrition and limited physical activity. What is the biochemical mechanism of this process?
35. According to modern theory which of these substances HDL, LDL, or VLDL are considered to be atherogenic? Why?
36. What key biochemical processes occur in the mitochondria, cytoplasm, nucleus, lysosomes?
37. Where in the cell are following enzymes located: Krebs cycle, synthesis of m-RNA, protein synthesis, fatty acid synthesis, beta-oxidation of fatty acids, lipolysis, urea formation and synthesis of nucleotides.
38. Which compounds are sources for cholesterol synthesis? The role of cholesterol in the body?
39. What is the mechanism of antitoxic of action glucose which is injected into patients with certain types of poisoning?
40. What compounds are needed for synthesis of phosphatidylserine, phosphatidylethanolamine, phosphatidylcholine?
41. Explain the mechanism of activation of pepsinogen, trypsinogen and chymotrypsinogen. The meaning of proenzymes activation?
42. What type of bilirubin is increased in the blood in the case of hemolytic jaundice, hepatitis and obstruction of the bile-excreted duct?
43. The quantity of the indican, paired sulfuric and glucuronic acids, is increased in the urine of a sick child. Explain why?
44. What disorders develop when sodium concentration in the body is increased or decreased?
45. What changes occur due to excess of sodium in the body?
46. What cations are mostly contained in plasma and cells (erythrocytes)? How to support the homeostasis of these cations?
47. Blood is the mirror of internal environment of the organism. Explain this statement using the examples of normal blood biochemical parameters.
48. Explain the expression: "Lipids burn in the flame of carbohydrates". What is its biochemical meaning?
49. What metabolic disorders cause acidosis? What substances accumulate in blood?
50. A patient has the gallbladder removed. What problems with assimilation of proteins, carbohydrates or lipids could he have? Why?
51. Myoglobin and hemoglobin protomers /HbA_1, $HвA_2$, HbF/ have similar primary structure. How could this family of related proteins appear in the process of evolution?
52. Enzymes involved in the digestion of proteins in the stomach and intestines have a wide range of substrate specificity. Is it possible on this basis to assume that they are not perfect enzymes?
53. What are the advantages of the double stranded DNA structure?
54. In the cell there are tens of different tRNA and tens of thousands of different mRNAs. How is this difference in the number of RNAs explained?
55. Nitrogenous bases from both nucleotides of pairs G...C were cleaved as a result of action of highly active chemical compounds. Can cellular systems correct this damage?
56. Malate and ADP are added to a suspension of mitochondria. What products are formed? What enzymes catalyze these reactions? What can the maximum value of the ratio P/O be?

Appendix 2

Tests for second year students "General medicine" (pages 1-5, full version at the department site).

1) Complex proteins are supramolecular protein complexes.

1. Monomers for nucleic acid:
1) nucleosides
2) nucleotides
3) Purine bases
4) nucleoproteins
5) pyrimidine bases.

2. Which bonds take part in the formation of secondary structure of DNA?
1) Complex ester bonds
2) 3′,5′-diphospho-ester bonds
3) Hydrogen bonds
4) Ionic bonds
5) Glycoside bonds

3. In DNA molecule carbohydrate is represented by:
1) ribose
2) galactose
3) deoxiribose
4) mannose
5) glucose

4. After completed hydrolysis of RNA you could find all compounds except:
1) Phosphoric acid;
2) thymine;
3) adenine;
4) guanine;
5) ribose.

5. All indicated compounds are present in DNA except:
1) cytosine
2) thymine
3) uracil
4) imidazole
5) adenine.

6. Adenil acid is:
1) nucleoside;
2) nucleotide;
3) Nitrogenious base;
4) Nucleic acid.

7. Denaturation of DNA is:
1) Destruction of primary structure
2) Increase of solution viscosity
3) Destruction of secondary structure
4) Hydrolysis of DNA
5) melting DNA

8. Specificity coefficient is ratio:
1)G / C
2) A / T
3) G+C / A+T
4) A+C / G+T
5) G/A

9. DNA includes all nitrogenous bases except:
1) uracil;
2) Thymine;
3) Adenine;
4) guanine;
5) Cytosine.

10. complimentary nitrogenous bases take part in:

1) Formation of ionic bonds with histons;
2) Formation of primary structure of DNA;
3) Relation with non-histone proteins;
4) Stabilization of secondary DNA structure
5) All statements are right

11. Pyrimidine nitrogenous bases include all, except:

1) uracil;
2) thymine;
3) guanine;
4) Cytosine.

