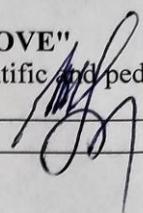


MINISTRY OF HEALTH OF UKRAINE
HIGHER STATE EDUCATIONAL ESTABLISHMENT OF UKRAINE
«BUKOVINIAN STATE MEDICAL UNIVERSITY»

"APPROVE"
Vice-rector for scientific and pedagogical work
Associate Professor  I.V. Gerush
" 15 " 06 _____ 2020

**STUDENT GUIDE
(SYLLABUS)
of studying the discipline**

BIOORGANIC AND BIOLOGICAL CHEMISTRY

Field of knowledge 22 Healthcare
(code and name of the field of knowledge)

Specialty 221 "Dentistry"
(code and name of the specialty)

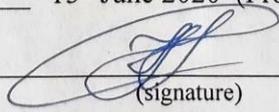
Educational degree master
(master, bachelor, junior bachelor)

Educational year 1-2

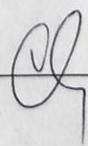
Form of study full-time
(full-time, part-time, distance)

Department Bioorganic and biological chemistry and clinical biochemistry
(name of the department)

Approved at the methodical session of the department
"15" June 2020 (Protocol №17).

Head of the Department  (Hryhorieva N.P.)
(signature)

Approved by the subject methodical
commission "18" June 2020 (Protocol № 11).

Chairman of the subject methodical
commission  (Tkachuk S.S.)
(signature)

Chernivtsi – 2020

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(signature)

1. GENERAL INFORMATION ABOUT SCIENTIFIC AND PEDAGOGICAL WORKERS WHO TEACH THE SUBJECT

Department	Bioorganic and biological chemistry and clinical biochemistry
Surname, name of scientific and pedagogical staff, scientific degree, academic status	Herush Ihor Vasylovych – PhD in medicine, associate professor Hryhorieva Nadiia Pylypivna – PhD in biology, associate professor Davydova Nataliia Valentynivna – PhD in medicine, associate professor Dikal Mariana Viktorivna – PhD in medicine, associate professor Yaremii Iryna Mykolaivna – PhD in biology, associate professor Bevzo Valentyna Viktorivna – PhD in biology, associate professor Turash Mykola Mykolaiovych – PhD in chemistry, associate professor Kushnir Oleksandra Yuriivna – PhD in medicine, associate professor Cherniukh Oksana Hryhorivna – PhD in biology, associate professor Lenha Evelina Leonidivna – PhD in biology, assistant Luhinich Nataliia Mykhailivna – PhD in biology, assistant Ferenchuk Olena Oleksandrivna - assistant Riabaia Oleksandra Vitaliivna - assistant Ihnat Karina Illivna - assistant Melnychuk Alina Oleksandrivna -assistant biochemistry@bsmu.edu.ua
Web page of the department on the official website of the university	https://www.bsmu.edu.ua/biochem/
Department website	http://chem.bsmu.edu.ua
E-mail	biochemistry@bsmu.edu.ua
Address	Chernivtsi, Bogomolets st., 2
Contact phone	+38 (0372) 53-52-53

2. GENERAL INFORMATION ABOUT THE DISCIPLINE

Status of the discipline	normative
Number of credits	8
Total amount of hours	240
Lectures	40
Practical lessons	110
Individual work	90
Type of final control	final module control

3. DESCRIPTION OF THE DISCIPLINE (ABSTRACT)

Bioorganic and biological chemistry is a discipline that is studied by students at the second (master's) level, field of knowledge 22 "Healthcare", specialty 221 "Dentistry" during the I-II years of study. 8 ECTS credits are allocated for the study of the discipline - 240 hours (150 hours practical classes and 90 hours independent student work). The program of the discipline is structured on modules, which include blocks of content modules. The amount of student

workload is described in ECTS credits which are credited to students upon successful completion of the correspondent module (credit).

The subject of the discipline is studying the chemical composition of living organisms (human body) and biochemical reactions, which the biomolecules undergo.

Bioorganic and biological chemistry makes the basis for studying molecular biology, genetics, physiology, pathology, general and molecular pharmacology, toxicology and propaedeutics of clinical disciplines, as well as the basics of clinical diagnosis of the most common diseases, disease monitoring, control over the effectiveness of drugs and prevention of pathological processes. The obtained theoretical knowledge, practical skills and abilities in the discipline form clinical thinking of students - future dentists.

4. POLICY OF THE SUBJECT

4.1. List of normative documents:

- Regulations on the organization of the educational process (<https://www.bsmu.edu.ua/wp-content/uploads/2020/03/polozhennya-pro-organizacziyu-osvitnogo-proczesu-u-vdnzu-bukovinskij-derzhavnij-medichnij-universitet.pdf>);
- Instructions for assessing the educational activities of BSMU students in the implementation of the European credit transfer system of the educational process (<https://www.bsmu.edu.ua/wp-content/uploads/2020/03/bdmu-instrukcziya-shhodo-oczinyuvannya-%D1%94kts-2014-3.pdf>);
- Regulations on the procedure for reworking missed and uncredited classes (<https://www.bsmu.edu.ua/wp-content/uploads/2019/12/reworks.pdf>);
- Regulations on the appeal of the results of the final control of knowledge of higher education (<https://www.bsmu.edu.ua/wp-content/uploads/2020/07/polozhennya-pro-apelyacziyu-rezultativ-pidsumkovogo-kontrolyu-znan.pdf>);
- Codex of Academic Integrity (https://www.bsmu.edu.ua/wp-content/uploads/2019/12/kodeks_academic_faith.pdf);
- Moral and ethical codex of students (https://www.bsmu.edu.ua/wp-content/uploads/2019/12/ethics_code.docx);
- Regulations on the prevention and detection of academic plagiarism (<https://www.bsmu.edu.ua/wp-content/uploads/2019/12/antiplagiat-1.pdf>);
- Regulations on the procedure and conditions for students to choose elective courses (https://www.bsmu.edu.ua/wp-content/uploads/2020/04/nakaz_polozhennyz_vybirkovi_dyscypliny_2020.pdf);
- Rules of internal labor regulations of the Higher State Educational Institution of Ukraine "Bucovynian State Medical University" (<https://www.bsmu.edu.ua/wp-content/uploads/2020/03/17.1-bdmu-kolektivnij-dogovir-dodatok.doc>).

4.2. Policy on adherence to the principles of academic integrity of higher education students:

- independent performance of educational tasks of current and final controls without the use of external sources of information;
- cheating during control of knowledge is prohibited;
- independent performance of individual tasks and correct registration of references to sources of information in case of borrowing of ideas, statements, information.

4.3. Policy on adherence to the principles and norms of ethics and deontology by higher education students:

- actions in professional and educational situations from the standpoint of academic integrity and professional ethics and deontology;
- compliance with the rules of internal regulations of the university, to be tolerant, friendly and balanced in communication with students and teachers, medical staff of health care institutions;
- awareness of the importance of examples of human behavior in accordance with the norms of academic integrity and medical ethics.

4.4. Attendance policy for higher education students:

- attendance at all training sessions (lectures, practical (seminar) classes, final modular control) is mandatory for the purpose of current and final assessment of knowledge (except for respectable reasons).

4.5. Deadline policy and completion of missed or uncredited classes by higher education students:

- reworks of missed classes are held according to the schedule of missed or uncredited classes and consultations.

5. PRECISIONS AND POST-REQUIREMENTS OF THE EDUCATIONAL DISCIPLINE (INTERDISCIPLINARY RELATIONS)

List of disciplines, on which the study of academic discipline is based	List of academic disciplines, for which the basis is laid as a result of studying the discipline
Medical anatomy	Pharmacology
Medical chemistry	Pathophysiology
Human anatomy	Internal Medicine
Medical and biological physics	Prevention of dental diseases
Histology, cytology and embryology	
Physiology	

6. PURPOSE AND TASKS OF THE EDUCATIONAL DISCIPLINE:

6.1 The purpose of studying the discipline "Biological and Bioorganic Chemistry" is to master the results of biochemical tests and changes of biochemical and enzymatic parameters used to diagnose human diseases. To analyze the biochemical metabolic processes and their regulation in maintenance of functioning of human organs and systems. The ultimate goal is to acquire practical skills.

6.2. The main tasks of studying the discipline are:

- to master the skills of biochemical components determination in biological fluids,
- to analyze the results of biochemical tests and changes in biochemical and enzymatic parameters used to diagnose the most common human diseases

7. COMPETENCIES, THE FORMATION OF WHICH IS CONTRIBUTED BY THE DISCIPLINE:

Competences and learning outcomes, the formation of which is facilitated by the discipline (relationship with the normative content of training of higher education, formulated in terms of learning outcomes in the Standard).

According to the requirements the standard discipline provides getting the following *competences*:

7.1. **Integral competence**: ability to solve complex problems and problems in the field of health care in the specialty "Dentistry" in a professional activity or in the learning process, which involves research and/ or innovation and is characterized by uncertainty of conditions and requirements.

7.2. **General competencies**:

GC 1. Ability for abstract thinking, analysis and synthesis.

GC 2. Knowledge and understanding of the subject area and understanding of professional activity

GC 3. Ability to apply knowledge in practice.

GC 7. Ability to search, process and analyze the information from various sources.

GC 9. Ability to identify, set and solve problems.

GC 11. Ability to work in a team.

7.3. Professional (special) competencies:

PC 2. Ability to interpret the results of laboratory and instrumental studies.

PC 4. Ability to plan and implement measures for the prevention of diseases of organs and tissues of the oral cavity and maxillofacial area.

PC 13. Ability to assess the impact of the environment on the people's health (individual, family, population).

8. RESULTS OF STUDYING THE DISCIPLINE.

As a result of studying the discipline student must:

8.1. Know:

- main classes of bioorganic compounds, their biological role in the human body;
- general principles of metabolism, the basis of carbohydrates, lipids, amino acids metabolic pathways and their regulation;
- molecular basis of hereditary pathologies, methods of their diagnostics;
- features of metabolic processes in the blood, liver, kidneys, gastrointestinal tract, muscles, nervous and connective tissues and tissues of the oral cavity;
- basic biochemical methods for diagnostics of major pathological conditions.

8.2. Be able to:

- analyze the compliance of the structure of bioorganic compounds with physiological functions that they perform in the human body;
- interpret the peculiarities of the physiological state of the organism and the development of pathological processes on the basis of laboratory studies: to analyze the reactivity of carbohydrates, lipids, amino acids, which provides their functional properties and metabolic transformations in the body;
- interpret the peculiarities of the structure and transformations of bioorganic compounds in the human body as the basis of their pharmacological action as drugs;
- interpret biochemical mechanisms of pathological processes in the human body and the principles of their correction;
- explain the basic mechanisms of biochemical action and the principles of targeted use of different classes of pharmacological agents;
- explain the biochemical and molecular basis of physiological functions of cells, organs and systems of the human body.

8.3. Demonstrate:

PLO 6. To plan and implement measures in order to prevent dental diseases among the population, against the spread of dental diseases.

PLO 15. To assess the impact of the environment on the population health in a medical institution using standard methods.

PLO 17. To follow a healthy lifestyle, use self-regulation and self-control techniques.

PLO 19. To adhere to the requirements of ethics, bioethics and deontology in their professional activities.

PLO 20. To organize the necessary level of individual safety (one's own and persons cared for) in case of occurrence of typical hazardous situations in the individual field of activity.

