Danylo Halytsky Lviv National Medical University

Department of Pharmaceutical, Organic and Bioorganic chemistry

SYLLABUS FOR "ORGANIC CHEMISTRY"

Second (master's) educational level
Field: 22 " Healthcare "
Specialty 226 "Pharmacy, industrial pharmacy**"**

1. General information	
Faculty	Pharmaceutical
Program	22 Healthcare, 226 Pharmacy, industrial pharmacy the second (master's) level, full-time
Academic year	2022/2023
Subject	Organic Chemistry, OK 14, Kaf_pharmchemistry@meduniv.lviv.ua
Department	Department Pharmaceutical, Organic and Bioorganic chemistry Pekarska 69, Lviv, Tel. +38(032)275-59-66, 275-59-77, 278-64-34 Kaf_pharmchemistry@meduniv.lviv.ua
Head of Department	Lesyk Roman, Doctor of Science, Professor roman.lesyk@gmail.com
Year of study	Second
Semester	Third and fourth
Type of course / module	Compulsory
Professors	Nataliya Zelisko, PhD, Associate Professor, NataljaZelisko@gmail.com Danylo Kaminskyy, PhD, Associate Professor, dankaminskyy@gmail.com Ivanna Subtelna , PhD, Associate Professor, subtelna@gmail.com
Erasmus yes/no	No
The person responsible for the syllabus	Ivanna Subtelna , PhD, Associate Professor, subtelna@gmail.com

Number of credits ECTS	8
Number of hours	240 (Lectures – 20 hours, Practical classes – 100 hours, Out of class work – 120 hours)
Language of study	English
Information about consultations	On schedule
Address, telephone and regulations of the clinical base, office ... (if necessary)	-

2. Short annotation to the course

The discipline "Organic Chemistry" is devoted to the systematic study of the chemical behavior of organic compounds in the relation on their structure and the formation of creative chemical thinking on this basis. It is necessary for the successful understanding of specialized disciplines, as well as for practical activity.

The main goal of Organic Chemistry as a fundamental discipline is to provide a scientific approach to solving such problems as pharmaceutical analysis, phytochemical and chemico-toxicological analysis, as well as the synthesis, evaluation of quality and technology of medical preparations and their storage conditions.

Training of specialists who need knowledge of Organic Chemistry requires not only theoretical base but also the versatile practical skills for chemical experiments.

The tasks of Organic Chemistry are to determine the structure of organic molecules both natural and synthetic; studying and understanding of the chemical transformations of organic molecules based on the nature of functional groups; detection of relationships between molecular and electronic structure of compounds and their physiological and pharmacological effects, revealing the patterns of the chemical transformations; studying the aspects of obtaining, purification, and analysis of organic compounds.

3. The purpose and objectives of the course

1. **Objectives of teaching of the "Organic Chemistry" course are:**

- mastering of regularity of chemical properties of organic compounds based on their structure; understanding of biochemical processes that occur in biological systems;
- be familiar with basic methods of organic compounds synthesis as the basis for new biologically active substances creation;
- gaining practical skills that will be helpful to learn the standardization techniques and grug quality control;
- disclosure of organic chemistry practical aspects, methods and ways of usage of its achievements in the pharmaceutical practice.

2. **The purpose of the "Organic Chemistry" course are:**

- to teach students the general principles of evaluation of the chemical properties of organic compounds, underlying the synthesis and analysis of organic substances;
- to reveal of organic chemistry practical aspects, the ways and methods of use its achievements in the pharmaceutical practice.

3. Competences and learning outcomes, the formation of which provides the study of the discipline.

ЗК – General competencies, ФК – Special responsibility, ПРН – Program learning outcomes

General competencies:

ЗК 2. The ability to apply knowledge in practical situations.

ЗК 3. The striving to save the environment.

ЗК 4. The ability to abstract thinking, analysis and synthesis; the ability to study and to be trained up-

to date
ЗК 6. Knowledge and understanding of the subject area and comprehension of the profession.
ЗК.7 Ability to adapt and act in a new situation.
ЗК 10. Ability to choose communication strategies, ability to work in a team and with experts from other fields of knowledge / types of economic activity.
ЗК 11. Ability to assess and ensure the quality of performed work.
ЗК 12. Ability to perform research at the appropriate level.
ЗК 14. Ability to preserve and increase moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies. active recreation and a healthy lifestyle.

Special responsibility:

ФК 2. Ability to provide advice on prescription and over-the-counter drugs and other pharmaceutical products; pharmaceutical care during the selection and sale of over-the-counter drugs by assessing the risk / benefit, compatibility, indications and contraindications based on data on the health of a particular patient, taking into account biopharmaceutical, pharmacokinetic, pharmacodynamic and physicochemical characteristics of the drug and other pharmaceutical products.
ФК 4. Ability to ensure rational use, obtain the necessary information from identified sources to ensure conditions for quality and safe pharmaceutical care of prescription and over-the-counter drugs and other pharmaceutical products in accordance with physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a particular disease and its pharmacotherapeutic regimen.
ФК 5 Ability to monitor the effectiveness and safety of the use of drugs by the population according to the data on their clinical and pharmaceutical characteristics, as well as taking into account subjective signs and objective clinical, laboratory and instrumental criteria for examination of the patient.
ФК 6. Ability to identify drugs, xenobiotics, toxins and their metabolites in body fluids and tissues, to conduct chemical and toxicological studies to diagnose acute poisoning, drug and alcohol intoxication.
ФК 7. Ability to ensure proper storage of medicines and other products of the pharmacy range in accordance with their physicochemical properties and the rules of Good Storage Practice (GSP) in health care facilities.
ФК 15. Ability to organize and participate in the production of medicines in the context of pharmaceutical companies, including the selection and justification of the technological process, equipment in accordance with the requirements of Good Manufacturing Practice (GMP) with the appropriate development and design of the necessary documentation. Determine the stability of drugs.
ФК 19. Ability to organize and control the quality of medicines in accordance with the requirements of the current State Pharmacopoeia of Ukraine and good practices in pharmacy, determine methods of sampling for control of medicines and standardize them in accordance with current requirements, prevent the spread of counterfeit medicines.
ФК 20. Ability to develop methods for quality control of medicines, including active pharmaceutical ingredients, medicinal plant raw materials and excipients using physical, chemical, physicochemical, biological, microbiological, pharmacotechnological and pharmacoorganoleptic control methods.

Program learning outcomes:

ПРН 1 carry out professional activities in social interaction based on humanistic and ethical principles; identify future professional activities as socially significant for human health.
ПРН 2 to apply knowledge of general and professional disciplines in professional activities;
ПРН 4 to use the results of independent search, analysis and synthesis of information from various sources for solving typical tasks of professional activity;
ПРН 10 Adhere to the norms of communication in professional interaction with colleagues, management, consumers, work effectively in a team.
ПРН 12 to use methods of performance indicators evaluation; to reveal reserves for improving of labor productivity.
ПРН 14 to determine the advantages and disadvantages of drugs of different pharmacological groups,

taking into account their chemical, physicochemical, biopharmaceutical, pharmacokinetic and pharmacodynamic features. To recommend to consumers over-the-counter medicines and other products of the pharmacy range with the provision of counseling and pharmaceutical care.
ПРН 16. to determine factors influencing the processes of absorption, distribution, deposition, metabolism and excretion of the drug and due to the condition, features of the human body and physicochemical properties of drugs.
ПРН 17 to use data from clinical, laboratory and instrumental studies to monitor the effectiveness and safety of drugs.
ПРН 30 to ensure quality control of medicines and document its results. Manage quality risks at all stages of the life cycle of medicines.
ПРН 32 to determine the main organoleptic, physical, chemical, physicochemical and pharmacotechnological indicators of medicines, to substantiate and choose methods of their standardization, to carry out statistical processing of results in accordance with the requirements of the current State Pharmacopoeia of Ukraine.

4. Pre-details of the course

1. Medical and biological physics (4,5 credits).
2. General and inorganic chemistry (9 credits).
3. Higher mathematics and statistics (4 credits).

