MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
MINISTRY OF EDUCATION AND SCIENCE OF THE KYRGYZ REPUBLIC

KYRGYZ-RUSSIAN SLAVIC UNIVERSITY

Endorsed by Karaeva Rosa

29. 09. 2023

Clinical Biochemistry

Course Outline (Module)

Assigned to **Chemistry and Biochemistry Department**
Academic Curriculum 31.05.01 General Medicine

Mode of Study **Intramural**

Total Credit Value **2 credit points**

Course Hours	72	Scope of Testing Semesters
including:		credits with a mark 9
in-class learning	36	
Individual work	36	

Course Hours Scheduling (per semester)

Semester (<Coursec>.< Semester in course>)	**9 (5.1)**		Total
weeks	18		
Type of Training	AC	CO	AC
Practical Session	36	36	36
Total In-class Session	36	36	36
Face-to-face Learning	36	36	36
Individual work	36	36	36
Total	72	72	72

The Course outline developed by:

N.S. Matushenko, associate professor, Ph.D in Biology, T.E. Kuchuk, associate professor Ph.D in Medical Science, and I.G.Ibraeva, associate professor , Ph.D in Medical Science _____

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The Course Outline

Clinical Biochemistry

developed in full compliance with FSES 3+:

Federal State Education Standards of Higher Professional Education for students trained for specialty 31.05.01 General Medicine (training level of highly qualified personnel). (The Ministry of Education and Science of the Russian Order of _____ №____)

in accordance with Academic Curriculum:

31.05.01. General Medicine

confirmed by KRSU Board of Academics in 29.09.2015, record № 2.

The Course Outline endorsed by **Chemistry and Biochemistry** Department Meeting.

Record of 4 September 2015 № 2
Valid for 2015-2021 academic years
The Head of Department Matushenko N.S., associate professor, *Ph.D in Biology* _____

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
16. 111 2016 .

The course outline has been revised, considered and endorsed for implementation in 2016-2017 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 02. 09. 2016 . № 2
The Head of Department Matushenko N.S., associate professor, CBS

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
15. 12. 2017.

The course outline has been revised, considered and endorsed for implementation in 2017-2018 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 04. 09. 2017. № 2
The Head of Department Matushenko N.S., associate professor, CBS

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
07. 12. 2018.

The course outline has been revised, considered and endorsed for implementation in 2018-2019 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 06. 06. 2018. № 16
The Head of Department Matushenko N.S., associate professor, CBS

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
04. 09. 2019.

The course outline has been revised, considered and endorsed for implementation in 2019-2020 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 26. 08. 2019. № 1
The Head of Department Matushenko N.S., associate professor, CBS

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
23. 09. 2020.

The course outline has been revised, considered and endorsed for implementation in 2019-2020 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 14. 09. 2020. № 2
The Head of Department Matushenko N.S., associate professor, CBS

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
9. 09 2021.

The course outline has been revised, considered and endorsed for implementation in 2016-2017 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 26. 08. 2021. № 1
The Head of Department Matushenko N.S., associate professor, *Ph.D in Biology*

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
_____6. 10.____2022.

The course outline has been revised, considered and endorsed for implementation in 2022-2023 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 09. 09. 2022. № 2
The Head of Department Matushenko N.S., associate professor, CBS

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
__ 19. 09 __ 2023.

The course outline has been revised, considered and endorsed for implementation in 2023-2024 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of __ 4. 09 __ 2023. № 2
The Head of Department Matushenko N.S., associate professor, *Ph.D in Biology*

The course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
__ _____ 2024.

The course outline has been revised, considered and endorsed for implementation in 2024-2025 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of __ _____ 2024. № __
The Head of Department Matushenko N.S., associate professor, *Ph.D in Biology*

1. COURSE OUTLINE OBJECTIVES	
1.1	In-depth study of the molecular basis of biological processes in normal and in some pathologies, mechanisms of metabolic regulation; identification of the reasons for metabolic changes in the body in some pathological conditions, mechanisms of regulation of metabolic processes. Formation of a holistic concept of the rational and effective using of biochemical methods and the laboratory research results for the diagnosis and development of modern preventive and therapeutic measures.

