FACULTY OF STOMATOLOGY

STUDY PROGRAM 0911.1 STOMATOLOGY

CHAIR OF BIOCHEMISTRY AND CLINICAL BIOCHEMISTRY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum Faculty of Stomatology
Minutes No. 2 of 13.02.2018
Committee president, PhD, DMS, associate professor

Stepco Elena _____

APPROVED
at the Council meeting of the Faculty of Stomatology
Minutes No. 6 of 20.02.2018
Dean of Faculty of Stomatology, PhD, DHMS, professor

Ciobanu Sergiu _____

APPROVED
approved at the meeting of the chair of Biochemistry and Clinical Biochemistry
Minutes No. 7 of 01.10.2017
Head of chair, dr. hab, associated professor

Olga Tagadiuc _____

CURRICULUM

DISCIPLINE BIOCHEMISTRY

Integrated studies

Type of course: **Compulsory**

Chisinau, 2017

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 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, structurally-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 equipments, 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.

- **Teaching language of the subject -** Romanian, Russian, English
- **Beneficiaries -** students of the I and II years, Faculty of Stomatology

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		**F.02.O.018 / F.03.O.031**	
Name of the discipline		**Biochemistry**	
Person(s) in charge of the discipline		**Tagadiuc Olga**	
Year	**I/II**	Semester	**II/III**
Total number of hours, including:			**90/90**
Lectures	**17/17**	Practical/laboratory hours	**17/17**
Seminars	**34/34**	Self-training	**22/22**
Form of assessment	**C / E**	Number of credits	**3/3**

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 determine the biochemical parameters of clinico-diagnostic utility;
- to carry out the collection of saliva for biochemical investigations;
- 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.);
- appreciate the usefulness of certain biochemical investigations in the diagnosis of specific conditions;
- interpret the results of biochemical tests correctly.

c) at the integration level:

- to appreciate the importance of Biochemistry in the context of general medicine and Dentistry in particular;
- to know the correlations between 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 biochemistry and substantiate their importance by collecting data from the literature.

IV. PROVISIONAL TERMS AND CONDITIONS

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 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. THEMESAND ESTIMATEALLOCATION OF HOURS

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

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
1.	Biological role of enzymes. Chemical nature and enzyme structure. Coenzymes. Vitamins as coenzymes. Microelements as cofactors.	1	3	1
2.	Mechanism of action of enzymes. Nomenclature and classification of enzymes. Enzyme specificity. Kinetics of chemical reactions.	1	3	1
3.	Regulation of enzyme activity. Activation and inhibition of enzymes. The role of biomedical enzymes. Saliva's enzymes.	1	2	1
	Concluding test I: "Enzymes"		1	
4.	Bioenergetics. Metabolism, role, phases, stages. Energy regulation of metabolism.	1	3	1
5.	Oxidative decarboxylation of pyruvic acid. The Krebs cycle. The role of the cictrat in the homeostasis of mineralized tissues.	1	3	2
6.	Biological oxidation. Respiratory chain and oxidative phosphorylation. Microsomal oxidation. Oxidation with free radicals.	1	3	2
7.	Carbohydrates. The role of biomedical. Digestion and absorption of carbohydrates. The role of food carbohydrates in dental pathology.	1	3	1
8.	Metabolism of glycogen. Glicogenozele.	1	3	2
9.	Metabolism of glucose. Aerobic and anaerobic oxidation of glucose. Gluconeogenesis. Cori and glucose-alanine cycle. Mutual regulation of glycolysis and gluconeogenesis.	1	3	1