12. In nucleoproteins nucleic acids are related to which proteins:
1) globulins
2) albumins
3) Histons and non- histon proteins
4) glutellins
5) protamins.

13. Primary structure of DNA is stabilized by:

1) Hydrophobic bonds;
2) 3′,5′- diphospho-ester bonds;
3) Hydrogen bonds;
4) Ionic bonds.
5) peptide bonds

14. In our body nucleic acids perform the following function:
1) Energy source
2) Storage and transfer of genetic information
3) reserve
4) hormonal
5) regulative

15. Secondary structure of DNA is presented by:
1) α-helix
2) «clover leaf»
3) Double helix
4) Triple helix.
5) β-structure

16. Protein component and nucleic acid are related by:

1) Hydrophobic bond
2) 3′,5′- diphospho-ester bond
3) Hydrogen bond
4) Ionic bond
5) Covalent bond.

17. Find complementary nitrogenous bases:

1) Adenine and thymine;
2) Adenine and cytosine;
3) Adenine and guanine;
4) Cytosine and uracil.
5) Thymine and cytosine

23. In the cell ribonucleoproteins are situated:

1) In mitochondria
2) In cytoplasm
3) In nucleus
4) In membrane
5) In ribosoms

20. Prosthetic group of chromoproteins is represented by:

1) DNA;
2) lipids;
3) carbohydrates;
4) pigments;
5) Phosphoric acid.

21. Prosthetic group of hemoproteins is represented by:

1) protoporphyrin;
2) flavinmononucleotide;
3) heme;
4) Magnesium porphyrin;
5) Flavinadenin dinucleotide.

22. Cytochromes refer to class of:

1) nucleoproteins;
2) chromoproteins;
3) glycoproteins;
4) lipoproteins;
5) phosphoproteins.

23. Catalase and peroxidase refer to class of chromoproteins, subclass…:

1) flavoproteids;
2) Magnesium porphyrins;
3) Cobalamid enzymes;
4) hemoproteids
5) There is no right answer

24. Prosthetic group of glycoproteins is represented by:

1) heme;
2) Derivates of lipids;
3) Derivates of carbohydrates
4) nucleotids;
5) Derivates of vitamin A.

25. All compounds refer to true glycoproteins except:

1) interferon;
2) transferrin;
3) heparin
4) thyrotrophic hormone;
5) haptoglobin.

26. Glycoseaminoglycans include:

1) sialic acids
2) Neuroamine acid
3) Dermatan sulfate
4) glusocoamine
5) galactose.

27. Main glycosaminoglycan for cartilage matrix is:

1) collagen;
2) agrecan;
3) elastin;
4) thyrotrophic hormone ;
5) ceruloplasmin.

28. What compounds are situated at the end position in oligosaccharides which include the most part of true glycoproteins:

1) glucosamines
2) galactosamines
3) Uronic acids
4) sialic acids
5) neutral saccharides.

29. Prosthetic group of true glycoproteins contains all compounds listed below except:

1) amino saccharides;
2) glucoseaminoglycans;
3) sialic acids;
4) deoxi saccharides.

30. Hyaluronic acid is:

1) proteoglycan;
2) true glycoprotein;
3) glycosaminoglycan;
4) acetylglucoseamine.

31. Prosthetic group of proteoglycans is:

1) neuraminic acid;
2) sialic acid;
3) hyaluronic acid;
4) mannose;
5) galactosamine.

