National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Department
biomedical engineering

"Biochemistry-1. Bioorganic Chemistry "

Working program of educational discipline (Syllabus)

Requisites of the Course

Cycle of Higher Education	***First (bachelor's)***
Branch of knowledge	*16 Chemical and Bioengineering*
Specialty	*163 Biomedical Engineering*
Educational program	*Medical Engineering*
Course status	*Mandatory discipline*
Mode of study	*full-time / day / mixed / remote*
Year of study/Semester	*1st year (autumn, spring semester)*
ECTS workload	*4 ECTS credits / 120 hours*
Testing and Assessment	*Final Test, Module Test, Academic essay*
Course schedule	*According to the schedule on the site http://rozklad.kpi.ua/*
Language of instruction	*English*
Information about course supervisor / teachers	***Lecturer:*** ***course (autumn semester, Biochemistry-1. Bioorganic chemistry)*** *Associate Professor of BME, PhD in Biological Sciences* *Kalashnikova Larysa , e-mail – doc_hom2000@yahoo/com* ***Practical:*** ***course (autumn semester, Biochemistry-1. Bioorganic chemistry)*** *Associate Professor of BME, PhD in Biological Sciences* *Kalashnikova Larysa , e-mail – doc_hom2000@yahoo/com*
Course placement	*Platform «Sikorsky» - course « **Biochemistry-1. Bioorganic chemistry**)*

Distribution of hours

Semester	Lectures	Practical	Laboratory	Self-study
autumn semester	36	36		48
spring semester	*36*	*36*		*48*

Curriculum of the discipline

1. Course description, goals, objectives, and learning outcomes

The discipline "Biochemistry-1. Bioorganic Chemistry " belongs to the cycle of normative disciplines and forms a systematic knowledge of the relationship between the structure and patterns of functioning of major biologically important classes of organic compounds and biopolymers, forms an understanding of basic chemical and biochemical processes occurring in living organisms at the molecular level.

The main tasks of studying the discipline are to provide students with knowledge about the basics of the chemical structure of biological molecules, including biopolymers and a set of biochemical processes in the body.

Course *"Biochemistry-1. Bioorganic Chemistry "*studies the relationship between the structure and patterns of functioning of the main biologically important classes of organic compounds and biopolymers, to understand the basic chemical and biochemical processes occurring in a living organism at the molecular level.

For studying the discipline *Course "Biochemistry-1. Bioorganic Chemistry "*, the following are required:

Skills: knowledge of the fundamentals of bioorganic chemistry; understanding of the relationship between the structure of biomolecules and their reactivity; ability to predict possible pathways and onditions for the transformation of functional groups in the most important classes of organic compounds during metabolism; ability to identify biologically important organic compounds based on knowledge of their chemical properties and the main methods for studying organic compounds; ability to analyze the correspondence between the structure of bioorganic compounds and the physiological functions they perform in the human body.

Competencies: ability for abstract thinking, analysis, and synthesis; ability to communicate in the state (official) language both orally and in writing; skills in using information and communication technologies; ability to search for, process, and analyze information from various sources.

Integral competence (IC)

The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms

General competencies

GC 6 *- Ability to search, process, and analyze information from various sources*

Special (professional) competencies

PC 5 *- Ability to apply physical, chemical, biological, and mathematical methods in the analysis and modeling of the functioning of living organisms and biotechnical systems*

The program learning outcomes after studying the discipline "Biochemistry-1. Bioorganic Chemistry " are:

PLO 17 *- Application of knowledge in chemistry and bioengineering to create, synthesize, and apply artificial biotechnical and biological objects*

PLO 18 *- Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes*

2. Prerequisites and postrequisites of the course (place in the structural and logical scheme of education according to the relevant educational program)

Prerequisites

The academic discipline "Biochemistry" belongs to the cycle of professional training and has an interdisciplinary character. It is directly preceded by the disciplines of basic school training.

Discipline	Knowledge, Skills, Experience
General and Inorganic Chemistry	Knowledge of chemical bonds and the spatial structure of molecules, types of chemical reactions and the basic principles governing their course, and the classification of chemical substances. Understanding of the concept of amount of substance, reactivity, and redox (oxidation–reduction) processes. Skills in solving chemical problems
Organic Chemistry Органічна хімія	Basic knowledge of the structural features, properties, reactivity, and synthesis methods of the main classes of organic compounds. Rules for determining the oxidation states of carbon in organic molecules.

Postrequisites

The academic discipline "Biochemistry. Part 1. Bioorganic Chemistry" belongs to the cycle of professional training and has an interdisciplinary character. According to the structural and logical scheme of the specialist training program, the discipline "Biochemistry" is closely related to other professional training disciplines, namely Materials Science and Structural Materials, Biomaterials and Biocompatibility, and Human Anatomy and Physiology.

Discipline	Expected knowledge, skills, and competencies
Human Anatomy and Physiology	Knowledge of the structural A of human body and the principles of its functioning. Forms an understanding of the role of bioorganic compounds in the formation of body structures and their involvement in the execution of physiological functions.
Materials Science and Structural Materials,	Knowledge of the structure, properties, and functional characteristics of polymers and low-molecular-weight synthetic substances used as raw materials in technologies for the development of new materials for medical applications.
Biomaterials and Biocompatibility	Focuses on the study of materials used in medical and biomedical applications and their interaction with biological systems. The course covers the classification, structure, properties, and functions of biomaterials, as well as the principles of biocompatibility, biodegradation, and biological safety. It provides fundamental knowledge necessary for the selection, design, and evaluation of materials intended for use in medical devices, implants, and tissue engineering.

3. Course Overview

The main parts and subjects that will be considered in the process of studying the course:

Chapter 1. Fundamentals of the Structure and Reactivity of Organic Compounds

Topic 1.1. Fundamentals of the structure of organic compounds. Classification of organic compounds. Nomenclature of organic compounds.