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
10.	Cycle of pentosophosphates. Metabolism of fructose and galactose. Synthesis of lactose.	1	3	1
11.	Regulation of carbohydrate metabolism. Disruptions of carbohydrate metabolism. Affecting the stomatognomyn system in diabetes.	1	2	1
	Concluding test II: "Bioenergetics and carbohydrates"		1	
12.	Biological role of lipids. Lipid digestion and absorption. Disorders of digestion and absorption of lipids. Resynthesis of the lipids in the intestinal epithelium. Metabolism of reserve lipids.	1	3	1
13.	Biosynthesis and beta-oxidation of fatty acids. Biosynthesis and use of ketone bodies. Impact of ketoneemia on dental homeostasis.	1	3	2
14.	Metabolism of structural lipids: biosynthesis and catabolism of cholesterol and phospholipids.	1	3	1
15.	Structural lipid metabolism: biosynthesis and catabolism of sphingolipids.	1	3	1
16.	Plasma lipoproteins.	1	3	1
17.	Hereditary and acquired pathology of lipid metabolism. Dislipiemias and tissue lipidoses.	1	2	2
	Concluding test III: "Lipids"		1	
18.	**Total hours semester**	**17**	**51**	**22**
19.	Metabolism of simple proteins. The dynamic state of proteins. The nitrogen balance. Digestion and absorption of proteins. The role of food proteins in maintaining the structural-metabolic homeostasis of the dental tissues.	1	3	1
20.	General ways of amino acid metabolism: deamination, transamination	1	3	1
21.	The final products of nitrogen metabolism. Ammonia detoxification. Ureogenesis	1	3	2
22.	Peculiarities of the metabolism of some amino acids. Biosynthesis of nonessential amino acids.	1	3	2
23.	Metabolism of chromoproteins.	1	2	1
	Concluding test IV: "Metabolism of Simple Proteins and Chromoproteins"		1	
24.	Metabolism of purine nucleotides. Metabolism of pyrimidine nucleotides.	1	3	2
25.	DNA biosynthesis - mechanism, regulation.	1	2	1
26.	RNA biosynthesis - mechanism, regulation.	1	3	1

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
27.	Biochemical bases of translation. Post-translational changes of proteins. General notions about folding. Hereditary disorders with impact on dental tissues.	1	3	1
	Concluding test V: Metabolism of Nucleotides. Biosynthesis of Nucleic Acids and Proteins .		1	
28.	Hormones, biological role, classification, mechanism of action. Neuro-hormonal regulation of metabolism. Hypothalamic-pituitary hormones.	1	3	1
29.	Hormones of the thyroid gland. Hypo- and hyperfunction of the thyroid gland.	1	2	1
30.	Hormones of the pancreas. Diabetes mellitus: Medullo- adrenal gland hormones.	1	2	2
31.	Adrenal cortex hormones . Hormones that regulate calcium and phosphate homeostasis (parathyroid hormone, calcitonin and calcitriol). Sex hormones.	1	4	1
32.	Biochemistry of blood. The chemical composition of blood plasma. Plasma proteins, blood enzymes, residual nitrogen, mineral substances. Correlations of the physiological blood components and structural-metabolic state of dental tissues and composition of saliva.	1	3	1
33.	The biochemical bases of maintaining the fluid state of the blood. Clotting. Fibrlinolysis	1	3	1
34.	Biochemical mechanismes of gas transport. Acid-base balance. Impact of acido-basic imbalances on the dental system.	1	3	1
35.	Biochemistry of the dental tissues.	1	3	2
	Concluding test VI: Hormones and blood. Biochemistry of the dental system.		1	
	Total hours semester	**17**	**51**	**22**
	Total hours year	**34**	**102**	**44**
	Total hours discipline	**180**		

VI. REFERENCE OBJECTIVES OF CONTENT UNITS

Chapter 1. Enzymes

Objectives	Content units
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 enzymes and the evaluation of enzyme activity. 5. Identify the types of enzyme specificity and its biomedical role. 6. Be able to represent the graphs of enzyme activity and reaction velocity dependence on various environmental factors. 7. Identify types of inhibition. 8. Be able to explain the mechanisms of regulation of enzyme activity. 9. Define the notion of isoenzymes and their biomedical role. 10. Be able to identify the enzymatic profile in the blood in some organ pathologies. 11. Explain the clinical-diagnostic value of enzymes in general and of individual enzymes used in clinical and dental medicine.	1. Notion of enzymes and their biological role. Similarities and differences between the action of enzymes and non-biological catalysts. 2. The chemical nature of enzymes. Evidence of the protein nature of enzymes. Structure of enzymes. Active center and allosteric center of enzymes. 3. Simple and conjugated enzymes. The notion of holoenzyme, apoenzyme, cofactor, coenzyme, co-substrate and prosthetic group. Coenzyme functions of vitamins and microelements. 4. Structure of vitamins B1, B2, B6, PP and their role as coenzyme. 5. Mechanism of action of enzymes. The active enzyme center and its role in catalysis. The role of reciprocal conformational changes of the enzyme and substrate molecules in the catalysis process. 6. Nomenclature (designation) and enzyme classification. The general characteristic of the main classes of enzymes. Enzyme code number. 7. Specificity of enzymes (types, examples). 8. Enzymatic kinetics. Influence of enzyme and substrate concentration, pH and temperature on enzyme activity and reaction rate. 9. Principle of determination of enzyme activity. Units of activity of enzymes (international unit, katal, specific activity). 10. Activation and inhibition of enzymes: a. Activation of enzymes by partial proteolysis. Zymogenes (proenzymes). b. Inhibition of enzyme activity (specific and non-specific, reversible and irreversible, competitive and uncompetitive). 11. Regulation of enzyme activity (allosteric regulation, covalent regulation). The importance of the retroinhibition principle. 12. Isoenzymes - the structural and functional peculiarities, their biomedical value. 13. The use of enzymes in medical practice (in diagnostic and therapy). 14. Methods of obtaining and purifying enzymes. Affinity Chromatography. 15. Saliva enzymes.

