FACULTY OF DENTISTRY
STUDY PROGRAM 0911.1 DENTISTRY
CHAIR OF BIOCHEMISTRY AND CLINICAL BIOCHEMISTRY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum Faculty of Dentistry
Minutes No. 01 of 05.10.2023
Chairman, PhD, associated professor
Stepco Elena _____

APPROVED
at the Council meeting of the Faculty of Dentistry
Minutes No. 02 of 12.10.2023
Dean of Faculty, PhD, associated professor
Solomon Oleg _____

FACULTATEA DE STOMATOLOGIE

APPROVED
at the meeting of the chair of Biochemistry and Clinical Biochemistry
Minutes No. 2 of September 20, 2023
Head of chair, dr. hab., professor
Tagadiuc Olga _____

SYLLABUS

DISCIPLINE **THE BASICS OF MEDICAL BIOCHEMISTRY**

Integrated studies

Type of course: **Compulsory**

Curriculum was elaborated by:

Tagadiuc Olga, PhD, dr. hab. of med., professor
Stratulat Silvia, PhD, dr. of med., associate professor
Timercan Tatiana, PhD, dr. of med., associate professor

Chisinau, 2023

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I. INTRODUCTION

General presentation of the discipline: place and role of the discipline in the formation of the specific competences of the professional / specialty training program

The aim of the Basics of Medical Biochemistry is to provide students of the Faculty of Dentistry theoretical background knowledge and general practical skills in medical biochemistry, indispensable to the professional activity of all medical professionals. Students will study the biochemical bases of human organism existence and functioning, structural-metabolic and functional disorders in some major pathologies, as well as the particularities of the composition and metabolism of mineralized dental tissues.

The activities of the discipline study will create the students' individual and team work skills, formulation and problem solving, working on certain laboratory equipment, analyzing and interpreting the results of the medical investigations, applying the theoretical knowledge in the dental practice, integration of information from different disciplines (fundamental and clinical), etc.

Mission of the curriculum in professional training is in studying:

a) the structure of the main chemical compounds of the living matter and of the fundamental metabolic processes underlying the functionality of the living organisms;
b) particularities of chemical compounds and metabolic processes that ensure the functioning of the organs and mechanisms underlying the metabolic disorders;
c) particularities of the composition and metabolism of mineralized dental tissues
d) clinical biochemical investigation methods and laboratory analysis and interpretation skills.

Language (s) of the discipline: Romanian, Russian, English

Beneficiaries - students of the 1st and 2nd years, study program 0911.1 Dentistry

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		**F.02.O.017 / F.03.O.029**	
Name of the discipline		**The basics of medical biochemistry**	
Person(s) in charge of the discipline		**Timercan Tatiana**	
Year	**I/II**	Semester	**II/III**
Total number of hours, including:			**90/120**
Lectures	**15/15**	Practical/laboratory hours	**15/15**
Seminars	**15/15**	Self-training	**45/75**
Form of assessment	**E / E**	Number of credits	**3/4**

III. TRAINING AIMS WITHIN THE DISCIPLINE

At the end of the discipline study, the student will be able to:

a) at the level of knowledge and understanding:

- to know the physico-chemical structure and properties of the main chemical compounds of medical interest;
- to know the fundamental metabolic processes that ensure the viability and reproduction of the human body;
- to know the structural and metabolic features of organs and tissues under physiological conditions and in some hereditary and acquired diseases;
- to understand the neuro-endocrine mechanisms of metabolic regulation that underlie the normal activity of the body;
- to know the influence of various factors (vitamins, pharmaceuticals, toxins) on cardinal metabolic processes;
- to learn the normal values and physiological variations of the main biochemical markers;
- to know the clinical-diagnostic value of the changes of the biochemical markers;
- to know the particularities of the composition and metabolism of mineralized dental tissues.

b) at the application level:

- to carry out the collection of saliva for biochemical investigations;
- to possess the way of working on the main machines used in the biochemical laboratory (simple and automatic pipettes, pH meter, photoelectric meter, spectrophotometer, centrifuge, etc.);
- to appreciate the usefulness of certain biochemical investigations in the diagnosis of specific conditions;
- to interpret the results of biochemical tests correctly.

c) at the integration level:

- to appreciate the importance of medical biochemistry in the context of general medicine and Dentistry in particular;
- to know the correlations between medical biochemistry and other fundamental, clinical and dental disciplines;
- to objectify the connections and interdependence between structural, metabolic and clinical biochemistry;
- to appreciate the evolution of physiological metabolic processes and their disorders that condition various diseases;
- to demonstrate the mechanisms of various metabolic processes regulation both under physiological conditions and in pathology;
- to formulate scientific research options in medical biochemistry and substantiate their importance by collecting data from the literature.