2. PLACE OF THE COURSE IN THE EDUCATIONAL PROGRAM	
Educational Program Units:	B1.B
2.1	**Students' Preliminary Training Requirements:**
2.1.1	Basic knowledge which is necessary for discipline studying is formed in the cycle of mathematical and natural science disciplines (chemistry, biochemistry, biology, anatomy, histology, embryology, cytology, normal physiology, pathophysiology) and disciplines of the professional cycle (propaedeutics of internal diseases).
2.2	**Course Units and Practical Sessions imposing the prior Proficiency:**
2.2.1	faculty therapy;
2.2.2	hospital therapy;
2.2.3	endocrinology;
2.2.4	outpatient therapy;
2.2.5	Infection diseases;
2.2.6	phthisiology;
2.2.7	anesthesiology, intensive care;
2.2.8	oncology

3. STUDENTS' COMPETENCIES RESULTING FROM THE COURCE UNIT (MODULE)	
MPC-9: ability to assess morphofunctional, physiological states and pathological processes in the human body to solve professional problems	
Knowledge:	
Level 1	Main ways and mechanisms of metabolic regulation of carbohydrates, lipids, proteins, amino acids, nucleotide exchanges
Level 2	Molecular basis of physiological processes and their disorders
Level 3	Diagnostically important indicators of the blood, saliva and urine composition and the ranges of their fluctuations in a healthy person
Skills:	
Level 1	Perform laboratory work, fill in the test report, evaluate its results
Level 2	Explain the molecular mechanisms of the structural and functional activity of the main organs and tissues
Level 3	Interpret the results of laboratory biochemical studies, i.e. make a logical connection between the detected deviations of biochemical parameters and metabolic disorders
Expertise:	
Level 1	Skills of independent work with reference, educational and scientific literature
Level 2	To evaluate of diagnostic and prognostic significance of the results of biochemical analysis of blood, gastric juice, saliva, urine
Level 3	Skills of biochemical thinking, biochemical knowledge application to understand molecular mechanisms of pathogenesis and principles of therapeutic effect.

Final Students' Competencis

3.1	**Knowledge:**
3.1.1	goals and main objectives of clinical biochemistry;
3.1.2	characteristics of diagnostic significance of laboratory studies, the main quality indicators of the laboratory diagnostics;
3.1.3	features of changes in the biochemical composition of biological fluids with the most common human diseases, the main biochemical markers of human pathological conditions;

3.1.4	general principles and features of diagnosis of hereditary diseases and congenital anomalies.
3.2	**Skills:**
3.2.1	To choose the best analytical method of clinical research; to send for laboratory and instrumental examination, for consultation with specialists.
3.2.2	To interpret the results of laboratory studies of biological material for the diagnosis of basic human pathological conditions.
3.3	**Expertise:**
3.3.1	skills of effective use of laboratory data to determine the presence of a disease, the effectiveness of its treatment.
3.3.2	the algorithm of the preliminary diagnosis, followed by an additional examination

4. COURSE (MODULE) STRUCTURE AND CONTENT

Class code	Subject Name /Type of Class/	Semester / Academic Year	Hours	Competencies	Literature	Interactive Sessions	Notes
	Section 1. Metabolic disorder. Biochemical indicators of metabolic disorders in the human body.						
1.1	Determination of proteins and parameters of protein metabolism. Protein homeostasis. Plasma proteins, diagnostic value of their determination /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
1.2	Laboratory evaluation of protein metabolism /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
1.3	Clinical and diagnostic assessment of carbohydrate metabolism. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
1.4	Disorders of carbohydrate metabolism /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
1.5	Clinical methods of lipid metabolism assessment. Lipid peroxidation. Biochemical aspects of atherosclerosis. Laboratory tests for dislipoproteinemia typing. Hereditary pathology of lipid metabolism /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
1.6	Biochemical mechanisms of lipid metabolism pathology /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
1.7	The study of pigment metabolism disorders /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
1.8	The pigment metabolism disorders. /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
1.9	Biochemical diagnostic methods of liver and digestive diseases /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
1.10	Pathobiochemistry of the liver. Laboratory diagnosis of liver diseases. Biochemistry of alcoholism /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	

1.11	The normal and pathological acid-base balance. Pathobiochemistry of the kidney. Water-electrolyte metabolism, its regulation and disorders /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
1.12	Estimation of parameters of water-electrolyte metabolism /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
1.13	Vitamins and their clinical use. Hypo-and hypervitaminosis. Vitamin-like compounds /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
1.14	Antivitamins, the mechanism of their action. Their using in Practical medicine. Methods of research of vitamins./IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
1.15	Pathobiochemistry of trace elements exchange. Iron metabolism. Disorders of the of other trace elements exchange (essential metals and non-metals). Trace elementosises. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
1.16	Trace elements. Endogenous insufficiency. Imbalance in the body. Toxic effects. /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
1.17	Biochemistry of signaling systems Diagnosis of endocrine system disorders. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
1.18	Disorders of metabolic regulation. /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
	Section 2. The mechanisms of the metabolic processes disorders in cells						
2.1	Intracellular regulation of metabolism. Enzymes in the diagnosis of internal organs diseases /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
2.2	Activity of enzymes and isoenzymes. Diagnostic value of their determination /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
2.3	Hypoxia as a cause of metabolic disorders in cells. Oxidative stress. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
2.4	Oxidative stress. /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
2.5	Laboratory evaluation of free radical processes, lipid peroxidation, antioxidant system - diagnostic and prognostic value. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	