9. INFORMATIONAL SCOPE OF THE DISCIPLINE

Description of each module of the discipline:

- 9.1. Specific objectives of the module (content modules).
- 9.2. Thematic structure of the module (content modules).

Module 1. Biologically important classes of bioorganic compounds. Biopolymers and their structural components.

(1 course)

Content module 1. Theoretical bases of structure and reactivity of bioorganic compounds

Specific objectives:

- To explain the basic rules of IUPAC nomenclature, to be able to use for naming bioorganic compounds.
- To make conclusions and analyze the relationship between the structure, configuration and conformation of bioorganic compounds.
- To interpret the dependence of the reactivity of bioorganic compounds on the nature of the chemical bond and the interaction of atoms in the molecule.
- To interpret the reaction mechanisms of different classes of bioorganic compounds, their transformation in biological systems.
- To explain of the biological activity of carboxylic acids on the spatial structure of the molecule.
- To interpret the dependence of carboxylic acids reaction mechanisms on the spatial structure of the molecules.
- To explain the biological role of different classes of lipids in life processes.

Topic 1. Classification, nomenclature, isomerism of bioorganic compounds. Types of chemical reactions and reagents.

Topic 2. Research of chemical properties of aldehydes and ketones.

Topic 3. Research of chemical properties of carboxylic acids.

Topic 4. Fatty acids. Lipids. Phospholipids.

Topic 5. Research of chemical properties and biological functions of heterofunctional compounds (hydroxy acids, α -, β -, γ -amino acids, keto acids and phenolic acids).

Content module 2. α -Amino acids, peptides, proteins, enzymes.

Specific objectives:

- To interpret the structure of alpha-amino acids as the basis of biopolymers-proteins, which are structural components of all body tissues.
- To make conclusions about the ways of alpha-amino acids transformations in the body and to analyze the dependence of physiologically active compounds formation from them on their structure and reactivity.
- To explain the mechanism of biogenic amines formation and their influence on physiological functions of the organism.
- To explain the dependence of physical-chemical properties of proteins on their amino acid composition.
- To be able to analyze qualitative reactions of alpha-amino acids to determine the amino acid composition of proteins and to use biuret reaction to quantify proteins.

Topic 1. Research of amino acid composition of proteins and peptides

Topic 2. Research of structural proteins organization

Topic 3. Research of enzymes properties

Content module 3. Carbohydrates. Mono-, oligo- and polysaccharides.

Specific objectives:

- To make conclusions about the existence of monosaccharides in different tautomeric forms, which affects their reactivity and allows laboratory research of monosaccharides in biological fluids.
- To interpret the features of structure and transformations of homopolysaccharides in the body as nutrients and sources of energy for life processes.
- To analyze the principles of methods for monosaccharides determination in blood, urine, and saliva.
- To explain the mechanisms of the biological role of heteropolysaccharides (glycosaminoglycans) in biological fluids and tissues.

Topic 1. Research of chemical properties of monosaccharides .

Topic 2. Research of structure and functions of di- and polysaccharides.

Content module 4. Biologically active heterocyclic compounds. Nucleosides, nucleotides, nucleic acids.

Specific objectives:

- To explain the dependence of the heterocyclic compounds reactivity on their structure, which promotes their biosynthesis in the body and laboratory synthesis in order to obtain drugs.
- To make conclusions about the biological activity of heterofunctional derivatives of heterocyclic compounds under conditions of their special structure and chemical reactivity.
- To analyze the role of mononucleotides for the construction of nucleic acids and nucleotide coenzymes.
- To interpret the mechanisms of vitamins in the construction of coenzymes that analyze biochemical reactions in the body.

Topic 1. Research of chemical properties of biologically important heterocyclic compounds.

Topic 2. Research of chemical properties of nucleosides and nucleotides.

Topic 3. Research of the structure and properties of nucleic acids.

Topic 4. Final control of the module 1.

10. STRUCTURE OF EDUCATIONAL DISCIPLINE

Names of content modules and topics	Amount of hours				
	Total	including			
		Classroom		Independent students' work	Individual work
		Lectons	Practicals		
1	2	3	4	5	6
Module 1 Biologically important classes of bioorganic compounds. Biopolymers and their structural components					
Content module 1 . Theoretical foundations of structure and reactivity and bioorganic compounds					
Topic 1. Classification, nomenclature, isomerism of bioorganic compounds. Types of chemical reactions and reagents.	5	2	2	1	
Topic 2. Research of chemical properties of aldehydes and ketones	5	1	2	2	
Topic 3. Research of chemical properties of carboxylic acids	4		2	2	
Topic 4: Fatty acids. Lipids. Phospholipids.	7	1	2	4	
Topic 5. Research of chemical properties and	6		2	4	

biological functions of heterofunctional compounds (hydroxy acids, α -, β -, γ -amino acids, keto acids and phenolic acids).					
Total on the content module 1	27	4	10	13	
Content module 2. α-Amino acids, peptides, proteins, enzymes.					
Topic 1. Research of amino acid composition of proteins and peptides	7	1	2	4	
Topic 2. Research of structural proteins organization	5	1	2	2	
Topic 3. Research of enzymes properties	5		2	3	
Total on the content module 2	17	2	6	9	
Content module 3. Structure and functions of carbohydrates.					
Topic 1. Research of chemical properties of monosaccharides	7	1	2	4	
Topic 2. Research of structure and functions of di- and polysaccharides.	7	1	2	4	
Total on the content module 3	14	2	4	8	
Content module 4. Biologically active heterocyclic compounds. Nucleosides, nucleotides, nucleic acids.					
Topic 1. Research of chemical properties of biologically important heterocyclic compounds.	15	1	2	4	
Topic 2. Research of chemical properties of nucleosides and nucleotides.	6		2	4	
Topic 3. Research of the structure and properties of nucleic acids.	3	1	2	4	
Topic 4. Final control of module 1.					
Total on the content module 4	24	2	6	12	
Final module control	12		4	8	
TOTAL HOURS	90	10	30	50	

11. THEMATIC PLAN OF LECTURES

№	Name of topic	Amount of hours
1.	Bioorganic chemistry as a science. Classification, structure, and reactivity of bioorganic compounds. Carbonyl compounds.	2
2.	Structure and chemical properties of carboxylic acids. Lipids.	2
3.	α -Amino acids, peptides, proteins.	2
4.	Classification, structure and chemical properties of carbohydrates.	2
5.	Heterocyclic compounds. Structure, properties and biological role of nucleic acids.	2

12. THEMATIC PLAN OF PRACTICAL (SEMINAR) CLASSES

№	Name of topic	Amount of hours
1.	Classification, nomenclature, isomerism of bioorganic compounds. Types of chemical reactions and reagents	2
2.	Research of chemical properties of aldehydes and ketones	2
3.	Research of chemical properties of carboxylic acids	2
4.	Fatty acids. Lipids. Phospholipids.	2
5.	Research of chemical properties and biological functions of heterofunctional compounds	2

6.	Research of amino acid composition of proteins and peptides	2
7.	Research of structural proteins organization	2
8.	Research of enzymes properties	2
9.	Research of chemical properties of monosaccharides	2
10.	Research of structure and functions of di- and polysaccharides.	2
11.	Research of chemical properties of biologically important heterocyclic compounds	2
12.	Research of chemical properties of nucleosides and nucleotides	2
13.	Research of the structure and properties of nucleic acids	2
14-15.	Final control of module 1: Biologically important classes of organic compounds. Biopolymers and their structural components	4
	Total	30

13. THEMATIC PLAN OF INDIVIDUAL WORK

№	Name of topic	Amount of hours
1.	Stereochemical structure and optical activity of bioorganic compounds	2
2.	Heterofunctional compounds (hydroxy acids, α -, β -, γ -amino acids, keto acids, phenolic acids), their structure, properties, biological significance.	4
3.	Composition and structure of "ketone" bodies, ways of formation in the body, laboratory methods of determination.	4
4.	The structure of unsaponifiable lipids, the concept of polyhydric alcohols and their biological significance in the construction of complex lipids (sphingolipids and glycolipids); their importance in constructions of biomembranes.	4
5.	Physical-chemical properties of enzymes.	4
6.	Structure and biologically important properties of some monosaccharides.	4
7.	Glycosaminoglycans: structure and biological role in hyaluronic acid, chondroitin sulfates and heparin.	4
8.	Structure and properties of heterocyclic compounds which are the structural basis of biologically important substances and drugs.	4
9.	Structure and biochemical functions of free nucleotides: nucleotides-coenzymes; cyclic nucleotides 3',5'-cAMP and 3',5'-cGMP	4
10.	Physiologically active compounds - vitamins, enzymes, neurotransmitters (GABA, acetylcholine).	4
11.	Analysis of the compliance of vitamins with biochemical functions that they perform in the body.	4
12.	Preparation for the final control of the module №1.	8
	TOTAL	50

14. LIST OF INDIVIDUAL TASKS

<i>Preparation of a review of the scientific literature on the topic:</i>	
1.	The value of conformational isomerism for the formation of biomolecules spatial structure.
2.	The role of aromatic amines in the synthesis of drugs.
3.	Benzopyrroles, their formation in the processes of putrefaction of proteins in the intestine.
4.	Thiazole as a structural component of the thiamine molecule.
5.	Thiophene as a structural component of the biotin molecule.
6.	Pyridoxine: structure, properties and coenzyme functions.
7.	Pyrimidine derivatives as drugs
8.	Six-membered heterocycles. Phenothiazines as neuroleptics.
9.	Methylated derivatives of xanthine (caffeine, theophylline, theobromine). Effects on the central nervous system
10.	Oligomeric proteins
11.	Methods of protein fractionation and analysis

12.	Analysis of the primary protein structure (Sanger and Edman methods).
13.	Principles of enzymes nomenclature and classification.
14.	Multienzyme complexes: features of structure and catalysis.
15.	Minor nitrogenous bases, their biological role
16.	RNA types and their role in protein biosynthesis.

15. LIST OF THEORETICAL TASKS TO THE FINAL MODULE CONTROL

- Types of classifications and nomenclature of bioorganic compounds. Examples.
- O.M. Butlerov's contribution to the development of the basic principles of isomerism.
- Schematic presentation of electrons distribution in atomic orbitals (AO) of carbon atom in normal and excited state.
- Valence states of the carbon atom corresponding to sp^3 , sp^2 and sp - hybridizations.
- Electron density distribution in organic molecules.
- Interaction of atoms. Electronegativity.
- General characteristics of chemical reactions of bioorganic compounds.
- Classification of reactions by direction and result.
- Classification of reactions by mechanism.
- Characteristics of nucleophiles and electrophiles. Nucleophilic addition reactions to oxo compounds.
- Influence of nucleophile on formation of new bonds with aldehydes and ketones: C-C, C-O, C-H, C-N.
- Aldol condensation and its significance for elongation of the carbon chain. Aldehydes and ketones oxidation.
- Qualitative reactions for detection of aldehyde group (Tollens and Trommer). Disproportionation reaction (dismutation, Cannizzaro). Haloform reactions. Iodoform test, its application for analytical purposes.
- Carboxylic acids, classification, representatives.
- Nucleophilic substitution reactions (S_N) near the sp^2 -hybridized carbon atom of the oxo group.
- Derivatives of carboxylic acids.
- Structure and properties of dicarboxylic acids.
- Higher fatty acids (FFA) as components of neutral lipids.
- Structure and properties of neutral lipids, their consistency, hydrolysis. Soaps.
- Structure of phospholipids, their biological significance.
- Classification and isomerism of hydroxy acids. Asymmetric carbon atom, chirality, optical activity. Enantiomers. Diastereoisomers.
- Chemical properties and biological significance of hydroxy acids.
- Biological significance of keto acids and their derivatives.
- Ketone bodies, diagnostic value of their determination in case of diabetes mellitus.
- Keto-enol tautomerism of keto acids and their derivatives.
- Classification of amino acids by the structure of the carbon chain, the ability to synthesize in the body and the polarity of the radical.
- General properties of amino acids.
- Chemical reactions of α -amino acids in vivo and in vitro.
- Qualitative reactions to α -amino acids, peptides, proteins.
- Proteins as biopolymers. Methods of combining α -amino acids in protein molecules.
- Bonds that form the primary, secondary, tertiary and quaternary protein structures. Globular and fibrillar proteins.
- Factors of proteins stability in colloidal solutions.
- The mechanisms of protein precipitation. Types of sedimentation. Reagents that cause salting out.
- Irreversible sedimentation. Factors that cause irreversible sedimentation.
- Denaturation, its signs. Factors that cause protein denaturation. Renaturation.
- Structure and properties of enzymes.

