Federal State Budgetary Educational Institution of Higher Education
"Privolzhsky Research Medical University"
Ministry of Health of the Russian Federation

APPROVED
Vice-Rector for Academic Affairs
_____ E.S. Bogomolova
31 August 2021

WORKING PROGRAM

Name of the academic discipline: **BIOORGANIC CHEMISTRY. CHEMISTRY OF STOMATOLOGICAL MATERIALS**

Specialty: **31.05.03 DENTISTRY**

Qualification: **DENTIST**

Faculty: DENTISTRY

Mode of study: **FULL-TIME**

Labor intensity of the academic discipline: 144 **academic hours**)

Nizhny Novgorod
2021

The working program has been developed in accordance with the Federal State Educational Standard for the specialty Dentistry 31.05.03, approved by Order of Ministry of Education No. 984 dated August, 12 2020 .

Developers of the working program:
Gordetsov A.S., Doctor of Chemical Sciences, Professor, Head of the Department of General Chemistry
Zimina S.V., Candidate of Chemical Sciences, Associate Professor, Associate Professor of the Department of General Chemistry

The program was reviewed and approved at the department meeting (protocol No. 01 June 2021 , date)
Head of the Department,
academic degree, academic title _____ (print name)
(signature)

01 June 2021

AGREED
Deputy Head of EMA ph.d. of biology _____ Lovtsova L.V.
(signature)

01 June 2021

1. The purpose and objectives of mastering the academic discipline "Bioorganic Chemistry. Chemistry of stomatological materials" (hereinafter – the academic discipline):

1.1. The purpose of mastering the academic discipline: participation in the forming of competencies UC-1, UC-4

1.2. Tasks of the discipline:

As a result of completing the discipline, the student should

Know:

• the main provisions of the theory of the structure of organic compounds by A.M.Butlerov;

• classification of organic compounds by the structure of the carbon skeleton and by the nature of the functional group;

• nomenclature of organic compounds (systematic, trivial); • structure of the main functional groups;

• theories of acids and bases (protolytic, Lewis theory)

Be able to:

• make formulas by name and name typical representatives of biologically important substances and medicines according to the structural formula.

• isolate functional groups, acidic and basic centers, conjugated and aromatic fragments in molecules to determine the chemical behavior of organic compounds.

• predict the direction and result of chemical transformations of organic compounds.

• explain the observed phenomena based on the chemical properties of various classes of organic compounds.

• make observations on the course of chemical reactions and draw reasonable conclusions;

• present the results of experiments and observations in the form of a completed research protocol;

• solve typical practical tasks and master the theoretical minimum at a more abstract level;

• solve situational problems based on theoretical propositions modeling chemical processes occurring in living organisms;

• moderate orientation in the information flow (use reference data and bibliography for one reason or another).

Possess:

• independent work with educational, scientific and reference literature; conduct a search and make generalizing conclusions;

• safe work in a chemical laboratory and the ability to handle chemical utensils, reagents, work with gas burners and electrical appliances.

2. Position of the academic discipline in the structure of the General Educational Program of Higher Education (GEP HE) of the organization.

2.1. The discipline "Bioorganic Chemistry. Chemistry of stomatological materials" refers to the *part formed by the participants of educational relations* of Block 1 of GEP HE (Academic discipline index).

The discipline is taught in __1,2__ semester/___ year of study.

2.2. The following knowledge having been formed by school disciplines is required to study the discipline:

1. general chemistry,
2. organic chemistry

2.3. Mastering the discipline is required for forming the following knowledge, skills and abilities for subsequent academic disciplines: biochemistry, biology, normal physiology,

pathophysiology, pharmacology, hygiene, anesthesiology, rheumatology and intensive care, nutrition basics of healthy and sick people, clinical pharmacology.

3. Deliverables of mastering the academic discipline and metrics of competence acquisition

Mastering the discipline aims at acquiring the following universal (UC) competencies

№	Competence code	The content of the competence (or its part)	Code and name of the competence acquisition metric	As a result of mastering the discipline, the students should:		
				know	be able to	possess
1.	**UC-1**	To be able to carry out a critical analysis of problem situations based on a systematic approach, develop an action strategy	***IEC 1.1*** Knows: methods of critical analysis and evaluation of modern scientific achievements; basic principles of critical analysis ***IEC 1.2*** is able to: gain new knowledge based on analysis, synthesis, etc.; collect data on complex scientific problems related to the professional field; search for information and solutions based on action, experiment and experience	the main provisions of the theory of the structure of organic compounds by A.M.Butlerov; - classification of organic compounds by the structure of the carbon skeleton and by the nature of the functional group; - nomenclature of organic compounds (systematic, trivial); - the structure of the main functional groups;	make formulas by name and name typical representatives of biologically important substances and medicines according to the structural formula. - to isolate functional groups, acidic and basic centers, conjugated and aromatic fragments in molecules to determine the chemical behavior of organic compounds.	independent work with educational, scientific and reference literature; to search and make generalizing conclusions; safe work in a chemical laboratory and the ability to handle chemical utensils, reagents, work with gas burners and electrical appliances.
2.	**UC-4**	Ability to apply modern communication	***IEC 4.1*** Knows: basics of oral and written	- nomenclature of	- predict the direction	