Chapter 2. Bioenergetics and metabolism

Objectives	Content units
1. Define the notions of metabolism, anabolism, catabolism and amphibolic phase and 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 bioenergetic processes in human cells - pyruvate oxidative decarboxylation (POD), Krebs cycle, electron transport chain (ETC) and oxidative phosphorylation 5. Know the regulatory enzymes of each metabolic pathway, their levels and tpes of regulation. 6. Explain the mechanism of oxidation coupling with phosphorylation. 7. Be able to calculate the energy yield of the PDO and the Krebs cycle. 8. Explain the mechanism of ETC inhibition and uncoupling of phosphorylation and oxidation. 9. Define microsomal oxidation and free radicals oxidation. 10. To be able to assess the impact of microsomal oxidation disturbances and excessive formation of reactive oxygen species: 11. To be able to explain the biological role of the antioxidant systems. 12. To present the connections between the main energy processes in the cell, as well as their impact on cell viability and cell homeostasis.	1. Metabolism. Anabolism and catabolism. The amphibolic stage of metabolism, its role. Metabolic pathways. 2. The laws of thermodynamics. Enthalpy, entropy and free energy. Standard free energy, its significance. Endergonic and exergonic reactions. 3. High energy compounds: role, main representatives, structural peculiarities. 4. The role and chemical structure of ATP. The ATP cycle. Variants of ATP hydrolysis. ATP synthesis mechanisms. 5. Principles of energy regulation of cellular metabolism. Cell energy state. 6. Pyruvate oxidative decarboxylation: polyenzyme complex, coenzymes, over all reaction, steps, process regulation, connection with Krebs cycle and ETC. The biomedical role. 7. Tricarboxylic acid cycle (Krebs): functions, reactions, enzymes, over all reaction, connection with the ETC, energy output, process regulation. Anaplerotic reactions. Their significance. The role of cictrat in the homeostasis of mineralized tissues. 8. Biological oxidation. Dehydrogenation of substrates - the main energy source for ATP synthesis. Reactions, enzymes and coenzymes of dehydrogenation. 9. Electron transport chain (ETC) - intracellular location, biological significance: 10. Structure and oxidoreduction properties of major proton and electron acceptors (NAD +, FAD, FMN, CoQ). Notions about the structure of cytochromes and Fe-S proteins. 11. Oxidation-reduction potential of ETC components. The correlation between oxidative-reducing potential of ETC components, free energy generated and ATP synthesis. 12. Enzymatic complexes of the ETC. ETC inhibitors. 13. Oxidative phosphorylation. Phosphorylation points. Regulation of the intensity of ETC function. P/O coefficient. 14. Mechanism of coupling of oxidation with phosphorylation (Mitchell hypothesis). ATP synthase. ATP-synthase inhibitors. 15. Notions regarding uncoupling of oxidation and phosphorylation processes and uncouplers. Examples of physiological and pathological uncoupling. 16. Microsomal oxidation. The role of cytochrome P450 in

	oxido-reduction reactions. 17. Oxidative stress and antioxidant systems.

Chapter 3. Structure and metabolism of carbohydrates.