2.6	The system "lipid peroxidation – free radical protection." Factors that stimulate LPO: reactive oxygen forms, hypoxia, ischemia, infectious agents. Antioxidant cell protection: antioxidants - enzymes, non-enzymatic antioxidants (redox-vitamins – stabilizers of cell membranes). /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
2.7	Metabolic syndrome. Molecular mechanisms of insulin resistance formation. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
2.8	The relationship of metabolic pathways. Pathochemistry of diabetes. Laboratory tests. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
2.9	Insulin metabolism and biochemistry of diabetes /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
2.10	Metabolic markers in the diagnosis and monitoring of diabetes. "Memory of blood sugar": glycosylated hemoglobin. Aged features. /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
2.11	Laboratory evaluation of biochemical blood markers in myocardial infarction, their diagnostic and prognostic value./Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
2.12	Myocardial pathobiochemistry /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 E1, E2, E3	0	
2.13	Molecular mechanisms of bone tissue formation and resorption. Osteoporosis. /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
2.14	Biochemical basis of hereditary pathology (disorders of carbohydrate metabolism, metabolism of individual amino acids, metabolism of purine and pyrimidine nitrogenous bases, vitamins, porphyrins, non-enzymatic proteins) /Pr/	9	2	MPC-9	L1.1, L1.2, L1.3	0	
2.15	Osteoporosis and its biochemical markers /IW/	9	2		L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
2.16	Biochemical basis of hereditary metabolic disorders /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
2.17	Disorders of intercellular interactions. Biochemical basis of carcinogenesis./Pr/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2	0	
2.18	Molecular biochemical markers of tumor growth /IW/	9	2	MPC-9	L1.1, L1.2, L1.3 L2.1, L2.2 E1, E2, E3	0	
2.19	/ credits with a mark /	9	0			0	

5. ASSESSMENT FUND
5.1. Advancement Questions and Assignments
Questions to check students' competence « Knowledge»:

1. Enzyme map of the cell. Compartmentalization. The structure of enzymes and their distribution in cells and tissues.
Vitamins and their coenzyme functions.
2. Enzymes which apoenzyme has Quaternary structure. Organ specificity in the enzyme distribution. Isoenzymes (lactate dehydrogenase, creatine phosphokinase, alkaline and acid phosphatase), their characteristics. Multienzymes. Allosteric (regulatory) enzymes.
3. Clinical enzymology. Classification of enzymes (hereditary, congenital, received).
4. General methods for determining enzyme activity. Factors affecting the enzyme level in extracellular fluid.
5. The main areas of enzyme use in medical Practice: a) enzymodiagnostics. The principle of enzyme activity determination in biological fluids; b) an enzymotherapy; C) the using of enzyme activity regulators as medicines.
6. Pathobiochemistry of the myocardium. The regulation of the myocardium metabolism at rest and on activity. The effect of hypoxia on myocardium metabolism. Biochemical aspects of laboratory diagnostics of myocardial infarction (enzyme investigation).
7. Changes in enzymatic blood activity at pancreatic pathology (acute and chronic pancreatitis).
8. Interrelation of anabolism and catabolism lipid processes with other types of metabolism. Pyruvate and acetyl-CoA, their formation from other metabolites.
9. Anabolic and catabolic stages of nitrogen-containing compounds. Communication with other metabolic pathways.
10. Insulin and contra-insular hormones as regulators of the deposition and the mobilization of glycogen and lipids.
11. Disorder of glycogen and lipid synthesis at insulin deficiency.
12. Normal regulation of acid-base balance. Blood buffer systems (bicarbonate, hemoglobin, phosphate, protein).
13. Indicators of acid-base balance (Siggor – Andersen' nomogram): - the value of the active solution reaction (pH); - partial pressure of carbon dioxide over the liquid (pCO2); true blood bicarbonate (AB); standard bicarbonate (SB); the sum of the bases of all blood buffer systems (BB); normal buffer bases (NBB); - excess (deficit) buffer bases (BE = BB – NBB).
14. The role of potassium and sodium cations in metabolism.
15. Normal phosphorus-calcium metabolism.
16. Methods of investigation of the functional state of the kidneys.
17. Proteinuria: glomerular, tubular, mixed.
18. Metabolism of lipoproteins, their role.
19. The system "lipid peroxidation – free radical protection."
20. Hereditary pathology of lipid metabolism (sphingolipids, gangliosides).
21. Deficiency of disaccharidases. Intolerance to maltose, isomaltose, lactose. Symptoms, Principles of treatment.
22. Molecular pathology of individual amino acid metabolism. Phenylketonuria, tyrosinemia, alkaptonuria, homocystinuria, cystinuria, histidinemia, Hartnup's disease, blue diaper syndromes, Tad' syndrome, Price' syndrome, Knapp - Komrover.
23. Porphyria: acute intermittent, cutaneous, erythropoietic, erythrohepatic. Liver coproporphyria