5. Program learning outcomes

List of learning outcomes

Learning outcome code	The content of the learning outcome	Reference to the code of the competence matrix
Зн – Knowledges Ум – skills АВ – independence and responsibility К – competence		ПРН – program learning outcomes
Зн-1	basic principles of classification, nomenclature, structural and spatial isomerism of bioorganic compounds	ПРН 2, ПРН 14
Зн-2	types of chemical bonds, conjugate systems, electronic effects, acidity and basicity of bioorganic compounds as a basic basis of their reactivity	ПРН 2, ПРН 14, ПРН 16, ПРН 17
Зн-3	principles of classification of organic reactions according to the direction, method of bond disconnection and mechanism of their course	ПРН 2, ПРН 14
Зн-4	structure, nomenclature, isomerism, chemical properties and biological role of hydrocarbons, halogen-, oxygen-, sulfuro- and nitrogen-containing derivatives of hydrocarbons, heterofunctional compounds, heterocyclic compounds, biopolymers and bioregulators	ПРН 2, ПРН 12 ,ПРН 14, ПРН 16, ПРН 17, ПРН 30, ПРН 32
Зн-5	names and purpose of chemical and laboratory equipment	ПРН 32
Ум-1	use chemical and reference literature, work with tabular and graphic data	ПРН 4, ПРН 12

Ум-2	to make separate laboratory installations	ПРН 30, ПРН 32
Ум-3	purify liquid and solid organic compounds, establish their purity	ПРН 30, ПРН 32
Ум-4	determine the physical constants of organic compounds	ПРН 17, ПРН 30, ПРН 32
Ум-5	to conduct elemental analysis	ПРН 14, ПРН 17, ПРН 30, ПРН 32
Ум-6	use laboratory methods of obtaining individual organic compounds	ПРН 30, ПРН 32
Ум-7	to carry out qualitative reactions to multiple bonds and the main functional groups;	ПРН 30, ПРН 32
Ум-8	independently carry out the synthesis and analysis of the proposed organic compound	ПРН 30, ПРН 32
К-1	have a scientific worldview and creative thinking	ПРН 2, ПРН 4,ПРН 12
К-2	have information management skills	ПРН 2, ПРН 4,ПРН 12
АВ-1	have the ability to critically evaluate the results of their own research	ПРН 1, ПРН 4,ПРН 10, ПРН 12
АВ-2	be able to improve their own learning	ПРН 1, ПРН 4,ПРН 10, ПРН 12
АВ-3	be able to learn new areas through self-study, using the acquired knowledge of organic chemistry	ПРН 1, ПРН 4,ПРН 10, ПРН 12

6. Format and scope of the course		
Format of the course	Full-time course	
Type of lessons	Number of hours	Number of groups
lectures	20	
practical	100	
seminars	-	-
out of class work	120	

7. Topics and content of the course

Class type code	Topic	Content of training	Code of result of training	Professor
Л – lecture, П – practical class, СРС – out of class work				
Л-1	Introduction into organic chemistry. Chemical bond and atoms interaction in the organic compounds.	The subject of bioorganic chemistry. Chemical bond. Conjugate systems. Interaction of atoms: induction and mesomeric electronic effects.	Зн-1 Зн-2 Ум-1 К-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
Л-2	Methods of the identification of the organic compound	The main stages of determining the structure of organic	Зн-1 Зн-3 Зн-5	Zelisko N., PhD, Associate Professor,

	structures. Spatial (stereo) structure of the organic compounds. Classification of the organic reactions and reagents.	compounds. Features of elemental analysis of organic compounds. Spectral methods of organic compounds research. IR, UV, PMR and mass spectra. Spatial structure of organic compounds. Stereoisomerism. Classification of chemical reactions. Intermediate particles of chemical reactions. Mechanisms of chemical reactions.	Ум-2 Ум-3 Ум-4 Ум-5 Ум-8	Subtelna I, PhD, Associate Professor
Л-3	Saturated hydrocarbons. Unsaturated hydrocarbons. Aromatic compounds.	Structure, nomenclature, isomerism, obtaining methods and chemical properties of alkanes and cycloalkanes. S_R reaction mechanism. Structure, nomenclature, isomerism, obtaining methods and chemical properties of alkenes, alkynes and alkadienes. A_E reaction mechanism. Structure, nomenclature, isomerism, extraction methods and chemical properties of mononuclear and multinuclear arenes. S_E reaction mechanism.	Зн-1 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna, PhD, Associate Professor
Л-4	Halogen-derivatives of the hydrocarbons.	Structure, nomenclature, isomerism,	Зн-4 Ум-1 Ум-2	Zelisko N., PhD, Associate Professor,

	Mechanisms of the nucleophilic substitution and elimination. Hydroxy-derivatives of hydrocarbons and thio-analogs (alcohols, thioles, phenols)	synthesis methods, chemical properties and practical significance of halogenated hydrocarbons. Reaction mechanisms S_N2, S_N1, E2, E1. Structure, nomenclature, isomerism, synthesis methods, chemical properties and practical significance of monohydric and polyhydric alcohols and phenols, naphthols, thioalcohols, thiophenols. Reaction mechanisms S_N2, S_N1, E2, E1.	Ум-7	Subtelna I, PhD, Associate Professor
Л-5	Nitrogen-containing organic compounds (amines, nitro-, diazo-, azocompounds, azodyes). Acidic and basic properties of organic compounds.	Structure, nomenclature, isomerism, synthesis methods, chemical properties and practical significance of amines, nitro compounds, diazonium salts, azo dyes. Theory of colour. Acidity and basicity of organic compounds. Bransted and Lewis theories.	Зн-1 Зн-2 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
Л-6	Aldehydes and ketones. Carboxylic acids and their functional derivatives. Carbonic acid derivatives. Sulfonic acids.	Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of aldehydes and ketones. The reaction mechanism of A_N. Structure, nomenclature, isomerism, synthesis methods,	Зн-1 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		chemical properties and biological role of carboxylic acids, their functional derivatives, carboxylic acid derivatives, sulfonic acids. The reaction mechanism of S_N.		
ЛІ-7	Heterofunctional compounds.	Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of heterofunctional compounds (halogen-, hydroxy-, hydroxy acids, amino alcohols, aminophenols, amino acids).	Зн-1 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
ЛІ-8	Five-membered heterocycles with one or two hetero atoms. Six-membered heterocycles with one or two hetero atoms. Seven-membered and condensed heterocycles. Alkaloids. The nucleic acid	Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of five-membered heterocycles with one and two heteroatoms. Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of six-membered heterocycles with one and two heteroatoms. Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of seven-membered and condensed heterocycles, alkaloids, nucleic acids.	Зн-1 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

Л-9	Carbohydrates	Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of carbohydrates (mono-, di- and polysaccharides).	Зн-1 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
Л-10	Proteinogenic amino acids. Peptides. Proteins. Lipids.	Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of proteinogenic amino acids. Structure and properties of peptides, proteins, saponifiable and non-saponifiable lipids.	Зн-1 Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
П-1 (практичне заняття 1)	Classification, nomenclature, and structural isomerism of the organic compounds.	The main statement of the theory of chemical structure of organic compounds and its significance for the development of organic chemistry. Fundamental concepts of organic chemistry: homology, hydrocarbon radical, substituent, functional group, poly- and heterofunctionality, isomerism. Classification of organic compounds. The main classification features of organic compounds - structure of the carbon skeleton and the nature of the functional group. Elements of structure that determine the reactivity of	Зн-1 Ум-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		compounds. Genetic relationship between classes of organic compounds. Nomenclature systems in organic chemistry - trivial, rational, IUPAC system. Types of formulas in organic chemistry: empirical, molecular, structural. Abbreviated and simplified structural formulas. Structural isomerism: carbon skeleton isomerism, position isomerism, functional group isomerism.		
П-2	Types of the chemical bonds and atoms interactions in the molecules of the organic compounds. Laboratory equipments.	Atomic and molecular orbitals. Types of hybridization: sp3, sp2, sp.Types of chemical bonds (covalent, ionic, coordination, semipolar). The concept of hydrogen bonding and its importance in the formation of structures of the molecule of proteins and nucleic acids. Electronic structure of σ- and π-bonds. Their characteristics (length, energy, polarity, polarization.Types of chemical bond broking (homolytic, heterolytic),	Зн-2 Зн-5	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		intermediate particles (carbocations, carbanions, free radicals), their electronic structure. Types of reagents (electrophiles, nucleophiles, free radicals). Conjugation and its types (π, π- and p, π-conjugation). Influence of electron delocalization on increasing the stability of conjugate systems. Conjugation energy. Conjugated systems with open and closed chain. Aromaticity and its criteria. Interaction of atoms: induction and mesomeric electronic effects. Electron-donor and electron-acceptor substituents, their influence on the reactivity of molecules. The main types of laboratory glass. Chemical utensils and equipment used in organic synthesis.		
П-3	Methods of the purification of the organic compounds. Determination of the physic-chemical constants of the organic compounds.	The most important equipment used in organic synthesis is for weighing, measuring, heating, cooling and filtering. Types of distillation (simple distillation, distillation with dephlegmator, steam distillation,	Зн-5 Ум-1 Ум-2 Ум-3 Ум-4 К-2	Zelisko N., PhD, Associate Professor, , Subtelna I, PhD, Associate Professor

		vacuum distillation) and their use. Extraction from solid mixtures and liquids. Solvent requirements for extraction. Recrystallization (utensils and equipment, solvent selection, use of adsorbents, heating of liquids, filtration). Drying of solids and liquids. Sublimation. Column and thin-layer chromatography. Establishing the individuality of organic compounds. Rf. Determination of the heating temperature. Determination of boiling point Determination of refractive index. Determination of density.		
П-4	Stereochemistry the biologically active compounds.	Configurations and conformations of molecules. Conformations of open chains (ethane type: n-butane, 1,2-dibromoethane, ethylene glycol). Conformations of cyclohexane. Axial and equatorial bonds. Methods of representation the spatial structure of molecules: Newman's projections, Fisher's formulas, stereochemical formulas.	Зн-1	Zelisko N., PhD, Associate Professor, , Subtelna I, PhD, Associate Professor