Topic 1.2. The concept of isomerism. Classification of isomerism. The concept of conformation and configuration

Topic 1.3. Electronic structure of carbon. Types of chemical. communication and their characteristics. Electronic effects in molecules of organic compounds. Interaction of atoms in molecules

Topic 1.4. General regularities of reactivity of bioorganic compounds

Topic 1.5. Basicity and Acidity of Organic Compounds. Lewis Theory, Pearson's Principle, Brønsted–Lowry Theory

Chapter 2 Structure, properties and functions of biologically important classes of bioorganic compounds.

Topic 2.1. Structure, Properties, and Medical and Biological Significance of Hydrocarbons of Various Classification Groups. Structure, properties and biological significance of cyclic compounds

Topic 2.2. Classification, Structure, and Significance of Biologically Important Heterocyclic Compounds.
Topic 2.3. Structure, classification, reactivity and biological significance of heterofunctional compounds
Topic 2.4 Bioregulators of natural origin.

Chapter 3. Biopolymers and bioregulators of natural origin. Their structure and medical and biological significance.

Topic 3.1. Lipids and low molecular weight bioregulators
Topic 3.2 Bioregulators of natural origin. Carbohydrates. Structure and chemical properties. Classification of carbohydrates
Topic 3.3. Structure and properties of biologically important amines and Charecters amino acids
Topic 3.4. Structure of peptides and proteins
Topic 3.5. Enzymes as biocatalysts
Topic 3.6. Nucleic acids. Structure and functions of DNA. Features of RNA structure. RNA types.

4. Coursebooks and teaching resources

Basic:

1. Вовянко С.І., Калашнікова Л.Є. «Біохімія» Методичні рекомендації для самостійної роботи студентів для студентів спеціальності 163 – «Біомедична інженерія» / КПІ ім. Ігоря Сікорського. – 2021. – 63 с.
2. Коваленко С. І. Біологічно важливі класи біоорганічних сполук : навчальний посібник для самостійної підготовки до практичних занять студентів І курсу, медичних факультетів, спеціальності «Стоматологія» / С. В. Коваленко [та ін]. – Запоріжжя: [ЗДМУ], 2021. – 235 с.
3. Біологічна і біоорганічна хімія : у 2 кн. : підручник. Кн. 2. Біологічна хімія / Ю.І. Губський, І.В. Ніженковська, М.М.Корда та ін. ; за ред. Ю.І. Губського, І.В. Ніженковської. – 3-є вид. – К.: ВСВ «Медицина», 2021. – 544 с.

Supplementary:

1. Сирова Г.О. та ін. Основи біоорганічної хімії (навчальний посібник) / Г. О. Сирова, В. М. Петюніна, В. О. Макаров, Л. В. Лук'янова. – Харків: ХНМУ. – 2018. – 238 с.
2. An Introduction to Organic Chemistry
3. David L. Nelson, Michael M. Cox. Lehninger Principles of Biochemistry. Seventh Edition, 2017. – 3270 p.
4. Davydov V.V., Bozhkov A.I., Rudko N.P. Foundations of biological chemistry (Tutorial on biochemistry for foreign students of medical department of higher education institutions) – Kharkov : V.N. Karazin Kharkov National University, 2015. – 400 p.
5. GAJERA H.P., PATEL S.V., GOLAKIYA B. A. Fundamentals of Biochemistry NTERNATIONAL BOOK DISTRIBUTING CO, 2008 - 557 p.
6. Jelena Dodonova Bioorganic chemistry (Set of lectures) Vilnius 2016.- 246 p.
7. Sharon Walker, David McMahon. Biochemistry Demystified by The McGraw-Hill Companies, 2008– 385 p.
8. Synelnyk T.B. Kostiuk O.S. Ostapchenko L.I. BIOORGANIC CHEMISTRY Synelnyk T.B. Kostiuk O.S. Ostapchenko L.I. Kyiv, _2021.-367
9. Zimenkovsky, Boris Semenovich. Biological and Bioorganic Chemistry : in 2 books : National textbook / 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. Book 1 : Bioorganic Chemistry. -- 2019. – 287;

Educational content

5. Methods of mastering the discipline (educational component)

№ s/n	Subject	Program learning outcomes	The main tasks	
			Control measure	Deadline
Autumn semester, 4 ECTS credits / 120 hours				
Section 1. Theoretical Foundations of Bioorganic Chemistry				
1	**Topic 1.1. Fundamentals of the Structure of Organic Compounds. Subject and Objectives of Bioorganic Chemistry** **Lecture.** Basic principles of A. M. Butlerov's Theory of the Structure of Organic Compounds. Classification of organic compounds according to the structure of the carbon chain. Classification of organic compounds by functional group. Nomenclature of organic compounds. For solving practical problems of bioorganic chemistry that involve the application of specific theories and methods of chemical, biological, and medical engineering, and are characterized by complexity and uncertainty of conditions. **Practical classes.** Discussion of the theoretical foundations of organic chemistry. Classification of methods for studying bioorganic compounds. Classification of organic compounds. Nomenclature of organic compounds. The discussion on the topic of the practical lesson is based on the understanding of fundamental and applied, medical-physical, and physico-chemical patterns of the functioning of biological objects, as well as bioengineering foundations of technologies and equipment for studying human body processes. It involves discussing methods for investigating objects, analyzing, and processing experimental data. This enables the application of chemical knowledge for the creation, synthesis, and use of artificial biotechnical objects. *Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes* *The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms*	*IC* *PLO 17* *PLO 18*	*Practical work 1*	*1st week*
2	**Topic 1.2. Fundamentals of the Structure of Organic Compounds. Isomerism** **Lecture.** Concept of isomerism. Classification of isomerism. Conformation. Configuration. Concept of optical isomerism. **Practical Lesson.** The discussion on the topic of the practical lesson is based on the understanding of fundamental and applied, medical-physical, and physico-chemical patterns of the functioning of biological objects, as well as the bioengineering principles of technologies and equipment used to study human body processes. The discussion focuses on methods for investigating optically active compounds, as well as the analysis and processing of research data. This knowledge enables solving complex specialized tasks and practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.\ Understanding of fundamental-applied, medical-physical, and physico-chemical principles governing the functioning of biological objects, as well as bioengineering fundamentals of technologies and equipment for researching human body processes	*IC* *PLO 17* *PLO 18*	*Practical work 2*	*2nd week*
3	**Topic 1.3. Electronic Structure of Carbon** **Lecture.** Types of chemical bonds and their characteristics. Electronic effects in molecules of organic compounds. Mutual influence of atoms in molecules.		*Practical work 3* *Quiz 1*	*3rd week*