Tasks to check students' competence « Skills»:
1. Describe the enzyme distribution in cells and tissues according to the functions. Explain coenzyme functions of vitamins.
2. Explain the organ specificity in the enzyme distribution: isoenzymes (lactate dehydrogenase, creatine phosphokinase, alkaline and acid phosphatase), their characteristics.
3. What is an enzyme activity. Explain the effect of factors affecting the level of enzymes in the extracellular fluid.
4. The uing of enzymes in medical practice: a) enzymodiagnostics. Principle of determination of enzyme activity in biological fluids; b) enzyme therapy;
5. Describe the hypoxia effect on the heart muscle metabolism. Laboratory diagnosis of myocardial infarction (investigation of enzymes).
6. Relation of carbohydrate metabolism with other types of metabolism.
7. Describe the relationship of lipid anabolism and catabolism with other types of metabolism.
8. Describe the relationship of anabolic and catabolic stages of nitrogen-containing compounds with other metabolic pathways.
9. Regulation of synthesis and mobilization of glycogen and lipids.
10. Describe the mechanism of: hyperglycemia; hyperketonemia and hypercholesterolemia; hypernitrogenemia, hyperaminoacidemia, hyperinsulinemia;
11. The development mechanism of tissue hypoxia.
12. Physiological mechanisms of regulation of acid-base balance (ABB): a) buffers; b) neutralization of volatile acids (CO2); c) generation of bicarbonate (HCO3-) in the kidneys; neutralization of non-volatile acids (organic acids, H2SO4, H2SO3) and ammonium salts (NH4+); d) participation of the liver in the regulation of ABB; d) the role of the pancreas and stomach.
13. Renal control of acid-base balance: a) Conversion of H2PO4- into HPO42; b) convertion of bicarbonates into carbonic acid; c) synthesis of ammonia in the kidneys and excretion of ammonium salts (acidic equivalents).
14. Interpretation of acid-base balance value and diagnostic principles.
15. Regulation of phosphorus-calcium metabolism.
16. Features of pathogenesis; characteristics of anabolic and catabolic stage of cholesterol metabolism.
17. Dislipoproteinemia. Classification. Laboratory tests of their typing.
18. Factors that stimulate PLO: reactive oxygen forms, hypoxia, ischemia, infectious agents.
19. Metabolic disorders of monosaccharides. Essential fructosuria, hereditary fructose intolerance, galactosemia.
20. Explain the development mechanism of development of different types of glycogenosis: Gierke's disease, Pompe's disease, Cori-Forbes's disease, Andersen disease, McArdle disease, Hers' disease, Tarui's disease, Hodgkin disease.
21. Explain the development mechanism of metabolic disorders of purine and pyrimidine nitrogenous bases development. The Lesch - Nyhan syndrome, gout, xanthinuria, orotaciduria.
22. Explain the development mechanism of porphyrin metabolism disorders development. Porphyria: acute intermittent, cutaneous, erythropoietic. Liver coproporphiria.