		Stereoisomerism: geometric (cis, trance) and mirror. Chirality of molecules. Optical isomerism. Enantiomers. Diastereomerism. Relative configuration. Glyceraldehyde is a configuration standard.D- and L-stereochemical series of chiral molecules. Optical activity and racemates. Concept about ways to separate optical antipodes. Mesoforms. Relationship of spatial structure with biological activity.		
П-5	Determination of the organic compounds structures. Classification of the organic reactions and reagents.	The main stages of establishing the structure of organic compounds. Features of elemental analysis of organic compounds. Discovery of Carbon and Hydrogen in Organic Compounds. Discovery of Nitrogen and Sulfur in organic compounds. Discovery of halogens in organic compounds. The concept of chemical elemental analysis of organic compounds. Methods for determining the molecular weight of organic compounds.	Зн-3 Зн-4 Ум-1 Ум-2 Ум-5 Ум-7 К-2	Zelisko N., PhD, Associate Professor, , Subtelna I, PhD, Associate Professor

		Derivation of the gross formula. Derivation of formulas of simple organic compounds (law of radicals). The practical significance of qualitative and quantitative analysis of organic compounds. Spectral methods of research of organic compounds. IR, UV, PMR and mass spectra. Characteristic frequencies of the most important functional groups (hydroxyl, carbonyl, amine groups). Classification of chemical reactions by direction.Classification of chemical reactions by the method of disconnection. Intermediate particles of chemical reactions are carbocations, carbanions and free radicals, their electronic structure. Electrophilic and nucleophilic reagents.Reagent and substrate. Mechanisms of chemical reactions. The role of the catalyst in the course of chemical reactions.		
П-6	Saturated hydrocarbons (alkanes, cycloalkanes. Unsaturated	Nomenclature and isomerism of alkanes. Alkyl radicals. Primary, secondary and	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, , Subtelna I, PhD, Associate Professor

	hydrocarbons (alkenes, alkynes, alcadienes).).	tertiary carbon atoms. Industrial and laboratory methods of alkane synthesis. Characterization of chemical bonds in alkane molecules. Reactions of radical substitution of SR in saturated hydrocarbons and factors influencing their course. Chemical properties of alkanes (halogenation, sulfochlorination, nitration, oxidation, cracking). Classification, isomerism, nomenclature and methods of extraction of cycloalkanes. Geometric isomerism of cycloalkanes. Cis-trans decalines. Characterization of chemical bonds in cycloalkane molecules. "Banana" bonds in the cyclopropane molecule. Chemical properties of cycloalkanes depending on the size of the cycle. Reactions of hydrogenation, halogenation, hydrohalogenation, narrowing and expansion of cycles. Industrial and medical-biological significance of alkanes and cycloalkanes.		

		Nomenclature, isomerism and methods of synthesis of unsaturated hydrocarbons. Electronic structure of multiple bonds. Electrophilic addition reaction A_E. σ and π-Complexes, their stability. Factors influencing the course of the electrophilic addition reaction. Chemical properties of unsaturated hydrocarbons (hydrogenation reactions, halogenation, hydrohalogenation, hydration, oxidation, polymerization). Markovnikov's rule and its modern interpretation. The peculiarity of the chemical behaviour of conjugated dienes. Diene synthesis (Diels-Alder reaction). CH-Acidity of alkynes. Identification of unsaturated hydrocarbons. The industrial, biological and practical significance of individual representatives.		
П-7	Mononuclear aromatic compounds. Polynuclear aromatic compounds. Final	Features of the structure of benzene. General criteria of aromaticity. Hückel's rule. Nomenclature and	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, , Subtelna I, PhD, Associate Professor

	test.	structural isomerism of mononuclear arenas. Synthesis methods. Chemical properties of mononuclear arenes. Electrophilic substitution reactions (SE). Structure of π- and σ-complexes. Reactions of halogenation, nitration, sulfonation, alkylation, acylation. Addition reactions. Oxidation reactions of benzene and its homologues. Influence of electron-donor and electron-acceptor substituents on the direction and rate of electrophilic substitution reactions. Orients of the I and II kind. The orientation in the S_E reaction in disubstituted benzene. Identification of mononuclear arenas. Individual representatives, their properties and uses. Polynuclear arenas. Classification, electronic structure, aromatic character. Conjugation energy. Naphthalene, synthesis methods. Chemical properties (electrophilic		

		substitution reactions, addition, oxidation). Orientation rules in the naphthalene cycle. Spatial isomerism of decalin. Individual representatives. Anthracene, phenanthrene. Synthesis. Chemical properties (electrophilic substitution reactions, addition, oxidation). Hydrogenated phenanthrene as a structural fragment of morphine alkaloids and steroids. Carcinogenic polynuclear condensed arenes. Biphenyl. Synthesis methods, chemical properties. Benzidine. Diphenylmethane. Synthesis. Chemical properties. Methylene group activity. Sinestrol. Triphenylmethane. Extraction, chemical properties. CH-acidity of the methine group. Structure of triphenylmethyl cation, anion and radical. Dyes of the triphenylmethane series. Brilliant green, phenolphthalein. Non-benzoid aromatic systems: cyclopentadienyl		

		anion, ferrocene, cycloheptatrienyl cation (tropilium ion), azulene. The reason for their aromaticity.		
П-8	Halogen-derivatives of hydrocarbons. Mechanisms of the nucleophilic substitution and elimination.Methods of halogenation.	Classification, nomenclature and isomerism of halogenated saturated, unsaturated and aromatic hydrocarbons. Methods of synthesis of mono-, di- and polyhalogenated hydrocarbons. Mechanisms of reactions of introduction of halogen into molecules of organic compounds (S_R, S_N, A_E, S_E). Reactivity of halogenated hydrocarbons. Characteristics of the carbon-halogen bond. Factors affecting the mobility of halogen atoms. Nucleophilic substitution reactions in haloalkanes and halogenarenes. Mechanisms of S_N1 and S_N2 reactions. Stereochemical aspects of nucleophilic substitution reactions. Cleavage reactions (elimination). The mechanism of E1 and E2 reactions. Zaitsev's rule. Factors influencing the course of competitive	Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		reactions of nucleophilic substitution and elimination. Unsaturated halogen derivatives (addition, polymerization, nucleophilic substitution and elimination of vinyl and allyl halides). Deactivating and activating effect of halogen on the course of electrophilic substitution reactions (SE) in halogenarenes. Interaction of alkyl halides with metals (Grignard, Wurtz and Wurtz-Fittig reactions). Identification of halogenated hydrocarbons. Individual representatives, their medical, biological and industrial significance. Methods of halogenation of organic compounds (halogenation pathways and halogenating agents). Identification of halogenated hydrocarbons. Individual representatives, their medical, biological and industrial significance. Methods of halogenation of organic compounds (halogenation pathways and		

		halogenating agents).		
П-9	Monoalcohols, ethers. Methods of halogenation (continuation).	Monohydroxy alcohols and ether: classification, nomenclature, and isomerism. Methods of preparations and properties. Peculiarity of the chemical behavior of saturated (primary, secondary, and tertiary) an unsaturated alcohols. Effect of the intermolecular association on physical properties and spectral characteristics of alcohols. Acid and basic characteristics of the organic compounds. Brønsted – Lowry theory of acids and bases; types of acids (OH- and CH-acids). Conjugated acids and bases. Factors determining acidity and basicity. Industrial, biological and medical use of the alcohols.	Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
П-10	Polyalcohols, phenols, naphtols. Thioalcohols.	Classification, nomenclature, isomerism, and chemical properties of the polyhydroxy alcohols, phenols, amino phenols, and naphtoles. Methods of preparation and chemical properties polyhydroxy	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		alcohols, phenols, amino phenols. Identification of the diols and triols. Electronic structure of the phenolic hydroxyl. Acidic and basic properties of the polyhydroxy alcohols, phenols, naphtoles and thiols. Electrophilic substitution reactions (S_E) of phenol. Identification reactions for the monohydroxy and polyhydroxy phenols and their oxidation by different oxidizers. Nomenclature and preparation of the thiols and thioethers. Derivatives of the polyhydroxy alcohols phenols, and thioethers as drugs.		
П-11	Amines. Acidic and basic properties of organic compounds. Nitro-compounds. The methods of nitration of the organic compounds.	Definition, classification, representatives, nomenclature and isomerism of amines. Comparative characteristics of the physical properties of amines and their salts. Methods of obtaining aliphatic and aromatic amines. Acid-base properties and their dependence on the electronic effects of substituents on the nitrogen atom in a	Зн-2 Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		number of amines. Salt formation with different acids and inverse conversion of salts into amine bases. Amines as nucleophilic reagents. Alkylation and acylation of amines. Formation of Schiff's bases. Reactions of primary, secondary and tertiary amines of aliphatic and aromatic series with nitric acid. Influence of amino group on the reactivity of the aromatic nucleus. Halogenation, sulfonation and nitration of aromatic amines. Definitions: amination, deamination, diazotization, nitrosation. Amino group identification reactions. Isonitrile test. Detection of amino groups by UV and IR spectra. Acidic and basic properties of organic compounds. Theories of Bransted and Lewis. Types of organic acids (OH-, SH-, NH- and CH-acids). The concept of pKa. Factors affecting the acidity and basicity of organic compounds. Classification,		