IV. PROVISIONAL TERMS AND CONDITIONS

The Basics of Medical Biochemistry is a biomedical discipline, the study of which during integrated university studies will allow future dental specialists:

– to know the molecular basis of physiological metabolic processes, biochemical mechanisms vital functions regulation;
– understand the causes and pathogenesis of hereditary and acquired diseases that damage different organs;

– to know the molecular basis of structural-metabolic homeostasis of mineralized dental tissues;
– to justify the necessity of biochemical investigation under physiological and pathological conditions, including pathology of the dental system;
– to understand the results of the laboratory test and correlate them with the clinical and functional data for diagnosis purposes;
– to develop the lifecycle correction schemes;
– to know the principles of the therapies adapted to the pathology and biochemical mechanisms.

To learn the discipline, a thorough knowledge of Chemistry and Biology, obtained in pre-university studies, as well as in the field of Structural Biochemistry, Anatomy, Human Histology and Physiology obtained in university studies are required.

Internet skills are also needed to identify the materials needed for study and individual work, documents, tables and presentations processing.

V. THEMES AND ESTIMATE ALLOCATION OF HOURS

Lectures, practical hours/laboratory hours/seminars and self-training

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
1	The importance of biochemistry for medical disciplines. Functional groups and types of chemical bonds specific to biomolecules. Amino acids - biomedical role, structure, classification and properties.	1	2	3
2	Role, structure and classification of proteins.	2	2	3
3	Physico-chemical properties of proteins. Methods of protein separation and purification.	1	2	3
4	Nucleoproteins. Nucleic acids - classification, structure and functions. Nitrogen bases, nucleosides and nucleotides - structure, nomenclature and properties.	1	2	3
5	*Concluding test on chapter "The structure of proteins and nucleic acids."*		2	3
6	Biological role of enzymes. Chemical nature and enzyme´s structure. Coenzymes. Vitamins as coenzymes. Mechanism of enzyme catalysis. Classification and nomenclature of enzymes	1	2	3
7	Kinetics of enzymatic reactions. Regulation of enzyme activity. The use of enzymes in medical practice.	1	2	3
8	General notions about metabolism. Oxidative decarboxylation of pyruvate. Krebs cycle.	1	2	3
9	Biological oxidation. Electron transport chain and oxidative phosphorylation.	2	2	3

10	*Concluding test on chapters "Enzymes" and "Bioenergetics".*		2	3
11	Carbohydrates: biological role, classification and structure. Digestion and absorption of carbohydrates. Glycogen metabolism.	3	2	3
12	Glucose metabolism.	2	2	3
13	Pentose-phosphate pathway. Metabolism of fructose and galactose. Regulation and disorders of carbohydrate metabolism.	1	2	3
14	*Concluding test on chapter "Metabolism of the carbohydrates"*		2	3
15	Evaluation of student's individual work.		2	3
	Total hours for the I semester	**15**	**30**	**45**
16	Lipids: structure, properties, biological role and classification. Digestion and absorption of lipids. Metabolism of triglycerides.	1	2	5
17	Metabolism of fatty acids and ketone bodies.	2	2	5
18	Metabolism of structural lipids. Regulation of lipid metabolism.	2	2	5
19	*Concluding test on chapter "Metabolism of lipids"*		2	5
20	Digestion and absorption of proteins. Putrefaction of amino acids in the intestine. General pathways of amino acid metabolism.	2	2	***5***
21	Synthesis of dispensable amino acids. Use of carbon skeletons of amino acids. End products of nitrogen metabolism. Mechanisms of ammonia detoxification.	2	2	5
22	Metabolism of nucleoproteins and chromoproteins.	2	2	5
23	*Concluding test on chapter "Metabolism of simple and conjugated proteins"*		2	5
24	The biochemical mechanisms of genetic regulation – replication, transcription, translation.		2	5
25	Hormones. Structure, classification, biosynthesis, regulation of synthesis and secretion. The mechanism of action and metabolic effects of proteic hormones and catecholamines.	1	2	5
26	Cytosolic-nuclear mechanism of hormones action of steroid and thyroid nature (T3 and T4). Regulation of synthesis and secretion. Effects of hormones: glucocorticoids; thyroid (T3 and T4). Vitamins A and D. Eicosanoids.	1	2	5
27	Blood. General composition. Composition of the blood plasma. Plasma proteins, enzymes, non-protein organic substances and mineral substances.	1	2	5
28	Biochemistry of saliva	1	2	5
29	***Concluding test on chapters "Genetic and hormonal regulation of metabolism" and „Biochemistry of humors (blood and saliva)"***		2	5

30	Evaluation of student's individual work.		2	5
	Total hours for the II semester	**15**	**30**	**75**
	Total fours for the year	**30**	**60**	**120**

VI. PRACTICAL TOOLS PURCHASED AT THE END OF THE COURSE

- To appreciate the biological value of nutrients depending on their composition.
- To explain the clinical-diagnostic value of individual enzymes used in clinical medicine (LDH, CPK, ALT, AST, alkaline and acidic phosphatases).
- To justify the clinical-diagnostic value and usefulness of determining biochemical indices: blood glucose, glycated hemoglobin, plasma albumin, urea, creatinine, total, conjugated and non-conjugated bilirubin, uric acid, triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol.
- To appreciate the biochemical role of water and fat-soluble vitamins.