Objectives	Content units
1. Define carbohydrates and appreciate their biomedical role. 2. Identify the stages of carbohydtares digestion, absorption and associated disorders. 3. To know the pathways of carbohydrate metabolism under different physiological and pathological conditions and the mechanisms involved. 4. Understand the connections between the carbohydrate and energy metabolism processes and the reciprocal regulatory influences. 5. Be able to calculate the energy output of anaerobic and aerobic oxidation of individual carbohydrates (glucose, galactose, fructose, sucrose, lactose). 6. To know the regulatory enzymes of glycogenolysis, glycogenogenesis, glycolysis, gluconeogenesis and glucose oxidation pentose phosphate pathways and types of regulation. 7. Can appreciate glucose metabolism disorders based on basic biochemical investigations (physiological and pathological hypo- and hyperglycemia). 8. Demonstrate the pathogenic mechanisms responsible for the development of diabetes melitus.	1. The biological role of carbohydrates. 2. Classification and structure of carbohydrates. Structure and role of chondroitin-sulphates. 3. Biochemical mechanisms of digestion and absorption of carbohydrates. Intolerance to disaccharides and the impact on calciul and phosphate and mineralized tissues homeostasis. 4. Impact of food carbohydrates on structural and functional state of the dental system. 5. Blood glucose transport into tissues - glucose transporters (GLUT). Use of carbohydrates in tissues. 6. Glycogen metabolism: glycogenogenesis and glycogenolysis. Reactions, enzymes, mutual regulation of processes. General notion of glycogenosis. 7. Glycolysis: reactions, enzymes. Overall reaction of anaerobic glycolysis and energy out-put. 8. Scheme of the aerobic pathway of glucose oxidation and energy efficiency. 9. Glycerol-phosphate and malate-aspartate shuttle systems of reducing cytosol equivalents transport into mitochondria. Their importance. 10. Gluconeogenesis - substrates, reactions, enzymes, overall reaction. General notions regarding Cori cycle and the glucose-alanine cycle. 11. Mutual regulation of glycolysis and gluconeogenesis. Influence of insulin, glucagon, catecholamines and glucocorticoids. 12. Pentose phosphate glucose oxydation pathway. Biological role of the process, reactions of the oxidative step, enzymes, coenzymes. The stoichiometric equation of stages I and II and of the whole process. 13. Fructose metabolism - hepatic and muscular pathways: reactions, enzymes, biological role. Hereditary disorders of fructose metabolism. 14. Galactose metabolism: reactions, enzymes, biological role. Hereditary disorders of galactose metabolism. 15. Disorders of the dental system in the glucose metabolism disturbances.

Chapter4. Lipids structure and metabolism

Objectives	Content units
1. Define lipids and appreciate their biomedical role. 2. Identify the stages of lipid	1. Food lipid digestion and absorption. Structure and role of bile acids. Hydrolysis of triglycerides, phospholipids, cholesterides: enzymes, hydrolysis products.

digestion, absorption, resynthesis and transport, and associated disorders. 3. Know the pathways of lipids metabolism in different tissues and the mechanisms involved. 4. Understand the connections between the lipid metabolism and the carbohydrate and energy metabolism processes and the reciprocal regulatory influences. 5. Demonstrate the pathways of mutual transformations glucose ↔ lipids. 6. Be able to appreciate lipid metabolism disorders based on basic biochemical investigations (hypo- and hyperlipidemia, hypercholesterolemia, lipidemia). 7. Demonstrate the pathogenic mechanisms responsible for organism damage in lipid pathology (obesity, atherosclerosis).	2. Absorption of food lipids hydrolysis products. Hormonal regulation (colecistokinin, secretin). Disorders of digestion and absorption of lipids. Pancreatic, hepatic and intestinal steatorrhea. 3. Resinthesis of lipids in enterocytes. Chylomicron formation. 4. Fatty acid biosynthesis - location, steps, reactions, enzymes, coenzymes, regulation (saturated and unsaturated (monoenic) with even number of carbon atoms). 5. Triglycerides biosynthesis: localization, reactions, enzymes and coenzymes, regulation. 6. Catabolism of triglycerides - reactions, enzymes, hormonal regulation (catecholamines, glucagon, insulin, glucocorticoids). 7. Metabolism of glycerol: ways of use and oxidation (reactions, enzymes, energy output). 8. β-oxidation of fatty acids: saturated with even number of carbon atoms (cellular location, stages, reactions, enzymes, coenzymes, energy efficiency, regulation) and unsaturated (peculiarities), biological role. 9. Ketone bodies: representatives, chemical structure, biosynthesis (tissue, substrate, reactions), use (tissues, reactions, final products, energy output). Ketonemia and ketonuria (causes, mechanism of development, impact on dental tissues). 10. Neurohormonal regulation of lipid metabolism. The action of catecholamines, glucagon, insulin, glucocorticoids, thyroid hormones. 11. Cholesterol biosynthesis - steps, first step reactions (up to mevalonic acid), enzymes, coenzymes, regulation. Catabolism and excretion of cholesterol (general notions). 12. Notions regarding biosynthesis of glycerophospho-lipids: localization, reactions, enzymes and coenzymes. Lipotrope substances, their role. 13. Notions regarding eicosanoids (prostaglandins, thromboxanes, leukotrienes): the precursor, enzymes responsible for synthesis, the role of biomedical. 14. Blood transport of lipids. Plasma lipoproteins: types (chylomicrons, VLDL, LDL and HDL), general notions regarding chemical composition, metabolism, functions. 15. general notions regarding disorders of lipid metabolism (dyslipidemias and tissue lipidoses). 16. Relationships between energy metabolism, carbohydrate and lipid metabolism.

