FACULTY OF MEDICINE
STUDY PROGRAM 0912.1 MEDICINE
CHAIR OF BIOCHEMISTRY AND CLINICAL BIOCHEMISTRY

APPROVED
at the meeting of the Commission for Quality Assurance and Evaluation of the Curriculum Faculty of Medicine
Minutes No. 6 of 27.02.2018
Chairman dr. hab., associated professor
Suman Sergiu _____

APPROVED
at the Council meeting of the Faculty of Medicne
Minutes No. 4 of 20.03.2018
Dean of Faculty PhD, associated professor
Bețiu Mircea _____

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 _____

SYLLABUS

DISCIPLINE STRUCTURAL 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 theprofessional / specialty training program

The aim of the Structural Biochemistry course is to provide students with theoretical background knowledge and general practical skills in medical biochemistry that are indispensable to the clinical work of all health professionals. Students will get acquainted with the qualitative and quantitative chemical composition of the human body, will study the particularities of the structure of the main chemical compounds of which the human body is composed, their physico-chemical properties and role in the body under physiological conditions and in some socially advanced diseases (obesity, atherosclerosis, diabetes, cancer). The activities during the discipline study will create the students individual and team work skills, abilities in problem formulation and solving, working on certain laboratory equipments, analyzing and interpreting the results of medical investigations, applying theoretical knowledge in medical practice, integration of information from different disciplines (fundamental and clinical), etc.

Mission of the curriculum (aim) in professionaltrainingis in studying

a) the structure of the main chemical compounds of the human body and their physico-chemical properties;

b) the biological and medical role of the chemical compounds in general and in nutrition in particular;

c) the biochemical investigation methods of clinical utility and the formation of the analytical and interpretation skills of laboratory data.

Teaching language of the subject - Romanian, Russian, English

Beneficiaries - students of the I year, Medicine study program

II. MANAGEMENT OF THE DISCIPLINE

Code of discipline		F.02.O.013	
Name of the discipline		Structural Biochemistry	
Person(s) in charge of the discipline		Globa Pavel	
Year	I	Semester	II
Total number of hours, including:			90
Lectures	17	Practical/laboratory hours	17
Seminars	17	Self-training	39
Form of assessment	E	Number of credits	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 biomedical role of the chemical compounds that make up the human body;
– to know the normal values and physiological variations of the main biochemical markers.

b) at the application level:

– to determine by themself some biochemical markers of general clinical-diagnostic utility;
– to know to work on the main devices used in the biochemical laboratory (simple and automatic pipettes, photoelectric colorimeter, centrifuge, etc.);
– appreciate the usefulness of certain biochemical investigations in the diagnosis of specific conditions;
– to correctly interpret the results of biochemical investigations.

c) at the integration level:

– to appreciate the importance of Structural Biochemistry in the context of General Medicine and in particular in the field of dentistry;
– to know the correlations between Structural Biochemistry and other fundamental disciplines;
– to appreciate the importance of knowing the structure of the main biochemical compounds in order to understand their functioning under physical conditions and in some diseases;
– to appreciate the importance of certain conditions maintenance (of pH, temperature) to ensure structural-functional integrity of the biological compounds.

IV. PROVISIONAL TERMS AND CONDITIONS

Structural biochemistry is a discipline that derives from general biochemistry and aims to familiarize students with the structure, properties and biomedical role of the chemical compounds that make up the human body. Knowing the structure and properties of biological compounds will enable students to understand their metabolic transformations, which are very diverse and complex, creating some difficulties in studying them, as well as understanding their medical importance.

In order to study the subject, it is necessary to have a thorough knowledge of general and organic chemistry but also of biology, obtained in pre-university studies.