37. Classification of carbohydrates.
38. Monosaccharides isomerism. Tautomeric forms of monosaccharides. Mutarotation.
39. Chemical reactions of monosaccharides which involve carbonyl groups: oxidation reduction reactions (qualitative tests for aldehyde group).
40. Formation of glycosides, their role in the construction of oligo- and polysaccharides, nucleosides, nucleotides and nucleic acids.
41. Glucose and fructose phosphorus esters, their importance in carbohydrate metabolic transformations.
42. Ascorbic acid as a derivative of hexose, the biological role of vitamin C.
43. Classification of disaccharides by their ability to redox reactions. Two types of bonds between monosaccharide residues and their effect on the reactivity of disaccharides.
44. The structure of lactose and sucrose, their properties. Sucrose inversion due to hydrolysis.
45. Homopolysaccharides as polyglycosides. Structure, biological role and application of starch, its components. Structure of amylose and amylopectin.
46. Starch hydrolysis, qualitative reaction for starch detection.
47. Structure and biological role of glycogen, cellulose, their role in the vital processes of the organism.
48. Heteropolysaccharides. The role of glucuronic acid, glucosamine and galactosamine in the formation of heteropolysaccharides.
49. Five-membered heterocycles with one and two heteroatoms, their derivatives.
50. Benzopyrrole (indole) as a component of tryptophan and its derivatives - biologically active compounds (tryptamine, serotonin) and toxic substances (skatol, indole).
51. Six-membered heterocycles with one and two heteroatoms are the basis of biologically important compounds and nitrogenous bases.
52. Nucleosides and nucleotides are products of incomplete hydrolysis of nucleic acids.
53. The structure of nucleotides - components of nucleic acids: AMP, GMP, UMP, CMP, d-TMP.
54. Structure and significance of 3',5'-cAMP, its role in the action of hormones on cells.
55. Phosphorylated nucleotide derivatives, values of ADP and ATP.
56. Role of nucleotides in the coenzymes structure. The mechanism of action of the coenzyme NAD^+ .
57. Nucleic acids are polynucleotides, biopolymers that store, transfer hereditary information and participate in protein biosynthesis.
58. Types of RNA: mRNA, rRNA, tRNA, their structural organization and biological role.
59. Structure and biochemical functions of DNA.
60. Differences in the structure, location and functions of RNA and DNA.

16. LIST OF PRACTICAL SKILLS AND TASKS TO THE FINAL MODULE CONTROL

1. Determine the presence of formaldehyde in the solution by the Trommer reaction. Conclude.
2. Evaluate the iodoform test for acetone. Conclude.
3. How and why will the color of KMnO_4 solution change with the addition of oleic acid?
4. Why is Wagner's reaction to fat unsaturation qualitative? Analyze the results.
5. Evaluate the difference in the chemical behavior of salol and aspirin in their interaction with FeCl_3 . Make the conclusion.
6. Evaluate the results of the phased preparation of Fehling's reagent. Where is it applied?
7. Why do glucose and lactose on the one hand and sucrose on the other interact in different way with Fehling's reagent? Explain the results.
8. What is the qualitative reaction to starch? Make conclusions.
9. How and why do we get different products when glucose interacts with $\text{Cu}(\text{OH})_2$ under different conditions (room temperature and heating)? Make conclusion.
10. Interpret qualitative reactions to amino acids and proteins: xanthoprotein test, ninhydrine test; Foil test; biuret test.
11. How and why do different colors of solutions appear?
12. Suggest a reaction that will distinguish peptides from proteins.

13. Evaluate the effect of ammonium sulfate, trichloroacetic and sulfasalicylic acids on proteins. Give an argument.
14. How and why does the composition of nucleic acids change during their hydrolysis? Determine the components of the hydrolyzate. Make conclusions.

2nd year

Module 2: General principles of metabolism. Metabolism of carbohydrates, lipids, aminoacids, its regulation

Content module 5. Introduction to biochemistry. Biochemical components of cells

Specific objectives:

- To analyze the stages and patterns of biochemistry foundation as a fundamental medical and biological science and educational discipline.
- To explain the principles and basics of biochemical investigation methods of functional state of the human body in normal and in pathological conditions.
- To use the results of biochemical analysis to assess the state of certain metabolic pathways.
- To interpret the basic biochemical concepts that characterize metabolic transformations and regulatory adaptive processes.

Topic 1. Control of the initial level of students' knowledge. Goals and objectives of biochemistry.

Colorimetric analysis in biochemistry.

Topic 2*. The main stages of biochemistry foundation. Development of biochemical science in Ukraine.

Topic 3*. Biochemical components of cells.

Content module 6. Enzymes and coenzymes. Regulation of metabolism

Specific objectives:

- To analyze the regulatory mechanisms of the main metabolic processes.
- To interpret the biochemical patterns of structure and function of different enzymes classes.
- To interpret the role of vitamins and their biologically active derivatives in the mechanism of catalysis involving the main classes of enzymes.
- To analyze the ways and mechanisms of regulation of enzymatic processes as the basis of metabolism in the body in normal and pathological conditions.
- To explain changes in enzymatic processes and the accumulation of metabolic intermediates in congenital and acquired metabolic defects.
- To analyze the changes in the enzymes activity of blood plasma in case of pathologies of certain organs and tissues.
- To explain the application of enzymes and enzyme inhibitors as pharmacological drugs in certain pathological conditions.

Topic 1. Structure and physical-chemical properties of enzymes. Coenzyme role of vitamins.

Qualitative tests for vitamins

Topic 2. Enzymes classification. Determination of alpha-amylase activity.

Topic 3. The application of enzymes in medicine. Determination of aminotransferases activity.

Topic 4. Regulation of enzyme activity.

Topic 5*. Modern models of the mechanism of enzymes action.

Content module 7. General principles of metabolism and molecular basis of bioenergetics.

Specific objectives:

- To interpret the biochemical principles of metabolism: catabolic, anabolic, amphibolic metabolic pathways.
- To interpret the biochemical principles of tricarboxylic acid cycle functioning, its anaplerotic and amphibolic reactions.

- To explain the biochemical mechanisms of tricarboxylic acid cycle regulation and its key role in metabolism and energy turnover.
- To interpret the role of biological oxidation, tissue respiration and oxidative phosphorylation in the generation of ATP under aerobic conditions.
- To analyze disorders of ATP synthesis under the influence of chemical, physical, biological pathogenic factors on human body.
- To explain the biochemical basis of endogenous toxins detoxification by microsomal oxidation enzymes.

Topic 1. General catabolic steps. Quantitative determination of pyruvate in the urine

Topic 2. Energy metabolism, oxidative phosphorylation.

Content module 8. Carbohydrate metabolism and its regulation

Specific objectives :

- To interpret the biochemical principles of intracellular carbohydrate metabolism: anaerobic and aerobic glucose oxidation.
- To interpret the biochemical principles of alternative metabolic pathways of monosaccharides: pentose phosphate pathway of glucose oxidation, pathways of fructose and galactose conversion, glucuronate pathway of glucose metabolism.
- To interpret the functional features and biological significance of glucose biosynthesis, glycogen synthesis and breakdown in tissues.
- To analyze the changes in blood glucose levels, mechanisms of their hormonal regulation (insulin, glucagon, adrenaline, glucocorticoids), pathological manifestations of glucose metabolism disorders: diabetes mellitus (types, biochemical diagnostic criteria), starvation.
- To interpret the concept of normoglycemia, hyperglycemia, glucosuria as normal and pathological states of glucose metabolism.
- To explain the molecular bases of inherited enzymopathies of fructose, galactose, glycogen metabolism.

Topic 1. Glycogen metabolism, its regulation. Determination of blood glucose.

Topic 2. Ways of glucose catabolism. Determination of lactic acid in oral fluid.

Topic 3. Alternative ways of glucose metabolism. Determination of glucose in urine.

Topic 4*. Aerobic oxidation of carbohydrates.

Topic 5*. Fructose and galactose metabolism. Disorders of their metabolism.

Content module 9 . Lipid metabolism and its regulation

Specific objectives :

- To interpret the biochemical functions of simple and complex lipids in the body: role in construction and functioning of biological cell membranes, depositing function, energy functions, and use as precursors in the biosynthesis of biologically active compounds of lipid nature.
- To interpret the biochemical principles of intracellular lipid metabolism: catabolism and biosynthesis of fatty acids, triacylglycerols, phospholipids, hormonal regulation of lipolysis.
- To interpret biochemical principles of regulation of cholesterol biosynthesis and its biotransformation: esterification, formation of bile acids, steroid hormones, vitamin D3.
- To analyze changes in the circulatory lipids transport in pathology, explain the functional significance lipoproteins, their role in atherogenesis.
- To analyze changes in antioxidant enzymes activity in biological fluids (blood, oral fluid) to assess the state of free radical oxidation in the human body.
- To explain the biochemical basis for the occurrence and development of genetic abnormalities of lipid metabolism, lipoproteins, cholesterol (lipoproteinemia), as well as acquired disorders of lipid metabolism: atherosclerosis, obesity, diabetes.

Topic 1. Lipid catabolism. Kinetics of lipase action and the role of bile acids.

Topic 2. Determination of ketone bodies in the urine.

Topic 3. Lipids synthesis. Quantitative determination of serum cholesterol.

Topic 4*. Metabolism of complex lipids.

Content module 10 . Amino acid metabolism. Enzymopathies of amino acid metabolism

Specific objectives :

- To interpret the biochemical patterns of intracellular amino acid metabolism: the processes of deamination, transamination, decarboxylation, to explain the biological action of biogenic amines: serotonin, histamine GABA, etc.
- To interpret the metabolic principles of ammonia formation and detoxification, circulatory ammonia transport, urea biosynthesis.
- To analyze changes in the transport system and its detoxification in case of genetic abnormalities of ammonia metabolism enzymes.
- To explain the peculiarities of the functioning of the general pathways of metabolism of nitrogen-free skeletons of amino acids and specialized transformations of cyclic amino acids.
- To explain the biochemical basis of the development and manifestations of genetic abnormalities of aromatic amino acid metabolism and analyze the causes of accumulation of intermediate products of their metabolism in phenylketonuria, alkaptonuria, albinism.