Chapter 5. Metabolism of simple proteins and chromoproteins

Objectives	Content units
1. Identify the stages of protein digestion and absorption in gastro-intestinal system. 2. Define the types of nitrogen balance and describe the groups of 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 for the human body. 5. 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. Know the metabolic use of the major amino acid, the sources and mechanisms of synthesis of the dispensable ones and the ways of their catabolism. 8. Differentiate the main types of jaundice (prehepatic, hepatic and posthepatic) by the bile pigments level assay in blood, urine and stool. 9. Know the pathway of hemoglobin biosynthesis and define porphyrias. 10. Differentiate the main types of anemias by laboratory markers.	1. Recommended daily intake of protein in the diet. Biological value of food proteins. 2. Proteolytic enzymes. Activation mechanism. The specificity of proteases. 3. Digestion of proteins in the stomach. Gastric proteolytic enzymes. The role of hydrochloric acid. 4. Digestion of proteins in the intestine. Pancreatic and intestinal proteolytic enzymes, their specificity of action. Regulation of protein digestion in the intestine. 5. Absorption of amino acids in the intestine. Active secondary and facilitated transport of amino acids. 6. Putrefaction of the amino acids in the large intestine. The putrefaction products. Considerations regarding the detoxification of toxic products in the liver. 7. The fate of the absorbed amino acids. Transport of amino acids into cells. Gamma-glutamyl cycle (general notions). 8. Common metabolic fund of amino acids. The dynamic state of proteins. The nitrogen balance. Protein deficiency, impact on the dental system homeostasis. Parenteral protein nutrition (notions). 9. Transamination of amino acids: mechanism, enzymes, coenzymes, process significance. Diagnostic value of blood transaminase activity (ALT and AST). 10. Decontamination of amino acids. Types. Direct deamination of amino acids. Oxidative detoxification of glutamic acid (reaction, enzyme, coenzymes, process importance). 11. Indirect amino acid deamination. Stages. Enzymes, coenzymes. The biological role. 12. Metabolism of alpha-ketoacids obtained by deamination of amino acids. Ketogenic and glucogenic amino acids. 13. Biosynthesis of non-essential amino acids (tranresamination). 14. Biochemical mechanisms of ammonia toxicity. Ammonia detoxification: carbamoyl-phosphate synthesis, reductive amination of α-ketoglutarate. Synthesis and role of glutamine. Kidney glutaminase. Formation and excretion of ammonium salts. 15. Urea biosynthesis. Reactions, enzymes, reactions. Clinical importance of urea assay in urine and blood. Hyperammonemia and uremia (causes, clinical manifestations, treatment principles). 16. Decarboxylation of amino acids (reactions, enzymes,

	coenzymes). Biosynthesis of histamine, serotonin, their biological role. Neutralization of biogenic amines. 17. Tetrahydrofolic acid.Its role in the synthesis of serine, glycine, purine and pyrimidine nucleotides. 18. Metabolism of glycine, serine and threonine (biosynthesis, metabolic role, catabolism). 19. Metabolism of proline and lysine. Role in dental tissues homeostasis. 20. Metabolism of dicarboxylic amino acids and their amides (Asp, Asn, Glu, Gln). Synthesis, metabolic role, catabolism. 21. The connection of protein, carbohydrate and lipid metabolism. The role of liver in metabolism integration. 22. Digestion and absorption of chromoproteins. 23. Metabolism of iron in the body. 24. Biosynthesis of hemoglobin: site, substrates, equations of the first two reactions, process regulation. Porphyrias (general notions). 25. Catabolism of hemoglobin. Bilirubin: formation, conjugation, biliary excretion, metabolism in the intestine. 26. Hyperbilirubinemia. The main types of jaundice (prehepatic, hepatic and posthepatic). The importance of determining blood, urinary and faecal pigments in the diagnosis and differentiation of the jaundice.