VII. OBJECTIVES OF CONTENT UNITS

Objectives	Content units
Chapter 1. Structure of proteins and nucleic acids.	
1. Define the concepts of bio element and biomolecule and identify the connections between them, their content in the body, the physico-chemical properties and their role in the organism. 2. Know the functional groups as reactive zones of the biomolecule. 3. Know the nature of chemical bonds and their role in the stability of biomolecules 4. Know the structure, role and properties of amino acids. 5. Define the notions of proteinogenic and non-proteinogenic amino acids, stereoisomerism, and solubility. 6. Select amino acids according to all classification principles. 7. To justify the need to know the properties of amino acids 8. Explain the importance of proteins for living organisms, especially for human beings. 9. Define the notion of protein. 10. Know the levels of proteins structural organization and their main properties.	1. The importance of biochemistry for medical disciplines. Structural, metabolic and clinical biochemistry and their tasks. 2. Organic and mineral bio elements. The main bio elements that make up the human body. 3. Biomolecules – macro and micro molecules. 4. Functional groups. Types of functional groups specific to biomolecules. Their general characteristic. 5. Types of chemical bonds specific to biomolecules. Their general properties 6. Amino acids - role in living organisms. Classification of amino acids according to chemical structure, physico-chemical properties, biological principle. Acid-base properties of amino acids. 7. Polypeptide theory of protein structure. Peptide bond properties. Name and reading the amino acids in peptides and proteins. N- and C-terminal amino acids. 8. Biological role of proteins. 9. Protein levels of structural-functional organization: primary, secondary, tertiary and quaternary structures, general description. Chemical bonds specific to these structures. Concepts of structural domains. 10. Proteins classification. 11. Simple proteins (albumins, histones) - properties and structural particularities. The biological role. 12. Conjugated proteins: nucleo-, phospho-, lipo-, glyco-, metallo- and chromoproteins (hemo- and flavoproteins), their general characteristic.

11. Identify the specific proteins of organs and their structural and functional particularities 12. Apply methods for protein separation and purification. 13. Explain the clinical-diagnostic value of the proteins. 14. Define the notion of nucleic acids and differentiate their types, subtypes and biological role. 15. Know the structures of DNA and RNA. 16. Identify the impact of the DNA and RNA structure disorders on the genesis of hereditary diseases.	13. Fibrillar proteins: collagen – peculiarities of amino acid composition and structure. Biologic role. 14. Notions about Ca-binding proteins. 15. Amphoteric properties of proteins. Total electrical charge of proteins. Factors that determine the electric charge of protein. Isoelectric point and state. 16. Solubility of proteins. Hydrophilic properties of the proteins according to their amino acid composition, structural peculiarities, solution pH and temperature. Colloidal solutions of proteins. States of the colloidal solutions (sol, gel, xerogel). Biomedical importance of xerogel. 17. Denaturation of proteins, agents causing denaturation. Structural changes in denaturated proteins. Biomedical role. 18. Methods of protein separation, purification and analysis: a) dialysis; c) electrophoresis; d) chromatography; e) spectrophotometry (principle of methods, biomedical importance). 19. Types of nucleic acids, functions and cell location. 20. Chemical composition of nucleic acids: nitrogenous bases, pentoses, and phosphate. 21. Nucleosides and nucleotides - structure, role, properties and nomenclature. 22. Primary structure of nucleic acids (DNA and RNA). Polynucleotide chain. Phosphodiester bonds. 23. Secondary and tertiary structure of DNA. Watson-Crick model. DNA double helix and its conformations (B, A, and Z). Levels of compaction of DNA molecule prokaryotes and eukaryotes (nucleosome, solenoid, chromatin, chromosomes). 24. RNA secondary and tertiary structures
Chapter 2. Enzymes	
1. Know the structure of enzymes and their mechanism of action. 2. Specify the properties of the enzymes resulting from their protein nature. 3. Identify the importance of vitamins as coenzymes. 4. Apply methods for the separation and purification of proteins and the evaluation of enzyme activity. 5. Identify the type of enzyme specificity and its biomedical role. 6. Be able to represent the graphs of enzyme´s activity dependence on various environmental factors. 7. Identify types of inhibition. 8. Be able to explain the mechanisms of regulation of enzyme activity.	1. Enzymes – definition and biological role. Properties that enzymes share with and are different from non-organic catalysts. 2. Chemical nature of enzymes. 3. Structure of the enzyme. Active and allosteric sites. Simple and conjugated enzymes. Notions of holoenzyme, apoenzyme, cofactor, coenzyme, co-substrate and prosthetic group. 4. Coenzyme function of vitamins and microelements. Structure of vitamins B_1, B_2, B_6, PP, ascorbic acid. Their metabolic role. 5. Mechanism of enzyme catalysis. The active center of the enzyme and its role in the formation and changes of the intermediate complexes between enzyme and substrate. The role of mutual conformational changes of the enzyme and substrate molecules in the catalysis. 6. Enzyme classification and nomenclature. Overview of enzyme classes.