32. Which compound is anticoagulant:

1) phibrinogen;
2) hyaluronic acid;
3) prothrombin;
4) heparin;
5) chondroitin sulfate

33. To what protein group does transferrin refer:

1) proteoglycans;
2) true glycoproteins;
3) Serum lipoproteins;
4) proteolipids;
5) chromoproteins

34. What type of chemical bonds is replaced between carbohydrate components of proteoglycans

1) Ionic and hydrogen;
2) hydrogen and hydrophobic;
3) O-, N-glycosidic and ionic;
4) O- glycosidic and N- glycosidic;
5) O-, N- glycosidic and hydrophobic.

35. Choose a statement, which does not characterize proteoglycans:

1) Bind and organize water molecules;
2) Form stroma of extracellular matrix;
3) Serve as lubricant and softener in the joints;
4) in vitreous humor;
5) Transport oxygen.

36. Agrecan is:

1) proteoglycan;
2) true glycoprotein;
3) glycosaminoglycan;
4) acetylglucoseamine.

37. Find types of bonds between protein and true carbohydrates in glycoproteins:

1) ionic and hydrogen;
2) hydrogen and hydrophobic;
3) O-, N-glycosidic and ionic;

4) O-glycosidic and N-glycosidic;
5) O-, N-glycosidic and hydrophobic.

38. Which representative of glycosaminoglycans is nonsulfated:

1) heparin;
2) keratan sulfate;
3) chondroitin sulfate;
4) hyaluronic acid;
5) dermatan sulfate

39. Chondroitin sulfate is:

1) proteoglycan;
2) true glycoproteun;
3) glycosaminoglycan;
4) acetylglucoseamine.

40. What proteins include glycosaminoglycans as prosthetic group:

1) proteoglycans;
2) proteolipids;
s Serum lipoproteins;
4) true glycoproteins.

41. What glycoprotein includes in its composition hydroxy proline and hydroxylysine:

1) gaptoglobine;
2) ceruloplasmin;
3) trancferrin;
4) immunoglobulin;
5) collagen

42. True glycoproteins perform all functions except:

1) Protective function;
2) Antiviral function;
3) Form stroma of extracellular matrix
4) cellular adhesion.

43. What is the function of heparin:

1) Delays coagulation;
2) stabilizes collagen fibers
3) Prevents transudation;
4) Transports hemoglobin

44. What proteins do include neutral saccharides, acetylhexosamins and sialic acids as prosthetic group:

1) proteoglycans;
2) proteolipids;
3) Serum lipoproteins;
4) true glycoproteins

45. Heredity defects of degradation of proteoglycan polysaccharide chains are the base for:

1) hemochromatosis;
2) Degeneration of nervous system;
3) collagenosis;
4) mucopolysaccharidosis;
5) anaemia.

46. Lipoproteins are complex proteins which prosthetic group is represented by:

1) heme;
2) Lipid derivates;
3) Carbohydrate derivates;
4) nucleotides;
5) group B vitamins.

47. Serum lipoproteins include all lipids, mentioned below except:

1) triacylglycerides;
2) cholesterol;
3) sphingolipids;
4) phospholipids.

48. Proteolipids include all lipids, mentioned below except:

1) triacylglycerides;
2) cholesterol;
3) sphingolipids;
4) phospholipids;
5) glycolipids.

49. Steroids include:

1) gangliosides;
2) triacylglycerides;
3) phospholipids;
4) Sex hormons;
5) sphingolipids.

50. Apolipoproteins in composition of serum Lipoproteins include all classes, except:

1) B-48;
2) B-100;
3) Apo-A;
4) F-50.

51. Name the bond between triacylglycerides and apolipoproteins:

1) hydrophobic;
2) ionic;
3) hydrogen;
4) disulfide;
5) glycosidic.

2) Neuroendocrine regulation of cellular function. Hormonal regulation of metabolism and functions.