Tasks to check students' competence «Expertise»:
1. Multienzymes. Allosteric (regulatory) enzymes.
2. The use of regulators of enzyme activity as drugs.
3. The regulation of the metabolism of the heart muscle at rest and on activity.
4. Interpretation of blood enzymatic activity at pancreatic pathology (acute and chronic pancreatitis).
5. Possible ways of carbohydrate synthesis in the body.
6. Diabetes. Forms. Epidemiology. Etiology. Risk factor.
7. Explain why the glycosylation of proteins is one of the most important causes of diabetes complications in the later stages.
8. Diagnostic tests for diabetes.
9. Typical forms of acid-base balance disorders: a) compensated and decompensated acidosis; b) the compensation and decompensation of respiratory acidosis; c) compensation and decompensation of metabolic alkalosis; d) the compensation and decompensation of respiratory alkalosis.
10. Changing the water-salt metabolism parameters at its disorders.
11. Disorder of phosphorus-calcium metabolism.
12. Biochemical study of blood at kidney diseases.
13. Biochemical aspects of atherosclerosis (etiology, risk factors, pathogenesis, laboratory diagnostics).
14. Antioxidant protection of cells: antioxidants-enzymes, antioxidants of non-enzymatic origin (redox-vitamins – stabilizers of cell membranes).
15. Reasons for collagenosis, clinical features, laboratory diagnosis, aspects of treatment.
16. Metabolic disorders of glycosaminoglycans. Hurler syndrome, Scheie syndrome, Hunter syndrome, Sanfilippo syndrome, Morquio syndrome, Maroteaux-Lamy syndrome.
17. Diagnosis of primary endogenous hypovitaminosis. Daria's syndrome, vitamin D-resistant rickets (phosphate diabetes), Leia disease, Wernicke-Korsakov syndrome, methylmalonic aciduria, Imerslund- Gräsbeck disease, pyridoxine-dependant cramps, pyridoxine-dependant anemia, cystathioninuria, syndrome Knapp-Komrover, Moeller-Barlow disease, propionic acidemia.
18. Diagnostics of non-enzymatic protein defects. Combined immunodeficiency (T and B-lymphocytes), deoxyadenosine, hypouricemia.

5.2. Course Papers Themes

Discipline does not involve writing a term paper.

5.3. Assessment Fund

Test examples of discipline "Clinical biochemistry»:
Task: choose the right answer:
1. The pathology of lipid metabolism includes:
   A) hyperbilirubinemia
   B) glucosuria
   C) hyperkaliemia
   D) hyperlipemia
2. The cause of the total protein increase cannot be:
   A) multiple myeloma
   B) Hyperalbuminemia
   C) dehydration
   D) hyperhydration
3. Residual nitrogen is increased by urea nitrogen at:
   A) acute hepatitis
   B) myocardial infarction
   C) chronic renal failure
   D) liver cirrhosis

4. What is not suitable for alkaline phosphatase:
A) high concentrations in the liver and bones
B) presence of organ-specific isoenzymes
C) increased serum activity at liver and bone diseases
D) high concentration in the Prostate gland
5. Increased activity of aminotransferases observed at:
A) liver diseases
B) myocardial infarction
C) severe hypoxia and compression of tissues
D) all is strue
6. The activity of γ-glutamyltransferase (GGT) is significantly increased in serum at:
A) liver disease and alcoholism
B) bone damage
C) cancer of the prostate gland
D) myocardial infarction
7. If we compare the activity of enzymes in the tumor and the original tissue we find out that there is an increasing activity of hexokinase, phosphofructokinase and pyruvate kinase, in addition, there is an intensive accumulation of lactic acid in tumor tissue. This indicates the predominance of the process:
A) Anaerobic glycolysis;
B) Aerobic glycolysis;
C) Gluconeogenesis;
D) All answers are correct;
E) there is no right answer.
8. The glucose uptake from the blood is intense in the tumor. Even though the blood glucose increases up to 16.7 mmol/l (300 mg%) the blood flowing out of the tumor does not contain glucose, so it is true that:
A) activity of regulated glucokinase increases, and hexokinase is sharply activated and less sensitive to hormonal regulation;
B) activity of regulated glucokinase reduces, activity of hexokinase sharply reduces and is less sensitive to hormonal regulation;
C) the activity of regulated glucokinase increases, hexokinase sharply activates and is more sensitive to hormonal regulation;
D) the activity of regulated glucokinase increases, the activity of sharply decreases and is less sensitive to hormonal regulation;
D) the activity of regulated glucokinase decreases, hexokinase dramatically activates and is less sensitive to hormonal regulation.
9. The increase of lactate dehydrogenase (its isoform - LDG4, LDG3), sorbitol dehydrogenase, fructose-1-phosphataldolase were found in the blood. Choose liver syndrome:
A) syndrome of cholestasis;
B) syndrome of cytolysis of hepatocytes;
C) syndrome of synthetic function failure;
D) mesenchymal-inflammatory syndrome;
E) immunopathological syndrome.
10. The aspartate aminotransferase activity is increased in 95% of myocardial infarction cases. Increased aspartate-transferase is a reliable diagnostic test in the acute period of myocardial infarction. At the same time, the activity of this enzyme is less increased than the activity of other enzymes. Choose them.
A) acid phosphatase, alkaline phosphatase;
B) ketose-1-phosphate aldolase, fructose-1,6-diphosphate aldolase;
C) alpha-amylase, alanine aminotransferase;
D) creatine kinase, lactate dehydrogenase;
E) alcohol dehydrogenase