Topic 1. General ways of aminoacid metabolism. Ways of ammonia detoxification. Quantitative determination of ammonia in urine.

Topic 2. Metabolism of aromatic amino acids. Inherited disorders of their metabolism. Determination of ketoacids in urine.

Topic 3. Metabolism of sulfur-containing amino acids. Determination of cysteine in urine.

9.2. MODULE 2 STRUCTURE

Names of content modules and topics	Amount of hours				
	Total	including			
		Classroom		Independent students' work	Individual work
		Lectures	Practicals		
1	2	3	4	5	6
Module 2: General principles of metabolism. Metabolism of carbohydrates, lipids, aminoacids, its regulation					
<i>Content module 5. Introduction to biochemistry. Biochemical components of cells</i>					
Topic 1. Control of the initial level of students' knowledge. Goals and objectives of biochemistry. Colorimetric analysis in biochemistry.	2,5		2	0,5	
Topic 2*. The main stages of biochemistry foundation. Development of biochemical science in Ukraine.	1			1	
Topic 3*. Biochemical components of cells.	1			1	
Total on the content module 5	4,5		2	2,5	
<i>Content module 6. Enzymes and coenzymes. Regulation of metabolism</i>					
Topic 1. Structure and physical-chemical properties of enzymes. Coenzyme role of vitamins. Qualitative tests for vitamins	3,5	1	2	0,5	
Topic 2. Enzymes classification. Determination of alpha-amylase activity.	2		2		
Topic 3. The application of enzymes in medicine. Determination of aminotransferases	2		2		

activity.					
Topic 4. Regulation of enzyme activity.	3,5	1	2	0,5	
Topic 5*. Modern models of the mechanism of enzymes action.	0,5			0,5	
Total on the content module 6	11,5	2	8	1,5	
<i>Content module 7. General principles of metabolism and molecular basis of bioenergetics</i>					
Topic 1. General catabolic steps. Quantitative determination of pyruvate in the urine	4,5	1	2	1,5	
Topic 2. Energy metabolism, oxidative phosphorylation.	5	1	2	2	
Total on the content module 7	9,5	2	4	3,5	
<i>Content module 8. Carbohydrate metabolism and its regulation</i>					
Topic 1. Glycogen metabolism, its regulation. Determination of blood glucose.	3		2	1	
Topic 2. Ways of glucose catabolism. Determination of lactic acid in oral fluid.	5	2	2	1	
Topic 3. Alternative ways of glucose metabolism. Determination of glucose in urine.	4,5	2	2	0,5	
Total on the content module 8	12,5	4	6	2,5	
<i>Content module 9 . Lipid metabolism and its regulation</i>					
Topic 1. Lipid catabolism. Kinetics of lipase action and the role of bile acids.	3	1	2		
Topic 2. Determination of ketone bodies in the urine.	3,5	1	2	0,5	
Topic 3. Lipids synthesis. Quantitative determination of serum cholesterol.	4	2	2		
Topic 4*. Metabolism of complex lipids.	2			2	
Total on the content module 9	12,5	4	6	2,5	
<i>Content module 10 . Amino acid metabolism. Enzymopathies of amino acid metabolism</i>					
Topic 1. General ways of aminoacid metabolism. Ways of ammonia detoxification. Quantitative determination of ammonia in urine.	4,5	2	2	0,5	
Topic 2. Metabolism of aromatic amino acids. Inherited disorders of their metabolism. Determination of ketoacids in urine.	4	1	2	1	
Topic 3. Metabolism of sulfur-containing amino acids. Determination of cysteine in urine.	4	1	2	1	
Total on the content module 10	12,5	4	6	2,5	
Final module control	12		4	8	
TOTAL HOURS	75	16	36	23	

11. THEMATIC PLAN OF LECTURES

№	Name of topics	Amount of hours
1.	Biochemistry as a science. Structure and the mechanism of action of enzymes . Regulation of enzyme activity.	2
2.	General catabolic pathways of carbohydrates, lipids, amino acids. Biological oxidation and oxidative phosphorylation.	2
3.	Carbohydrate metabolism 1. Glycolysis, aerobic glucose oxidation; pentose phosphate pathway of glucose-6-phosphate oxidation.	2
4.	Carbohydrate metabolism 2. Glycogen turnover, gluconeogenesis. Regulation and disorders of carbohydrate metabolism. Diabetes mellitus.	2
5.	Lipid metabolism. Catabolism of triacylglycerols, fatty acid oxidation.	2
6.	Lipids synthesis. Regulation and pathologies of lipid metabolism	2
7.	Amino acid metabolism 1. General pathways of amino acid conversions. Ammonia metabolism: urea biosynthesis and its disorders.	2
8.	Amino acid metabolism 2. Specific pathways of amino acid conversions; hereditary enzymopathies.	2
	Total	16

12. THEMATIC PLAN OF PRACTICAL (SEMINAR) CLASSES

№	Name of topics	Amount of hours
1.	Control of the initial level of students' knowledge. Goals and objectives of biochemistry. Colorimetric analysis in biochemistry.	2
2.	Structure and physical-chemical properties of enzymes. Coenzyme role of vitamins. Qualitative tests for vitamins	2
3.	Classification of enzymes. Determination of alpha-amylase activity in oral fluid	2
4.	The application of enzymes in medicine. Determination of aminotransferase activity in blood serum	2
5.	Regulation of enzyme activity	2
6.	General catabolic steps. Quantitative determination of pyruvate in the urine	2
7.	Energy metabolism, oxidative phosphorylation	2
8.	Glycogen metabolism, its regulation. Determination of blood glucose	2
9.	Ways of glucose catabolism. Determination of lactic acid in oral fluid	2
10.	Alternative ways of glucose metabolism. Determination of glucose in urine	2
11.	Lipid catabolism. Kinetics of lipase action and the role of bile acids.	2
12.	Determination of ketone bodies in the urine	2
13.	Lipids synthesis. Quantitative determination of serum cholesterol	2
14.	General ways of aminoacid metabolism. Ways of ammonia detoxification. Quantitative determination of ammonia in urine.	2
15.	Metabolism of aromatic amino acids. Inherited disorders of their metabolism. Determination of ketoacids in urine.	2
16.	Metabolism of sulfur-containing amino acids. Determination of cysteine in urine	2
17-18.	Final control of module 2: General principles of metabolism. Metabolism of carbohydrates, lipids, aminoacids, its regulation	4
	Total	36

13. THEMATIC PLAN OF INDIVIDUAL WORK

№	Name of topics	Amount of hours
1.	Topics for self-study:	
1.1.	The main stages of biochemistry foundation. Development of biochemical science in Ukraine.	1
1.2.	Biochemical components of cells	1
1.3 .	Modern models of the mechanism of enzymes action	1
1.4 .	Metabolism of complex lipids	2
2.	<i>Preparation for practical classes :</i>	
2.1.	<i>Acquire practical skills in regulating metabolism:</i>	
	Preparation of material (biological fluids, cells, subcellular organelles) for biochemical research	0.5
	Plotting the dependence of the enzymatic reaction rate on the substrate concentration, pH, temperature.	0.5
	Writing the structures of coenzyme vitamins and explaining the mechanism of coenzyme forms formation.	0.5
2.2.	<i>Acquire practical skills in the molecular basis of bioenergy:</i>	
	Reproduction of successive stages of common pathways of proteins, carbohydrates and lipids catabolism.	1
	Writing a sequence of reactions of the intermediates conversion in the tricarboxylic acid cycle.	0.5
	Write a diagram and explain the structure and mechanism of action of the electron transport chain.	1
	Explain the mechanism of oxidation and phosphorylation coupling, ATP synthesis in ETC on the basis of the chemoosmotic theory .	1
2.3.	<i>To acquire practical skills in biochemistry of carbohydrate metabolism:</i>	
	Writing enzymatic reactions of conversion of intermediates in glycolysis, pentose phosphate pathway, glycogen metabolism.	0.5
	Explaining the molecular mechanisms of carbohydrate metabolism regulation.	0.5
	Evaluate the state of carbohydrate metabolism by biochemical parameters in pathologies.	0.5
2.4.	<i>Acquire practical skills in the biochemistry of lipid metabolism:</i>	
	Build schemes and write biochemical reactions of lipid transformations in metabolic pathways.	0.5
	Explain the molecular mechanisms of lipid metabolism regulation and individual metabolic pathways.	0.5
	Evaluate the biochemical parameters of lipid metabolism disorders in pathological conditions.	0.5
2.5.	<i>Acquire practical skills in biochemistry of amino acid metabolism:</i>	
	Build schemes and write biochemical (enzymatic) reactions of amino acid transformations in metabolic processes.	0.5
	Analyze and interpret molecular mechanisms of regulation of amino acid metabolism and their specific metabolic pathways.	0.5
	Evaluate the biochemical parameters of amino acid metabolism disorders in congenital and acquired metabolic defects.	1
3 .	Preparation for the final control of the module №2.	8
	TOTAL	23

LIST OF THEORETICAL TASKS TO THE FINAL MODULE CONTROL 2

1. Goals and objectives of biochemistry. Main stages and modern trends in the development of biochemistry.
2. Methods of biochemical examinations.
3. Development of biochemical investigation in Ukraine, scientific biochemical schools.
4. The concept of metabolism (catabolism and anabolism).
5. Biological membranes: structure, biological functions.
6. Enzymes: structure, characteristic of action.
7. Cofactors and coenzymes. Coenzyme function of vitamins, examples.
8. Units of enzyme activity and methods of their determination.
9. Classification of enzymes. Examples of each class.
10. The development of ideas about the mechanism of action of enzymes. The modern theory of the mechanism of action of enzymes.
11. Kinetics of enzymatic reactions. Influence of temperature, pH, substrate and enzyme concentrations on the velocity of enzymatic reactions.
12. Inhibitors, enzyme activators. Physiologically active compounds and xenobiotics as reversible (competitive, non-competitive) and irreversible enzyme inhibitors.
13. Ways and mechanisms of regulation of enzyme activity. Allosteric regulation.
14. Regulation of enzyme activity by regulation of enzyme synthesis (cytosolic mechanism of hormones action).
15. Regulation of enzyme activity via cAMP (adenylacyclase cascade).
16. Regulation of enzyme activity by Ca²⁺ ions, inositol phosphates and diacylglycerols.
17. Cellular, secretory and excretory enzymes.
18. Isoenzymes, their role in enzymodiagnosics, examples.
19. Application of enzymodiagnosics in practical medicine.
20. Enzymopathologies: inherited, acquired, examples.
21. Enzymotherapy, application of enzymes as drugs, examples.
22. General rules of metabolism: anabolic, catabolic and amphibolic pathways.
23. Oxidative decarboxylation of pyruvate. Characteristic of pyruvate dehydrogenase and α -ketoglutarate dehydrogenase multienzyme complexes.
24. Cycle of tricarboxylic acids: sequence of reactions, enzymes characteristic, biochemical value.
25. Ways of ATP synthesis in the cells: substrate and oxidative phosphorylation
26. Molecular organization of mitochondrial chain of biological oxidation.
27. Oxidative phosphorylation. Energy release in respiratory chain and sites of ATP formation.
28. Proton electrochemical gradient. Chemiosmotic theory of oxidative phosphorylation. Inhibitors of electron transport and uncouplers of oxidative phosphorylation.
29. Anaerobic oxidation of glucose – glycolysis: enzymatic reactions of glycolysis, energy effect, biological role.
30. Aerobic oxidation of glucose, sequence of reactions. Energy effect.
31. Gluconeogenesis. Biological role and regulation. Glucose-lactate (Cory cycle) cycle.
32. Gluconeogenesis from amino acids. Biological significance. Glucose-alanine cycle.
33. Aerobic glucose oxidation, sequence of reactions, energy effect, regulation.
34. Shuttle systems of NADH oxidation, biological role.
35. Pentose-phosphate pathway of glucose-6-phosphate oxidation, sequence of reactions, biological value.
36. Ways of fructose conversion in the human organism. Hereditary enzymopathies of fructose metabolism, fructosemia.
37. Conversion of galactose in the organism. Hereditary enzymopathies of galactose, galactosemia.
38. Glycogen biosynthesis and its regulation.
39. Ways of glycogen degradation. Regulation of glycogen phosphorylase activity.
40. Genetic abnormalities of enzymes of glycogen metabolism: glycogenosis and aglycogenosis.