1. Choose from the list hormones which are peptides or proteins

1) adrenalin
2) insulin
3) testosteron
4) corticosteron
5) thyroxine

2. Choose from the list hormones which are derivates of amino acids

1) thyroxin
2) glucagon
3) estriol
4) insulin
5) corticosteron

3. Choose from the list hormones which have steroid structure:

1) oxitocin
2) thyrotropic hormon
3) progesteron
4) insulin
5) glucagon

4. Find the second stage of hormonal action mechanism, which activates adenylate-cyclase system

1) Changing the activity of adenylate-cyclase
2) interaction with receptor at the cellular surface
3) Proteinkinase activation
4) Changing concentration of c-AMP
5) Activation of G-protein

5. What is the role of G-protein in the of hormonal signal transduction:

1) Increases transduction of hormonal signal
2) Performs proteolysis of receptor
3) Relates to ATP
4) Relates to hormone
5) Relates to c-AMP

6. What statement about c-AMP is true:

1) glucocorticoids potentiate c-AMP accumulation
2) c-AMP is formed under the action of phospholipase C
3) Level of c-AMP quickly decreases due to its hydrolysis by phosphodiesterase
4) c-AMP phosphorylates proteins in the cell
   c-AMP is formed by the action of phospholipase
5) A

7. Phospholipase C:

1) Exists as membrane phospholipid
2) Diffuses in cytosol and provokes release of Ca^{2+} ions from intracellular storage
3) Hydrolysis of Phosphoinositol-bisphosphate to Inositol-triphosphate and diacylglycerol which are secondary messengers
4) Directly activates proteinkinase C
5) Dephosphorylates Inositol-triphosphate

8. Which hormone has the longest effect:

1) Thyroxin
2) Insulin
3) Glucagon
4) Adrenalin
5) Oxitocin

9. Which compounds react as secondary messengers of hormone signal:

1) cyclic nucleotids
2) enzymes
3) Ca^{2+} ions
4) ATP
5) Products of hydrolysis of phosphoinositides

10. Which hormone has anabolic effect:

1) Vasopressin
2) Histamine;
3) Serotonin
4) Somatotropic hormone
5) Thyrotropic hormone

11. The main stimulator of renin secretion by juxtaglomerular cells is:

1) increase of arterial pressure
2) decrease of arterial pressure
3) increase of the volume of blood circulation
4) K^+ ions
5) Ca^{2+} ions

12. The main effect of aldosterone is:

1) increase of potassium reabsorbtion in renal tubules
2) decrease of proton excretion
3) decrease of volume of blood circulation
4) increase of sodium reabsorbtion in renal tubules
5) increase of proton excretion

13. What hormones influence protein, lipid and carbohydrates exchange:

1) Adrenalin
2) Insulin
3) parathormone
4) calcitonin
5) glucocorticoids

14. The main glucocorticoid in the human body is:

1) Corticosteron
2) Cortisol (hydrocortison)
3) Cortison
4) Estron
5) Progesteron

15. Steroid diabetes is related to:

1) Insufficiency of insulin
2) Excessive concentration of glucagon
3) Insufficiency of vasopressin
4) Excessive concentration of glucocorticoids
5) Excessive concentration of insulin

16. Effects of glucocorticoids:

1) Decrease glucose level in the blood
2) Do not influence lipid exchange
3) Are synthetized from cholesterol
4) Activate catabolism of proteins in connective tissue
5) Perform anti-inflammatory, anti-allergic actions

17. Thyroid hormones are :

1) Growth and development hormones
2) Decrease glucose level in the blood
3) Increase consumption of oxygen
4) Could not penetrate biomembrane
5) Decrease consumption of oxygen

18. There are three forms of insulin in the blood:

1) Free form
2) Binding form
3) A form
4) As C-peptide
5) In the form of HbA_1

19. Choose the false statement about insulin:

1) Activates pyruvate-dehydrogenase, alfa-ketoglutarate-dehydrogenase, hexokinase
2) Inhibits glycogen-phosphorilase
3) Activates phosphoenolpiruvate-carboxykinase (gluconeogenesis)
4) Activates acetyl-CoA carboxylase
5) Produces anabolic effect

20. find activation effects of insulin on the metabolism:

1) Glycogen synthesis
2) Glycogenolysis
3) gluconeogenesis
4) glycolysis
5) lipogenesis

21. Glucagon is synthesized under certain condition:

1) hypoglycemia
2) stress
3) hyperglycemia
4) increasing arterial pressure
5) decreasing arterial pressure