	To compare and understand the characteristics of chemical bonds, it is necessary to apply knowledge of the fundamentals of mathematics, physics, biophysics, and chemistry to solve problems of biomedical engineering. **Practical class.** Discussion based on an understanding of fundamental and applied, medical-physical, and physico-chemical laws of the functioning of biological objects for studying processes in the human body. The discussion on the topic of the practical lesson is based on the understanding of fundamental and applied, medical-physical, and physico-chemical patterns of the functioning of biological objects, for the study of human body processes. *The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms* Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.	*IC* *PLO 18*		
4	**Topic 1.4.** General Principles of the Reactivity of Bioorganic Compounds. Concept of Reaction Mechanism. Classification of Reactions Involving Organic Compounds **Lecture.** Classification of organic reactions. Reaction mechanisms.To determine differences, it is necessary to apply knowledge of the fundamentals of mathematics, physics, biophysics, and chemistry to solve biomedical engineering problems. **Practical class.** Discussion based on an understanding of fundamental and applied, medical-physical, and physico-chemical laws of the functioning of biological objects for studying processes in the human body. Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Such knowledge of chemistry can be applied for the creation, synthesis, and use of artificial biotechnical objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms	*IC* *PLO 17* *PLO 18*	*Practical work 4*	*4th week*
5	**Topic 1.5. Basicity and Acidity of Organic Compounds. Lewis Theory, Pearson's Principle, Brønsted–Lowry Theory** **Lecture.** Basic principles of theories of acidity and basicity. Comparative characteristics of the Brønsted–Lowry and Pearson theories. To determine differences, it is necessary to apply knowledge of the fundamentals of mathematics, physics, biophysics, and chemistry to solve biomedical engineering problems. **Practical class.** Discussion based on an understanding of fundamental and applied, medical-physical, and physico-chemical laws of the functioning of biological objects for studying processes in the human body. Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Such knowledge of chemistry can be applied for the creation, synthesis, and use of artificial biotechnical objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the	*IC* *PLO 17* *PLO 18*	*Practical work 5*	*5th week*

	complexity and non-strict terms.			
Section 2. Structure, Properties, and Functions of Biologically Important Classes of Bioorganic Compounds.				
6.	***Topic 2.1. Structure, Properties, and Medical and Biological Significance of Hydrocarbons of Various Classification Groups.*** ***Lecture.*** *Structural features. Characteristics of covalent bond structure in saturated and unsaturated hydrocarbons. Features of reactivity. Comparative characteristics of the chemical properties of bioorganic compounds of different classification groups. Their significance for natural processes. Their applications in medicine.* ***Practical class.*** *Discussion of practical problems related to the application of aliphatic hydrocarbons; use of specific methods of chemical and biological engineering, characterized by complexity and uncertainty of conditions. Application of knowledge of organic chemistry for the synthesis of artificial bioorganic compounds and biological objects. Understanding fundamental and applied, medical-physical, and physicochemical principles governing the functioning of bioorganic compounds for the study of processes in the human body.* Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Such knowledge of chemistry can be applied for the creation, synthesis, and use of artificial biotechnical objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms	*IC* *PLO 17* *PLO 18*	*Practical work 6* *Quiz 2*	*6th week*
7	***Topic 2.2. Classification, Structure, and Significance of Biologically Important Heterocyclic Compounds.*** Classification of cyclic compounds by the type of heteroatom, by the number of rings, and by ring size. Nomenclature of heterocyclic compounds: trivial and international. Principles of constructing international names. Reactivity of heterocyclic compounds. Distribution of heterocyclic compounds in nature and their applications in medicine. Representatives of heterocyclic compounds of the furan, thiophene, and pyrrole series. Solving practical problems that involve the application of methods for the synthesis of new bioorganic compounds and theories of biological engineering, characterized by complexity and uncertainty of conditions. To determine differences in reactivity and structure of cyclic organic compounds, applying knowledge of the fundamentals of mathematics, physics, biophysics, and chemistry to solve problems of biomedical engineering. **Practical class.** Discussion on the topic of the practical session is based on an understanding of fundamental and applied, medical-physical, and physicochemical principles governing the functioning of biological objects for the study of processes in the human body. Application of knowledge of organic chemistry for the synthesis of artificial bioorganic compounds and biological objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.	*IC* *PLO 17* *PLO 18*	*Practical work 7*	*7th week*
8.	*Topic 2.3. Structure, classification, reactivity and biological significance of heterofunctional compounds.* ***Lecture.*** *Classification of heterofunctional compounds by molecular structure, type of functional groups and by number of*		*Practical work 8*	*8th week*