41. Glucosemia: normal value and abnormalities.
42. . Digestion of lipids in the gastrointestinal tract. Steatorrhea.
43. Resynthesis of lipids in the enterocytes. Transport forms of lipids.
44. Catabolism of triacylglycerols, its regulation (via adrenalin, noradrenalin, glucagon, insulin).
45. Biosynthesis of triacylglycerols, its regulation.
46. Biosynthesis of phosphoglycerols, its regulation. Lipotropic factors
47. Metabolism of sphingolipids. Sphingolipidosis.
48. Oxidation of saturated fatty acids with even number of carbon atoms (β -oxidation), its energy effect
49. Biosynthesis of higher fatty acids by the example of palmitate, its regulation.
50. Biosynthesis of ketone bodies.
51. Degradation of ketone bodies, its physiological significance.
52. Metabolism of ketone bodies in pathologies (diabetes mellitus, starvation).
53. Biosynthesis of cholesterol, its regulation.
54. Biotransformation ways of cholesterol. Role of cytochrome P-450 in biotransformation of physiologically active steroids.
55. Abnormalities of cholesterol metabolism. Atherosclerosis, atherogenic lipoproteins.
56. General ways of free aminoacids conversion.
57. Transamination of aminoacids: reactions, biochemical value, mechanism of aminotransferase action.
58. Deamination of aminoacids. Mechanism of indirect deamination of L-aminoacids.
59. Decarboxylation of aminoacids. Synthesis and oxidation of biogenic amines.
- 60.
61. General ways of ammonia synthesis and detoxification. Ammonia toxicity.
62. Residual nitrogen of the blood. Types of azotemias.
63. Circulatory transport of ammonia (glutaminic and glucose-alanine cycles).
64. Biosynthesis of urea: sequence of reactions, enzymes, enzymopathies.
65. Metabolism of glycine and serine, role of tetrahydrofolate.
66. Metabolism of sulfur-containing aminoacids, reactions of methylation.
67. Synthesis of creatine and creatinine, clinical-biochemical significance of abnormalities of their metabolism.
68. Metabolism of branched-chain amino acids.
69. Metabolism of arginine, biological role of nitric oxide (II), NO synthase.
70. Metabolism of phenylalanine and tyrosine. Enzymopathies of their turnover.
71. Tryptophan metabolism: kynurenine and serotonin ways. Hartnup's disease.

LIST OF PRACTICAL SKILLS AND TASKS TO THE FINAL MODULE CONTROL

1. To explain the basic principles of methods for determining the activity of enzymes on the example of salivary amylase (iodine-starch reaction and Tromer and Fehling reactions).
2. To prove the protein nature of enzymes by biuret reaction, Fol's reaction, by formalin titration by Serensen with gradual protein hydrolysis and explain the principles of methods.
3. To draw a graph of the dependence of enzyme activity on the pH of the medium based on the results of determining the activity of pepsin and salivary amylase. Explain it.
4. To prove the absolute specificity of sucrase (in reactions with sucrose and starch) and the relative specificity of amylase.
5. The principle of the method, clinical-diagnostic value of alanine aminotransferase and aspartate aminotransferase activities.
6. The principle of the method and clinical-diagnostic value of alpha-amylase activity in serum.
7. The principle of the method and clinical-diagnostic value of determining the pyruvate concentration in biological fluids by colorimetric method.
8. Determination of the body's supply with vitamin B₁ by the content of pyruvic acid in blood plasma. Explain the principle of the method.

9. The principle of the method in the detection of vitamin B₂. Give examples of biochemical reactions involving vitamin B₂.
10. Inhibition of TCA enzymes by malonic acid. Name the type of inhibition. How can you get rid of the negative effects of malonic acid? Which class and subclass of enzymes do TCA enzymes belong to?
11. To which class and subclass of enzymes do the enzymes of the respiratory chain (succinate dehydrogenase, cytochrome oxidase) belong to? Explain the principle of methods for their determination.
12. Name inhibitors of respiratory chain enzymes, oxidative phosphorylation inhibitors.
13. What are the physiological and pharmacological compounds are uncouplers of oxidation and phosphorylation? Explain the biochemical mechanism of their action.
14. The principle of the method and the clinical-diagnostic value of determining blood glucose by glucose oxidase method. Write the equations of the reactions underlying the method.
15. The principle of the method of blood glucose determination by Hagedorn-Jensen method. Explain the discrepancy in the absolute values of blood glucose obtained by different methods.
16. The principle of the method and the clinical-diagnostic value of urine glucose determination by Fehling's and Trommer's reactions. Write an equation.
17. The principle of the method of determination the final product of anaerobic glycolysis - lactic acid by the Uffelmann's method.
18. Study of the kinetics of pancreatic lipase. What compounds in the body activate lipase? Illustrate the answer with the results of practical work.
19. The principle of the method and the clinical-diagnostic value of the ketone bodies detection in urine (reactions with sodium nitroprusside and iron chloride). Detection of ketone bodies in urine by express method.
20. Clinical-diagnostic value of determining the content of total lipids in human serum.
21. Clinical-diagnostic value of determining the content of cholesterol in human blood. Methods of cholesterol determination.
22. The principle of the method and the clinical and diagnostic value of the determination of ammonia in urine.
23. The principle of the method and clinical and diagnostic value of determination of urea in blood and urine by color reaction with diacetylmonooxime. Write the reactions of urea synthesis in the body.
24. The principle of the method and the clinical and diagnostic value of a qualitative reaction to phenylpyruvic acid (Fehling's test).

Module 3. Molecular biology. Biochemistry of tissues and physiological functions and their regulation

Content module 11. Fundamentals of molecular biology and molecular genetics.

Specific objectives :

- To analyze the sequence of reactions of purines and pyrimidines biosynthesis and catabolism, disorders of uric acid synthesis and biochemical basis of gout development.
- To interpret the molecular and biological mechanisms of storage and transferring the genetic information, the role of enzyme systems that provide a semi-conservative mechanism of replication in prokaryotes and eukaryotes.
- To explain the mechanisms of RNA synthesis enzyme functioning.
- To interpret the concept of protein synthesis in ribosomes.
- To explain the mechanisms of protein-synthesizing system functioning (enzymes of amino acid activation, initiation, elongation and termination of polypeptide chain biosynthesis).
- To interpret the mechanisms of gene expression regulation at the level of operon transcription.
- To interpret biochemical mechanisms of genetic recombination, gene amplification, features of gene expression regulation in eukaryotes.
- To analyze the consequences of genomic, chromosomal and gene mutations, mechanisms of most common mutagens action, biological significance and mechanisms of DNA repair.

- To explain the biochemical and molecular-biological principles of genetic engineering methods, recombinant DNA technology, gene transplantation and synthesis of hybrid DNA molecules.
- To explain the principles of gene cloning in order to obtain biotechnological drugs.

Topic 1. Metabolism of nucleotides. Quantitative determination of uric acid in the urine.

Topic 2. Biosynthesis of nucleic acids and proteins. Quantitative determination of DNA by deoxyribose content.

Topic 3*. Regulation of gene expression. Molecular mechanisms of hereditary diseases.

Content module 12. Molecular mechanisms of hormones action on target cells. Biochemistry of hormonal regulation.

Specific objectives :

- To interpret the biochemical and physiological functions of hormones and bioregulators in the system of intercellular integration of human life.
- To analyze and explain the correspondence of mechanism of hormonal action on target cells to the chemical nature of hormones (protein-peptide, amino acids derivatives, steroid).
- To interpret the molecular mechanisms of action of hormones with protein-peptide nature, amino acid derivatives on target cells using signaling molecules.
- To interpret the molecular mechanisms of direct regulatory action on target cells genome of steroid hormones.
- To analyze changes in metabolism and biochemical parameters that characterize of carbohydrate, protein and lipid metabolism in case of endocrine glands disorders to summarize the prognostic assessment of these disorders.
- To interpret the mechanisms of hormonal regulation of calcium homeostasis in the body, forms of calcium in blood plasma, the contribution of bone tissue, small intestine and kidneys in calcium homeostasis.
- To explain the biochemical mechanisms of occurrence and development of pathological processes and typical manifestations of endocrine system disorders in the body.

Topic 1. Hormones of the central nervous system. Quantitative determination of adrenaline by Folin.

Topic 2. Pancreatic hormones. Diagnostics of diabetes mellitus.

Topic 3. Metabolism and mechanism of steroid and thyroid hormones action. Determination of 17- ketosteroids in urine.

Topic 4. Hormonal regulation of Ca^{2+} metabolism. Physiologically active eicosanoids.

Content module 13. Biochemistry of human nutrition. Vitamins and inorganic substances as food components.

Specific objectives :

- To interpret the physiological needs and energy value of essential nutrients - components of human nutrition: proteins, carbohydrates, lipids, vitamins, macro-and micronutrients.
- To explain the biochemical mechanisms of digestive processes and the entry of digestive products into tissues, as well as the causes and consequences of the main pathological digestive processes in the stomach and intestines.
- To interpret the biochemical concepts of vitamins functioning as components of human nutrition and regulators of enzymatic reactions and metabolic processes.
- To interpret the functions of water-soluble coenzyme vitamins B₁ , B₂ , PP, B₆ , B₁₂ , H, C, P and the relationship of hypovitaminosis with diseases of tissues oral cavity.
- To explain bioregulatory and antioxidant function of lipid soluble vitamins A, E, K, F, D.
- To analyze the causes and molecular biochemical mechanisms of disorders in case of hypo- and hypervitaminosis.

Topic 1. Biochemistry of nutrition. The role of macro- and microelements in nutrition. Quantitative determination of serum calcium.

Topic 2. Vitamin deficiency diseases. Qualitative tests for lipid-soluble vitamins.

Content module 14. Biochemistry and pathobiochemistry of blood.

Specific objectives :

- To analyze the biochemical composition of blood and explain the diagnostic role of blood plasma proteins, non-protein nitrogen-containing compounds, nitrogen-free organic components of blood in normal and under conditions of pathology.

- To analyze the state of human health on the basis of biochemical parameters of changes in intermediate and final products of metabolism in the blood.

- Explain the biochemical basis of blood pressure regulating systems functioning and scientifically based application of antihypertensive drugs - angiotensin-converting enzyme inhibitors.

- To interpret biochemical principles of clotting, anticoagulation and fibrinolytic systems of blood.