Internet skills are also needed to identify the materials needed for study and individual work, document, 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.	Bioelements and biomolecules. Functional groups and types of chemical bonds specific to biomolecules. The water. Physical and chemical structure and properties of water. Ionization of water. The notion of pH. Biological buffer systems.	1	4	5
2.	Aminoacids - stereoisomerism, classification, structure. The acid-base properties of amino acids. Reactions of biological importance of alpha-amino acids. Primary structure of proteins. The properties of the peptide bond. Methods for determining the composition and sequences of amino acids in the polypeptide chain.	2	2	5
3.	Proteins - biomedical role, organization levels and classification. Secondary, tertiary and quaternary structure of proteins. Simple and conjugated proteins. Physico-chemical properties of proteins. Methods of protein analysis.	2	2	5
4.	Nucleic acids - classification and biomedical role. Nitrogen bases, nucleosides and nucleotides - structure and nomenclature. Natural derivatives of the nucleotides - structure and biomedical importance. Primary structure of nucleic acids. Higher levels of DNA and RNA compaction.	2	2	4
5.	Carbohydrates. Classification of carbohydrates. Monosaccharides. Structure, isomerism and chemical properties of monosaccharides. Biomedical importance. Oligosaccharides and polysaccharides. Disaccharides (maltose, lactose, sucrose), homopolysaccharides (starch, glycogen, cellulose) and heteropolysaccharides (hyaluronic acid, chondroitin-sulfates, heparin) - structure, properties and biomedical role.	2	2	4
6.	Water-soluble vitamins. The structure of vitamins B1, B2, B6, PP, pantothenic acid, biotin, folic acid, vitamin C and their role as coenzymes.	2	2	4
7.	Lipids. Saturated and unsaturated fatty acids. Triglycerides and glycerophospholipids. Sphingomielines and glycolipids. Classification, structure, physico-chemical properties, biological role.	2	2	4
8.	Steroids. Cholesterol and its derivatives - steroid hormones (corticosteroids and sex hormones - gestagens, estrogens, androgens), bile acids and vitamin D. Liposoluble vitamins A, E, K.	2	2	4

No. d/o	THEME	Number of hours		
		Lectures	Practical hours	Self-training
9.	Biological membranes. Chemical composition, structural-functional organization, properties and functions. Membrane transport.	2	2	4
10.	Concluding tests (nr. 3)		3	
11.		17	34	39
Total		90		

VI. REFERENCE OBJECTIVES OF CONTENT UNITS

Chapter 1. Bioelements and biomolecules

Objectives	Content units
1. Define the concepts of bioelement 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 biological importance of water depending on its physico-chemical properties. 5. Know the importance of determining the pH environment required for structural-functional stability of biomolecules. 6. To present the connections between the physico-chemical properties of the biomolecules and their structural-functional stability depending on the pH variation of the environment.	1. The importance of biochemistry for medical disciplines. Structural (descriptive) biochemistry and its tasks. 2. Organogenic and mineral bioelements. The content and general feature of the main bioelements that make up the human body. 3. Biomolecules - macro and micromolecules. 4. Functional group notions. Types of functional groups specific to biomolecules. Their overall feature. 5. Types of chemical bonds specific to biomolecules. Their overall feature. 6. Theory of solutions. 7. Water, its physical and chemical properties. The role of water in the life of living organisms. 8. Principles of electrolytic dissociation. 9. Principles of Brönsted-Lowry acid-base protolithic theory. 10. Dissociation of water. The ionic water product. 11. Notion of pH. Calculation of pH and pOH of solutions. 12. Buffer system. The action of buffer solutions. Henderson-Hasselbalch equation. Capacity of buffer solutions. 13. The pH of the body's internal media. Biological buffer systems (bicarbonate).

7. To explain the role and mechanism of buffers functioning.	
Chapter 2. Structure and properties of amino acids and proteins	
Objectives	Content units
1. Know the structure, role and properties of amino acids. 2. Define the notions of proteinogenic and nonproteinogenic amino acids, stereoisomerism, solubility. 3. Select amino acids according to all classification principles. 4. Can give examples of chemical reactions involving amino acids. 5. To justify the need to know the properties of amino acids 6. Explain the importance of proteins for living organisms, especially for human beings. 7. Define the notion of protein. 8. Know the levels of proteins structural organization and their main properties. 9. Identify the specific proteins of organs and their structural and functional particularities 10. Apply methods for protein separation and purification. 11. Explain the clinical-diagnostic value of the proteins.	1. Aminoacids - the role in living organisms. Protein and nonproteinogenic amino acids. 2. Classification of amino acids according to chemical structure, physico-chemical properties, biological principle. 3. Stereoisomerism, solubility and acid-base properties of amino acids. 4. Chemical properties of amino acids: carboxylation, decarboxylation, hydroxylation, deamination and transamination reactions. 5. Polypeptide theory of protein structure. The properties of the peptide bond. Notation and reading of amino acids in peptides and proteins. N- and C-terminal amino acids 6. Methods for determining the composition and sequences of amino acids in the polypeptide chain. The biological role of proteins. 7. Structural levels of the protein molecule: primary, secondary, tertiary and quaternary structure; the general characteristic, the chemical bonds specific to these structures. Concepts of structural domains. 8. Classification of proteins. 9. Simple proteins (albumin, histone) - properties and structural particularities. The biological role. 10. Conjugated proteins: nucleoproteins, phosphoproteins, lipoproteins, glycoproteins, metalloproteins, chromoproteins (hemo- and flavoproteins), their general characteristic. 11. Globular proteins. Hemoglobin - structure and biological role. 12. Fibrillar proteins: collagen and elastin - the particulars of the amino acid and structural components. The biological role. 13. Ca^{2+} binding proteins (coagulation plasma, Ca^{2+}-ATPase, calmodulin, collagen) - structural features that cause Ca^{2+} binding. The role of biomedical.

