

EUROPEAN MEDICAL UNIVERSITY

“APPROVED”

First pro-rector of EMU

_____Herman TITOV

«_____»_____202__

SYLLABUS OF THE EDUCATIONAL DISCIPLINE "BIOLOGICAL CHEMISTRY AND BIOORGANIC CHEMISTRY"

Cycle of Higher Education:

**second cycle of higher education
(Master's degree)**

Field of Study:

22 «Healthcare»

Specialty:

222 «Medicine»

Educational qualification:

Master of Medicine

Professional qualification:

doctor

1. Name, Code of the discipline and number of credits

Syllabus of the educational discipline "BIOLOGICAL AND BIOORGANIC CHEMISTRY"

Cycle of Higher Education: second cycle of higher education (Master's degree)

Field of Study: 22 «Healthcare»

Specialty: 222 «Medicine» (2 course)

Educational qualification: Master of Medicine

Professional qualification: doctor

Semester: 3, 4

Number of credits ECTS (number of hours): 8 credits ECTS (240 hours).

Distribution by types of trainings and hours of study – Lectures 18 hours, Practical lessons – 114 hours, Independent work – 108 hours.

2. Time and place of educational discipline

Semester: 3, 4

dp1funddis@dmitnm.edu.ua, 10 Titova Str.; Dnipro

3. Prerequisites and Postrequisites of educational discipline

Prerequisites: Biological and bioorganic chemistry as an educational discipline:

- is based on students' study of medical biology, biophysics, medical chemistry (inorganic, physical, colloid and organic chemistry), morphological disciplines and integrates with these disciplines;
- lays the foundations for students to study molecular biology, genetics, physiology, pathology, general and molecular pharmacology, toxicology and propaedeutics of clinical disciplines, which involves the integration of teaching with these disciplines and the formation of skills to apply knowledge of biological and bioorganic chemistry, primarily biochemical processes that take place in the body of a healthy and sick person, in the process of further education and professional activity;
- lays the foundations for clinical diagnosis of the most common diseases, monitoring the course of the disease, control over the effectiveness of the use of medicines and measures aimed at preventing the occurrence and development of pathological processes.

Postrequisites: knowledge, skills and abilities acquired after the completion of this discipline are necessary for such a discipline as biological and bioorganic chemistry.

4. Characteristic of the educational discipline

4.1. Purpose and definition of the educational discipline:

The purpose of teaching the educational discipline "Biological and bioorganic chemistry" is: students' assimilation of theoretical laws regarding the chemical properties of bioorganic compounds in relation to their structure and, on this basis, understanding of biochemical processes that take place in biological systems; familiarization with the main methods of identification of bioorganic compounds as a basic prerequisite for the subsequent assimilation of laboratory methods of diagnosis and understanding of many pathological processes in the human body; disclosure of practical aspects of bioorganic chemistry, ways and methods of using its achievements in medical practice.

The discipline "Biological and bioorganic chemistry" studies the structure and reactivity of various classes of organic substances, and on their basis the most important biologically active substances that are part of living organisms - low molecular weight biomolecules, biopolymers (proteins, nucleic acids, polysaccharides), natural and synthetic physiologically active compounds (hormones, vitamins, medicines, toxic substances, etc.).

The tasks of bioorganic chemistry are to determine the structure of biomolecules, natural and synthetic bioregulators, to identify the dependence between their molecular and electronic structure and physiological, in particular pharmacological, effects, and to identify patterns of their transformations.

4.2. The task of studying the discipline

The main tasks of studying the discipline "Biological and bioorganic chemistry" are: to teach students the general principles of the course of chemical reactions of bioorganic compounds, as the basis of biochemical processes in the human body; formation of the relationship between the structure and function of bioorganic compounds; to reveal practical aspects of bioorganic chemistry, ways and methods of using its achievements in medical practice.

4.3. General competences (GC)

- GC 1. Ability to think abstractly, analyses and synthesize.
- GC 2. Ability to learn and master modern knowledge.
- GC 3. Ability to apply knowledge in practical situations.
- GC 4. Knowledge and understanding of the subject area and understanding of professional activities.
- GC 6. Ability to make justified decisions.
- GC 10. Ability to use information and communication technologies.
- GC 11. Ability to search, process and analyses information from various sources.
- GC 12. Certainty and perseverance in relation to the tasks set and responsibilities assumed.