Topic 1. Blood plasma proteins. Quantitative determination of protein in serum

Topic 2. Respiratory function of blood. Quantitative determination of hemoglobin

Topic 3. Reactive oxygen species. Antioxidant systems. Determination of catalase activity.

Topic 4*. Biochemistry of immune processes.

Topic 5*. Biochemistry of clotting and anticoagulation systems of blood.

Content module 15. Functional and clinical biochemistry of tissues and organs.

Specific objectives :

- To interpret the biochemical patterns of liver functions: carbohydrate, lipid-regulating, protein-synthesizing, urea-producing, pigment, bile-forming.

- To explain the role of the liver in providing normoglycemia and development of pathological changes - hypo-, hyperglycemia, glucosuria.

- To interpret the biochemical mechanisms of the liver detoxification system: microsomal oxidation and conjugation reactions, biotransformation of xenobiotics and endogenous toxins.

- To analyze the differential changes in the biochemical parameters of blood and urine to assess the pathobiochemistry of jaundice.

- To explain the biochemical principles of porphyrin metabolism regulation, the occurrence and development of hereditary disorders of porphyrin metabolism - porphyrias.

- To explain the biochemical basis for the development of liver failure under conditions of chemical, biological and radiation damage.

- To interpret the biochemical mechanisms of water-salt metabolism regulation and the role of kidneys in urine formation.

- To analyze the biochemical composition of urine in normal and under conditions of pathological processes: to assess the functional significance of end products of nitrogen metabolism (urea, uric acid, creatinine) and detoxification products (animal indican, hippuric acid), changes in their daily excretion.

- To analyze the state of human health on the basis of biochemical parameters of intermediates and final products of metabolism in blood and urine.

- To explain the biochemical basis of energy supply and molecular mechanisms of muscle contraction.

- To explain the features of chemical composition and metabolism of connective, bones, nerve tissue, molecular mechanisms of neurotransmitters action, the biochemical basis of disorders of neurotransmitters and modulators metabolism in the brain in case of mental disorders.

Topic 1. Biochemistry of the liver. Veltman's test.

Topic 2. Metabolism of porphyrins. Determination of total bilirubin in blood serum.

Topic 3. Biochemistry of the muscular tissue. Quantitative determination of creatinine in urine.

Topic 4 . Biochemistry of the kidneys. Clinical analysis of urine.

Topic 5 . Biochemistry of the connective tissue. Quantitative determination of vitamin C in urine.

Topic 6*. Biochemistry of the nervous tissue.

Content module 16. Biochemistry of oral organs.

Specific objectives :

- To analyze the chemical composition of mineralized tissues of teeth.
- To explain the biochemical basis for the development of major dental pathologies (caries, periodontitis, sialosis).
- To analyze the biochemical composition of oral fluid in norm and under conditions of dental pathologies development.
- To interpret the biochemical mechanisms of endogenous and exogenous toxins influence on the condition of oral tissues.

Topic 1. Biochemistry of bone tissue and mineralized tissues of teeth. Determination of pH effect on the enamel solubility.

Topic 2. Biochemistry of saliva and gingival fluid. Determination of protein content in oral fluid.

Topic 3. Biochemical mechanisms of dental pathologies. Determination of average molecular peptides in saliva.

Topic 4. Diagnostic value of basic biochemical constants (control of practical skills and test control).

Topic 5*. Influence of exogenous toxins on metabolic processes in the oral cavity.

9.3. MODULE 3 STRUCTURE

Names of content modules and topics	Amount of hours				
	Total	including			
		Classroom		Independent students' work	Individual work
	Lectures	Practicals			
1	2	3	4	5	6
Module 3. Molecular biology. Biochemistry of tissues and physiological functions and their regulation					
<i>Content module 11. Fundamentals of molecular biology and molecular genetics</i>					
Topic 1. Metabolism of nucleotides. Quantitative determination of uric acid in the urine.	2.5		2	0.5	
Topic 2. Biosynthesis of nucleic acids and proteins. Quantitative determination of DNA by deoxyribose content.	4.5	2	2	0.5	
Topic 3*. Regulation of gene expression. Molecular mechanisms of hereditary diseases.	2	2			
Total on the content module 11	9	4	4	1	
<i>Content module 12. Molecular mechanisms of action of hormones on target cells. Biochemistry of hormonal regulation</i>					
Topic 1. Hormones of the central nervous system. Quantitative determination of adrenaline by Folin.	2.5		2	0.5	
Topic 2. Pancreatic hormones. Diagnostics of diabetes mellitus.	2		2		
Topic 3. Metabolism and mechanism of	2.5		2	0.5	

steroid and thyroid hormones action. Determination of 17- ketosteroids in the urine.					
Topic 4. Hormonal regulation of Ca^{2+} metabolism. Physiologically active eicosanoids.	2.5		2	0.5	
Total on the content module 12	9.5		8	1.5	
Content module 13. Biochemistry of human nutrition. Vitamins and inorganic substances as food components.					
Topic 1. Biochemistry of nutrition. The role of macro- and microelements in nutrition. Quantitative determination of serum calcium.	2.5		2	0.5	
Topic 2. The role of vitamins and minerals in nutrition. Detection of minerals in oral fluid.	2.5		2	0.5	
Total on the content module 13	5		4	1	
Content module 14. Biochemistry and pathobiochemistry of blood.					
Topic 1. Blood plasma proteins. Quantitative determination of protein in serum	3	1	2		
Topic 2. Biochemistry of blood. Quantitative determination of hemoglobin.	2.5		2	0.5	
Topic 3. Reactive oxygen forms. Antioxidant systems. Determination of catalase activity.	2		2		
Topic 4*. Biochemistry of immune processes.	1			1	
Topic 5*. Biochemistry of coagulation and anticoagulation systems of blood.	2	1		1	
Total on the content module 14	10.5	2	6	2.5	
Content module 15. Functional and clinical biochemistry of tissues and organs.					
Topic 1. Biochemistry of the liver. Veltman's test.	3	1	2		
Topic 2. Metabolism of porphyrins. Determination of total bilirubin in blood serum.	4	2	2		
Topic 3. Biochemistry of the muscular tissue. Quantitative determination of creatinine in the urine.	2		2		
Topic 4 . Biochemistry of the kidneys. Clinical analysis of urine.	3, 5	1	2	0.5	
Topic 5. Biochemistry of the connective tissue. Quantitative determination of vitamin C in urine.	3		2	1	
Topic 6*. Biochemistry of the nervous tissue.	2			2	
Total on the content module 15	17.5	6	10	1.5	
Content module 16. Biochemistry of oral organs.					
Topic 1. Biochemistry of bone tissue and mineralized tissues of the tooth. Determination of the pH effect on the enamel solubility.	4	2	2		
Topic 2. Biochemistry of saliva and gingival	3.5	1	2	0.5	

fluid. Determination of protein content in oral fluid.					
Topic 3. Biochemical mechanisms of dental pathologies. Determination of average molecular peptides in saliva.	3	1	2		
Topic 4. Diagnostic value of basic biochemical constants (control of practical skills and test control).	2		2		
Topic 5*. Influence of exogenous toxins on metabolic processes in the oral cavity.	1			1	
Together on the content module 16	13.5	4	8	2	
Individual work (if available)					
Final module control	10		4	6	
TOTAL HOURS	75	16	44	15	

THEMATIC PLAN OF LECTURES

№	Name of topics	Amount of hours
1.	Biosynthesis of nucleic acids and protein	2
2.	Regulation of gene expression. Molecular mechanisms of mutations.	2
3.	Blood biochemistry. Features of erythrocyte biochemistry. Respiratory function of blood. Coagulation, fibrinolytic and immune systems of blood. Blood pathochemistry.	2
4.	Biochemical functions of liver and kidneys. Biochemistry of urine	2
5.	Metabolism of porphyrins. Detoxification of toxic substances. Biochemistry of jaundice.	2
6.	Biochemistry of bone tissue and mineralized tissues of teeth.	2
7.	Biochemistry of saliva and gingival fluid. Biochemical markers of dental diseases.	2
	Total	14

THEMATIC PLAN OF PRACTICAL (SEMINAR) CLASSES

№	Name of topics	Amount of hours
1.	Nucleotide metabolism. Quantitative determination of uric acid in urine	2
2.	Biosynthesis of nucleic acids and proteins. Quantitative determination of DNA by deoxyribose content.	2
3.	Hormones of the central nervous system. Quantitative determination of adrenaline by Folin.	2
4.	Pancreatic hormones. Diagnostics of diabetes mellitus.	2
5.	Metabolism and mechanism of steroid and thyroid hormones action. Determination of 17- ketosteroids in urine.	2
6.	Hormonal regulation of Ca ²⁺ metabolism. Physiologically active eicosanoids.	2
7.	Biochemistry of nutrition. The role of macro- and microelements in nutrition. Quantitative determination of serum calcium.	2
8.	Vitamin deficiency diseases. Qualitative tests for lipid-soluble vitamins.	2
9.	Blood plasma proteins. Quantitative determination of protein in serum	2
10.	Respiratory function of blood. Quantitative determination of hemoglobin	2
11.	Reactive oxygen species. Antioxidant systems. Determination of catalase activity	2
12.	Biochemistry of the liver. Veltman's test.	2
13.	Metabolism of porphyrins. Determination of total bilirubin in blood serum.	2

14.	Biochemistry of muscle tissue. Quantitative determination of creatinine in urine.	2
15 .	Biochemistry of the kidneys. Clinical analysis of urine.	2
16 .	Biochemistry of the connective tissue. Quantitative determination of vitamin C in urine.	2
17 .	Biochemistry of bone tissue and mineralized tissues of teeth. Determination of pH effect on the enamel solubility.	2
18 .	Biochemistry of saliva and gingival fluid. Determination of protein content in oral fluid.	2
19 .	Biochemical mechanisms of dental pathologies. Determination of average molecular peptides in saliva.	2
20 .	Diagnostic value of basic biochemical constants (control of practical skills and test control).	2
21- 22 .	Final control of module 3 : Molecular biology. Biochemistry of tissues and physiological functions and their regulation	4
	Total	44

THEMATIC PLAN OF INDIVIDUAL WORK

№	Name topics	Amount of hours
1.	Topics for self-study:	
1.1 .	Biochemistry of immune processes	1
1.2 .	Biochemistry of coagulation and anticoagulation systems of blood	1
1.3 .	Biochemistry of nervous tissue	1
1.4 .	Influence of exogenous toxins on metabolic processes in the oral cavity	1
2.	Preparation for practical classes :	
2.1.	To acquire practical skills in nucleotide metabolism.	0.5
2.2.	To acquire practical skills in the basics of molecular biology.	0.5
2.3	To acquire practical skills in the biochemistry of hormonal regulation:	
	Writing the structural of hormones derived from amino acids and steroid hormones.	0.5
	Explaining the molecular-cellular mechanisms of peptide, steroid, thyroid, amino acid derivative hormones action.	0.5
	Evaluating the changes in calcium homeostasis in hormonal imbalance.	0.5
2.3.	To acquire practical skills in biochemistry of nutrition:	
	Explaining the biochemical mechanisms of proteins, carbohydrates, lipids digestion involving enzymes in the gastrointestinal tract.	0.5
	Assessing the body's vitamins security and hypovitaminosis manifestations by biochemical parameters.	1
2.4.	To acquire practical skills in functional and cellular biochemistry of organs and tissues:	
	To assess the functional state of tissues and organs by blood biochemical parameters.	1
	To assess the presence of normal and pathological components in urine.	1
2.5.	Acquire practical skills in oral biochemistry:	
	To assess the condition of the organs of the oral cavity by biochemical parameters of oral fluid.	1
3 .	Preparation for the final control of mastering the module 3.	6
	Total	17