9. Define the notion of isoenzymes and their biomedical role. 10. Be able to identify the enzymatic profile in the blood in various organ disorders. 11. Explain the clinical-diagnostic value of enzymes in general and of individual enzymes used in medical practice.	7. Specificity of enzymes (types, examples). 8. Enzyme kinetics. Influence of enzyme and substrate concentration, pH and temperature on enzyme activity. 9. Activation and inhibition of enzymes: – activation of enzymes by partial proteolysis. Zymogens. – inhibition of enzyme activity (specific and non-specific, reversible and irreversible, competitive and non-competitive). 10. Regulation of enzyme activity (allosteric and covalent regulation). Importance of *feedback* inhibition principle. 11. Isoenzymes – structural and functional peculiarities, biomedical importance. 12. Enzyme usage in medicine: – enzyme diagnostic; – enzyme therapy; – usage of enzymes in laboratory activity. 13. Principle of enzyme activity determination. Units of enzyme activity (international unit, katal, specific activity)
Chapter 3. Bioenergetics	
1. Define the notions of metabolism, anabolism, catabolism and amphibolic phase of metabolism. Identify the connections between them. 2. Apply the laws and main principles of thermodynamics to living organisms. 3. Know the biological importance of the main energy processes in the human body. 4. To know the main bioenergetics processes in human cells - pyruvate oxidative decarboxylation, Krebs cycle, electron transport chain and oxidative phosphorylation 5. Know the regulatory enzymes of each metabolic pathway, levels and types of their regulation. 6. Explain the mechanism of oxidation and phosphorylation coupling. 7. Be able to calculate the energy yield of pyruvate oxidative decarboxylation and Krebs cycle. 8. Explain the mechanism of electron transport chain inhibition and uncoupling of oxidative phosphorylation.	1. Notion about metabolism. Anabolism and catabolism. Metabolic pathways. Amphibolic stage of metabolism, its role. 2. Thermodynamic laws. Thermodynamic concepts in the area of bioenergetics: enthalpy, entropy and free energy. Standard free energy, its significance. Endergonic and exergonic reactions. 3. High energy compounds: role, main representatives, structural peculiarities. 4. Chemical structure and function of ATP. ATP cycle. ATP hydrolysis pathways. Mechanisms of ATP biosynthesis. 5. Energetic regulation of cellular metabolism 6. Oxidative decarboxylation of pyruvate – enzyme complex, cofactors, overall reaction, stages, regulation, connection with Krebs cycle and electron transporting chain. Biomedical role. 7. The tricarboxylic acid cycle (Krebs): functions, reactions, enzymes, overall reaction, connection with the electron transporting chain, energy output, regulation. Anaplerotic reactions – importance. 8. Biologic oxidation. Dehydrogenation – energy source for ATP biosynthesis. Reactions, enzymes and coenzymes of dehydrogenation. 9. Electron transport chain (ETC) – location, the biological significance. • Structure and oxidoreduction properties of the main acceptor of protons and electrons (NAD^+, FAD, FMN, CoQ). General descriptions of the cytochromes and Fe-S proteins structure. • Redox-potential of ETC components. Connection between the free energy and oxido-reduction potential.

9. To present the connections between the main energy processes in the cell, as well as their impact on cell viability and homeostasis.	• Scheme of the respiratory chain. Enzyme complexes. Inhibitors of ETC. 10. Oxidative phosphorylation. Phosphorylation points. Regulation of the ETC function. The P/O ratio. 11. The mechanism of phosphorylation and oxidation coupling (Mitchell hypothesis). ATP synthase. The inhibitors of ATP-synthase. Role of the inner mitochondrial membrane in ATP biosynthesis. 12. Uncoupling of oxidation and phosphorylation processes. Uncoupling agents, their mechanism of action. Examples of physiological and pathological uncoupling.
Chapter 4. Structure and metabolism of carbohydrates.	
1. Define carbohydrates and appreciate their biomedical role. 2. Know the classification of carbohydrates. 3. Understand the differences between different types of monosaccharides 4. Understand the role of structural peculiarities and isomerism that leads to the diversification of monosaccharides. 5. Understand which structural particularities underlie the polymerization of carbohydrates 6. Know the link between structure, properties and the role of oligo- and polysaccharides. 7. Identify the stages of carbohydrates digestion, absorption and associated disorders. 8. Understand the connections between the carbohydrate and energy metabolism processes and the reciprocal regulatory influences. 9. Be able to calculate the energy output of anaerobic and aerobic oxidation of individual carbohydrates (glucose, galactose, fructose). 10. To know the regulating enzymes of glycogenolysis, glycogenogenesis, glycolysis, gluconeogenesis and glucose oxidation pentose phosphate pathways, their levels and types of regulation.	1. The biological role of carbohydrates. 2. Classification and structure of carbohydrates: – monosaccharides (glyceraldehyde, dihydroxyacetone, glucose, galactose, fructose, ribose, deoxyribose) – disaccharides (maltose, lactose, sucrose); – homopolysaccharides (glycogen, starch, cellulose); 3. Biochemical mechanisms of digestion and absorption of carbohydrates. Disaccharide intolerance. 4. Glucose transport from blood into tissues – glucose transporters (GLUT). Carbohydrates usage in the tissues. 5. Glycogen metabolism: glycogenogenesis and glycogenolysis. Reactions, enzymes, reciprocal regulation of processes. Glycogenoses (general notions). 6. Glycolysis: biological role, reactions, enzymes, the overall reaction. 7. The scheme of aerobic oxidation of glucose. 8. Shuttle systems (glycerol-phosphate and malate-aspartate) for the reducing equivalents transportation from cytosol into mitochondria. Their importance. 9. Energy output of glucose oxidation in aerobic and anaerobic conditions. 10. Gluconeogenesis - substrates, reactions, enzymes, overall reaction. Cori cycle. 11. Reciprocal regulation of glycolysis and gluconeogenesis. 12. Pentose phosphate pathway of glucose oxidation. Biological role of the process, reactions of the oxidative phase, enzymes, coenzymes. Overall equation of the I stage and of the entire process. 13. Fructose metabolism - liver and muscle pathways: partial reactions, enzymes, biological role. Hereditary disorders of fructose metabolism. 14. Galactose metabolism – partial reactions, enzymes, biological role. Hereditary disorders of galactose metabolism. 15. Hormonal regulation of carbohydrate metabolism: influence of insulin, glucagon, catecholamines and glucocorticoids.