	14. Molecular weight of proteins. Basic principles used for molecular weight determination (ultracentrifugation, chromatography, mass spectrometry). 15. Amphoteric properties of proteins. Electrical charge of proteins. Factors that determine the protein charge. Isoelectric point and state. 16. Solubility of proteins. Hydrophilic properties of proteins based on amino acid composition, structural particuliarities, pH and temperature of the medium. Properties of protein solutions as colloidal solutions. Aggregation states of protein solutions (soil, gel, xerogel). 17. Protein denaturation, factors that cause denaturation. Structural modifications of the protein to denaturation. The biomedical importance of denaturation. 18. Methods of separation, purification and analysis of proteins: a) salification; b) dialysis; c) electrophoresis; d) chromato-graphy (principle of methods, biomedical importance).
Chapter 3. Structure and properties of nucleic acids	
Objectives	Content units
1. Define the notion of nucleic acids and differentiate their types, subtypes and biological role. 2. Know the structures of DNA and RNA. 3. Identify the impact of the DNA and RNA structure disorders on the genesis of hereditary diseases.	1. Types of nucleic acids, their functions and their distribution in the cell. 2. Nucleic Acid Constituents: Nitrogen bases, pentoses, phosphoric acid. 3. Nucleosides and nucleotides: structure, role. 4. Primary structure of DNA. Polynucleotide chains. The phosphodiester bond. 5. Secondary DNA structure. The Watson-Crick model. Double helix and its B, A, and Z conformations. Compaction levels of the prokaryote (nucleoid) and eukaryotic molecules (nucleosome, solenoid, chromatin, chromosomes). 6. Primary, secondary and tertiary structure of ribonucleic acids (RNA).
Chapter4. Structure and properties of carbohydrates	
Objectives	Content units
1. Define sugars and appreciate their biomedical role	1. The biological role of carbohydrates.

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	2. Classification and structure of carbohydrates. Spread in nature and the biological role of carbohydrates. 3. Structure and properties of the main monosaccharides (glyceraldehyde, dihydroxyacetone, ribose, deoxyribose, glucose, galactose, fructose). 4. Stereoisomer of monosaccharides. Enantiomer. Steric series D- and L-. Diastereomers and epimers. 5. Linear and cyclic forms. Cyclic structures of monosaccharides with 5 and more carbon atoms (furanose and pyranose cycles). The Haworth formulas. The role and properties of the semiacetal hydroxyl group, the notions of α- and β-anomers. 6. Important chemical properties of monosaccharides (formation of glycosides, phosphoric esters, oxidation and reduction of monosaccharides). 7. Ascorbic acid - structure, synthesis and biomedical importance. 8. The notion of aminoglucides (glucosamines, galactosamines and sialic acids), their biological role. 9. Classification and structure of oligosaccharides: reductive and non-reducing disaccharides (maltose, lactose, sucrose) - biomedical properties and role; 10. Classification and structure of polysaccharides: homopolysaccharides (glycogen, starch, cellulose) - structure, properties and biomedical role; heteropolysaccharides (hyaluronic acid, chondroitin sulfates, heparin) - structure, properties and biomedical role.
Chapter 5. Structure and properties of water-soluble vitamins	
Objectives	Content units
1. Be able to distinguish the structures and characterize the differences between vitamins and coenzymes 2. To argue about the metabolic role and the daily necessity of vitamins. 3. Understand how hypo- and hypervitaminoses develop.	1. The classification and biological role of vitamins 2. Hydro-soluble vitamins B1, B2, B6, PP, C, B12, biotin, folic and panthotenic acids: – chemical structure; – the coenzymes of these vitamins; – metabolic role; – daily requirements, food source, – hypo- and hypervitaminoses.
Chapter 6. Structure and properties of lipids	