Special (professional, subject) competencies (SC)

- SC 2. Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results.
- SC 23. Ability to develop and implement scientific and applied projects in the healthcare sector.
- SC 25. Compliance with professional and academic integrity, being responsible for reliability of the obtained scientific results.

Program results of learning (PRL)

- PRL 1. Have a thorough knowledge of the structure of professional activity. Be able to carry out professional activities that require updating and integrating knowledge. Be responsible for professional development, the ability to further professional training with a high level of autonomy.
- PRL 2. Understanding and knowledge of fundamental and clinical biomedical sciences at a level sufficient to solve professional problems in the field of healthcare.
- PRL 3. Specialized conceptual knowledge that includes scientific achievements in the field of healthcare and is the basis for conducting research, critical understanding of problems in the field of Medicine and related interdisciplinary problems.
- PRL 21. Searching for the necessary information in professional literature and databases of other sources, analyzing, evaluating and applying this information

4.4. Content of the discipline

Lectures plan (L)

№	THEMES	hours
1.	Introduction to Biochemistry	2
2.	Structures, classifications and properties of Amino acids and Proteins	2
3.	Enzymes as biological catalysts	2
4.	Common pathways of catabolism. Enzymes of biological oxidation	2
5.	Oxidative decarboxylation of pyruvate. The citric acid cycle	2
6	Metabolism of carbohydrates. Oxidation of glucose - glycolysis. Aerobic and anaerobic glycolysis. Synthesis of glucose - gluconeogenesis.	2
7	Lipids. Classification. Structure and functions.	2
8.	Metabolism of lipids. Lipid anabolism. Lipoproteins.	2
9.	Metabolism of proteins and amino acids. Common catabolic pathways of amino acids.	2
Total		18

Practical lessons plan (PL)

№	THEMES	hours
3rd semester		
1.	Introduction to biochemistry. Biomolecules, their structures and functions. Common ways of catabolism of proteins, carbohydrates, lipids.	3
2.	Amino acid composition of proteins and peptides. The structural organization of proteins	3
3.	Enzymes: chemical nature, structural and functional organization. Cofactors and coenzymes, coenzyme functions of vitamins.	3
4.	Enzyme properties. Effect of activators and inhibitors. Determination of enzyme activity.	3
5.	Main ways of regulation of enzymatic processes. Medical enzymology. Enzymes Review.	3
6.	Common pathways of catabolism. Biological oxidation. Enzymes of biological oxidation, their classification and mechanism of action. High-energy compounds. Ways of ATP synthesis.	3
7.	Tissue respiration: mechanism, significance of the process. Electron transport chain. Oxidative Phosphorylation.	3
8.	Oxidative decarboxylation of pyruvic acid. Tricarboxylic acid cycle: biorole, regulation, interrelation with respiratory chains. Enzymes and Biological Oxidation Review.	3

9.	The structure and functions of mono-, di-, and polysaccharides.	3
10.	Digestion of carbohydrates. Glycolysis. Anaerobic and aerobic oxidation of glucose.	3
11.	Glucose biosynthesis – gluconeogenesis. Pentose phosphate pathway. Fructose and galactose metabolism	3
12.	Glycogen catabolism and synthesis, its regulation. Genetic disorders of glycogen metabolism	3
13	Regulation and pathologies of carbohydrate metabolism. Blood glucose (glycemia): normoglycemia, hypo- and hyperglycemia, glycosuria. Diabetes mellitus.	3
14	Enzymes, Biological Oxidation and Carbohydrate Metabolism. Review	3
15	Structure and properties of natural fatty acids. Lipids. Phospholipids.	3
16	Catabolism of lipids. Digestion of lipids. Catabolism of triacylglycerides. Fatty acid oxidation. Metabolism of ketone bodies.	3
17	Biosynthesis of fatty acids, triacylglycerides, phospholipids. Regulation of these processes.	3
18	Cholesterol biosynthesis and metabolism. Bile acids. Plasma lipoproteins. Pathologies of lipid metabolism: steatorrhea, obesity, atherosclerosis.	3
19	Lipid Metabolism and its Regulation Review	3
Total of 3 semesters		57
4rd semester		
20	Molecular and cellular mechanisms of hormone action on target cells.	3
21	Hormonal regulation of metabolic processes. Biochemical bases of endocrine pathologies.	3
22	Hormonal regulation of calcium homeostasis and water-salt metabolism	3
23	Vitamins as nutrition components: exogenous and endogenous hypovitaminoses. Vitamin-dependent reactions	3
24	Fat –soluble vitamins. Antioxidants.	3
25	Purine and pyrimidine nitrogenous bases. Structures and biochemical functions of nucleosides and nucleotides. Nucleic acids. Structure and functions of DNA and RNA.	3
26	Biosynthesis and catabolism of purine nucleotides. Hereditary disorders of nucleotide metabolism.	3
27	Biosynthesis and catabolism of pyrimidine nucleotides. Hereditary disorders of pyrimidine nucleotide metabolism.	3