	functional groups. Nomenclature of heterofunctional compounds. Study of methods for studying heterofunctional compounds: physical and physicochemical research methods Knowledge of methods for studying objects, analyzing and processing experimental data. ***Practical class.*** *Discussion on the topic of the practical session is based on an understanding of fundamental and applied, medical-physical, and physicochemical principles governing the functioning of biological objects for the study of processes in the human body.* Application of knowledge of organic chemistry for the synthesis of artificial bioorganic compounds and biological objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions..	*IC* *PLO 17* *PLO 18*		
9 10	***Topic 2.4.*** *Bioregulators of natural origin.* **Lecture.** Structure and natural functions of vitamins, alkaloids and terpenes. Fat- and water-soluble vitamins, alkaloids and terpenes. Application of knowledge of the chemistry of organic compounds for the synthesis of artificial xenobiotics based on bioregulators of natural origin and biological objects. Chemical and physicochemical methods for studying bioregulators of natural origin. **Practical** • Low molecular weight bioregulators Vitamins - structure and biological content. Water-soluble and water-insoluble vitamins • Low molecular weight bioregulators. Alkaloids, terpenes, steroids Discussion of fundamental and applied, medical and physical, physicochemical laws of the functioning of biological objects of the human body Application of knowledge of the chemistry of organic compounds for the synthesis of artificial lipids and artificial biological membranes. Liposomes and their application in chemistry. Physical and physicochemical methods for studying bioregulators of natural origin. Application of knowledge of organic chemistry for the synthesis of artificial bioorganic compounds and biological objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions..	*IC* *PLO 17* *PLO 18*	*Practical work 9* *Practical work 10* *Quiz 3*	*9th week* *10th week*
Section 3. Biopolymers and Bioregulators of Natural Origin. Their Structure and Medical and Biological Significance.				
11	***Topic 3.1. Lipids and low-molecular-weight lipid-derived bioregulators.*** ***Lecture*** *Lipids as low molecular weight bioregulators Structure of lipids. Classification of lipids. Chemical properties of lipids. Saponifiable lipids: representatives and their significance in medicine and in nature. Non-saponifiable lipids. Their classification and medical and biological significance. Application of knowledge of organic compound chemistry to the synthesis of artificial lipoids and artificial biological membranes. Liposomes and their applications in chemistry. Physical and physicochemical methods for studying bioregulators of natural origin* ***Practical*** *Discussion of fundamental and applied, medical-physical, and*	*IC* *PLO 17* *PLO 18*	*Practical work 11*	*11th week*

	physicochemical principles governing the functioning of biological objects of the human body. Application of knowledge of organic chemistry for the synthesis of artificial bioorganic compounds and biological objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions. Application of knowledge in chemistry and bioengineering to create, synthesize, and apply artificial biological objects			
12	**Topic 3.2. Carbohydrates.** Structure and chemical properties. Classification of carbohydrates. **Lecture.** Optical isomerism of monosaccharides. Spatial structure of monosaccharides. Glycosidic bond. Biologically important oligosaccharides. Classification of heteropolysaccharides. Structure and functions of heteropolysaccharides. Application of knowledge of organic compound chemistry to the synthesis of artificial polysaccharides or analogues of monosaccharides and biological objects. **Practical class.** Discussion of fundamental and applied, medical-physical, and physicochemical principles of the functioning of biological objects of the human body. Chemical and physicochemical methods for the study of bioregulators of natural origin Application of knowledge of organic chemistry for the synthesis of artificial bioorganic compounds and biological objects. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Application of knowledge in chemistry and bioengineering to create, synthesize, and apply artificial biological objects	*IC* *PLO 17* *PLO 18*	*Practical work 12*	*12th week*
13	**Topic 3.3.** Structure and properties of biologically important amines and Charecters amino acides **Lecture.** Covers the structure and properties of biologically important amines and amino acids. Attention is given to their chemical structure, classification, acid–base properties, stereochemistry, and reactivity. The biological roles of amines and amino acids as key components of living systems, including their participation in metabolic processes, neurotransmission, and protein structure, are considered. The topic also introduces basic chemical and physico-chemical methods used to study these compounds and highlights their importance in biomedical and bioengineering applications. **Practical class.** Discussion on the structure of proteinogenic amino acids, their classification, and the features of their physical and chemical properties. Characteristics of non-proteinogenic amino acids. The role of amines in nature. The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Application of knowledge in chemistry and bioengineering to	*IC* *PLO 17* *PLO 18*	*Practical work 13*	*13th week*

	create, synthesize, and apply artificial biological objects			
14	***Topic 3.4. Structure of Peptides and Proteins.*** *Protein monomers. Classification of peptides. Protein structure: primary, secondary, tertiary, and quaternary levels of protein organization.* *The significance of proteins in nature. Application of knowledge of systems analysis, mathematics, chemistry, and biophysics necessary for determining protein properties and their amino acid composition, and for solving biomedical engineering problems based on this knowledge.* ***Practical class.*** *Discussion of chemical and physicochemical methods for the study of peptides and proteins. Discussion of fundamental and applied, medical-physical, and physicochemical principles governing the functioning of biological objects of the human body.Structure of peptides and proteins Enzymes as biocatalysts* The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms Understanding the topic of the practical lesson teaches how to solve practical problems in biomedical engineering or in learning processes that involve the application of specific theories and methods from chemical, biological, and medical engineering, characterized by complexity and uncertainty of conditions.. Application of knowledge in chemistry and bioengineering to create, synthesize, and apply artificial biological objects	*IC PLO 17 PLO 18*	*Practical work 14*	*14th week*
15	***Topic 3.5. Enzymes as Biocatalysts.*** **Lecture.** Structure and classification of enzymes. Main properties of enzymes. Theoretical mechanisms of enzyme action. Application of knowledge of systems analysis, mathematics, chemistry, and biophysics necessary for determining enzyme properties and their chemical composition, and for solving biomedical engineering problems based on this knowledge. **Practical class.** Discussion of chemical and physicochemical methods for the study of enzymes. Discussion of fundamental and applied, medical-physical, and physicochemical principles governing the functioning of biological objects of the human body. Application of knowledge in *chemistry and bioengineering to create, synthesize, and apply artificial biological objects* The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms	*IC PLO 17 PLO 18*	*Practical work 15 Quiz 4*	*15th week*
16	***Topic 3.6. Nucleic Acids*** ***Lecture.*** *Structure and functions of DNA. Structure of a nucleotide. Concept of complementarity. Levels of DNA structural organization. Types of DNA in nature. Features of RNA structure. Types of RNA and their functions.* ***Practical class.*** *Determin ation of the properties of nucleic acids using knowledge of systems analysis, mathematics, chemistry, and biophysics, and their structure, as well as solving biomedical engineering tasks based on this knowledge. Study of chemical and physicochemical methods for investigating nucleic acids.* *Application of knowledge in chemistry and bioengineering for the creation, synthesis, and use of artificial biotechnical and biological objects.* *Discussion of fundamental and applied, medical-physical, and physicochemical principles governing the functioning of biological objects, as well as bioengineering foundations of technologies and equipment for studying processes in the human body.* The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms	*IC PLO 17 PLO 18*	*Practical work 16 Module Test writing*	*16th week*
17	***Module Test*** *Understanding the medical-physical and physicochemical principles governing the functioning of biological objects, as well as the bioengineering foundations of technologies and equipment for studying processes in the human body***.**	*IC PLO 17 PLO 17*	*Practical work 17 Module Test writing*	*17th week*