Chapter 6. Nucleoproteins metabolism. Biosynthesis of nucleic acids and proteins.

Objectives	Content units
1. Know the metabolic use of nucleotides in general, their sources and mechanisms of synthesis and catabolism. 2. To demonstrate the clinical importance of uric acid assay in urine and blood. 3. To know the principles of pathogenic treatment of gout. 4. Present the biochemical molecular mechanisms and identify the similarities and differences of the replication, transcription and translation processes.	1. Digestion and absorption of nucleic acids. 2. Purine nucleotide biosynthesis: purine ring atom's sources, reactions of phosphoribosylamine synthesis, IMP structure, AMP and GMP synthesis reactions, synthesis of nucleoside diphosphates and nucleoside triphosphates. Regulation. 3. Pyrimidine nucleotide biosynthesis: sources of atoms in the pyrimidine ring, UTP and CTP biosynthesis. Biosynthesis of deoxyribonucleotides. Biosynthesis of thymidine nucleotides. Regulation. 4. Salvage pathway of purines and pyrimidines metabolism. 5. Catabolism of purine nucleotides (uric acid synthesis). Gout - causes, clinical manifestations, treatment principles. Hyperuricaemia. Imact on dental system. 6. The final products of pyrimidine nucleotide catabolism, their fate. 7. Replication of DNA in prokaryotes (E. coli) - matrix, substrates, enzymes and protein factors. Biochemical

	mechanism and stages of DNA biosynthesis. Replication inhibitors - mechanism of action and biomedical role (acyclovir, foscarnet, doxorubicin). 8. Eukaryotic replication peculiarities. Telomeres and telomerase. Telomerase structure (notions). The biomedical role of telomerase. 9. Biochemical mechanisms of the point mutation genesis. The biomedical role of mutations. Pathologies caused by mutations (osetogenesis imperfecta). 10. Primary, secondary and tertiary structure of ribonucleic acids (tRNA, mRNA, rRNA). Ribonucleoprotein complexes. 11. Peculiarities of the gene structure in prokaryotes. Structural and regulatory genes. 12. Prokaryotic transcription (E. coli): matrix, substrates, enzymes, biochemical mechanism. Transcription inhibitors (rifampicin, nalidixic acid, α-amanitin). 13. Peculiarities of transcription in eukaryotes. Post-transcriptional modifications of mRNA. 14. Biochemical mechanisms that regulate gene expression in prokaryotes and eukaryotes (notions). 15. Reverse transcription. Biochemical mechanism (notions) and biomedical role. 16. The composition and structure of ribosomes in pro and eukaryotes. 17. Biochemical bases of the genetic code. Its properties. 18. Protein biosynthesis in prokaryotes. Steps: activation of amino acids; translation - initiation; elongation; termination. 19. Peculiarities of protein biosynthesis in eukaryotes - translation factors and post-translational modifications of synthesized proteins. Folding of synthesized proteins (notions). 20. Regulation of protein biosynthesis in prokaryotes and eukaryotes (notions). Translational inhibitors (tetracycline, chloramphenicol, erythromycin, streptomycin, diphtheria toxin). The medical role. 21. Polymorphism of proteins (hemoglobin variants, blood groups). 22. Biochemical bases of hereditary pathologies. Biochemical diagnostic methods.
CHapter 7. Hormones	
Objectives	**Content units**
1. Define the notion of hormones and know their general properties. 2. Identify the steps necessary for	1. Hormones definition. The general properties and role of hormones in the body. 2. Hormone classification. 3. Mechanisms of the synthesis, secretion and action of