28	Enzymes and molecular mechanisms of replication. Reparation of damaged DNA. Xeroderma pigmentosum.	3
29	Enzymes and molecular mechanisms of transcription.	3
30	Enzymes and molecular mechanisms of translation. Antibiotics - inhibitors of transcription and translation.	3
31	Biochemical functions of the liver. Biotransformation of xenobiotics and endogenous toxins in liver. Microsomal oxidation	3
32	Porphyrin Metabolism. Pathobiochemistry of jaundice.	3
33	Biochemistry and pathobiochemistry of blood. Metabolism of erythrocytes	3
34	Biochemistry and pathobiochemistry of blood. Blood plasma proteins and enzymes	3
35	Biochemistry and pathobiochemistry of blood. The biochemical composition of the blood in normal and pathological conditions	2
36	Biochemistry of muscles	3
37	Biochemistry of connective tissue	3
38	Final test-control	3
Total of 4 semesters		57
Total		114

Independent work topics (IW)

№	THEMES	hours
3rd semester		
1	Complex lipids (sphingolipids and glycolipids); their importance in the construction of biomembranes	4
2	Glycosaminoglycans: structure and biological role of hyaluronic acid, chondroitin sulfates and heparin	4
3	General methods and approaches for studying the structure of proteins: electrophoresis, gel filtration, ion exchange chromatography	4
4	Structure and biochemical functions of free nucleotides: nucleotides - coenzymes; cyclic nucleotides 3', 5'-cAMP and 3',5'-cGMP	4
5	Clinical-diagnostic value of changes in biochemical parameters determined in the clinic.	4
6	Principles of determination of enzyme activity in biological fluids	4
7	Interpretation of the graphs of the dependence of the rate of the enzymatic reaction against the concentration of the substrate, the enzyme, the change in pH and the temperature of the medium	4
8	The role of cofactors and coenzymes - vitamins and their active derivatives in the manifestation of catalytic activity of enzymes.	4

9	Enzyme diagnostics. The diagnostic value of determining changes in the quantitative content and activity of isozymes in pathologies.	4
10	Methods for evaluation of metabolic substrates	4
11	Determination and explanation of the value of the phosphorylation coefficient for the reactions of aerobic oxidation of substrates according to the type of coenzyme or the prosthetic group of the enzyme.	4
12	Inhibitors and uncouplers of oxidative phosphorylation	4
13	Anabolic and anaplerotic reactions of CTC	4
14	Clinical and diagnostic value of evaluation of metabolic substrates of anaerobic glucose oxidation under physiological and pathological conditions	4
15	Hereditary disorders of biosynthesis of enzymes of glycogen metabolism. Metabolism of carbohydrate components of glycoconjugates and genetic disorders of their metabolism.	4
16	Construction of schemes of alternative ways of glucose metabolism. Assessment of the state of carbohydrate metabolism by biochemical indicators in normal and pathological conditions	4
17	Sphingolipidosis – genetic abnormalities of sphingolipid metabolism. Lysosomal diseases.	4
18	Cholesterol metabolism in the body. The main ways of biotransformation and excretion of cholesterol.	4
19	Changes in the system of circulatory transport lipids: CM, VLDL, LDL, HDL, their functional significance. Assessment of the state of lipid metabolism in normal and pathological conditions.	3
Total of 3 semesters		75
4rd semester		
20	Drawing up schemes of circulatory transport of ammonia in the body. Analysis of changes in ammonia neutralization systems with genetic abnormalities of its metabolic enzymes. Study of disorders of amino acid metabolism in congenital and acquired metabolic disorders according to biochemical indicators	2
21	Clinical and biochemical characteristics of disorders of uric acid metabolism	2
22	Representation of schemes of successive stages of processes of replication, transcription and translation	2
23	Evaluation of hereditary defects of metabolism (molecular diseases) as a consequence of genetic damage and point mutations	2
24	The influence of physiologically active compounds on the processes of replication, transcription and translation	2
25	Pathologies of the thyroid gland; features of metabolic process disorders under conditions of hyper- and hypothyroidism. Mechanisms of occurrence of endemic goiter and its prevention.	2