18	***Final Test*** The ability to solve complex, specialized problems and practical problems in biomedical engineering and in the process, which provides the use of specific theories and methods of chemical, biological and medical engineering, and is characterized by the complexity and non-strict terms		*Final Test Pass*	*18th week*

Hourly distribution of topics

TOPICS	Lecture		Practical		Assessment
	Weeks	Hours	Weeks	Hours	
Topic 1. Basics of the Structure of Organic Compounds. Subject and Tasks of Bioorganic Chemistry	1	2	1	2	Practical Work №1
Topic 2. Basics of the Structure of Organic Compounds. Isomerism	2	2	2	2	Practical Work №2
Topic 3. Electronic Structure of Carbon	3	2	3	2	Practical Work №3; **Express Test №1**
Topic 4. General Patterns of Reactivity of Bioorganic Compounds	4	2	4	2	Practical Work №4;
Topic 5. General Patterns of Reactivity of Bioorganic Compounds	5	2	5	2	Practical Work №5
Topic 6. Structure, Properties, and edical-Biological Significance of Hydrocarbons of Different Classification Groups	6	2	6	2	Practical Work №6
Topic 7. Classification, Structure, and Significance of Biologically Important Heterocyclic Compounds	7	2	7	2	Practical Work №7; **Express Test №2**
Topic 8. Structure, Classification, Reactivity, and Biological Significance of Heterofunctional Compounds	8	2	8	2	Practical Work №8; Express Test №3
Topics 9–10. Natural Bio-regulators	9-10	4	9-10	4	Practical Work №9; №10
Topic 11. Lipids and Low-Molecular-Weight Lipid-Derived Bio-regulators	11	2	10	2	Practical Work №11 **Express Test №3**
Topic 12. Carbohydrates. Structure and Chemical Properties. Classification of Carbohydrates	12	2	11	2	Practical Work №12
Topic 13. Structure and Properties of Biologically Important Amines and Characteristics of Amino Acids	13	2	13	2	Practical Work №13
Topic 14. Structure of Peptides and Proteins. Protein Monomers. Classification of Peptides. Protein Structure	14	2	12	2	Practical Work №14
Topic 15. Enzymes as Biocatalysts	15	2	13	2	Practical Work №15
Topic 16. Nucleic Acids. Structure and Functions of DNA. Structure of Nucleotide	16	2	14	2	Practical Work №16 Express Test №4
Modular Control Work	17	2	17	2	Practical Work №17
Final Test	18	2	18	2	Practical Work №18

6. Self-study

6.1. Types of Independent Work:

No.	Type of Independent Work	Number of Hours (Self-Study)
1	Review of lecture material and study of topics assigned for independent work	10
2	Preparation for practical classes	12
3	Preparation for express control works	6
4	Preparation for modular control work	6
5	Writing the research paper (essay)	8
6	Preparation for the final test	6
Total		**48**

Distribution of Students' Independent Work Hours by Topic of Study Content:

No.	Topics and Questions for Independent Study & References	Number of Hours (Self-Study)
1	Basics and fundamental principles of the structure of organic compounds. Subject and tasks of bioorganic chemistry. Questions for independent study: Classification of organic compounds. Homologous series of organic compounds. [1-3]	1
2	Basics of organic compounds. Isomerism. Questions for independent study: Types of optical isomerism. Concept of configuration. Conformational isomerism of cyclic compounds. [1-3]	4
3	Electronic structure of carbon. Questions for independent study: Electronic effects in organic molecules. [1-3]	2
4	General characteristics of organic reactions. Questions for independent study: Types of organic reactions and their main characteristics. [1-3]	1
5	General patterns of reactivity of bioorganic compounds. Questions for independent study: Theories of redox processes and their basic principles. [1-3]	2
6	Structure, properties, and medical-biological significance of hydrocarbons of different classification groups. Questions for independent study: Chemical properties of hydrocarbons. Their medical applications.	1
7	Classification, structure, and significance of biologically important heterocyclic compounds. Questions for independent study: Chemical properties of hydrocarbons. Their medical applications. [1-3]	1
8	Structure, classification, reactivity, and biological significance of heterofunctional compounds. Questions for independent study: Chemical properties of hydrocarbons. Their medical applications. [1-3]	1
9	Natural bioregulators. Questions for independent study: Distribution in nature. Chemical properties of the most important representatives. Their medical applications. [1-3]	1
10	Lipids and low-molecular-weight lipid-derived bioregulators. Questions for independent study: Distribution in nature. Chemical properties of the most important representatives. Their medical applications. [1-3]	1
11	Carbohydrates: Structure, chemical properties, and classification. Questions for independent study: Distribution in nature, chemical properties of key representatives, isomerism, optical properties, medical applications. [1-3]	1
12	Structure and properties of biologically important amines and characteristics of amino acids. Questions for independent study: Distribution in nature, chemical properties, isomerism, optical properties of amino acids, biological significance. [1-3]	1
13	Structure of peptides and proteins. Protein monomers. Classification of peptides. Protein structure. Questions for independent study: Distribution in nature. Key physical properties of proteins.	1
14	Enzymes as biocatalysts. Questions for independent study: Distribution in nature. Chemical and physical properties. Their medical and biological significance.	1
15	Nucleic acids: Structure and functions of DNA, nucleotide structure, free nucleotides. Questions for independent study: Features of the structure of different types of nucleic acids. Biological significance of free nucleotides. [1-3]	2
16	Preparation for express control works	6
17	Modular control work	6
18	Research paper (essay)	8
19	Final test	6
Total		**48**

One of the main types of semester control before the hour of opening the initial discipline "Biochemistry" preparing report (5-7 minutes) for one of the practical classes according to the discipline plan.