Examples of situational tasks
Task 1.
The 30 year old patient come to the doctor with complaints about an abdominal pain, especially after eating fatty foods, a rash on the skin of his hands, feet, abdomen. On examination: the patient is obese, the liver and spleen are enlarged on palpation, xanthomas are on the skin.
Laboratory analysis: the serum is cloudy in all volume. After staying for 10 hours in the refrigerator a creamy layer is formed over the cloudy serum.
Cholesterol total – 5.2 mm/l (norm: 3.5-6.5 mm/l) At the start of the densitogram is detected:
TAG - 7.5 mm/l (normal: 0,5-2,0 mm/l), a strip of ChM and a wide strip of preβ - lipoprotein are appeared.
HDL - 0.9 mm/l (norm: >0.9 mm/l)
What is the type of hyperlipoproteinemia? Prove your answer.

Task 2.
A 55-year-old man, who suffered from obesity, woke up at night (after spending the evening at a business dinner) from an unbearable pain in the first metatarsal-phalanx joint of the left leg. He couldn't stand on his feet. The affected joint was hot, swollen, reddened and sharply painful. The patient was treated with indomethacin, and the symptoms were quickly relieved. A year before an episode the patient had had an attack of renal colic but then he said that he was too busy to spend time on examination on this occasion.
From laboratory data:
Serum urates 0.78 mmol/l.
Task:
1. Suppose the diagnosis.
2. Explain the cause of the observed symptoms.

Task 3.
A 12-year-old patient suffering from type 1 diabetes mellitus was taken to hospital with complaints about severe leg swelling and all over the body, as well as fatigue and weakness. During the clinical study the patient was diagnosed with proteinuria (more than 500 mg/day), hypoalbuminemia, after which "nephropathy" was diagnosed which is one of the main forms of diabetic microangiopathy. What metabolic disorders led to a decrease in glomerular filtration rate and, as a consequence, to diabetic nephropathy? To answer: a) what is the cause of insulin-dependent diabetes and list the metabolites which blood and urine concentration increased in such patients; b) explain the main symptoms of diabetes, reflecting disorders of carbohydrate, protein and lipid metabolism;
c) explain the mechanisms of development of late complications of insulin-dependent diabetes, causing changes in the kidney glomerular apparatus.

Task 4
The young woman was taken to hospital being unconscious. She took a suicidal dose of paracetamol. Biochemical blood test showed: AST – 5500M/l, alkaline phosphatase – 125 m/l, bilirubin - 70 micromol/l, creatinine – 350 micromol/l, glucose – 2.6 mmol/l, blood pH 7.1. How do you assess the obtained data? Explain the basic mechanisms of a drug biotransformation.

Task 5
The high activity of creatine phosphokinase (MB-isoform), myoglobin and troponin T are found in the patient blood. What is the possible diagnosis? Prove your answer.

Task 6
A man 52-year-old come to the doctor with complaints about a prolonged chest pain, asphyxia. A preliminary diagnosis is "myocardial infarction". What specific biochemical tests are to be done to confirm the diagnosis?

Task 7
A sharp increasing activity of LDH, AST and ALT was found in biochemical blood analysis. The de Ritis' coefficient is 3.85.
A. What disease you could assume?
B. The activity of what blood enzyme will be also increased?

Task 8
After the biochemical blood test the patient received the following results: alkaline phosphatase is 800 U/l, ALT - 45 U/l ACT – 33 U/l. What disease you could assume?