LIST OF THEORETICAL TASKS TO THE FINAL MODULE CONTROL

1. Biosynthesis of purine nucleotides.
2. Biosynthesis of pyrimidine nucleotides.
3. Catabolism of purine nucleotides. Gout. Lesch-Nihan syndrome.
4. Catabolism of pyrimidine nucleotides.
5. General scheme of DNA biosynthesis. Enzymes of DNA replication in prokaryotes and eukaryotes.
6. General scheme of transcription. Stages and enzymes of RNA synthesis. RNA polymerases of prokaryotes and eukaryotes.
7. Antibiotics – inhibitors of replication and transcription, their biomedical significance.
8. Genetic (biological) code and its characteristics.
9. Components of protein-synthesizing system of ribosomes, their characteristic.
10. Steps and mechanisms of translation.
11. Post translation modification of polypeptide chains.
12. Antibiotics - inhibitors of translation in prokaryotes and eukaryotes, their biomedical significance.
13. Regulation of gene expression in prokaryotes and eukaryotes.
14. Genetic recombination; transposons. Recombination processes in eukaryotes on the example of gene formation of H- and L-chains of immunoglobulin molecules.
15. Gene amplification (genes of metallothionein, dihydrofolate reductase).
16. Polymerase chain reaction, its application in medicine.
17. Regulation of gene expression in eukaryotes on the transcriptional level.
18. Mutations: genomic, chromosomal, gene; the role in the formation of enzymopathies and hereditary diseases.
19. Biochemical mechanisms of action of chemical mutagens – analogues of nitrogen bases.
20. Mechanisms of DNA repair, biological significance
21. Hormones, features of action, classifications according to chemical structure. Mechanisms of hormone transport with the blood.
22. Hormone receptors: membrane (ionotropic, metabotropic) and cytosolic receptors.
23. Mechanisms of action of hormones.
24. Hormones of the hypothalamic-pituitary system. Liberins and statins of the hypothalamus. Mechanism of action.
25. Pancreatic hormones. Insulin: structure, biosynthesis, secretion, influence on carbohydrate, lipid and aminoacid metabolism.
26. Diagnostic criteria for diabetes mellitus - glucose tolerance test, double sugar loading.
27. Pancreatic hormones. Glucagon, structure, mechanism of action.
28. Parathormone - structure, mechanism of hypercalcemic action.
29. Calcitonin - structure, effect on the metabolism of calcium and phosphates.
30. Structure, biosynthesis and mechanism of tyronines action.
31. Synthesis of steroid hormones from cholesterol. Mechanism of action.
32. Glucocorticoids, role in the regulation of gluconeogenesis, Itsenko-Cushing's disease.
33. Sex hormones: synthesis, biological role, mechanism of action, application in medicine.
34. Aldosterone and natriuretic peptides, structure, biological role, mechanism of action.
35. Catecholamines: structure, biosynthesis, mechanism of action.
36. Melatonin. Synthetic , mechanism of action.
37. Eicosanoid biosynthesis, biological and pharmacological properties, clinical application. Aspirin as an inhibitor of prostaglandin synthesis.
38. The role of proteins, carbohydrates and lipids in human nutrition. Protein levels in the diet. Biological value of proteins.
39. Disorders of digestion in the stomach and intestines; hereditary enzymopathy of digestive processes.
40. Disorders of the secretory function of the pancreas. Types of steatorrhoeas.
41. Influence of the gastrointestinal tract diseases on the condition of tissues in oral cavity.

42. Chemical structure, biological role, manifestations of insufficiency and hypervitaminosis of vitamins A, D, E, K.
43. Antioxidant properties of vitamins. The application of lipid-soluble vitamins in dentistry.
44. Biological role of sodium and potassium; regulation of their concentration in the human body.
45. Biological role of calcium and phosphorus; regulation of their concentration in the human body.
46. Biological role of magnesium, chlorine, sulfur.
47. Biological role of trace elements: iron, zinc, manganese, chromium, selenium, fluorine, iodine, molybdenum, cobalt. Manifestations of microelement deficiency.
48. The use of sodium fluoride and vitafluoride in dental practice.
49. Basic blood functions.
50. Blood plasma proteins. Clinical significance of acute phase proteins.
51. Immunoglobulins: structure, biological functions, mechanisms of regulation of immunoglobulins synthesis.
52. Non-protein substances of blood plasma, their diagnostic value. Residual blood nitrogen.
53. Blood buffer systems.
54. Biological role of hemoglobin. Respiratory function of blood.
55. Hereditary hemoglobinopathies.
56. Features of erythrocyte metabolism.
57. Blood plasma enzymes . Enzymodiagnosics of bone diseases.
58. Biochemical bases of blood coagulation. The role of vitamin K in coagulation reactions.
59. Characteristics of the anticoagulation system.
60. Fibrinolytic blood system. Drugs that affect the fibrinolytic system.
61. The main functions of liver. Liver functional tests.
62. Detoxification of toxic substances in the liver. Features of pharmacological drugs metabolism used in dental practice.
63. The role of liver in metabolism of carbohydrates, lipids, proteins.
64. The role of the liver in pigment metabolism.
65. Bile-producing function of the liver. Biochemical composition of bile. Influence of bile acids and ammonia on the condition of the oral mucosa.
66. Heme synthesis and its regulation.
67. Inherited abnormalities of porphyrins metabolism (enzymopathies).
68. Hemoglobin decomposition and formation of bilirubin, types of bilirubin.
69. Detoxification of bilirubin in the liver and its transformation in the intestines.
70. Pathobiochemistry of jaundices. Jaundice of the newborn.
71. Biochemical mechanisms of urine formation, its regulation.
72. Role of the kidneys in maintenance of acid-base balance.
73. Hormonal mechanisms of acid-base balance and renal functions (renin- angiotensin-aldosterone system, natriuretic factors, mechanism of renal hypertension).
74. Physico-chemical characteristics and biochemical composition of human urine in norm.
75. Pathological components of urine. Proteinuria, hematuria, hemoglobinuria, porphyria, ketonuria, glucosuria, their clinical and diagnostic value.
76. Diagnostic value of urea determination in renal azotemia.
77. Features of brain metabolism.
78. Neurotransmitters, their chemical structure, biological role.
79. Neurochemical mechanisms of psychotropic drugs action (neuroleptics, antidepressants, anxiolytics, nootropics).
80. Molecular mechanisms of muscle contraction. Sources of ATP.
81. Creatine metabolism. Creatine phosphokinase reaction, its biological role.
82. Features of bioenergetic processes in the myocardium.
83. Biochemical tests in the diagnosis of myocardial diseases and myopathies.
84. Structure and metabolism of collagen and elastin. The role of vitamin C in collagen metabolism.

85. Proteoglycan metabolism in connective tissue. Structure of glycosaminoglycans.
86. Biochemical mechanisms of mucopolysaccharidosis and collagenosis.
87. Mechanisms of bone mineralization. The role of Ca-P-factor in assessing the state of bone mineralization.
88. Biochemical tests to assess bone metabolism.
89. Regulation of bone metabolism. Biological role of parotin.
90. Disorders of bone metabolism (osteoporosis, osteosclerosis, osteomalacia).
91. Features of the chemical composition of tooth tissues (enamel, dentin, cement).
92. Inorganic components of enamel.
93. Organic substances of enamel.
94. Features of metabolism in tooth tissues and its regulation.
95. Biochemistry of tooth mineralization and enamel demineralization processes.
96. Regulation of the acid-base state of the oral cavity.
97. Pathogenetic significance of acid-base balance disorders in the oral cavity.
98. Biological role of saliva.
99. Organic components of saliva. Salivary enzymes.
100. Protection mechanisms in the oral cavity.
101. Influence of pathologies of the gastrointestinal tract, liver and kidneys on biochemical parameters of oral fluid.
102. Formation and secretion of saliva is normal. Regulation of saliva secretion.
103. Types of salivation disorders (hypersalivation, hyposalivation).
104. The role of salivary glands in the digestive system.
105. Changes in the chemical composition of oral fluid during smoking.
106. The role of biochemical examination of saliva in the diagnostics of diseases.
107. Biochemical composition and biological role of gingival fluid. Changes in the biochemical composition of gingival fluid in dental pathologies.
108. Plaque formation and its main components. The role of microorganisms in the formation of plaque .
109. The role of microorganisms (aerobic and anaerobic) in oral fluid in the formation of organic acids and plaque.
110. The role of carbohydrates in the formation of plaque. Cariogenicity of plaque.
111. Mineral components of dental plaque. The role of calcium in the formation of tartar.
112. Influence of tartar on periodontal tissues.
113. Biochemical bases of caries occurrence.
114. Basic principles of caries prevention and treatment.
115. The main metabolic changes in periodontitis and the basics of metabolic correction.
116. Sialodentitis, sialosis.
117. The role of essential fatty acids, fat-soluble vitamins and antioxidants in the prevention and treatment of inflammatory processes in the oral cavity.

16. LIST OF PRACTICAL SKILLS AND TASKS TO THE FINAL MODULE CONTROL 3

1. The principle of method and clinical - diagnostic value of determining the content of uric acid in the biological fluid with Folin's reagent.
2. Prove the mechanism of antibiotics action which are inhibitors of initiation: streptomycin, aurointricarboxylic acid, rifamycin, rifampicin.
3. Prove the mechanism of antibiotics action - inhibitors of elongation: amycetin, chloramphenicol, erythromycin, cycloheximide, puromycin, tetracyclines.
4. Prove the mechanism of antibiotics action - inhibitors of termination: anisomycin, chloramphenicol, erythromycin, lincomycin, streptomycin.
5. Explain the mechanism of interferons action.
6. Explain the mechanism of diphtheria toxin action.
7. Explain the mechanism of antitumor effect of antibiotics. Explain the mechanism of aaphidicolin, actinomycin D effect.

8. Explain the molecular mechanisms of mutations. What are the most common mutagens you know?
9. Explain how genetic engineering techniques can be used in biology and medicine.
10. Explain and compare the mechanism of anti-inflammatory action of aspirin and glucocorticoids.
11. Detection of saturation of the body with vitamin C. The principle of the method.
12. Explain the mechanism of antioxidant action of lipid-soluble vitamins.
13. The principle of method and clinical-diagnostic value of total protein and protein fractions determination in serum.
14. The principle of the method and clinical-diagnostic value of hemoglobin. Diagnostic value of glycosylated hemoglobin.
15. Characteristics of the main liver functional tests.
16. *Evaluate detoxification function of liver by hippuric acid test.*
17. The principle of method and clinical-diagnostic value of bilirubin and its fractions determination in blood serum.
18. Differential diagnosis of jaundice.
19. Differential diagnosis of steatorrhoeas.
20. The main biochemical parameters of blood used is diagnostics of myocardial infarction.
21. The principle of method and clinical-diagnostic value of pathological components of urine (protein, glucose, blood, ketone bodies, bile pigments, alpha-amylase).
22. The main methods of increasing enamel resistance is fluoration. What is the mechanism of fluorine anti-carries action?
23. Patients with periodontitis have the activity of acid phosphatase and salivary hyaluronidase increased. What do these changes mean?
24. The patient consulted a doctor with complaints of bleeding gums. Examination revealed periodontitis. Which drugs in the form of applications could be most effective in this case?
25. The patient complains of increased salivation for a long time, loss of appetite, heaviness in the stomach, unpleasant belching. The doctor found that hypersalivation (sialorea) is a consequence of periodontal disease. Explain how does the large amounts of saliva affect the biochemical processes in the stomach?
26. How do the mineralization processes in teeth change in a patient with salivary stone disease?
27. What is the main mechanism of multiple caries during hyposalivation?
28. The course of diabetes is often complicated by diseases of the oral cavity. Explain the possible mechanisms of their development.
29. How do changes in the pH of oral fluid affect the mineralization and remineralization of teeth tissues?
30. What biochemical markers of blood plasma show osteolysis process?
31. Parathyroid hormone regulates blood calcium levels. What is the main effect of parathyroid hormone in bone tissue?
32. Which salivary proteins prevent the precipitation of calcium phosphate salts and maintain them in a colloidal state?
33. How do glucocorticoids, mineralocorticoids, thyroxine, somatotropin affect the metabolism of the main components of connective tissue?