11. Can appreciate glucose metabolism disorders based on main biochemical investigations (physio-logical and pathological hypo- and hyperglycemia).	16. Disorders of carbohydrate metabolism in diabetes mellitus, steroid diabetes, chronic alcohol consumption 17. Diagnostic value of carbohydrate metabolism assessing tests: basal glycaemia, glucose tolerance test, concentration of insulin, C-peptide and glycated hemoglobin.
Chapter 5. Structure and metabolism of lipids.	
1. Define lipids and their biomedical role. 2. Define lipids and appreciate their biomedical role 3. Be able to differentiate between classes of lipids according to their structure and functions 4. Understand how the structure determines the properties and functions of different types of lipids. 5. Identify the stages of lipid digestion, absorption, resynthesis and transport, and associated disorders. 6. Know ways to metabolize lipids in different tissues and the mechanisms involved. 7. Understand the connections between the processes of lipid, carbohydrate and energy metabolism and the reciprocal regulatory influences. 8. Demonstrate the ways of mutual transformations glucose ↔ lipids. 9. Be able to appreciate lipid metabolism disorders based on main biochemistry investigations (hypo- and hyperlipidemia, hypercholesterolemia, lipidemia).	1. Biological functions of lipids. The importance of lipids in the diet. Indispensable fatty acids (vit. F). 2. Classification of lipids (structural, functional, according to physico-chemical properties). 3. Structure, physico-chemical properties, representatives. Biomedical role: – saturated and unsaturated fatty acids (palmitic, stearic, palmitoleic, linoleic, linolenic) – acylglycerols – mono-, di- and triglycerides. – glycerophospholipids: phosphatidylserine, phosphatidyl-ethanolamine, phosphatidylcholine, phosphatidylinositols. 4. Digestion and absorption of dietary fat: • Structure and role of bile acids. • Digestion of triglycerides, phospholipids, cholesterides: enzymes, hydrolysis products. • Absorption of lipid hydrolysis products. 5. Lipid resynthesis in enterocytes. Formation, role and notions about metabolism of chylomicrons. 6. Metabolism of triglycerides. Biosynthesis and catabolism of triglycerides: location, reactions, enzymes and coenzymes, hormonal regulation (action of catecholamines, glucagon, insulin, glucocorticoids). 7. Glycerol metabolism – sources and pathways for using; oxidation: reactions, enzymes, energy output. 8. Biosynthesis of fatty acids - location, steps, reactions, enzymes, coenzymes, regulation: a) saturated with even number of carbon atoms; b) unsaturated with even number of carbon atoms. 9. Beta-oxidation of fatty acids: – saturated with even number of carbon atoms (location, steps, reactions, enzymes, coenzymes, energy output, regulation); – unsaturated with even number of carbon atoms (monoenic). 10. Ketone bodies: representatives, chemical structure; biological role; biosynthesis (location, substrate, reactions and enzymes); usage (tissues, reactions, the final products, energy output). Ketonemia and ketonuria (causes, mechanism of development). 11. Neurohormonal regulation of lipid metabolism. Action of catecholamines, glucagon, insulin, glucocorticoids, thyroid hormones. 12. Cholesterol biosynthesis – stages, the first step reactions (up to mevalonic acid), enzymes, coenzymes, regulation.