the mechanism of action of hormones of different structure. 3. Know the biomedical importance of hormonal regulation. 4. Describe the main mechanisms of action of hormones. 5. Know the hormones of the main endocrine glands, their role, mechanism of action and metabolic effects. 6. Be able to distinguish the main disorders of hormonal secretion. 7. Present the biochemical mechanisms responsible for the effects of various secretion abnormalities for each hormone in particular. 8. To know the biochemical mechanisms of dental tissues damage in disorders of hormonal secretion. 9. Can appreciate hormonal disturbances based on laboratory biochemical investigations.	hormones regulation: the concept of feed-back regulation and hormonal biorhythms. 4. Structure of membrane and nuclear receptors. Interactions between hormone and receptor. 5. Mechanisms of action of hormones: a) membrane-intracellular mechanism mediated by cyclic AMP, cyclic GMP, calcium ions, diacylglycerols, inositolphosphates; b) the cytosolic-nuclear mechanism. 6. Hypothalamic hormones: representatives and their role. 7. Anterior pituitary hormones: pro-opiomelanocortin-derived peptides, the group of somatomatorop hormones and the glycoproteic hormones. Chemical nature, mechanism of action, biological effects, secretion regulation and disorders. Practical use. 8. Posterior pituitary hormones: vasopressin (antidiuretic hormone) and oxytocin. Mechanism of action, biological effects. Diabetes insipidus. 9. Hormones that regulate calcium and phosphate metabolism (parathyroid hormone, calcitonin, calcitriol): structure, biosynthesis, secretion control, mechanism of action, target tissues, effects. Abnormalities of parathyroid hormone secretion. Impact on the dental system. 10. Pancreatic hormones. Structure, biosynthesis and regulation of secretion. Mechanisms of action and metabolic effects of insulin and glucagon. Metabolic disorders in diabetes melitus. Disorders of dental tissues in diabetes mellitus. 11. Thyroid hormones (T3 and T4): structure, biosynthesis, secretion regulation, transport, metabolism, mechanism of action and metabolic effects. Disorders of the thyroid function (hyperthyroidism and hypothyroidism). The impact of the thyroid function disorders on the dental system. 12. Adrenal medulla hormones (adrenaline and noradrenaline): chemical structure and secretion. Mechanism of action and metabolic effects of catecholamines. Pheochromocytoma - general notions. 13. Adrenal cortex hormones - glucocorticoids and mineralocorticoids: structure, regulation of secretion, mechanism of action, effects, disorders of secretion (Addison's disease: suprarenometabolic syndrome, Cohn's disease). Sex hormones: structure, secretion regulation of secretion. Mechanism of action and biological effects of androgens, estrogens and progesterone.The impact of the glucocorticoid scretion disorders on the dental system.

Chapter 8. Biochemistry of the blood.

Objectives	Content units
1. To know the main chemical compounds of the blood. 2. Define the structural-functional peculiarities of the main nitrogen-containing and non-nitrogen containing chemical compounds in the blood. 3. Explain the sequence of hemostasis phases. 4. Demonstrate the intrinsic and extrinsic mechanisms of coagulation. 5. Define fibrinolysis, the anticoagulant system and demonstrate their mechanisms. 6. Explain the mechanisms of O_2 and CO_2 transport by the blood and their role in maintenance of the blood pH constant. 7. Define the notion of hypoxemia and hypoxia. Explain the causes of their occurrence. 8. Be able to explain the physiological and biochemical mechanisms of maintaining the acid-base balance (ABB). 9. Explain mechanisms of buffer systems functioning and their biomedical role. 10. Use the main ABB markers to differentiate acidosis and alkaloids.	1. Chemical composition and blood functions. 2. Organic nitrogen-containing substances of blood plasma. 3. Plasma proteins. Albumin, globulins (fibrinogen, transferrin, ceruloplasmin, haptoglobin, immunoglobulins). Variations of protein fractions in diseases. 4. Plasma enzymes. Functional classification. Mechanisms of plasma disenzymia. The principal plasma enzymes with diagnostic value, including enzymes that reveal the functional-metabolic state of the dental system. 5. Nitrogen-containing non-protein compounds of blood plasma. Residual nitrogen, its fractions in physiological state and pathology. 6. Non-nitrogen containing organic compounds of blood plasma (glucose, lipids, organic acids, ketone bodies). The importance of their determination. 7. Blood plasma mineral compounds. Their role. Blood ionogram.. 8. Hemostasis. The general characteristic of hemostasis phases (parietal, plasma and fibrinolytic stages). 9. Coagulation of the blood. Plasma and platelets coagulation factors. The site of the synthesis, the structural particularities, the mechanism of activation of the main plasma factors. The role of vitamin K. 10. Intrinsic and extrinsic coagulation cascades. Molecular mechanisms of clot formation and stabilization. Coagulopathies. 11. Fibrinolytic and anticoagulant systems: the role, the main factors, their chemical nature, the mechanism of activation. Therapeutic applications, including dentistry. 12. O_2 and CO_2 transport by blood. Biochemical mechanism. The importance of hemoglobin in these processes and in the maintenance of blood pH constanse. Hypoxemia and hypoxia. Causes of their occurrence. 13. Biochemical and physiological mechanisms to maintain acid-base balance (ABB). Blood buffer systems. The main ABB indices. Acidoses and alkaloids. The impact of acidosis of the dental system.