Examples of questions for credits:

1. Causes and pathology of cell organelles (membrane, mitochondria, ribosomes, Golgi apparatus, peroxisomes).
2. Evaluation of the reliability of laboratory investigated methods: reproducibility, accuracy, specificity, sensitivity, permissible error of the results.
3. Homeostasis. Blood composition. Osmotic, oncotic pressure. Electrolyte composition. The role of plasma proteins.
4. Inflammation, causes, phases of inflammation (alteration, exudation, proliferation). Regulation of inflammation.
5. The principles of column chromatography, possibilities of the method. Ultracentrifugation, alcohol deposition.
6. The main properties of enzymes and their characteristics.
7. Absolute and relative specificity of enzymes (examples).
8. One - and two-component enzymes, their structural features. Types of centers: active, substrate, allosteric.
9. Multienzyme complexes - metabolons, localization of enzymes in the cell.
10. Multiple molecular forms. The reasons for their formation.
11. Functional and non-functional blood enzymes. Enzymopathies. The causes of their occurrence.
12. Properties of diagnostically important enzymes: alcohol dehydrogenase, lactate dehydrogenase. The value of determination.
13. Methods to determine enzymes.
14. Value of determination of alanine and aspartate transferases. De Ritis' coefficient.
15. Creatine kinase, a common type and its isoenzymes. The value of determination.
16. Alkaline and acid phosphatase, amylase. The value of determination.
17. General rules to determine the serum enzyme activity. The units of enzyme activity.
18. Plasma lipids. Fatty acids, mono-, di-, triglycerides, phospholipids.
19. Lecithins (cholin-containing phospholipids). Cefalins (phosphatidylethanolamine), phosphatidylserine and their complexes.
20. Glycolipids: cerebrosides, gangliosides, sulfatides. Structure, role in the body.
21. Steroids, cholesterol, cholesterol esters. Its meaning of cholesterol in the body.
22. Plasma liporoteins. The structure, differences with the membrane lipoproteins.
23. The process of lipoprotein formation in the intestine and blood.
24. Apoproteins, their classification. Functions.
25. Disorders of a lipid metabolism, lipoproteins. Primary hyperlipoproteinemias: type I, IIa and IIb type. Features of catabolism.
26. Primary lipoprotein disorders. Hyperlipoproteinemia type III (family), type IV, type V. Longevity syndrome.
27. Hormones of the central and peripheral endocrinal glands. Lipophilic hormones, their receptors. Regulatory action.
28. Hydrophilic hormones, classification, their receptors. Biological effect of hydrophilic hormones.
29. Three types of receptors for hydrophilic hormones. Secondary messangers. The biological response of a cell.
30. Hormonal studies in the practice. Dissecretive and dissensitive hormonal disorders.
31. Glucose (hexose) – the main substrate of tissue respiration. Nutritional, extrainsular and insular hyperglycemia.
32. Regulation of blood glucose level (nervous, endocrine). Gluconeogenesis.
33. Insulin, proinsulin. Physiological effects, mechanism of action.

34. Diabetes mellitus: insulin-dependent and insulin-independent.
35. Contemporary diagnosis of diabetes. One-step glucose study, determination of C-peptide, glycosylated hemoglobin, albumin, ketone bodies, triglycerides.
36. Blood proteins and their function. Hypo-and hyperproteinemia.
37. Paper electrophoresis of blood proteins. Characteristic. The meaning of investigfation. Constellation types.
38. Blood proteins at electrophoresis in polyacrylamide gel (PAAG). Characteristics of albumin, GC proteins, their role in the body.
39. C-reactive protein, its characteristics. The value of determination.
40. Interferon, lysozyme, and haptoglobin. Characteristic. The meaning of their definition.
41. The system of complementary proteins. Classic and alternative way of activation. The value of determination.
42. Ceruloplasmin – acute phase reactant, structure, function, value of determination.
43. Iron-containing proteins: transferrin, hemoglobin, myoglobin, ferritin. The meaning of their definition.
44. Cryoglobulins, alpha -2-macroglobulin are protease inhibitors. The meaning of their detection.
45. Neutral glycoproteins (PAS - positive) and acidic mucopolysaccharides. The value of investigation.
46. Classification of antigens associated with tumors.
47. Characteristics of some tumor markers.
48. Laboratory diagnostics and interpretation of the results of tumor markers studies.

5.4. List of Assessment Tools

Test
Discussion of situational tasks
Tests
Interview
Grading scales are given in Appendix 1.

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	William J. Marshall	Clinical biochemistry: Metabolic and clinical aspects	London, 2014
L1.2	Michael Lieberman, Alisa Peet	Marks' medical biochemistry. A clinical approach. FIFTH EDITION	Wolters Kluwer, 2018
L1.3	Vladimír Bartoš, Milan Dastych, Milan Dastych jr. and others	Clinical biochemistry	Prague, 2016

6.1.2. Advanced Reading

	Authors, Compliers	Title	Book publisher, Year
L2.1	O. P. Gumilevskaya, E. A. Zagorodneva. K. P. Vakhania et al.	Clinical biochemistry	Volgograd, 2014
L2.2	S.V. Lelevich, T.V. Popechits	Clinical biochemistry	Grodno, 2010