		nomenclature and isomerism of nitro compounds. Methods of obtaining. Nitration methods. Nitrating agents. Chemical transformations of nitro compounds. Acy-nitro-tautomerism in a number of nitro compounds. Influence of nitro group on reactivity of carbohydrogen radical. Nitration of aromatic hydrocarbons and its mechanism. Methods for identification of nitro compounds. Interaction with nitric acid. Reduction to amines. Spectral characteristics.		
П-12	Diazo- and azocompounds. Azo-dyes. The methods of nitration of the organic compounds (continuation). The methods of diazotation and azo-coupling. Final test.	Diazo compounds. Classification, structure, nomenclature and isomerism. Methods of synthesis of diazonium salts. Diazotization reaction, conditions of its course and mechanism. Reactivity of diazonium salts. The structure of the diazocation. Reactions of diazonium salts with nitrogen evolving as an indirect method of removing the amino group from the aromatic	Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		nucleus and a method of obtaining various derivatives of aromatic hydrocarbons. Reaction of diazonium salts without nitrogen evolving. Azo compounds, their structure, nomenclature and isomerism. Methods of preparation of azo compounds. Reaction of azocoupling, conditions of its course, mechanism and importance. Physical and chemical properties of azo compounds. Azo dyes (methyl orange, methyl red) and their indicator properties. Theories of color. Chromophores, auxochromes. Importance of azo compounds in parmalinysis, for synthesis of drugs, dyes and indicators. Diazotization reaction. Conditions and mechanism of its performing. Diazotizing agents and necessary catalysts. Reactivity of diazo compounds. Azo coupling reactions. Conditions and mechanism of azo compound reaction (diazo and azo components). Factors that prevent		

		its implementation. Physical foundations of the theory of color. The concept of chromophores and auxochromes. Azo compounds as azo dyes, acid-base indicators (methyl orange, methyl red) and pharmaceuticals (salazopyridazine, salazodimethoxine) . Significance of diazo and azo combination reactions in organic synthesis and formalanalysis.		
П-13	Aldehydes and ketones.	Classification, nomenclature and isomerism of aldehydes and ketones. Methods of preparation of aldehydes and ketones. Ways of direct introduction of the carbonyl group into the aromatic nucleus. Electronic structure of carbonyl group. Reaction centers in molecules of aldehydes and ketones. The mechanism of nucleophilic addition reactions. Influence of electronic effects and spatial factors on the course of AN reactions. The role of acid and basic catalysis. Reversibility of AN -reactions. Addition of water, alcohols, sodium	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		hydrogen sulfite, cyanide acid, organomagnesium compounds. The mechanism of addition-elimination reactions. Obtaining imines, oximes, hydrazones and semicarbazones. Use of oxime and hydrazone formation reactions in qualitative analysis. Reactions involving the CH-acid center. The structure of enolate ion. Keto-enol tautomerism. Condensation of aldol and croton types. Haloform reaction. Redox properties of aldehydes and ketones. Specific properties of aromatic carbonyl compounds. Interaction with ammonia. Cannitsaro's reaction. Cross aldol condensation. Benzoin condensation. Electrophilic substitution reactions in the benzene nucleus. Quinones. Methods of production and chemical properties. Identification of aldehydes and ketones. Some		

		representatives and their biological and medical significance (formaldehyde, acetaldehyde, acetone, acrolein, crotonic aldehyde, benzaldehyde, vanillin, acetophenone, benzophenone).		
П-14	Monocarboxylic acids. Dicarboxylic acids. Methods of acylation.	Classification, nomenclature and isomerism of monocarboxylic acids. Obtaining methods. The structure of the carboxyl group and the carboxylate anion as p, π-conjugate systems. Acidic properties of carboxylic acids, salt formation. Dependence of acidic properties on electronic effects of substituents. Acidity and basicity of organic compounds. The concept of pKa. Brønsted–Lowry theories. Nucleophilic substitution reactions at a trigonal carbon atom, reaction mechanism. The role of acid and basic catalysis. Influence of carboxyl group on the course of chemical reactions on the hydrocarbon radical. CH-Acidity of α-carbon atom (Gel-Folgard-Zelinsky reaction, ester (ester)	Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		condensation). Addition against Markovnikov's rule in α, β-unsaturated acids. Deactivating and orienting action of the carboxyl group in electrophilic substitution reactions (S_E) in aromatic carboxylic acids. Methods for identification of carboxylic acids. Some representatives of monocarboxylic acids (formic, acetic, propionic, butyric, valeric, isovaleric, acrylic, methacrylic, benzoic, cinnamic acids). Polyacrylic. Classification, nomenclature and isomerism of dicarboxylic (dibasic) acids. Obtaining methods. Acidic properties of dicarboxylic acids. Structure and stability of carboxylate anion and dianion. Comparative evaluation of the pKa of some aliphatic acids. Mono- and bifunctional derivatives of dicarboxylic acids. The relation of dicarboxylic acids to heat. Influence of carboxyl groups on the course of chemical reactions involving a hydrocarbon radical.		

		Representatives of dicarboxylic acids and their practical use: oxalic, malonic, succinic, adipic, maleic, fumaric, phthalic acids. Phenolphthalein. Nylon. Identification of individual representatives of dicarboxylic acids. General characteristics and significance of the acylation reaction. Acylating agents and their activity. Acylation of alcohols and phenols. Acylation of amines. C-Acylation of aromatic hydrocarbons and their derivatives (Friedel-Crafts reaction). Reaction mechanism.		
П-15	Functional derivatives of carboxylic acids: soaps, twins, waxes. Derivatives of carbonic acid. Methods of acylation (continuation).	Esthers. Nomenclature, obtaining methods, hydrolysis, amonolysis, transesterification. Anhydrides, halides as the main acylating reagents, their synthesis and properties. Amides of acids, nomenclature. Obtaining methods. Acid-base properties, hydrolysis, cleavage by hypobromites, dehydration. Hydrazides, nitriles. Their structure,	Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		nomenclature, synthesis methods and properties. Soaps. Synthetic soap substitutes. Waxes, twins. Their structure. Beeswax. Spermaceti. Carbonic acid derivatives: acid chlorides, amides, urethanes. Urea (carbonic acid diamide). Its properties: hydrolysis, salt formation, interaction with nitric acid and hypobromites. Guanidine (imineurea). Basic properties.		
П-16	Halogeno-, hydroxy- and oxo-acids.	Halogeno-, hydroxy- and oxo-acids, their structure, classification, nomenclature and isomerism. Stereochemistry of halogeno-, hydroxy acids (enantiomeric, diastereomeric, optical activity, relative configuration, racemates, meso-forms). Halogeno- acids. Methods of synthesis. Acidic properties depending on the number of halogen atoms and the relative position of halogen and carboxyl group. Formation of salts, esters, halides, amides. Nucleophilic	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		substitution reactions involving a halogen atom (conversion of halogen acids to hydroxy acids). Practical usage (chloroacetic, α-bromo-valeric acid). Hydroxy acids (alcohol and phenolic acids) Synthesis methods. Properties as bifunctional compounds. The iconversion of α-, β- and γ-hydroxy acids to heating. Cleavage of α-hydroxy acids under the action of sulfuric acid. Decarboxylation of phenolic acids. Practical significance (lactic, γ-butyric, malic, tartaric, citric, salicylic, gallic, o-hydroxycinnamic acids and their derivatives). Oxoacids. Methods of obtaining. Properties as bifunctional compounds. Specific properties (decarboxylation of α- and β-oxo acids). Tautomerism, dual reactivity, cleavage and synthetic importance of acetoacetic ester; acetone (ketone) bodies. Practical usuge (pyruvic, oxaloacetic, α-ketoglutaric acids).		
П-17	Aminoalcohols, aminophenols,	Amino alcohols, aminophenols,	Зн-4 Зн-5	Zelisko N., PhD, Associate

	aminoacids. Derivatives of p-aminobenzoic and sulfanilic acids. Methods of sulfonation.	amino acids, their structure, nomenclature, isomerism. Chemical properties of amino alcohols (choline and colamine) *in vivo* and *in vitro*. Catecholamine - dopamine, norepinephrine, adrenaline, their biosynthesis and properties. Spatial structure of adrenaline and noradrenaline. Chemical properties of aminophenols. Spatial structure of amino acids. Acid-base properties of amino acids. Chemical properties of amino acids as bifunctional compounds. Specific chemical properties of amino acids. Medico-biological significance of amino acids, aminophenols, amino alcohols and their derivatives as metabolites and drugs. p-Aminobenzoic acid. Structure, synthesis methods and chemical properties (acidity, basicity, amphotericity, properties of carboxyl and amine groups) Derivatives of p-aminobenzoic acid - novocaine and	Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	Professor, Subtelna I, PhD, Associate Professor