Chapter 8. Biochemistry of the dental system

Objectives	Content units
1. Define the notion of dental system and identify its elements.	1. Composition of bone. Mineral and organic constituents of bone - their structural organization and biological

2. Exhaustively describe the mineral component of bone tissue and mineralized dental tissues and identify similarities and differences. 3. Know the peculiarities of the organic composition of the mineralized tissues and its importance in tissue homeostasis. 4. Describe the metabolic features of mineralized tissues, including enamel and dentin under physiological conditions. 5. Explain in logical sequence the patho-chemical mechanisms that determine the damage of dental tissues in major dental diseases. 6. Know the usefulness of laboratory diagnostic methods in dental practice.	role. Bone remodeling. Bone formation and resorption: mechanisms, regulation (role of vitamin D, prostaglandins and hormones - PTH and calcitonin). 2. Composition of mineralized dental tissues. Mineral constituents: representatives, forms, role. Organic constituents of dental tissues: representatives, their role. Structural organization of hard teeth tissues (enamel and dentin). 3. Normal biochemical processes specific for teeth. Biochemical processes involved in the appearance and development of dental caries. 4. Biochemistry of periodontium. Chemical composition of periodontium. Normal metabolism of periodontium. Pathological metabolic processes in periodontium. 5. Dental plaque and tartrum - chemical composition, properties and role. 6. Saliva biochemistry. Role of saliva. Chemical composition of the saliva - the main inorganic constituents (anions, cations) and organic (proteins, enzymes, non-protein nitrogenous substances, non-nitrogen contining substances), their origin and role. Saliva properties - volume, pH, viscosity, density, flow, buffer action.

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

Professional (specific) (SC) competences

SC1. Knowledge, understanding and use of language specific to medical biochemistry.

SC2. General knowledge of key vital chemical compounds for the human body.

SC4. Advanced knowledge of the chemical composition and metabolism peculiarities of the dental system under physiological conditions and in the most important diseases.

Study outcomes

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;

7. solve case studies in medical biochemistry..

VIII. 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.	Problem situations solved	Individual solving of problem situations in the subjects in accordance with the Practical Guide, with subsequent verification and individual discussion with the teacher in non-auditory hours.	Rating 0-0.5 for each	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.	Rating 0-0.5 for each	Every studied chapter
5.	Scientific report on modern topics presented to the scientific	Selection of basic information and details on the current topics of biochemistry from scientific sources over the last 5 years.	Note from 0 to 1.0 for each report	Throughout the year

	circle at the chair and at national and international scientific conferences.			

IX. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

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

Biochemistry is 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, 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 teaching strategies / technologies****(specific to the discipline)*

Classical teaching strategies (inductive, deductive, analogic, algorithmic and heuristic) are applied in the teaching of 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.
At the Structural Biochemistry course, during the semester of study there are 3 concluding tests:
Concluding test I: Enzymes
Concluding test II: Bioenergetics and metabolism. Structure and metabolism of carbohydrates.
Concluding test III: Lipid structure and metabolism.
Concluding test IV: Metabolism of simple proteins and Chromoproteins.
Concluding test V: Metabolism of nucleoproteins. Biosynthesis of nucleic acids and proteins.
Concluding test VI: Hormones. Biochemistry of the blood. Biochemistry of the dental system.

The final mark of a concluding test is obtained from the computerized test and oral answer score. At the final grade obtained, the mark from the individual work assessment (0-0.5) is added.

Final

The final mark will consist of the average score of three concluding tests (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 note 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.

X. RECOMMENDED LITERATURE:

A. Compulsory:

1. Champe Pamela C., Harvey Richard A. Biochemistry. Lippincott's Illustrated Reviews. (forma electronică)
2. Lehninger A.L. Principles of Biochemistry The Johns Hopkins University School of Medicine, Worth Publishers Inc., 2007. (forma electronică)
3. Gavriliuc Ludmila. Biochemistry. Lectures for student of Medical Departments. 2009.

B. Additional

1. Bhagavan N.V., Ha Chung-Eun. Essentials of Medical Biochemistry: With Clinical Cases. Academic Press; 1st edition, 2011.
2. www.themedicalbiochemistrypage.org