« BIOLOGICAL AND BIOORGANIC CHEMISTRY »	5	150	75	18	57	75
4th semester						
« BIOLOGICAL AND BIOORGANIC CHEMISTRY »	3	90	57	-	57	33

The topics of the lecture course in the 1st year reveal the problematic issues of the relevant sections of "BIOLOGICAL AND BIOORGANIC CHEMISTRY".

Practical skills: not provided

The applicant's independent work involves preparation for practical classes and final class, mastering topics for independent work, preparation of abstract reports, presentations, tables. Control of mastering the topics of practical classes and independent work is carried out in practical classes and the final class and exam in the discipline.

Individual work includes researching scientific literature, preparing reviews on the given topics for presentation, performing scientific and practical research, participation in specialized Olympiads, scientific and practical conferences, competitions, scientific works.

Methodical recommendations for practical classes, independent work, lecture materials are available on the website of the department.

The way to get materials: EMU site/Student/Department of fundamental disciplines/Educational and methodological support of the department/"BIOLOGICAL AND BIOORGANIC CHEMISTRY"/ or follow the link Department of fundamental disciplines/Discipline "BIOLOGICAL AND BIOORGANIC CHEMISTRY". Materials are accessed from the student's Office 365-based corporate account.

5. Forms and methods of monitoring learning success

Current control in practical classes	Methods: individual oral survey, structured written works, test tasks with the choice of correct answers.
Control of mastering the thematic section of the discipline in intermediate control classes	Methods: oral or written survey, electronic testing, <i>methods of self-control and self-assessment</i> .
Final semester control	According to the regulation on control measures in EMU (regulation of EMU)
Final control of the discipline - <i>exam</i>	Methods: by exam cards in the form of an oral exam, monitoring of acquiring of practical skills (According to the Regulation on control measures in DMI TNM (Regulation of EMU).
Tools for diagnosing learning success	Theoretical questions, tests, clinically oriented situational tasks, practical tasks, demonstration of practical skills.

6. Evaluation criteria

Knowledge assessment is carried out according to regulation on control measures in EMU (regulation of EMU).

Current control	According to the four-point system of traditional grades: 5 "Excellent", 4 "Good", 3 "Satisfactory", 2 "Unsatisfactory"
Control of practical skills	According to the four-point system of traditional grades
Exam	Based on a 200-point scale (the sum of points for the current academic activity of the student, the result of passing the exam and for successful completion of an individual task, if any) Credited: 120 to 200 points Not credited: less than 120 points (see Rating scale)
Final control for the discipline	The final control of students' academic performance is carried out after completing the study of the discipline and is implemented in the form of an exam.
Discipline assessment:	The score on the discipline is determined based on the results of assessment of current activities and is expressed using a fourpoint scale : ("Excellent", "Good", "Satisfactory", "Unsatisfactory"), multi-point scale and ECTS. The assessment in the discipline consists of an assessment of the current academic performance and the result of passing the exam (in points), which is set when evaluating theoretical knowledge and practical skills in accordance with the list defined by the discipline program. The number of points that the applicant scored for current academic. performance in the discipline is defined as the arithmetic mean of the number of points that the applicant received during the study of the discipline (practical, seminar, laboratory classes, etc.). The resulting value of the average traditional rating is converted to points according to the scale of conversion of traditional ratings to rating points. The maximum number of points is 200.