		benzocaine (anesthesin). Structure, properties and medical significance. Sulfonic acids (sulfonic acids). Structure, chemical properties. Sulfanilic acid. Structure, synthesis, properties and significance in pharmacy. Sulfanilamide drugs - white streptocide (sulfanilamide), sulfacil (Sulfacetamide sodium). Sulfonation reaction. Sulfonating agents. Sulfonation of arenes. Influence of temperature on the direction of naphthalene sulfonation reaction.		
П-18	5-Membered heterocycles.	Heterocyclic compounds, their classification and nomenclature. Five-membered heterocycles with one heteroatom: pyrrole, furan, thiophene. Aromatic character. The structure of the pyrrole atom of Nitrogen. π-Excess aromatic systems. Acidophobicity of pyrrole and furan. Electrophilic substitution reactions (S_E). Peculiarityes of nitration, sulfonation and	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		halogenation reactions of acidophobic heterocycles. Reduction and oxidation. Specific properties of pyrrole and furan. NH-Acidity of pyrrole, pyrrole salts. Methods for identification of pyrrole, furan and thiophene. Indole (benzopyrrole). Acidophobia. NH-Acid properties. Features of electrophilic substitution reactions. Important derivatives of five-membered heterocycles with one heteroatom: furfural, furacillin, pyrrolidine, tetrahydrofuran, polyvinylpyrrolido ne, porphine and metalloporphins (heme, chlorophyll, vitamin B12), indoxyl, indigo, indifoloc-intocarmine, tridocarmino, carbino. Five-membered heterocycles with two heteroatoms (azoles) - pyrazole, imidazole, thiazole, oxazole, isoxazole. Aromaticity. The structure of the nitrogen atom of the pyridine type. Synthesis methods. Azole tautomerism of imidazole and pyrazole.		

		Acid-base properties. Electrophilic substitution reactions (SE). Reduction. Pyrazolone-3, tautomeric forms pyrazolone-3. Drugs: antipyrine, amidopyrine, analgin. Synthesis of antipyrine. Derivatives of five-membered heterocycles with two heteroatoms that are important: histidine, histamine, benzimidazole, dibazole, 2-aminothiazole (its synthesis and chemical properties). Thiazolidine is a structural fragment penicillin antibiotics.		
П-19	6-Membered heterocycles.	Six-membered heterocycles, their classification and nomenclature. Six-membered heterocycles with one Nitrogen heteroathom - azines. Structure, aromaticity. Synthesis of pyridine. Chemical properties of pyridine. Reactions involving the nitrogen atom: basic and nucleophilic properties. Electrophilic Substitution Reactions (S_E) and nucleophilic	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		substitution (S_N). Reduction of pyridine. Oxidation of pyridine; pyridine-N-oxide, features of chemical behavior. Homologues of pyridine (α, β, γ-picolins), hydroxy- and aminopyridines. Their synthesis and chemical properties. Pyridoxine (vitamin B_6). Pyridinecarboxylic (nicotinic and isonicotinic) acids and their derivatives (nicotinamide, cordiamine, isoniazid, ftivazide). Application in medicine. Methods of synthesis of quinoline (Skraup synthesis), isoquinoline (Bischler - Napieralski reaction) and their derivatives. Chemical properties of quinoline, isoquinoline, acridine. Quinoline derivatives: 8-hydroxyquinoline, its complexing ability; quinozol, nitroxoline (5-NOC), application. Acridine derivatives: 9-aminoacridine, ethacridine lactate (rivanol). Their application.		

		Six-membered heterocycles with one oxygen atom. Features of the structure of α- and γ-piranes. Structure and chemical properties of α- and γ-pyrones. Pyryl salts, their aromaticity. Benzopyrones: coumarin, chromone, flavone, isoflavone. Structure, chemical properties. Flavonoids: luteolin, quercetin, rutin. Tocopherol (vitamin E). Six-membered heterocycles with two nitrogen heteroatoms - diazines. Structure, syntesis, aromaticity of diazines. Chemical properties. Electrophilic substitution reactions (S_E) and nucleophilic substitution (S_N). Hydroxy- and amino derivatives of pyrimidine (uracil, thymine, cytosine). Their lactam-lactim tautomerism. Barbituric acid: synthesis, properties, tautomeric forms. Derivatives of barbituric acid - barbiturates as drugs. Vitamin B_1, orotic acid. Their biological and medical		

		significance. Thiazine, phenothiazine, their derivatives as drugs preparations.		
П-20	7-Membered heterocycles, fused heterocycles. Alkaloids Nucleic acids	Classification and nomenclature of condensed heterocyclic compounds. Purine (aromaticity, tautomerism, amphotericity). Hydroxy derivatives of purine: hypoxanthine, xanthine, uric acid. Their tautomerism and acid-base properties. Amino derivatives of purine (adenine, guanine), their tautomeric forms, biochemical significance in the formation of nucleotides and coenzymes. Methylated derivatives of xanthine (caffeine, theophylline, theobromine) as physiologically active compounds with action on the central nervous and cardiovascular systems. Murexide test is a qualitative reaction to compounds containing a purine nucleus. Pteridine. Folic acid. Its antagonism with sulfonamides. Riboflavin. Seven-membered heterocycles. 1,4-benzdiazepine	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		derivatives as tranquilizers. Alkaloids (definition, their importance as biologically active substances and drugs). Representatives of alkaloids: pyridine groups (nicotine, anabasine, lobeline), quinoline (quinine), isoquinoline (papaverine, morphine, codeine), tropane (atropine), indole (reserpine). Purine and pyrimidine bases, minor bases. Lactime-lactam tautomerism and complementarity. Nucleosides. Their nomenclature, structure and scheme of formation. The nature of the bond between the heterocyclic base and the carbohydrate residue. Hydrolysis. Nucleotides as phosphorylated derivatives of nucleosides (nucleoside mono-, di- and triphosphates). Their nomenclature, structure and hydrolysis. Nucleotide coenzymes (ATP, NAD^+, NAD–H, $NADP^+$, NADP–H) and their role in biochemical		

		processes. ATP hydrolysis. Nucleic acids (DNA, RNA) as polynucleotides. The primary structure of DNA and RNA (nucleotide sequence). Secondary structure of DNA and factors that stabilize it. Genetic role of DNA. RNA types. The role of RNA in protein biosynthesis		
П-21	Monosaccharides	Monosaccharides, their structure, classification and nomenclature. Stereoisomerism. D- and L-Stereochemical series. Haworth's formulas. Mutarotation. Conformations of cyclic forms of monosaccharides. Chemical properties of monosaccharides: Redox properties. Hemiacetal hydroxyl reactions. O-, N-, S-Glycosides, their relationship to hydrolysis. Esterification and esterification reactions. Monosaccharide identification reactions. Representatives: pentose (D-xylose, D-ribose, L-arabinose), hexose (D-glucose, D-galactose, D-	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		mannose, D-fructose), deoxy sugars (D-deoxyribose). D-glucuronic, D-galacturonic, D-gluconic acid, neuraminic acid. Amino derivatives of monosaccharides: glucosamine, galactosamine. L-ascorbic acid (vitamin C, properties). Products of reduction of monosaccharides: sorbitol, mannitol, dulcite.		
П-22	Di- and polysaccharides	Disaccharides, their structure and nomenclature. Reducing disaccharides (maltose, cellobiose, lactose), the relationship between monosaccharide residues and its spatial orientation. Cyclo-oxo-tautomerism and mutarotation of reducing disaccharides. Chemical properties of reducing disaccharides. Non-reducing disaccharides (sucrose), bonds between monosaccharide residues. Chemical properties of non-reducing disaccharides. Sucrose inversion. Polysaccharides, their classification	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		and the principle of construction. Homopolysaccharides: starch (amylose, amylopectin), glycogen, cellulose, dextrans. Spatial structure of amylose and cellulose. Heteropolysaccharides, their structure. Structure and biomedical significance of glycosaminoglycans (mucopolysaccharides) - chondroitin sulfates, hyaluronic acid, heparin. The concept of mixed biopolymers (glycoproteins, proteoglycans, glycolipids).		
П-23	Proteinogenic amino acids. Peptides. Proteins.	Structure and classification of natural amino acids. Stereoisomerism of α-amino acids, D- and L-Stereochemical series. Bipolar structure of α-amino acids. Isoelectric point Chemical properties of natural amino acids. The structure of the peptide group. Primary structure of peptides and proteins. The concept of secondary, tertiary and quaternary structure of proteins. Synthesis of peptides. Protection	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		and activation of functional groups. Analysis of peptides and proteins. Partial and complete hydrolysis of proteins. Qualitative reactions to α-amino acids and proteins.		
П-24	Saponifiable lipids. Prostaglandins.	Lipids and their classification. Higher fatty acids (palmitic, stearic, oleic, linoleic, linolenic, arachidonic) are important structural components of saponifiable lipids, their structure, stereoisomerism, properties. The concept of biosynthesis of higher fatty carboxylic acids. Fats (triacylglycerols) as representatives of simple saponifying lipids, their structure, properties The concept of lipid peroxidation (LPO). Complex saponifiable lipids, their structure, classification. Glycerophosphatides - derivatives of phosphatidic acids, their structure and properties. Representatives of glycerophosphatides - lecithin, cephalins, phosphatidylserines, plasmalogen.	Зн-4 Ум-6 Ум-7	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		Structure of sphingolipids: ceramide and sphingomyelins. Glycolipids. The concept of the structure of cerebrosides and gangliosides. Medico-biological significance of saponifiable lipids. Structure, properties and biological role of prostaglandins.		
П-25	Nonsaponifiable lipids (terpenes, carotenoids, steroids).	Derivatives of menthane (menthol, terpene), their structure, properties and applications in medicine. Terpenes, their classification (acyclic, monocyclic, bicyclic). Isoprene rule. Acyclic monoterpenes (geraniol, citral). Monocyclic monoterpenes (limonene, menthol, terpine), their medical significance. Bicyclic monoterpenes. Camphor, its structure, synthesis and medical significance. Carotenoids, their structure and biological significance. Retinol (vitamin A). β-Carotene (provitamin A). Chemistry of the light transmission process in the body.	Зн-4 Ум-6 Ум-7 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		Steroids, general characteristics, classification. The structure of the steran. Stereoisomerism: cis-trans-articulation of cyclohexane rings. The structure of hydrocarbons that are the parent of steroid groups (estrane, androstane, pregnane, cholan, cholestan). Derivatives of cholesterol (sterols): cholesterol, ergosterol, vitamin D2. Derivatives of cholane (bile acids): cholic, deoxycholic, glycocholic acids. Derivatives of estrane (female sex hormones): estrone and estradiol. Their structure and biological role. Derivatives of androstane (male sex hormones): androsterone and testosterone. Structure and biological role. Derivatives of pregnane (corticosteroids): corticosterone, deoxycorticosterone, hydrocortisone. Cardiac glycoside aglycones: digitoxygenin; strophanthidine. The general principle of the structure of cardiac glycosides.		