Objectives	Content units
1. Define lipids and appreciate their biomedical role 2. Be able to differentiate between classes of lipids according to their structure and functions 3. Understand how the structure determines the properties and functions of different types of lipids	1. Biological role of lipids. 2. Classification of lipids (structural, functional, according to physico-chemical properties). 3. Saturated and unsaturated fatty acids. Structure, physico-chemical properties, major representatives, biomedical role. 4. Triglycerides - structure, physico-chemical properties, biomedical role. 5. Glycerophospholipids - phosphatidylserine, phosphatidyl-ethanolamine, phosphatidylcholine, phosphatidylinositols. Structure, physico-chemical properties, biomedical role.

Chapter 6. Steroids and liposoluble vitamins

Objectives	Content units
1. Define steroids and appreciate their biomedical role. 2. Be able to differentiate different types of steroids according to certain structural particularities. 3. Understand how the structure determines the general properties of different types of steroids 4. Know the biological role of steroids. 5. Understand the connection between the structure and functions of liposoluble vitamins.	1. Steran. Cholesterol. Structure, physico-chemical properties, biomedical role. 2. Classification of steroids. 3. Steroid hormones (corticosteroids and sex hormones - gestagens, estrogens, androgens). Structure and biological importance. 4. Bile acids (colic, glycolic and taurocolic acid). Structure and biological importance. 5. Group D vitamins (cholecalciferol, ergocalciferol). Calcitriol. Structure and biological importance. 6. Isoprenoids. β-carotene, liposoluble vitamins (A, E, K). Structure and biological importance.

Chapter 8. Biological Membranes

Objectives	Content units
1. To know the qualitative and quantitative content of the membrane components 2. To know the structure of the main membrane components 3. To understand how certain structural peculiarities of the membrane components underlie the reciprocal	1. Biological Membranes: – Biological and medical role. – Chemical composition - lipids, proteins, carbohydrates. Their functional role. – Structural-functional organization - the Singer-Nicolson fluid-mosaic model. – Properties: fluidity, motility, selective permeability, asymmetry, self-assembly and self-repair. – Diversity and structural and functional specificity.

interaction resulting in assembly and its properties 4. To be able to differentiate different types of membrane transport.	2. Membrane transport: – Passive transport: a) Simple diffusion; b) Facilitated diffusion - glucose transporters (GLUT), anion exchangers; c) Alpha and beta types (structural features). – Active transport: a) Primary (Na +, K + -ATP-aza, Ca2 + -ATP-aza, ABC-transporters); b) secondary (transport of amino acids, glucose). – Pathologies due to deficiencies of membranes transporters.

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

Professional (specific) (SC) competences

SC1. Knowledge, understanding and use of structural biochemistry specific language.

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

SC3. Advanced knowledge of the structural features of the main biomolecules that make up the human body.

SC4. Knowledge of the principles of biochemical laboratory methods, the diagnostic value of the main laboratory merkers and the ability to interpret the results of basic laboratory investigations.

SC5. Possession of the working technique at the main laboratory equipment (spectrophotometer, centrifuge, automatic pipette, pH meter).

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 effectively apply 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 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 biomedical role of the main chemical compounds that make up the human body;
3. to know the normal values and the physiological variations of some compounds;

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

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. Generali-zations 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
	Self-assess-ment 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

IX. METHODOLOGICAL SUGGESTIONS FOR TEACHING-LEARNING-ASSESSMENT

Teaching and learning methods used

Structural 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 learnthe 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, scheme/figure development, modeling, deduction, and experiment are recommended to students.

Applied teaching strategies / technologies

Classical teaching strategies (inductive, deductive, analogic, algorithmic and heuristic) are applied in the teaching of Structural 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

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: Bioelements and biomolecules. Water and its properties. The chemistry of the proteins.

Concluding test II: Nucleic Acids. Carbohydrates chemistry. Water-soluble vitamins.

Concluding test III: Lipid Chemistry. Liposoluble vitamins. Biological membranes.

The final mark of a concluding test is obtained from the computerized test and oral answer score. To 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-assited 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	

NOTE. 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 P. C., Harvey R. 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 L. 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