Next, preparation for classroom classes corresponds to the plan of disciplines. The discipline plan is presented on the MOODLE platform. The MOODLE system can be accessed by following the links

Approximate subject of reports:

Autumn semester, Biochemistry-1 module. "Bioorganic chemistry":

• Heterocyclic compounds. Classification, structure, medical and biological significance.

• Nucleosides, nucleotides. Nitrogen bases of pyrimidine and purine series.

• Amines. Structure, properties. Biological significance of biogenic amines (adrenaline, tryptamine, serotonin, histamine) and polyamines (putrescine, cadaverine)

• The concept of keto acid (example acetoacetic acid). Acetoacetic ether.

• Heterofunctional derivatives of the benzene series as drugs.

• Properties of enzymes: catalytic activity, specificity of interaction. Types of specificity.

• Medicinal substances-derivatives of the heterocyclic series. Structure, classification, nomenclature. Pharmacological action.

• General characteristics of poisons and toxins of plant and animal origin.

• Antibiotics. Classification of drugs of the penicillin group. Their structure. Nomenclature. Medico-biological action.

• Low molecular weight bioregulators. Strekhnina group. Structure, nomenclature. Biological significance.

Structure of the Research Paper

Title Page *– the first page should include: the Ministry; the educational institution; faculty; department; specialty; educational-professional program; course title; research paper topic; student's full name, year of study, academic group number, and year.*

Table of Contents – *follows the title page and should outline the introduction, main sections (key topics studied), subsections (if needed), conclusion, and references. Page numbers for each section should be indicated on the right. Each section begins on a new page. Headings in the table of contents must exactly match the text. A list of symbols or abbreviations may be included if necessary.*

Introduction *– justifies the relevance and practical significance of the topic; defines the object, subject, purpose, and objectives of the research; describes the methods used; presents the structure and main content. The introduction should provide a systematic analysis of theoretical, methodological, and practical novelty, significance, advantages, and limitations of previous studies.*

Main Sections and Subsections *– present analyzed and systematized material according to the table of contents. Each section covers a separate topic; subsections address specific parts. Key ideas and points of each subsection should be highlighted, including theoretical foundations and practical applications.*

Conclusions *– summarize the work in concise points aligned with the research objectives; highlight positive aspects, limitations, and provide specific recommendations.*

List of References *(5–10 sources) – reflects the volume of sources used. Include full bibliographic descriptions. For online sources, indicate the author, title, and website URL. All references must be cited in the text using numbers in brackets [2], corresponding to the reference list.*

Appendices *– optional; do not count toward the main text length but increase credibility. May include sample questionnaires, tests, tables, diagrams, charts, maps, and illustrations.*

Volume *– 20–25 pages of main text (depending on the topic and as agreed with the instructor). Length should reflect the student's ability to explain and analyze scientific information concisely and thoroughly.*

Mandatory Requirement *– all data, figures, facts, quotes, and formulas must be properly cited to ensure academic integrity.*

Assessment Criteria *– logical structure; completeness and depth of topic coverage; accuracy of conclusions; formatting; justification of the student's own opinion in the conclusion.*

Submission Deadline *– 12th week of study. An oral presentation of 5–7 minutes on the chosen topic is required.*

The research paper is not checked for plagiarism, but must comply with academic integrity. Papers found in violation will be annulled and not assessed.

Policy and control

7.Attendance policy

Attending classes

Attendance at lectures is optional. Attending practical classes is desirable. All works and activities are aimed at the students' compliance with the assessment rating requirements. A significant part of a student rating is formed through active participation in activities in practical classes. Therefore, skipping a practical class does not allow a student to get points in the semester rating. General assessment takes place according to a scheme of the agreed grading system. Expected learning outcomes, control measures and deadlines are announced to students in the first practical class.

Control measures missed

Missed control measures (defense of practical work) can be worked out during the next classes, (provided that the task is scheduled for the current lesson), or in consultations.

Skipped express tests/ quizzes cannot be completed.

Skipped Module Test can be worked out in consultations.

Violation of deadlines, penalty points and rewarding points

Incentive Points	Criterion	Points
1	Improvement of practical work, active participation in practical classes	1 point (per practical work)
2	Completion of online courses on topics approved by instructors	3 points
3	Writing abstracts on the topics of the course	3 points
4	Preparation of a scientific paper for participation in student research competitions	5 points
5	Participation in international or national events/competitions, or winning a prize in a university competition related to the course	10 points
6	Writing a scientific article on the topics of the course	10 points

** if the control measure was missed for a good reason (illness, which is confirmed by a certificate of the established sample) - penalty points are not accrued.*

Academic integrity

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Norms of ethical behavior

Normative principles of behavior of students and employees, defined in sections 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: https://kpi.ua/code.

Procedure for appealing the results of control measures

Students have the opportunity to raise any issue related to the control procedure and expect it to be addressed according to predefined procedures.

The student has the right to appeal the results of the control measure according to the approved provision on appeals in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (approved by the order №NON/128/2021 from 20.05.2021) - https://osvita.kpi.ua/index.php/node/182

Inclusive education

The course "Biochemistry" can be taught to the most of students with special educational needs.