Matching grades on a 200-point scale, a 4-point (traditional) scale, and ECTS scale

On a 200-point scale	Rating on a 4-point scale
180–200	«5» Excellent
140–179	«4» Good
120–139	«3» Satisfactory
0–119	«2» Unsatisfactory
On a 200-point scale	ECTS evaluation
192–200	A

172–191	B
148–171	C
128–147	D
120–127	E
0–119	F

Discipline/course policy

The student has the right to receive high-quality educational services, access to up-to-date scientific and educational information, qualified advice during the study of the discipline and mastering practical skills. The policy of the department in the provision of Educational Services is student-centred, based on the regulatory documents of the Ministry of Education and the Ministry of Health of Ukraine, the Charter of the EMU and the procedure for providing educational services regulated by the regulation on the organization of the educational process in the DMI TNM and the principles of academic integrity.

Compliance with the EMU schedule, safety precautions in the classroom.

Requirements for preparing for practical classes.

Students should arrive at classes on time, without being late. A student who is more than 10 minutes late for classes is not allowed in and must work it out in accordance with the established procedure. During practical classes, the student must wear a work uniform (medical gown, cap). Students who do not have a work uniform are not allowed to attend classes. The student must follow the safety rules during practical classes and while staying in the Department's premises. When discussing theoretical issues, students should demonstrate tolerance, politeness and respect for their colleagues and the teacher; when performing practical tasks, the workplace should be kept in order and cleaned after completing practical work.

Use of mobile phones and other electronic devices. The use of mobile phones and other electronic devices in the classroom is not allowed, only during Distance Learning, provided that it is technically necessary.

Academic integrity. When studying the discipline, the student should be guided by the following regulations: on academic integrity of EMU (regulation of EMU). In case of violation of the regulations of academic integrity during the current and final controls, the student receives a grade of "2" and must work it out to the teacher in accordance with the established procedure.

Regulation on control measures in EMU (Regulation of EMU).

Skipping classes. Missed classes should be worked out in accordance with the procedure established in the regulations on control measures in the EMU (regulation of EMU) during the time determined by the work schedule (Department of fundamental disciplines) to the teacher on

duty. To work out a missed lesson the student must pass a test and answer in writing or verbally the question on the topic of the lesson.

Procedure for admission to the final control in the discipline is given in the regulations on control measures and regulations on the organization of the educational process in the EMU (regulation of EMU) and regulations on control measures in the EMU (regulation of EMU). Students who do not have missed not worked out practical classes and lectures and have received an average traditional grade of at least "3" are allowed to participate in the final control.

Additional individual points. Points are awarded subject to the mandatory participation of the head, head teacher and teacher. These points are encouraging and are added once to the total score of the current academic performance and the result of passing the comprehensive exam. Their total number for one student should not exceed 10, and the final amount of points for an academic discipline should not exceed 200 points.

Individual tasks include:

- 1) writing essays and creating multimedia presentations with reports at meetings of the student scientific group of the department – 3 points;
- 2) participation in the creation of tables, graphological structure, posters on the topics of practical classes – 2 points;
- 3) participation in the student competition in the discipline at the First Stage – 1 point;
- 4) participation/prize-winner of the All-Ukrainian student competition in the discipline - 7/10 points;
- 5) author or co-author of abstracts/article – 2/5 points;
- 6) author or co-author of an oral/information stand report at a scientific conference – 6/3 points;
- 7) author of a student scientific paper accepted for participation or awarded by a diploma of I-III degree in the All – Ukrainian competition of student scientific papers at Stage II - 8 (participation) or 10 (diploma) points.

Resolving conflict issues. If there are misunderstandings and complaints against the teacher due to quality of educational services provided, knowledge assessment, and other conflict situations, the student must first report his/her claims to the teacher. If the conflict issue is not resolved, the student has the right to submit an appeal to the head of the department in accordance with the regulations on consideration of applications from applicants for higher education in EMU (regulation of EMU), Regulations on consideration of applications, complaints, and proposals of students in DMI TNM (regulation of EMU), Regulations on meeting the requirements of the organization of the educational process (regulation of EMU), Regulation on the appeal of the results of the final control of knowledge of applicants for higher education in EMU (regulation of EMU), Regulations on safe educational environment in EMU (regulation of EMU).

Policy in the context of distance learning. The procedure for distance learning is regulated by regulation of EMU. The main training platforms for conducting training sessions are Microsoft Teams, Zoom. The procedure for conducting practical classes and lectures, working out and consultations during Distance Learning is published on the Department's Web page Department of fundamental disciplines.

Feedback from the teacher is provided directly during the lesson and/or consultation, and is also possible via email (in case of force majeure) during working hours.