6.2. Online Resources

E1	National Library of Medicine	http://www.nlm.nih.gov/
E2	Clinical biochemistry/ Health Careers	https://www.healthcareers.nhs.uk/.../clinical-biochemistry
E3	Indian Journal of Clinical Biochemistry	https://www.springer.com/life.../biochemistry+%26.../12291

6.3 List of Information and Education Technologies

6.3.1 Competence-based Educational Technologies

6.3.1.1	Recent Clinical Biochemistry Articles – Elsevier https://www.journals.elsevier.com/clinical-biochemistry/recent-articles
6.3.1.2	IJCBR-International Journal of Clinical Biochemistry and Research, https://www.innovativepublication.com/journal/IJCBR

6.3.2 List of Information Reference Systems and Software

6.3.2.1	Karolinska Institute: Diseases and Disorders: http://www.mic.ki.se/Diseases/C18.html
6.3.2.2	Lipids Online: http://lipidsonline.org/
6.3.2.3	Society for Neuroscience: http://www.sfn.org

7. COURSE (MODULE) LOGISTICS	
7.1	For successful studying of disciplines students are provided with:
7.2	Special rooms for lectures, seminars, group and individual work, midterm examination and evaluation as well as for individual work, for storage facilities and maintenance of training equipment.
7.3	Rooms equipped with special furniture and technical tools for education which are used to provide a large audience with educational information.
7.4	Lecture rooms with a set of multimedia equipment: a laptop, a projector, a screen to make presentations, to provide thematic illustrations for corresponding subjects (modules) and course disciplines.
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	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 to practice.
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 STUDENTS)

The planning sheet of discipline is in Appendix 4.
Recommendations to organize students' independent work on Biochemistry.
- Studying the theoretical part of the discipline is intended to extend and consolidate the knowledge gained in the auditorium classes, as well as 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 the Internet to expand their knowledge in the discipline.

- Carry out time management the way to study the course during the whole semester with regular revision of the course material.
During the laboratory classes students achieve the following aims:
- to deep and consolidate of theoretical knowledge of the course, using practical tasks;
- to develop skills in scientific experimentation, to analyze of the obtained results;
- to form of primary skills of organization, planning and research;
- to prepare each lab and perform in front of the group.
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;
- record the obtained results in the form of diagrams, tables, charts;
- process the results, analyze data, formulate conclusions induvidualy;
- to make and defend a report.
Individual work in studying discipline includes:
- study lecture note on a regular basis and work out extra information from additional sourses;
- 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 questions on the discipline topics, solving tasks of IW;
Preparation for midterm examination and control includes:
- revision of lecture notes;
- revision of notes of practical classes;
- revision of 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:
- revision of theoretical material using literature sources, periodicals, Internet resources;
- 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 with 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 a necessary chapter.
- read all titles of chapters, introduction, paragraphs, diagrams, charts, graphs and drawings. Choose and read the required section or chapter;
- select passages, providing the main 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 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 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 discuss issues with group mates;
- use additional information to deep and expand theoretical knowledge to check the material;
- if questions are not clear ask the teacher for explanation.

Appendix 1

The assessment scales

Assessment criteria for answers to situational tasks:

5 points - student gives precise answers to all questions on situational problems (86- 100%), using terms and definitions from basic, main and additional literature.

4 points – a student answers all the questions correctly, but not in details, makes minimal mistakes (76-85%), uses references from basic and main literature.

3 points - student solves the problem correctly, but doesn't answer all the questions (60 - 75%), omitting details, answers with errors, uses references from basic literature.

0-2 points – student solves the fragments of the task correctly, doesn't answer all the questions making mistakes and uses references from basic literature (knows less than 60% of information).

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

Appendix 2

The planning sheet of discipline

Discipline: Clinical biochemistry
Area/specialization: General Medicine
Course/semester: **5/9**
Credit units (CU): 2

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. Metabolic disorder. Biochemical indicators of metabolic disorders in the human body.	Formative assessment	Activity, attendance, conspectus, performance and presentation of lab works, individual work with tables, discussion of situational tasks	10	20	9
	Midterm examination	Evaluation test	10	15	
Module 2					
Module 2. The mechanisms of the metabolic processes disorders in cells	Formative assessment	Activity, attendance, conspectus, performance and presentation of lab works, individual work with tables, discussion of situational tasks, writing of reports	10	20	17
	Midterm examination	Evaluation test	10	15	
Total for semester			**40**	**70**	
Midpoint assessment			20	30	
Summative assessment			60	100	