17. METHODS AND FORMS OF IMPLEMENTATION OF THE CONTROL

Credit-module system organization of educational process provides:

- study of the discipline by modules that are completed parts of the curriculum ;
- each module is mastered in the process of implementing the appropriate forms of educational process (listening to lectures, current educational activities, independent work, individual tasks);
- all types of student work (classroom, independent, individual , getting of practical skills) in time are combined into credits. One credit equals 30 hours;

- the study of the module finishes with the final modular control;
- the concept of current educational activities of the student includes:
 - a) listening to lectures and mastering lecture material;
 - b) preparation for practical classes;
 - c) performance of laboratory and practical work during practical classes;
 - d) mastering the educational material, which is submitted for independent extracurricular study;

e) writing essays or performing research work of students (optional).

Types of student learning activities according to the curriculum are:

- a) lectures,
- b) practical classes,
- c) extracurricular independent work of students (PSRS),
- d) individual independent work of students (ISRS).

The topics of the lecture course reveal the problematic issues of the relevant sections of bioorganic and biological chemistry .

In practical classes, students write down the protocols of research, which indicate the purpose of the study, the principle of the method and procedure of work, research results and conclusions.

Assimilation of the topic is controlled in practical classes in accordance with specific objectives using the following diagnostic tools for the level of preparation of students: computer or written testing, solving situational problems and biochemical transformations, laboratory research and interpretation and evaluation of their results, control of practical skills.

Tasks for independent work are the obligatory tasks written in workbooks which the student should prepare for each class; filling out a workbook, learning vocabulary, studying subtopics that do not require explanation.

Individual tasks are creative, exploratory in nature, contribute to the development of cognitive activity of students . Students perform individual tasks themselves under the guidance of a teacher. These are additional tasks that allow the student to improve their knowledge of the discipline.

At the last practical class before the final module control students take test control of of whole discipline. Students who have passed the test control are admitted to the final module control. The "passed" criterion for test control is determined at meeting of the department.

Final module controls are carried out at the last practical class of the modules. They provide an opportunity to identify the level of theoretical and practical training of the student in the range of issues studied according to the programs of modules and the discipline as a whole. Final module controls are carried out by taking written test, computer or written MCQ test, oral interviews, solving clinical and biochemical situational problems and transformations, performing practical work.

Assessment of student success in the discipline is a rating and is presented on a multi-point scale as the arithmetic mean of all modules and is determined by the ECTS scale and the traditional scale adopted in Ukraine.

For those students who did not fulfill the curriculum and were not allowed to take the final module control of knowledge and skills, reworks and consultations are provided according to the schedule during summer and winter holidays. Taking remodules of final module is carried out according to the schedule compiled by dean's office.

18. EVALUATION OF THE LEVEL OF STUDENT TRAINING IN THE DISCIPLINE

Procedure, methods and criteria for assessing the current educational activities, methods and criteria for assessing during the final module control, assessment of the discipline as a whole).

When evaluating each topic, the student is graded on a four-point (traditional) scale, using the evaluation criteria adopted by the BSMU and approved by the methodological commission. This takes into account all types of activities provided by the methodological development for the

study of the topic. The marks on the traditional scale are converted into points depending on the number of topics in the module.

The value of each topic within one module in points should be the same, but may be different for different modules of the same discipline and be determined by the number of topics in the module.

Forms of current educational activities assessment should be standardized and include control of theoretical and practical training.

Criteria for evaluating current learning activities:

An "excellent" grade is given to student who takes an active part in the discussion of the most difficult questions on the topic, gives at least 90% of correct answers to standardized test questions, gives written answers without mistakes, performs practical work and writes down a protocol.

A "good" grade is given to a student who participates in the discussion of the most difficult questions on the topic, gives at least 75% correct answers to standardized test questions, makes some nonsignificant mistakes in answering written tasks, performs practical work and writes down a protocol.

A "satisfactory" grade is given to student who does not participate in discussion of the most difficult questions on the topic, gives at least 60% correct answers to standardized test questions, makes significant mistakes in answering written tasks, performs practical work and writes down a protocol.

A "unsatisfactory" grade is given to a student who does not participate in the discussion of the most difficult questions on the topic, does less than 60% correct answers to standardized test questions, makes gross mistakes in answering written tasks or does not answer them at all, does not perform practical work and does not writes a protocol.

Distribution of points assigned to students (with notes: - on the maximum and minimum number of points for studying the module, - on the conversion of points into traditional grades "5", "4", "3", "2" when mastering the topic of the module; - on the minimum number of points for admission to the final module control (FMC); - the minimum number of points for the modular control).

Distribution of points for the current activity of the student in modules on bioorganic and biological chemistry

Number of module number / of study hours / number of credits ECTS	Number of content modules, their numbers	Number of practical classes	Conversion into point of the traditional scale				Scores for individual task	Minimum score *
			Traditional scale					
			"5"	"4"	"3"	"2"		
Модуль 1 90 / 3	4 (№№ 1-4)	13	8,5	7	5,5	0	9,5	71,5
Модуль 2 75 / 2,5	6 (№№ 5-10)	16	7,5	6	4,5	0	-	72
Модуль 3 75 / 2,5	6 (№№ 11-16)	20	6	5	4	0	-	80

N.B. Assessment of current educational activities, module control and discipline in general is carried out in accordance with the "Instructions for assessing the educational activities of students of Bucovynian State Medical University in the implementation of the European credit transfer system of educational process" (approved by the Academic Council of May 29, 2014, protocol 9).

The maximum number of points that a student can score when studying the module is calculated by multiplying the number of points corresponding to the grade "5" by the number of topics in the module with the addition of points for individual independent work and is equal to 120 .

*The minimum number of points that a student must score to pass the module is calculated by multiplying the number of points that correspond to the grade "3" by the number of topics in the module and is determined individually for each module:

Module 1: $5,5 \times 13 = 71,5$

Module 2: $4.5 \times 16 = 72$

Module 3: $4 \times 20 = 80$

The final score for the current activity is defined as the arithmetic sum of scores of each lesson and individual work.

Assessment of students individual work

The individual work, which is provided in the topic of module along with the classroom work, is assessed during the current control of the topic in the relevant lesson. Assimilation of topics that are submitted only for independent work is controlled by the final module control.

Assessment of students individual tasks

Points for individual tasks are accrued to the student only if they are successfully completed, depending on the volume and significance, but not more than 12. They are added to the sum of points earned by the student for the current educational activity.

Final modular control

The final module control is carried out upon completion of the study of all topics of the module at the last control lesson from the module.

Students who have attended all the classes provided by the curriculum in the discipline and have scored at least the minimum number of points during the study of the module are admitted to the module control. A student who, for good reason, has missed classes, is adjusted to the individual curriculum and is allowed to work off academic debt until a certain deadline. For students who missed classes without good reason, the decision to take reworks is made personally by dean of the faculty.

The maximum number of points that a student can score when completing the final module control is 80 .

The final module control is considered passed if the student has scored at least 50 points .

Evaluation of discipline

The grade in the discipline is given only to students who have passed all modules in the discipline. The number of points that a student scored in the discipline is defined as the arithmetic mean of the number of points in all modules of the discipline.

ECTS scale scores are NOT CONVERTED to a four-point scale and vice versa. Discipline scores for students who have successfully completed the discipline program are converted by the department into a traditional four-point scale according to the absolute criteria as shown in the table below.

200 point scale	Four-point scale
180 - 200 balls	«5»
150 - 179 балів	«4»
149 - the minimum number of points that a student must score	«3»
Below the minimum number of points	«2»

These criteria also apply in determining the assessment for the module if necessary.

Students of one faculty, course, one specialty, are ranked on the ECTS scale based on the number of points scored in the discipline as follows:

ECTS grade	Statistical indicator
«A»	The best 10% of students
«B»	The next 25% of students
«C»	The next 30% of students
«D»	The next 25% of students
«E»	The last 10% of students

Ranking with assignments of grades "A", "B", "C", " D ", "E" is carried out by deans and for students of the same course and faculty who study in one specialty and have successfully completed the study of the discipline.

Students who have got grades " FX" and "F" ("2") are not included in the list of ranked students, even after retaking the module. Such students automatically receive an "E" score after remodule.

Grades "FX", "F" ("2") are given to students who have not passed at least one module of the discipline after completing its study.

The grade " FX" is given to students who got the minimum number of points for the current educational activity, but who did not pass the final module control. These students can take remodule of the final module control according to the approved schedule (but not later than the beginning of the next semester). Remodule of the final module control is allowed no more than twice.

Grade "F" is given to students who have attended all classes in the module, but did not score the minimum number of points for the current educational activity and are have not been admitted to the final module control. These students have to repeat study of the module.

With the permission of the rector, the student can increase the grade in the discipline by retaking the final module control (not more than three times for the entire period of study).

The ECTS score is NOT converted to the traditional four-point scale, as the ECTS scale and the four-point scale are independent.

19. RECOMMENDED LITERATURE

19.1 Basic

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19.2. Auxiliary

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3. Newsholme E.A., Leech T.R. Functional biochemistry in health and disease.- John Wiley & Sons Ltd, 2010.- 561 p.
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19.3 Information resources

1. Bioorganic and biological chemistry for students speciality "Dentistry". Educational and methodical materials posted on the server of distance learning Moodle
 - module 1 <http://moodle.bsmu.edu.ua/course/category.php?id=1839>
 - module 2 <http://moodle.bsmu.edu.ua/course/view.php?id=2556>
 - module 3 <http://moodle.bsmu.edu.ua/course/view.php?id=2555>
2. <http://oli.cmu.edu/courses/free-open/biochemistry-course-details>
3. <http://www.learnerstv.com/Free-medical-Video-lectures-ltv041-Page1.htm>
4. http://biochem.vsmu.edu.ua/biochem_common_u/vor_sav_krav_1.pdf

20. COMPILERS OF THE STUDENT HANDBOOK (SYLLABUS)

Herush Ihor Vasylovych – Vice-Rector on Scientific and Pedagogical Work, PhD in medicine, associate professor;

Hryhorieva Nadiia Pylypivna – Head of bioorganic and biological chemistry and clinical biochemistry department, PhD in biology, associate professor

Davydova Nataliia Valentynivna – PhD in medicine, associate professor