		Monosaccharides that are part of cardiac glycosides: digitoxose, digitalose, cymarose.		
СРС-1 (самостійна робота 1)	Types of the chemical bonds. Quantum-mechanical bases of chemical bonding theory. Types of hybridization of atomic orbitals (Nitrogen, Oxygen). The main characteristics of covalent σ- and π-bonds. Electronic effects. The mutual influence of atoms in molecules.	Atomic and molecular orbitals. Types of hybridization: sp^3, sp^2, sp. Types of chemical bonds (covalent, ionic, coordinate, semipolar). The concept of hydrogen bonding and its importance in the formation of structures of the molecule of proteins and nucleic acids. Electronic structure of σ- and π-bonds. Their characteristics (length, energy, polarity, polarization) Types of chemical bond breaking (homolytic, heterolytic), intermediate particles (carbocations, carbanions, free radicals), their electronic structure. Types of reagents (electrophiles, nucleophiles, free radicals). Conjugation and its types (π, π- and p, π-conjugation). Influence of electron delocalization on increasing the stability of conjugate systems. Conjugation energy.	Зн-2 Зн-5	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		Conjugated open and closed chain systems. Aromaticity and its criterions. Interaction of atoms: inductive and mesomeric electronic effects. Electronreleasig and electronwithdrawing substituents, their influence on the reactivity of molecules.		
CPC-2	Methods of separation and purification of organic compounds.	The most important equipment used in organic synthesis for weighing, measuring, heating, cooling and filtering. Types of distillation (simple distillation, fractional distillation, steam distillation, vacuum distillation) and their use. Extraction from solid mixtures and liquids. Solvent requirements for extraction. Recrystallization (glassware and equipment, solvent selection, use of adsorbents, heating of liquids, filtration). Drying of solids and liquids. Sublimation. Column and thin-layer chromatography. Establishing the individuality of organic compounds. Rf. Determination of the melting	Зн-5 Ум-2 Ум-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		temperature. Determination of boiling point. Determination of refractive index. Determination of density.		
CPC-3	Conformers and isomers. Newman and Fischer projections. Enantiomers and diastereomers.	Configurations and conformations of molecules. Conformations of open chains (ethane type: n-butane, 1,2-dibromoethane, ethylene glycol). Conformations of cyclohexane. Axial and equatorial bonds. Methods of depicting the spatial structure of molecules: Newman's projections, Fisher's formulas, stereochemical formulas. Stereoisomerism: geometric (cis, trans) and mirror. Chirality of molecules. Optical isomerism. Enantiomers. Diastereomerism. Relative configuration. Glycerin aldehyde as a configuration standard. D- and L-stereochemical series of chiral molecules. Optical activity and racemates. Concept about ways to separate optical antipodes. Meso compound. Relationship of spatial structure with biological activity.	Зн-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

CPC-4	Physical methods of determination of organic compounds structures.	Spectral methods of research of organic compounds. IR, UV, PMR and mass spectra. Characteristic frequencies of the most important functional groups (hydroxyl, carbonyl, amine groups).	Зн-5 Ум-1 Ум-2 Ум-4 К-2 АВ-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-5	Types of chemical reactions and their mechanisms. Energy conditions of reactions.	Classification of chemical reactions by direction. Classification of chemical reactions by the method of bond breaking. Intermediate particles of chemical reactions: carbocations, carbanions and free radicals, their electronic structure. Electrophilic and nucleophilic reagents. Reagent and substrate. Mechanisms of chemical reactions. The role of the catalyst in the course of chemical reactions.	Зн-3 К-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-6	Reaction of polymerization and polycondensation.	Polymerization of alkenes. Types of polymerization (free radical, cationic, coordination). Polymerization of conjugated dienes. Natural and synthetic rubber. Polymerization of vinyl halides. Polyvinyl chloride. Polycondensation reactions.	Зн-3 Зн-4 Ум-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-7	Stability of	Multinuclear	Зн-2	Zelisko N., PhD,

	polynuclear arenes depending on the number of cycles and their mutual location. Non-benzene aromatic systems.	arenas. Classification, electronic structure, aromatic character. Conjugation energy. Stability of multinuclear arenas depending on the number of cycles and their mutual location. Non-benzoid aromatic systems: cyclopentadienyl anion, ferrocene, cycloheptatrienyl cation (tropilium ion), azulene. The reason for their aromaticity.	Зн-4 Ум-1	Associate Professor, Subtelna I, PhD, Associate Professor
СРС-8	Triphenylmethane dyes	Dyes of a triphenylmethane row. Brilliant green, phenolphthalein. Properties, application.	Зн-4 Ум-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
СРС-9	Reactivity of halogenated hydrocarbons depending on the nature of the halogen and hydrocarbon radical.	Reactivity of halogenated hydrocarbons. Characteristics of the carbon-halogen bond. Factors affecting the mobility of halogen atoms. The reaction of nucleophilic substitution in haloalkanes and halogenarenes.	Зн-4 Ум-1 Ум-7 К-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
СРС-10	Synthesis and properties of naphtoles	Methods of synthesis of naphthols. Chemical properties of naphthols.	Зн-4 Ум-1 Ум-7 К-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
СРС-11	Methods of the identification of aromatic and aliphatic amines	Reaction of primary, secondary and tertiary amines of aliphatic and aromatic rows with nitric acid. An amino group identification	Зн-4 Ум-1 Ум-7 К-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		reaction. Isonitrile probe. Detection of amino groups at UV and IR spectra.		
CPC-12	Physical bases of chromophore-auxochrome theory. Structure of azo dyes	Physical bases of dyes theory. The concept of chromophores and auxochromes. Azo compounds as azodyes, acid-base indicators (methyl orange, methyl red) and pharmaceutical preparations (salazopyridazine, salazodimethoxin).	Зн-4 Ум-1 Ум-7 К-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-13	Hard and soft acids and bases	Acid and basic properties of organic compounds. Lewis's theory. The concept of hard and soft acids and bases.	Зн-2 Ум-1 К-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-14	Theoretical and practical aspects of oxidation and reduction reactions of different classes of organic compounds.	Oxidation and reduction reactions in organic chemistry. Oxidation of hydrocarbons, alcohols, ethers, thiols, amines. Reduction of unsaturated and aromatic hydrocarbons, nitro compounds.	Зн-2 Зн-4 Ум-1 К-1	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-15	Relationship between acidity and basicity of organic compounds. Amphotericity.	Acid and basic properties of organic compounds. Factors affecting the acidity and basicity of organic compounds. Amphotericity.	Зн-2 Ум-1 К-1 АВ-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-16	Aldol condensation, its analogy *in vivo.*	Aldol condensation reaction. Conduction and mechanism. Aldol condensation reaction in the biosynthesis of	Зн-3 Зн-4 Ум-1 Ум-7 К-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

		higher fatty acids.		
CPC-17	Decarboxylation reactions of carboxylic acids and their role *in vivo*.	Carboxylic acid decarboxylation reactions. Conditions of passage and their role in the body.	Зн-3 Зн-4 Ум-1 Ум-7 К-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-18	Specific reactions of bifunctional carboxylic acids.	Specific properties of bifunctional carboxylic acids (reactions that occur when heated). The ratio of *α-*, *β-* and *γ*-hydroxy acids to heat. Decarboxylation of phenolic acids. Decarboxylation of *α-* and *β*-oxoacids. Specific chemical properties of *α-*, *β-* and *γ*-amino acids.	Зн-3 Зн-4 Ум-1 Ум-7 К-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-19	Drug bearing carbonylic, carboxylic groups, and heterofunctional compounds as a drugs.	Drugs, the structural basis of which are fragments of molecules of aldehydes, carboxylic acids and heterofunctional compounds. Structure and medico-biological action.	Зн-4 Ум-1 К-1 К-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-20	Stereochemistry of hydroxy and amino acids.	Stereochemistry of hydroxy and amino acids (enantiomerism, diastereomerism, optical activity, relative configuration, racemates, meso-forms).	Зн-4 Ум-1 К-1 К-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-21	Three-, four-, and seven-membered heterocycles.	Structure, nomenclature, isomerism, synthesis methods, chemical properties and biological role of three-, four- and seven-membered heterocycles.	Зн-4 Ум-1 Ум-7 К-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