Distance learning

Distance learning takes place through the Sikorsky Distance learning Platform «Sikorsky».

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / test tasks, practical work).

Performance of practical works is carried out during independent work of students in a remote mode (with a possibility of consultation with the teacher through e-mail, social networks).

Teaching in a foreign language

Teaching in English is carried out only for foreign students.

At the request of students, it is allowed to study the material with the help of English-language online courses on topics that correspond to the topics of specific classes.

8.Monitoring and grading policy

8.1.Grading system (current control):

№ s/n	*Control measure*	*%*	*Weight points*	*Number*	*Total*
1.	*Express control works / quizzes*	*40*	*4*	*10*	*40*
2.	*Active work on a practical classes*	*10*	*2*	*5*	*10*
3.	*Express control works*	*15*	*3*	*5*	*15*
4.	*Presentation of a report on a practical classes*	*15*	*15*	*1*	*15*
5.	*Module Test (MT)*	*20*	*20*	*1*	*20*
5.	*Final Test*[1]	*85*	*85*	*1*	*85*
	Total				*100*

In the final practical class of the course, students will add their rewarding points, if there are any, to the performance score, and /or subtract their penalty points if there are any, from the performance score, and in case it is in total higher than 60 points, they may either get their Pass or take the Final Test to improve their grade. If the grade for the Final Test is higher than the final performance grade, the student receives the grade based on the results of this Test. If the grade for the Test is lower, the final performance grade is cancelled and the student receives a grade based on the results of the Test.

Students whose final performance grade is 30-60 points have to take the Final Test in order to complete the course.

Students whose score is below 30 did not meet the requirements of the course and are not allowed to take the Final Test.

8.2. Practical Class Work. Assessment Criteria

Weight – 2 points*Five assessed responses are planned.* ***Maximum score – 2 points × 5 = 10 points.***

Grade	**Description**	**Score**
Excellent	Answers are complete and correct (at least 90% of the required information)	2 points
Good	Answers are sufficiently complete (at least 75% of the required information)	1.5 points
Satisfactory	Answers are incomplete (at least 60% of the required information)	1 point
Unsatisfactory	Answers are absent or incorrect (less than 60% of the required information)	0 point

8.3. Modular Test. Assessment Criteria for the Modular Tes

Weight of the Modular Test – 25 points

Assessment Criteria

Grade	***Description***	***Score (points)***
Excellent	*Answers are complete and correct (at least 90% of the required information)*	*20–25*
Good	*Answers are sufficiently complete (at least 75% of the required information)*	*14–19*
Satisfactory	*Answers are incomplete (at least 60% of the required information)*	*8–13*

[1] *Taken into account in the amount of the rating together with the grade for CGW in case the student has not scored 60 points per semester or he wants to improve his grade.*

Grade	*Description*	*Score (points)*
Unsatisfactory	*Answers are absent or incorrect (less than 60% of the required information)*	*0-7*

8.4. Research Esse

Weight – 15 points

The research paper is assessed according to the following criteria: logical structure of the plan; completeness and depth of topic coverage; accuracy of conclusion formulation; formatting; justification of the student's own opinion on the topic in the form of a conclusion; mastery of the topic (defense of the research paper). ***The defense of the research esseis mandatory***

Assessment Criteria for the Research Paper

Grade	Description	Points
"Excellent"	The research paper is submitted and defended on time; all main requirements are fully met (at least 90%); the student is well oriented in the topic.	13–15 points
"Good":	the main requirements for the research paper are met with some comments (at least 75%); the student demonstrates a good understanding of the topic. Or: the research paper is submitted after the deadline; the main requirements for the research paper are fully met (at least 90%); the student demonstrates a good understanding of the topic.	10–12 points
"Satisfactory"	Not all main requirements are met (at least 60%); the student is generally oriented in the topic.	7–9 points
"Unsatisfactory"	Main requirements are not met, or the student is not oriented in the topic.	0-6 points

<u>9.Calendar control</u> *(CC) is performed twice a semester as monitoring of the current state of compliance with syllabus requirements.*

The purpose of calendar control is to improve the quality of student learning and monitor the implementation of the schedule of the educational process by students.

Criterion			*The first CC*	*The second CC*
Deadline of calendar controls			*8th week*	*14th week*
Conditions for obtaining a positive calendar control	*Current grade*		*≥ 15 points*	*≥ 30 points*
	Execution of practical work	*КП №№1-4*	+	+
		КП №№5-8	-	+
	Express control works /quizzes	*At least 4 of any lectures*	+	-
		At least 8 of any lectures	-	+
	Module Test	*Estimated MCW*	-	+

In the case of a plagiarism or an academic poor quality during training the control measure is not credited.

10.Semester certification of students

No	Mandatory Condition for Admission to the Final Test	Criterion
1	Current rating	RD ≥ 35
2	Receiving a positive grade for the research paper	More than 7 points
3	All practical works completed and defended	More than 5 points
4	Completion of at least 2 test assignments	More than 15 points

10.1. Assessment Criteria for Final Theoretical Questions (5 questions,)

Grade	**Description**	**Score Range**
Excellent	The answer is correct and complete (at least 90% of the required information)	75–85 points
Very Good	Minor inaccuracies in the answer (at least 80% of the required information)	65–74 points
Good	Minor inaccuracies in the answer (at least 80% of the required information)	55–64 points
Satisfactory	The answer contains shortcomings and certain errors (at least 60% of the required information)	45–54 points
Sufficient	The answer contains shortcomings and certain errors (at least 60% of the required information)	35–44 points
Unsatisfactory	The answer is absent or does not meet the requirements for a “Satisfactory” grade	0 points

10.2. Assessment Criteria for a Final Theoretical Question
(Weighting factor – 17)

Grade	**Description**	**Score Range**
Excellent	Answers are complete and correct (at least 90% of the required information)	15–17 points
Good	Answers are sufficiently complete (at least 75% of the required information)	12–14 points
Very Good	Minor inaccuracies in the answer (at least 80% of the required information)	9–11 points
Satisfactory	The answer contains shortcomings and certain errors (at least 60% of the required information)	6–8 points
Sufficient	Incomplete answers (at least 60% of the required information)	3–5 points
Unsatisfactory	Answers are absent or incorrect (less than 60% of the required information)	0-3 points

The results are announced to each student separately in the presence or remotely (by e-mail). It is also recorded in the "Electronic Campus" system.