	Catabolism and excretion of cholesterol (general concepts). 13. Biosynthesis of glycerophospholipids: location, reactions (scheme), enzymes and coenzymes. Lipotropic substances, their role. 14. Notions about blood transport of lipids. Plasma lipoproteins: structure, separation methods, fractions (chylomicrons, VLDL, LDL and HDL), chemical composition (lipids and apoproteins), functions. 15. Reference values of serum lipids. The diagnostic significance of serum triglycerides, total cholesterol, HDL- and LDL-cholesterol assay. 17. Interrelations between energy, carbohydrates and lipid metabolism.
Chapter 6. Metabolism of simple and conjugated proteins	
1. Identify the stages of protein digestion and absorption in GIT. 2. Define the types of nitrogen balance and describe the people for whom it is specific. 3. Be aware of the biomedical importance of the transamination process and enzymes. 4. Describe the main processes that generate ammonia and its toxicity mechanisms. 5. To know the ways of temporary and final detoxification of ammonia, elimination of the detoxification products and the diseases associated with the disturbances of these processes. 6. Explain the clinical importance of urea assay in urine and blood. 7. To know the path of hemoglobin biosynthesis. 8. Differentiate the main types of jaundice (prehepatic, hepatic and posthepatic) by the level of bile pigments in blood, urine and stool. 9. Know the pathways of the metabolic use of nucleotides in general, their sources and mechanisms of synthesis and metabolism.	1. Dietary proteins requirements. Biological value of food proteins. Nitrogen balance. 2. Protein digestion and absorption. • Proteolytic enzymes. Activation mechanism. The specificity of proteases. • Digestion of proteins in the stomach. Gastric proteolytic enzymes. The role of hydrochloric acid. • Digestion of proteins in the intestine. Pancreatic and intestinal proteolytic enzymes. Regulation of proteins digestion in the intestine. • Absorption of amino acids in the intestine. Secondary active transport and facilitated transport of amino acids. 3. Notions about putrefaction of amino acids in the intestine. Putrefaction products. General notions about detoxification mechanisms of toxic products in the liver. 4. The fate of absorbed amino acids. Transport of amino acids in the cell. The gamma-glutamylic cycle. Amino acid pool. 5. Transamination of amino acids: mechanism, enzymes, coenzymes, importance of the process. Diagnostic value of determination of transaminase activity (ALT and AST) in the blood. 6. Amino acid deamination. Types. • Oxidative deamination of glutamic acid (reaction, enzyme, coenzymes, importance of process). • Indirect oxidative deamination of amino acids. Stages. Enzymes, coenzymes. The biological role. 7. Metabolism of alpha-ketoacids obtained by deamination of amino acids. Ketogenic and glucogenic amino acids. 8. Biosynthesis of dispensable amino acids (transreamination, biosynthesis from essential amino acids). 9. Biochemical mechanisms of ammonia toxicity. Ammonia detoxification: carbamoyl phosphate synthesis, reductive amination of alpha-ketoglutarate. 10. Synthesis and role of glutamine. Kidney-type glutaminase. Formation of ammonium salts.

	11. Biosynthesis of urea. Reactions, enzymes, overall reaction. Ureogenetic cycle enzyme deficiencies. 12. Hyperammonaemia and uremia (causes, clinical manifestations, treatment principles). Decarboxylation of amino acids (reactions, enzymes, coenzymes). Biosynthesis of histamine, serotonin, dopamine, gamma-aminobutiric acid, their biological role. General notions about neutralization of biogenic amines. 13. Digestion and absorption of nucleic acids and chromoproteins. 14. Hemoglobin biosynthesis: place, substrates, the first two reactions, regulation. Porphyria (general notions). 15. Hemoglobin catabolism. Bilirubin: formation, conjugation, biliary excretion, its metabolism in the intestine. 16. Hyperbilirubinemia. The main types of jaundice (prehepatic, hepatic and posthepatic). The importance of blood, urinary and fecal pigments assay in the diagnosis and differentiation of the jaundices. 17. General concepts about purine and pyrimidine nucleotide biosynthesis: the sources of atoms in the purine ring, reactions to phosphoribosyl amine, the scheme of synthesis pathways, regulation. 18. Notions about reuse of purine and pyrimidine nucleotides. 19. General concepts about nucleotides catabolism. Pathways (scheme) and end products of nucleotide cleavage. Gout - causes, clinical manifestations, treatment principles.
Chapter 7. Genetic and hormonal regulation of metabolism	
1. Present the molecular biochemical mechanisms and identify the similarities and differences of the replication, transcription and translation processes. 2. Define the notion of hormones and know their general properties. 3. Know the biomedical importance of hormonal regulation. 4. Describe the main mechanisms of action of hormones. 5. Identify the particular steps of different structure hormones mechanisms of action. 6. Know the individual hormones, their role, mechanism of action and the effects on the main metabolic processes. 7. Be able to distinguish the main disorders of hormonal secretion.	1. Replication of DNA in prokaryotes - template, substrates, enzymes and protein factors. Biochemical mechanism and stages of DNA biosynthesis. 2. The peculiarities of DNA replication in eukaryotes. Telomeres and telomerase – role and structure (general concepts). The biomedical role of telomerase. 3. Transcription in prokaryotes – the template, substrates, enzymes, biochemical mechanism. 4. The peculiarities of RNA biosynthesis in eukaryotes. Post-transcriptional modifications of mRNA. 5. Biochemical mechanisms underlying the regulation of gene expression in prokaryotes and eukaryotes. 6. Protein synthesis in prokaryotes. Stages: activation of amino acids; translation - initiation, elongation, termination. 7. Peculiarities of protein synthesis in eukaryotes - translation factors and post-translational changes of the synthesized proteins. 8. General concepts about hormones. General properties and role of hormones in the body. 9. Classification of hormones.