CPC-22	Identification of key monocyclic and fused bicyclic heterocyclic system.	Methods of identification of pyrrole, furan and thiophene. Murexide test is a qualitative reaction to compounds containing a purine nucleus.	Зн-4 Ум-1 Ум-7 К-1 К-2	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-23	Pyridine-carboxylic acids based drugs.	Pyridinecarboxylic (nicotinic and isonicotinic) acids and their derivatives (nicotinamide, cordiamine, isoniazid, ftivazide). Application in medicine.	Зн-4 Ум-1 К-1 К-2 АВ-1 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-24	The structure of heteropolysaccharides and their role in the body.	Heteropolysaccharides, their structure. Structure and biomedical significance of glycosaminoglycans (mucopolysaccharides) - chondroitin sulfates, hyaluronic acid, heparin.	Зн-4 Ум-1 К-1 К-2 АВ-1 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-25	Mentane and its derivatives: synthesis, structure, and practical usage.	Derivatives of menthane (menthol, terpene), their structure, properties and applications in medicine.	Зн-4 Ум-1 К-1 К-2 АВ-1 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-26	Nucleic acids and their role in transmission of genetic information.	Nucleic acids (DNA, RNA) as polynucleotides. Primary structure of DNA and RNA (nucleotide sequence). Secondary structure of DNA and factors that stabilize it. Genetic role of DNA.	Зн-4 Ум-1 К-1 К-2 АВ-1 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
CPC-27	Phospholipids: structure,	Glycerophosphatides - derivatives of	Зн-4 Ум-1	Zelisko N., PhD, Associate

	properties and biological role.	phosphatidic acids, their structure and properties. Representatives of glycerophosphatides - lecithin, cephalins, phosphatidylserines, plasmalogens.	К-1 К-2 АВ-1 АВ-2 АВ-3	Professor, Subtelna I, PhD, Associate Professor
СРС-28	O-, and N-glycosides: spreading in nature and biological function.	O-, N - Glycosides, their relationship to hydrolysis. Nucleosides. Their nomenclature, structure and scheme of formation. The nature of the bond between the heterocyclic base and the carbohydrate residue. Hydrolysis. Cardiac glycoside aglycones: digitoxygenin; strophanthidine. The general principle of the structure of cardiac glycosides. Monosaccharides that are part of cardiac glycosides: digitoxose, digitalis, cimarose.	Зн-4 Ум-1 К-1 К-2 АВ-1 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor
СРС-29	Prostaglandins: classification and biological function.	Structure, properties and biological role of prostaglandins.	Зн-4 Ум-1 К-1 К-2 АВ-1 АВ-2 АВ-3	Zelisko N., PhD, Associate Professor, Subtelna I, PhD, Associate Professor

Teaching methods are explanatory-illustrative, problem-solving, partial-search. When studying organic chemistry, students use textbooks, lecture notes, guidelines, chemical computer programs, models of molecules, laboratory equipment and utensils needed to perform experiments, appropriate reagents.

According to the curriculum, the methods of organization and implementation of educational activities are:

a) lectures

b) practical classes

c) out of class work of students.

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

Lecture material is presented using multimedia equipment, computer, video clips, graph projector,

models of organic molecules and demonstration experiments.

Practical classes according to the methods of their organizations are laboratory because they include: laboratory research on synthesis and detection of certain classes of organic compounds by the properties of their functional groups, qualitative reactions, synthesis of organic compounds, their isolation and purification, the establishment of physicochemical constants.

It is recommended that students in laboratory classes briefly record research protocols, indicating the purpose of the study and conclusions.

Students also use exercises and solve situational problems. The practical classes use computer programs ISIS DRAW, HyperChem, Chemistry in motion, video clips developed by the department, models of molecules.

The structure of the organization of practical classes includes:

1. Discussion and explanation of the most difficult issues of the topic;
2. Written test;
3. Performance of practical (laboratory) works.
4. Registration of the protocol of practical employment.
5. The result of the lesson

Independent work of students includes:

1. Elaboration of literature on this topic.
2. Solving training exercises and tests.

8. Verification of learning outcomes

Carried out in each lesson according to specific goals, as well as during the individual work of the teacher with the student for those topics that the student develops independently and they are not part of the structure of the practical lesson. A standardized form of control of theoretical and practical training of students is used.

The standardized form of control of the theoretical part includes 10 tasks. Five of them of the first level are test (1 point each), and five tasks of the second level, to which in addition to the test answer you need to give a written answer (2 points each).

Assessment of practical training of students - as a result of the practical part - is made in the form of a protocol.

At the end of each of the 4 content modules on which the discipline is structured, the student writes a final test, which includes 50 tests of A format (1 point) and 3 theoretical questions (10 points).

The final grade for the current educational activity is set on a 4-point (national) scale.

Criteria for evaluating current learning activities:

A grade of "5" (excellent) is given to a student who actively participated in the discussion of the most difficult questions on the topic of the lesson, gave at least 90% correct answers to standardized test tasks, answered written tasks without errors, did practical work and drew up a protocol.

Grade "4" (good) is given to the student who participated in the discussion of the most difficult questions on the topic, gave at least 75% correct answers to standardized test tasks, made some minor mistakes in answering written tasks, did practical work and drew up a protocol.

Grade "3" (satisfactory) is given to a student who did not participate in the discussion of the most difficult questions on the topic, gave at least 60% correct answers to standardized test tasks, made significant mistakes in answering written tasks, did practical work and drew up a protocol.

Grade "2" (unsatisfactory) is given to a student who did not participate in the discussion of the most difficult questions on the topic, gave less than 60% of correct answers to standardized test tasks, made gross mistakes in answering written tasks or did not answer them at all. performed practical work and did not draw up a protocol.

Learning outcome code	Code of the type of classes	Method of verification of learning outcomes	Enrollment criteria
Зн-1 Ум-1 К-2	П-1	1. Acquaintance with the organization and procedure of practical classes in organic chemistry.	evaluation according to the established criteria on a traditional 4-point scale

		2. Acquaintance with safety precautions and rules of work in a chemical laboratory. 3. Consideration of the basic principles of classification and nomenclature of organic compounds and types of structural isomerism. 4. Acquaintance with the equipment used in the chemical laboratory. 5. Performing training exercises and tests.	
Зн-2 Зн-5	П-2 СРС-1	1. Control of home self-preparation. 2. Solving training exercises. 3. Control of knowledge of theoretical material. 4. Work with chemical utensils and laboratory equipment, assembly of equipment for various distillation methods, etc.	evaluation according to the established criteria on a traditional 4-point scale
Зн-5 Ум-1 Ум-2 Ум-3 Ум-4 К-2	П-3 СРС-2	1. Checking the preparation of students for classes. 2. Demonstration of methods for isolation and purification of organic compounds 3. Familiarity with the methods of establishing physical constants of organic compounds. 4. Performance by students of a	evaluation according to the established criteria on a traditional 4-point scale

		practical part of the class.	
Зн-1	П-4 СРС-3	1. Control of homework. 2. Consideration on models, computer programs and tables of the spatial structure of organic compounds, conformations and configuration states of molecules and methods of their representation. 3. Solving training exercises and monitoring their implementation. 4. Practical part: - a compilation of models of chiral molecules of lactic and tartaric acids; - assembly of ethane, butane and ethylene glycol conformation models.	evaluation according to the established criteria on a traditional 4-point scale
Зн-3 Зн-4 Ум-1 Ум-2 Ум-5 Ум-7 К-2	П-5 СРС-4 СРС-5	1. Control of home self-preparation. 2. Solving training exercises. Monitoring their implementation. 3. Performing of experiments. 4. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-6 СРС-6	1. Control of home self-preparation. 2. Solving training exercises. Monitoring their implementation. 3. Performing of experiments. 4. Control of mastering the topic from theoretical material and from	evaluation according to the established criteria on a traditional 4-point scale