Optional requirements for admission to closure:

1. *Active work during practical classes.*
2. *Positive result of the first and the second calendar control.*
3. *Attending of lectures.*

The final performance score or the results of the Final Test are adopted by university grading system as follows:

Number points	*Assessment on the university scale*
100-95	*Excellent*
94-85	*Very good*
84-75	*Good*
74-65	*Satisfactory*
64-60	*Satisfactory enough*
Less 60	*Unsatisfactory*
The course requirements are not met	*Not allowed*

11.Additional information on the course (educational component)

The list of questions for preparation for modular control work, and also for preparation for credit is given in appendix 1 ("Biochemistry-1.Bioorganic chemistry")

Distance learning through additional online courses on certain topics is allowed subject to agreement with students. If a small number of students wish to take an online course on a specific topic, studying the material with such courses is allowed, but students must complete all the tasks provided in the discipline.

The list of courses is offered by the teacher after the students have expressed a desire (because the bank of available courses is updated almost every month).

The student provides a document confirming the completion of the distance course (in the case of a

full course) or provides practical tasks from the distance course and subject to an oral interview with the teacher on the topics can receive grades for control measures provided for the studied topics (express control / quizzes, practical work).

Work program of the course (syllabus):

is developed by *Associate Professor of BME, Candidate of Biological Sciences, Larisa Kalashnikova.*

Approved by *the Department of Biomedical Engineering (protocol № _16_ to __21.06.2024_)*

Approved by *the Methodical Commission of the Faculty of Biomedical Engineering (protocol № 09 to _26.06.2024)*

Appendix 1 to the syllabus of the course

"Biochemistry-1.Bioorganic chemistry"

1. *The subject of bioorganic chemistry. The purpose and objectives of the discipline. Fundamentals of the structure of organic compounds. The theory of A.M. Butlerova.*
2. *The phenomenon of hybridization. The mechanism of formation of hybrid states of the carbon atom*
3. *Classification of organic compounds by the structure of the carbon chain and the multiplicity of bonds*
4. *Classes of organic compounds. Functional groups that determine the class of organic compounds.*

5. Functional and characteristic group of organic compounds. Define and compare. Classification of organic compounds by the number of functional groups.

6. Methods of imaging organic molecules

7. Types of nomenclature of organic molecules. Basic rules of forming the name of organic compounds for each type of nomenclature.

8. The phenomenon of isomerism. Structural isomerism. Classes of structural isomerism. Their characteristics.

9. Spatial isomerism. Classification of spatial isomers.

10. The nature of the phenomenon of chirality. Chiral carbon atom. Types of chirality of organic compounds

11. Describe the types of chemical bonds.

12. The phenomenon of isomerism. Spatial isomerism. isomerism. Types of spatial isomerism. Their characteristics. Compare the concepts of configuration and conformation.

13. The concept of conformers. Application of Newman's structural formulas.

14. Describe the mesomeric effect

15. Describe the inductive effect

16. Types of conjugation in organic molecules

17. What are enantiomers. What properties do they have. The concept of mirror isomerism What is a racemic mixture. Methods of separation of racemates.

18. Diastomerism. Types of diastomers. Methods of calculating the number of diastomers.

19. Ways to display the spatial structure of organic compounds on paper.

20. Systems of isomer designation.

21. Bronsted acids

22. Brandsted Basics

23. Lewis acids and bases.

24. Pearson's principle. The concept of chemical hardness.

25. Compare the concepts of acids and bases according to the theories of Bransted-Lowry, Lewis, Pearson.

26. Classification and isomerism of hydroxy acids. Chemical properties and biological significance of hydroxy acids

27. Biological significance of keto acids and their derivatives.

28. Phenolic acids and their derivatives.

29. Amines. Their biological activity and toxicity.

30. Classification of carboxylic acids, some representatives of monocarboxylic acids.

31. Derivatives of carboxylic acids. Structure and properties of dicarboxylic acids. Higher fatty acids.

32. Structure, properties and classification of lipids, their functions in the body.

33. Structure and classification of carbohydrates. Chemical properties of carbohydrates. Optical isomerism of carbohydrates .. The concept of glycosides.

34. Homopolysaccharides as polyglycosides. Structure, biological role and application of starch, its components and biological role of glycogen, fiber, its role in the vital processes of the organism.

35. Heteropolysaccharides. The role of glucuronic acid, glucosamine and galactosamine in the formation of heteropolysaccharides.

36. Vitamins - classification, structure, functional features. .

37. Structure and medical and biological significance of prostaglandins and leukotrienes.

38. The concept of hormones - structure and functional significance for the body.

39. Alkaloids biological activity and toxicity

40. The structure and 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.

41. Structure and properties of proteins and peptides. Structural organization of proteins. Hydrolysis of a simple protein.

42. Levels of structural organization of protein molecules. Methods of combining α-amino acids in protein molecules. Connections that form the primary, secondary, tertiary and Quaternary structures. Globular and fibrillar proteins.

43. Pyrimidine and purine bases. Structure of nucleosides and nucleotides

44. Phosphorylated nucleotide derivatives, values: ADP and ATP; AMP, GMF, UMF, CMF.

45. Macromolecular structure and functions of nucleic acids. DNA structures

46. Macromolecular structure and functions of nucleic acids. RNA structure (ribosomal, transport, matrix).