8. Present the biochemical mechanisms responsible for the effects of various secretion abnormalities for each individual hormone. 9. Can appreciate hormonal disturbances based on biochemistry investigations.	10. Mechanisms regulating the hormones synthesis, secretion and action: the concept of feedback regulation; hormonal biorhythms. 11. Mechanisms of action of protein hormones and catecholamines: • structure of membrane receptors • the interactions between the hormone and the receptor • structure, classification and role of G proteins • effector enzymes and their activation mechanisms (adenylate /guanylate cyclase, phospholipase C) • the mechanisms for generating the second messengers (cyclic AMP, cyclic GMP, calcium ions, diacylglycerols, inositol triphosphates) • the activation mechanisms of protein kinases A,B,C • key enzymes of metabolism regulated by phosphorylation/ dephosphorylation. 12. The effects of catecholamines, insulin, glucagon, parathyroid hormone and calcitonin. 13. Cytosolic-nuclear mechanism of action of steroid and thyroid hormones (T3 and T4): • the structure of cytosolic and nuclear receptors • interactions between hormones and receptors • regulation of gene expression by the hormone-receptor complex 14. The effects of thyroid hormones (T3 and T4) and glucocorticoids 15. Vitamins D: structure, properties, metabolic role, hypo- and hypervitaminosis (causes and metabolic manifestations).
Chapter 8. Biochemistry of humors (blood and saliva)	
1. To know the general composition of blood. 2. To identify the main chemical compounds in blood. 3. To define the structural-functional peculiarities of the main nitrogenous and non-nitrogenous chemical compounds in the blood. 4. To know the functions of the main blood compounds. 5. To know the functions and general composition of saliva. 6. To identify the main compounds of major importance for the integrity of the dental tissues. 7. To be aware of the role of saliva in maintaining the integrity of the dental tissues. 8. To apply the evaluation of saliva for diagnostic purposes.	1. Blood chemical composition and function. 2. Nitrogen-containing organic compounds of blood plasma: • Plasma proteins. Albumin, globulins (fibrinogen, transferrin, ceruloplasmin, haptoglobin, immunoglobulins). Methods of dosing and separation of proteins. Variations of protein fractions in disease. • Plasma enzymes. Functional classification. Mechanisms of plasma disenzymia. The main plasma enzymes with diagnostic value. • Non-protein nitrogen containing compounds of blood plasma. Residual nitrogen, its fractions in normal and pathological conditions. 3. Nitrogen free organic compounds of blood plasma (glucose, lipids, organic acids, ketone bodies). Importance of their determination. 4. Plasma mineral compounds. Their role. Ionogram of blood. 5. Biological role of saliva. 6. Physico-chemical properties of saliva: • Volume and flow. Hypo- and hyperptialism – causes, manifestations, consequences.

	• Viscosity and density. • pH – physiological and pathological variations. Salivary buffer systems Impact of changes in salivary pH on tooth condition. 7. Chemical composition of saliva: the main inorganic (anions, cations) and organic (proteins, enzymes, non-protein nitrogenous compounds and nitrogen free compounds) – representatives, origin and role. 8. The mechanism of salivary secretion at the acinar and ductal level. 9. The role of saliva in maintaining the integrity of the dental tissues. 10. Then usefulness of saliva in diagnosis.

VIII. PROFESSIONAL (SPECIFIC (SC)) AND TRANSVERSAL (TC) COMPETENCES AND STUDY OUTCOMES

✓ Professional (specific) (SC) competences

- PC1. Knowledge, understanding and use of language specific to medical biochemistry.
- PC2. General knowledge of key vital chemical compounds for the human body.
- PC3. Explaining the outcome of major metabolic processes that ensure the viability of the body and the mechanisms of the most important disease-specific disorders.
- PC4. Advanced knowledge of the chemical composition and metabolism peculiarities of the dental system under physiological conditions and in the most important diseases.
- PC5. Knowledge of the principles of biochemical laboratory methods, the diagnostic value of the main laboratory indices and the ability to interpret the results of basic laboratory investigations.
- PC6. Ability to work at the main laboratory equipment (spectrophotometer, centrifuge, pipette).

✓ Transversal competences (TC)

- TC1. Communication skills, written and oral, in the field of medicine and biochemistry.
- TC2. Individual and team work skills.
- TC3. The ability to apply effectively information technology to medical activity as well as to identify sources of information and continuous education in the field of activity.
- TC4. Understanding and the ability to apply the principles and values of general and professional ethics in action.