		performed experiments.	
Зн-4 Ум-6 Ум-7	П-7 СРС-7 СРС-8	1. Control of home self-preparation. 2. Solving training exercises. Monitoring their implementation. 3. Performing of experiments. 4. Control of mastering the topic from theoretical material and from performed experiments. 5. Writing the final test.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-8 СРС-9	1. Discussion of the main points of the topic. 2. Test control of knowledge. 3. Solving training exercises and monitoring their implementation. 4. Performing of experiments. 5. Verification of theoretical preparation of students for synthesis. 6. Performing of syntheses. 7. Control of mastering of theoretical material and practical part (performed experiments and syntheses) of the topic.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-9 СРС-14	1. Continuation of synthesis and calculation of product yield. 2. Homework control. 3. Solving training exercises and monitoring their implementation. 4. Execution of	evaluation according to the established criteria on a traditional 4-point scale

		experiments. 5. Control of mastering the topic from theoretical material and from performed experiments.	
Зн-4 Ум-6 Ум-7	П-10 СРС-10	1. Control of home self-preparation. 2. Solving training exercises. Monitoring their completion. 3. Execution of experiments. 4. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-11 СРС-11 СРС-13 СРС-15	1. Consideration of the main points of the topic. 2. Execution of training exercises and control of their completion. 3. Checking the synthesis plan and the correctness of the assembly of equipment. 4. Execution of experiments and syntheses. 5. Control of theoretical knowledge and acquired practical skills.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-12 СРС-8	1. .Finishing of experiments 2. Consideration of the main points of the topic. 3. Checking the theoretical preparation of students for synthesis. 4. Test control of knowledge. 5. Execution of syntheses (methyl	evaluation according to the established criteria on a traditional 4-point scale

		orange, β-naphthol orange). 6. Control of synthetic work. 7. Writing the final test.	
Зн-4 Ум-6 Ум-7	П-13 СРС-16	1. Control of home self-preparation. 2. Solving training exercises. 3. Execution of experiments. 4. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-14 СРС-17	1. Control performance of home self-training. 2. Solving of educational exercises. 3.Support of molecules models. 4. Performing of experiments. 5. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-15	1. Control of mastering the topic from theoretical material and from performed experiments. 2. Control performance of home self-training. 3. Solving of educational exercises. 4. Performing of experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-16 СРС-18	1. Control performance of home self-training. 2. Solving of educational exercises. 3. Performing of	evaluation according to the established criteria on a traditional 4-point scale

		experiments. 4. Control of mastering the topic from theoretical material and from performed experiments.	
Зн-4 Зн-5 Ум-1 Ум-2 Ум-3 Ум-6 Ум-7 Ум-8 АВ-1	П-17 СРС-19 СРС-20	1. Control performance of home self-training. 2. Control of mastering the topic from theoretical material and from performed experiments. 3. Execution of syntheses and registration of protocols. 4. Writing of final control work.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-18 СРС-21	1. Control performance of home self-training. 2. Solving of educational exercises. 3.Support of molecules models. 4. Performing of experiments. 5. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-19 СРС-23	1. Control performance of home self-training. 2. Consideration of models, slides and structures of structure and reactivity of six-member heterocyclic compounds. 3. Solving of educational exercises. 4. Scoring models of molecules of six-membered	evaluation according to the established criteria on a traditional 4-point scale

		heterocycles. 5. Performing of experiments. 6.Control assimilation of the topic theoretical material and the experiments performed.	
Зн-4 Ум-6 Ум-7	П-20 СРС-22 СРС-26	1. Control performance of home self-training. 2. Solving of educational exercises. 3. Consideration in the schemes of the structure of nucleosides, nucleotides, nucleic acids. 4. Support of molecules models. 5. Performing of experiments. 6. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-21 СРС-28	1. Control performance of home self-training. 2. Consideration of models, slides and structures of structure, reactivity and relationship between structure and pharmacological effects of monosaccharides derivatives. 3. Solving of educational exercises. 4. Performing of experiments. 5. Control assimilation of the topic theoretical material and the	evaluation according to the established criteria on a traditional 4-point scale

		experiments performed.	
Зн-4 Ум-6 Ум-7	П-22 СРС-24 СРС-28	1. Control performance of home self-training. 2. Solving of educational exercises. 3. Performing of experiments. 4. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-23	1. Control performance of home self-training. 2. Solving of educational exercises. 3. Performing of experiments. 4. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7	П-24 СРС-27	1. Control performance of home self-training. 2. The consideration on the schemes of the issues of structure and reactions occurring in vivo and in vitro. 3. Solving of educational exercises. 4. Performing of experiments. 5. Control of mastering the topic from theoretical material and from performed experiments.	evaluation according to the established criteria on a traditional 4-point scale
Зн-4 Ум-6 Ум-7 АВ-2	П-25 СРС-25 СРС-29	1. Control performance of home self-training. 2. Consideration of	evaluation according to the established criteria on a traditional 4-point scale

AB-3		models, slides and structures of structure, reactivity and interconnection structure-pharmacological effects of derivatives of mentan, terpenes, carotenoids and steroids. (3. Solving of educational exercises. 4. Performing of experiments. 5. Control of mastering the topic from theoretical material and from performed experiments. 6. Writing a final control work.	
Final control			
General evaluation system	Participation in the work during the semester / exam - 60% / 40% on a 200-point scale		
Rating scales	Traditional 4-point scale, multi-point (200-point) scale, ECTS rating scale		
Conditions of admission to the final control	The student attended all practical (laboratory, seminar) classes and received at least 72 points for current performance		
Type of final control	Methods of final control	Enrollment criteria	
Exam	The exam is held during the examination session according to the schedule and includes: 50 tests (Form A), which are evaluated by 1 point (50 minutes), 6 “open” questions, which are evaluated by 5 points (40 minutes)	Enrollment of the test task of the I level: correct answer -1 point, incorrect answer - 0 points. The answer to the theoretical problem of the II level is estimated from 0 to 3 points: correct letter answer -1 point, incorrect letter answer - 0 points. The written task is evaluated from 0 to 2 points. **The maximum number of points** that a student can score when taking the exam is 80. **The minimum number of points** in the exam - not less than 50.	
The maximum number of points that a student can score for the current academic activity for admission to the exam is 120 points. **The minimum number of points** that a student must score for the current academic activity for admission to the exam is 72 points. **The calculation of the number of points** is based on the grades received by the student on a 4-point (national) scale during the study of the discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The resulting value is converted into points on a multi-point scale as follows:			

9. Course policy

The student must independently complete homework, training exercises and tests, tasks of current and final control. It is not allowed to spy on another student's work, write off, use a textbook, notebook or mobile phone while writing a test, final or exam paper, use cheat sheets, copy your work by other students. Omissions of practical classes are not allowed. If a student misses classes for good reasons, which are documented, he has the right to practice them.

10. Literature

The main literature

1. J. Komarytsia. Organic Chemistry. Handbook for pharmaceutical students. Lviv 2000.-151 p.
2. B.S.Zimenkovsky, V.A. Muzychenko, I.V.Nizhenkovska, G.O.Syrova. Biological and bioorganic chemistry.Aus Medicine Publishing. Kyiv.2018. – 288 p.

The additionary literature

1. Stoker, H.S. (2001). Organic and biological chemistry. Houghton Mifflin. 2001. 556p.
2. L.G. Wade Jr. Organic Chemistry. 8th edition. Pearson. 547p.
3. T. Graham Solomons. Organic Chemistry. Sixth edition. John Willey and Sons, Inc.- 1218 p.
4. Harold Hart, Leslie E. Crain, David J. Hart. Organic Chemistry. A Short Course. Houghton Mifflin Company. – 543 p.
5. David C. Eaton. Laboratory investigation in Organic Chemistry. – McGRAW-HILL BOOK COMPANY. – New York – Toronto. – 893 p.

Information resources

1. www.ncbi.nlm.nih.gov/PubMed – free access to the database of scientific research in the field of biomedical sciences.
2. https://pubchem.ncbi.nlm.nih.gov/ free access to the database of scientific data in the field of biomedical sciences.
3. http://www.orgsyn.org - has provided the chemistry community with detailed, reliable, and carefully checked procedures for the synthesis of organic compounds.
4. http://www.organic-chemistry.org - offers an overview of recent topics, interesting reactions, and information on important chemicals for organic chemists.

6.www.bioorganica.org.ua - a scientific publication that presents works on bioorganic and medical chemistry.

11. Equipment, logistics and software of the discipline

Equipment for laboratory work in the discipline, chemical utensils, reagents, multimedia projector for classes, overhead projector, computers, Internet for individual tasks, platform for distance learning MISA; thematic tables, molecule models, methodical instructions for practical and independent work are posted on the MISA distance learning service and are freely available to students.

12. Additional information

The department has a permanent student research group.

The Syllabus was developed by:
Ivanna Subtelna, PhD, Associate Professor

Head of Department of Pharmaceutical, Organic
and Bioorganic chemistry
Prof. R.B. Lesyk