22. Volume of liquid circulation is regulated by:

1) Cortisol

2) Aldosteron
3) Vasopressin
4) atrial natriuretic factor
5) Oxitocin

23. Which compound is necessary for adrenaline synthesis:
1) Vitamin D
2) Tyrosine
3) Cysteine
4) S-adenosylmethionine
5) Tryptophan

24. Which hormon like insulin effects protein exchange:
1) Glucagon
2) Growth hormone
3) glucocorticoids
4) Adrenalin
5) Oxitocin

25. Steroid hormones are synthesized in:
1) gonads
2) Pituitary gland
3) genital organs
4) adrenal glands
5) pancreas

26. estrogens are formed from:
1) androgens
2) glucocorticoids
3) catocholamins
4) aldosteron
5) Progesteron

27. Which hormone is synthesized by increasing concentration of glucose in the blood:
1) glucagon
2) insulin
3) adrenalin
4) testosteron
5) thyroxin

28. What enzyme distroys secondary messenger c-AMP:
1) adenylate-cyclase
2) phosphodiesterase
3) Proteinkinase A
4) Phosphatase of kinase phosphorilase
5) Proteinkinase C

29. Where is adenylate-cyclase localized in the cell:
1) Cytoplasmic membrane
2) Cytosol
3) External mitochondria membrane
4) Internal mitochondria membrane
5) Matrix of mitochondria

30. Adenylate-cyclase is stimulated by:
1) adrenalin
2) glucagon
3) insulin
4) cortisol
5) thyroxine

31. Find possible consequences of insulin action:
1) decrease of cholesterol in the blood
2) increase level of fatty acids in the blood
3) decrease of glucose in the blood
4) increase of glucose in the blood
5) development of hypoaminoacidemia

32. What statements are true:
1) target organs for insulin are the liver, muscle and fatty tissue
2) Excessive concentration of insulin decreases the level of glucose in the blood
3) Hypersecretion of insulin promotes excessive storages of glycogen
4) target organs for insulin are the brain, RBC and bones
5) Insulin stimulates storage of neutral lipids

33.Find possible reasons for hyperglycemia in a healthy person:
1) ingestion
2) Hypersecretion of insulin
3) Hypodynamia
4) Activation of lipid peroxydation
5) Deficiency of insulin.

34. Where is oxitocin synthesized:
1) anterior pituitary
2) Posterior pituitary
3) placenta
4) Nucleus of hypothalamus
5) Adrenal glands

35. Which hormones are activated in cytoplasm of tagret cells:
1) Antidiuretic hormone
2) Luteinizing hormone
3) triiodothyronine
4) testosteron
5) adrenalin
.

36. Pathology of which endocrine formation is accompanied by Appearance of reverse secondary sexual characteristics:
1) pancreas
2) medulla of the adrenal glands
3) cortex of the adrenal glands
4) pituitary gland
5) thymus

37.Explain why excessive concentration of anti-insulin hormone is dangerous:
1) Development of hyperglycemia
2) Development of hypoglycemia
3) Inhibition of glycogenolysis
4) Inhibition of glucose synthesys
5) Activation of glycogenolysis

38. Which enzyme destroys phosphotidal inositolphosphate to secondary messengers diacylglycerol and inositol-1,4,5-triphosphate:
1) phospholipase A_1
2) phospholipase A_2
3) phospholipase C
4) phospholipase D
5) phosphorilase.

39.Excessive concentration of which hormones could be a reason for hyperazotemia development:
1) somatomedines
2) atrial natriuretic factor
3) calcitriol
4) ACTH
5) testosteron