✓ Study finalities

Upon completion of the course, the student will be able to:

1. to know the structure and physical-chemical properties of the main chemical compounds of medical interest (proteins, carbohydrates, lipids, nucleic acids and vitamins);
2. to know the fundamental metabolic processes that ensure the viability and reproduction of the human body,
3. to know the structural and metabolic peculiarities of the dental system;
4. to know the normal values and the physiological changes of the main biochemical markers;

5. to appreciate the usefulness of certain biochemical investigations in the diagnosis of specific conditions and correctly interpret the results of biochemical investigations.
6. to determine independently some biochemical parameters of general clinical and diagnostic utility and in dental diseases;

IX. STUDENT'S SELF-TRAINING

No.	Expected product	Implementation strategies	Assessment criteria	Implementation terms
1.	Working with information sources	Selection of basic information and details on the questions of the topic by reading the lecture, the material in the manual and additional information sources on the topic. Full reading of text and systematization of essential content. Generalizations and conclusions about the importance of the theme / subject.	Level of assimilation of information and volume of work	During the semester
2.	Working with on-line information sources	Studying the teaching materials on the Department's website and supplementation of the information on the studied subject.	Level of assimilation of information and volume of work	During the semester
3.	Situational problems solved	Individual solving of situational problems in the subjects in accordance with the Practical Guide, with subsequent verification and individual discussion with the teacher in non-auditory hours.	Mark	Every studied chapter
4.	Self-assessment tests solved	Individual solving of self-evaluation tests for the topic in accordance with the Practical Guide, with subsequent verification and individual discussion with the teacher at non-auditory hours.	Mark	Every studied chapter
5.	Project (individual; group)	Selection of basic information and details on the current topics of biochemistry from scientific sources over the last 5 years.	Mark	At the end of each semester

X. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

- ***Teaching and learning methods used***

The Basics of Medical Biochemistry are taught in accordance with the classical university standard: courses, laboratory works and seminars.
The course is held by the course holders.
Laboratory work is carried out in order to learn the principles and methods for qualitative and quantitative biochemical analysis; the work is finished by completing the minute and analyzing the results obtained.
The theoretical subjects according to the guide are discussed, the tests and problem situations are solved, and interactive methods of teaching and learning are applied.
For the study of the discipline, a number of learning methods such as observation, analysis, comparison, classification / schema / figure development, modeling, deduction, and experiment are recommended to students.

- ***Applied*** *(specific to the discipline)* ***teaching strategies / technologies***

Classical teaching strategies (inductive, deductive, analogic, algorithmic and heuristic) are applied in the teaching of The Basics of Medical Biochemistry. The strategies are achieved through several teaching and learning methods (active-participative, individual study, verification and assessment) such as exposure and didactic conversation, working with the text-book, theoretical problems and laboratory work, testing, etc. For the implementation of the strategies and methods, a set of technical means of training are used both in the courses and seminars, as well as in the laboratory works.

- ***Methods of assessment*** *(including the method of final mark calculation)*

Current

Various current assessment methods are used for each laboratory work and seminar: control papers, problem solving and testing, etc.
During the semester there are 3 concluding tests, 6 – for both semesters:
Concluding test I: The structure of proteins and nucleic acids
Concluding test II: Enzymes. Bioenergetics.
Concluding test III: Metabolism of the carbohydrates.
Concluding test IV: Metabolism of lipids.
Concluding test V: Metabolism of simple and conjugated proteins.
Concluding test VI: Genetic and hormonal regulation of metabolism. Biochemistry of humors (blood and saliva).
The 4th mark in both semesters will be obtained from the individual work assessment.

Final

The final mark will consist of the average score of three concluding tests and individual work mark (share 0.5) and the final computer-assisted exam (share 0.5).

The average annual mark and the marks of all the final exam stages (assisted by computer, test) - all will be expressed in numbers according to the scoring scale (according to the table), and the final mark obtained will be expressed in two decimal places to be passed in the record book.

Method of mark rounding at different assessment stages

Intermediate marks scale (annual average, marks from the examination stages)	National Assessment System	ECTS Equivalent
1,00-3,00	**2**	**F**
3,01-4,99	**4**	**FX**
5,00	**5**	**E**
5,01-5,50	**5,5**	
5,51-6,0	**6**	
6,01-6,50	**6,5**	**D**
6,51-7,00	**7**	
7,01-7,50	**7,5**	**C**
7,51-8,00	**8**	
8,01-8,50	**8,5**	**B**
8,51-8,00	**9**	
9,01-9,50	**9,5**	**A**
9,51-10,0	**10**	

The average annual mark and the marks of all stages of final examination (computer assisted, test, oral) - are expressed in numbers according to the mark scale (according to the table), and the final mark obtained is expressed in number with two decimals, which is transferred to student's record-book.
Absence on examination without good reason is recorded as "absent" and is equivalent to 0 (zero). The student has the right to have two re-examinations.

XI. RECOMMENDED LITERATURE:

A. Compulsory:

1. Rodwell V.W., Bender D.A., Botham K.M. et al. HARPER´s illustrated biochemistry. 31st edition. Mc Graw Hill Education. 2018.
2. Champe P. C., Harvey R. A. Biochemistry. Lippincott's Illustrated Reviews. 7th edition, 2017.
3. Gavriliuc Ludmila. Biochemistry. Lectures for students of Medical Departments. 2009.

B. Additional

1. Bhagavan N. V., Ha Chung-Eun. Essentials of Medical Biochemistry With Clinical Cases. 2nd Edition. Academic Press. 2015
2. Nelson D. L., Cox M.M. Lehninger Principles of Biochemistry. 8th ed., 2021
3. www.themedicalbiochemistrypage.org