1. Training resources

Educational and methodological support of the discipline is published on the website of the Department (Department of fundamental disciplines). Consultations are held according to the consultation schedule.

2. **Schedule and distribution of groups by teacher** are published on the Department's Web page (Department of fundamental disciplines).
3. **Questions for intermediate and final control of the discipline** are published on the Department's Web page (Department of fundamental disciplines).

Questions for the exam

Theoretical questions

1. The subject and tasks of biological and bioorganic chemistry. Chemical composition of living organisms. Main classes of biomolecules. Classification, nomenclature and isomerism of organic compounds. Nature of chemical bonds. Structure and properties of alkanes, alkenes, arenes of alcohols, aldehydes and ketones.
2. Structure, properties and biological significance of carbonyl compounds, carboxylic acids, heterofunctional compounds (hydroxy-, keto-, amino-, phenoloacids). Higher fatty acids. Saponified and non-saponified lipids. Phospholipids. Qualitative reactions to hydroxy-, keto-, phenoloacids.
3. Carbohydrates. Monosaccharides: structure, chemical properties and biological significance. Structure, properties and biological role of disaccharides. Homo- and heteropolysaccharides: structural components, binding types, biological role. Fehling's reaction.
4. Amino acids: structure, classification according to the structure of the radical. Replacement and essential amino acids. Deamination, decarboxylation, transamination of α -amino acids. Color reactions.
5. Proteins. Physicochemical properties, biological roles. Structural organization of protein molecules. Simple and complex proteins. Denaturation of proteins. Study of phosphoprotein - caseinogen of milk.
6. Classification, structure and value of heterocyclic compounds. Vitamins B6, PP, ubiquinone, heme, their aromatic properties. Purine and pyrimidine nitrogenous bases, nucleosides, nucleotides. Nucleic acids Structure and DNA and RNA. Qualitative reactions to purine bases.
7. Enzymes as biocatalysts. Functional organization (active, allosteric centers), isoenzymes. Co-enzyme functions of vitamins Enzyme properties. Exposure to activators and inhibitors. Enzyme activity units. Determination of urinary α amylase activity by Wolgemut.

8. Mechanisms of action of enzymes. Kinetics of enzymatic catalysis. Regulation of enzymatic reactions. Medical enzymology. Study of the coenzyme function of vitamin PP.
9. Biological oxidation enzymes, their classification and mechanism of action. Tissue respiration: mechanism, regulation, inhibitors, process values. Macroergic compounds, general characteristic. Pathways for ATP formation and use. Determination of ATP RV in blood serum.
10. Common paths of catabolism. Oxidative decarboxylation of PVC. CTC, biological role, regulation, relationship with respiratory chains. Investigation of PMC aerobic oxidation reaction.
11. Dietary carbohydrate digestion enzymes. Glycolysis. Aerobic and anaerobic glucose oxidation. Glycerol phosphate and malate-aspartate-shuttle mechanisms. Studies of glycolysis in skeletal muscle.
12. Glucose biosynthesis is gluconeogenesis. Pentose-phosphate pathway, fructose and galactose metabolism.
13. Catabolism and glycogen biosynthesis. Genetic disorders of glycogen metabolism. Blood glucose. Regulation and pathology of carbohydrate metabolism. Research on glycogenolysis in skeletal muscle.
14. Digestion of lipids. Triacylglycerol catabolism, its regulation. Oxidation of fatty acids and glycerol. Ketone body exchange studies. Qualitative reaction to acetone.
15. Biosynthesis of fatty acids, triacylglycerols, phospholipids. Regulation of these processes. Determination of total serum lipids.
16. Biosynthesis, metabolism and biotransformation of cholesterol (vitamin D, bile acids, steroid hormones).
17. Transport forms of lipids Lipid metabolism pathologies: steatorrhea, obesity, atherosclerosis., diabetes mellitus. Analysis of laboratory data on the determination of cholesterol in blood lipoproteins.
18. Protein digestion and amino acid absorption studies. Common amino acid conversion pathways in tissues. Gastric juice analysis.
19. Investigation of ways of ammonia formation and neutralization. Urea biosynthesis.
20. Specialized routes of exchange of acyclic and cyclic amino acids. Amino acid metabolism enzymopathies. Determination of creatinine in urine.
21. Purine and pyrimidine nitrogenous bases. Structure and biochemical functions of nucleosides, nucleotides Metabolism of purine and pyrimidine nucleotides. Pathologies of exchange.
22. Enzymes and molecular mechanisms of DNA replication. Transcription - RNA biosynthesis.
23. Protein biosynthesis in ribosomes. Antibiotics are transcription and translation inhibitors.
24. Regulation of gene expression in prokaryotes and eukaryotes. Molecular mechanisms of mutations. DNA repair. Recombinant DNA.
25. Molecular cell mechanisms of action of hormones on target cells. Qualitative reactions to thyroxine, insulin, folliculin.
26. Hormonal regulation of metabolic processes. Violation of exchanges.
27. Hormonal regulation of calcium homeostasis and water-salt metabolism. Determination of phosphate content in the serum of a healthy and rickets-affected child.
28. Kinins, renin - angiotensin system, their role in maintaining blood pressure.