Appendix 3

The assessment scales

Abstract evaluation criteria

Points	5	4	3	2
Contents	The work is fully completed.	Practically the most important components of the work are completed but not fully.	Not all important components of the work are completed.	The work is done partially with the teacher's help.
	The work demonstrates deep understanding of the described processes.	The work demonstrates understanding of the main points but some details are not specified.	The work demonstrates partial understanding of the described processes.	The work demonstrates little understanding of the described processes.
	The work contains interesting discussion material. Scientific vocabulary is used correctly.	There is some discussion material. Scientific vocabulary is used, but sometimes not correctly.	Discussion material is present but does not help to understand the problem. Scientific terminology is used but not correctly.	Minimal discussion material is present. Few scientific terms are used.
	The student provides his own interpretation or development of the topic (generaliza-tions, applications, analogies).	The student offers his own interpretation or development of the topic in most cases.	The student sometimes offers his interpretation.	Interpretation is limited or is not related to the subject.
Literacy	No error - grammatical or syntactic.	Minimal errors are present.	There are errors making the meaning difficult to understand.	A lot of errors, making the material difficult to read.
Report	The student clearly explains the abstract content and makes visual contact with the audience.	The student clearly explains the content of the essay.	The student clearly explains the content of the essay.	The student reports incorrect information.

51-- 60 points – 5
41 – 50 points – 4
31 – 40 points – 3
Less than 30 points – 2.

Assessment criteria for answers to situational tasks:
5 points - student gives precise answers to all questions on situational problems using terms and definitions from basic, main and additional literature.
4 points - student correctly, but not in details, answers to all the questions with minimal errors using references from basic and main literature.
3 points - student correctly solves the problem, but doesn't answer all the questions (70 - 89%), omitting details, answers with errors using references from basic literature.
2 points – student correctly solves the fragments of the task, doesn't answer all the questions making mistakes and using references from basic literature.
1 point – student demonstrates isolated fragments of knowledge could not solve the whole problem.
0 points - student does not solve the task, gives wrong answers, the answers do not relate to the task questions.

The criteria for test assessment
5 points – 85 - 100% of correct answers
4 points – 76 - 85% of correct answers
3 points – 61 - 75% of correct answers
2 points – 0 - 60% of correct answers

Assessment criteria for exam questions:
1. Knowledge of the basic processes, functions and laws of the subject, depth and completeness of answers to question.
2. Knowledge of terms and concepts, their use in the response.
3. Ability to explain the meaning of processes, laws, mechanisms, to make conclusions and summarization, ability to explain cause-and-effect relations.
4. Ability to answer questions.
5. Use of literary language, scientific terms, logic and consistency of answers, ability to express his/ her opinion.

Appendix 4.

The planning sheet of discipline

Discipline Biochemistry
Area/specialization General Medicine
Course/semester 1/2
Credit units (CU) 4

Title of module according to WPD	Type of control	Forms of control	Minimal credit points	Maximal credit points	Week of control
Module 1					
Module 1. **Molecular basics of structural cellular organization**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks	5	8	4
	Midterm examination	Evaluation test	5	8	
Module 2					
Module 2. **Neuroendocrine regulation of cellular activity**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks	5	9	7
	Midterm examination	Evaluation test	5	9	
Module 3					
Module 3. **Molecular basics of vital functions and pathology**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks, writing of reports	5	9	12
	Midterm examination	Evaluation test	5	9	
Module 4					
Module 4. **Biological oxidation, cell energetics and carbohydrate metabolism.**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks	5	9	16
	Midterm examination	Tests	5	9	
Total for semester			40	70	
Midpoint assessment			20	30	
Summative assessment			60	100	

Head of department Zurdinova A.A.

The planning sheet of discipline

Discipline Biochemistry
Area/specialization General Medicine
Course/semester 2/3
Credit units (CU) 4

Title of module according to WPD	Type of control	Forms of control	Minimal credit points	Maximal credit points	Week of control
Module 1					
Module 1. **Metabolism and functions of lipids**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks	4	7	3
	Midterm examination	Evaluation test	6	11	
Module 2					
Module 2. **Metabolism of proteins and amino acids**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks, writing of reports	4	7	6
	Midterm examination	Evaluation test	6	11	
Module 3					
Module 3. **Molecular mechanisms of transfer of genetic information**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks, reports	3	5	10
	Midterm examination	Tests	3	5	
Module 4					
Module 4. **Functional biochemistry of organs and tissues.**	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work with tables, discussion of situational tasks, reports	6	10	16
	Midterm examination	Evaluation test	8	14	
Total for semester			40	70	
Midpoint assessment			20	30	
Summative assessment			60	100	

Head of department Zurdinova A.A.