29. Vitamins as nutritional components: exogenous and endogenous hypovitaminoses. Research on the coenzyme function of vitamin B1.
30. Fat-soluble vitamins. Antioxidants. Macro- and microelements. Qualitative reaction to vitamin A.
31. Biochemistry and blood pathological biochemistry. Red blood cell respiratory function.
32. The biochemical composition of the blood is normal and in pathology.
33. Vaginal, anti-clotting and fibrinolytic blood systems. Hereditary irregularities.
34. Biochemical functions of the liver. Biotransformation of xenobiotics and endogenous toxins in the liver.
35. Porphyrin metabolism, jaundice biochemistry.
36. Biochemistry of connective tissue.
37. Urinary function of the kidneys. Normal and pathological components of urine.
38. Biochemistry of muscles and nervous tissue.
39. Neuroendocrine and metabolic regulation of physiological processes in the body. Influence of genetic and external factors, lifestyle.

Literature

1. Harvey R.A., Ferrier D.R. Lippincott's Illustrated Reviews: Biochemistry. Seventh Edition. – 2017. – 567 p.
2. Prasad R Manjeshwar. Textbook of Biochemistry for Medical students. Revised Fourth Edition. – 2016. – 640 p.
3. Andrea T. Da Poian, Miguel A. R. B. Castanho Integrative Human Biochemistry. A Textbook for Medical Biochemistry. Springer Science. 2015. – 422 p/
Biological and Bioorganic Chemistry : in 2 books : textbook. Book 1. Bioorganic Chemistry / B.S. Zimenkovsky, V.A. Muzychenko, I.V. Nizhenkovska, G.O. Syrova ; edited by B.S. Zimenkovsky, I.V. Nizhenkovska. — Kyiv : AUS Medicine Publishing, 2019. — 288 p.
2. Biochemistry. Short course [Text] : [study guide] / Z. M. Skorobogatova ; Nat. acad. of sciences of Ukraine, L. M. Litvinenko inst. of physical-organic a. coal chemistry. - Kyiv : Biocomposite, 2018 .- 73p.
3. Biochemie de Harper [Text] (фр.): научное издание / David A. Bender [et al.] ; пер. Lionel Domenjoud. - 6e ed. - Louvain-la-Neuve : De Boeck Superior, 2017. - 817 p.
4. Gubsky U. Biological Chemistry : Textbook . – Vinnytsia : Nova Kniha, 2017. – 488 p.
- 5.
6. Chaterjea MN, Rana Shinde Textbook of Medical Biochemistry. 7th Edition. – JAPPEE BROTHERS, 2007. – 810 p.

Information resources:

1. <https://www.wiley.com/college/boyer/0470003790/animations/animations.htm>
2. https://www.wpunj.edu/sec/vsec/science_courses/biochem/
3. <https://chemwiki.ucdavis.edu>
4. <https://alevlnotes.com>

5. <https://www.chemguide.co.uk>
6. DM Vasudevan - Textbook of Biochemistry For Medical Students, 6th Edition.pdf
<https://archive.org/details/pdfy>
7. Lippincott's Illustrated Reviews: Biochemistry Fifth Edition Richard A. Harvey, Denise R. Ferrier, 2011
<http://103.4.234.46/books/Lippincotts%20Illustrated%20Reviews%20Biochemistry%205th%20edition.pdf>
8. <https://www.labster.com/try/>
9. <https://vlab.amrita.edu/>