		technologies, including those ones in foreign language(s), for academic and professional interaction	communication in Russian and foreign languages, functional styles of the native language, requirements for business communication, modern means of information and communication technologies ***IEC 4.2*** Knows how to: express their thoughts in Russian and foreign languages in professional communication ***IEC 4.3*** Has practical experience: writing texts in Russian and foreign languages related to professional activities; experience in translating medical texts from a foreign language into Russian; experience of speaking Russian and foreign languages	organic compounds (systematic, trivial); - the structure of the main functional groups; - theories of acids and bases (protolytic, Lewis theory) mechanisms of action of buffer systems of the body, their relationship and role in maintaining acid-base homeostasis; features of acid-base properties of amino acids and proteins; - patterns of physical and chemical processes in living systems from the point of view of their competition arising	and result of chemical transformations of organic compounds. - explain the observed phenomena based on the chemical properties of various classes of organic compounds. - to make observations on the course of chemical reactions and to make justifications conclusions; to present the results of experiments and observations in the form of a completed research protocol; solve typical practical tasks and master the theoretical minimum at a more abstract	

				from the combination of different types of equilibria; - the role of biogenic elements and their compounds in living systems; physical and chemical bases of surface phenomena and factors; - affecting the free surface energy; features of adsorption at different phase boundaries; - features of physical chemistry of disperse systems and solutions of biopolymers	level; solve situational problems based on theoretical propositions modeling chemical processes occurring in living organisms; moderate orientation in the information flow (use reference data and bibliography for one reason or another).	

4. Sections of the academic discipline and competencies that are formed when mastering them

№	Competence code	Section name of the discipline	The content of the section in teaching units
	EC-1,	Theoretical	Spatial structure of organic compounds. The problem of the

	EC-4	foundations of the structure of organic compounds and factors determining their reactivity.	relationship of stereochemical structure with the manifestation of biological activity. The most important concepts of stereochemistry are conformation and configuration. Conformations of open chains. Rotation around a single bond as the cause of various conformations. Newman projection formulas. Energy characteristics of conformational states: obscured, inhibited, slanted conformations. Spatial convergence of certain sections of the chain as one of the reasons for the predominant formation of five- and six-membered cycles. Conformations (chair, bath) of cyclic compounds (cyclohexane, tetrahydropyrane). Axial and equatorial connections. Configuration. Fischer projection formulas. Stereochemical nomenclature: D,L – systems. Glycerin aldehyde as a configuration standard. Optical activity. Chiral and achiral molecules. Stereoisomers: enantiomers and σ– diastereomers. Mesoforms. Racemates. π – Diastereomers (cis- and trans - isomers). Mutual influence of atoms and methods of its transfer in molecules of organic compounds. Coupling as one of the most important factors in increasing the stability of molecules and ions of biologically important compounds. types of conjugation: π,π – conjugation and p,π – conjugation. Conjugated systems with an open chain: 1,3–dienes (1,3-butadiene), polyenes (β-carotene, retinal, etc.), α, β – unsaturated carbonyl compounds, a carboxyl group. Coupled closed-circuit systems. Aromaticity; criteria of aromaticity. Aromaticity of benzoid (benzene, naphthalene) and heterocyclic (furan, thiophene, pyrrol, pyrazole, imidazole, pyridine, pyrimidine, purine) compounds. Bond polarization and electronic effects (inductive and mesomeric). Electron-donating and electron-acceptor substituents. Acidity and basicity of organic compounds. The theories of Brensted and Lewis. General patterns in the change of acidic and basic properties in relation to the nature of the atom in the acidic and basic centers, electronic effects of substituents at these centers and solvation effects. Acidic properties of organic compounds with hydrogen-containing functional groups (alcohols, thiols, carboxylic acids). The main properties of neutral molecules containing a heteroatom with an unshared pair of electrons (alcohols, esters, carbonyl compounds, amines) and anions (hydroxide-, alkoxide-, enolate-, acylate- ions). Acid–base properties of nitrogen-containing organic heterocycles (pyrrol, imidazole, pyridine). Hydrogen bonding as a specific manifestation of acid–base properties.
1.	**EC-1, EC-4**	General regularities of the reactivity of organic compounds as the chemical basis of their biological functioning.	Classification of organic reactions by result (substitution, addition, elimination, rearrangement, redox) and by mechanism - radical, ionic (electronophilic, nucleophilic). Types of covalent bond rupture in organic compounds and the particles formed in this case: free radicals (hemolytic rupture), carbocations and carboanions (heterolytic rupture). The electronic and spatial structure of these particles and the factors that determine their relative stability. Free radical substitution reactions: homolytic reactions

			involving C-H bonds of an sp^3-hybridized carbon atom. Halogenation. The interaction of organic compounds with oxygen as the chemical basis of peroxide oxidation of lipid-containing systems. Inhibition of peroxide oxidation with the power of antioxidants (phenols, α – tocopherol). Electrophilic addition reactions: heterolytic reactions involving the π bond. The mechanism of hydrohalogenation and hydration reactions. Acid catalysis. The influence of static and dynamic factors on the regioselectivity of reactions, Markovnikov's rule. Features of electrophilic addition to conjugated systems (1,3 – dienes, α, β – unsaturated aldehydes, carboxylic acids). Electrophilic substitution reactions: heterolytic reactions involving the aromatic system. Mechanism of reactions of halogenation and alkylation of aromatic compounds. The role of the catalyst in the formation of an electrophilic particle (Lewis acids; acid catalysis in alkylation with alkenes and alcohols). The effect of substituents in the aromatic core and heteroatoms in heterocyclic compounds on reactivity in electrophilic substitution reactions. Orienting influence of substituents and heteroatoms.
2.	**EC-1, EC-4**	Biologically active low molecular weight organic substances (structure, properties, participation in the functioning of living systems).	Nucleophilic substitution reactions in sp3-hybridized carbon atom: heterolytic reactions due to the polarization of the σ-bond carbon – heteroate (halogen derivatives, alcohols). The influence of electronic, spatial factors and the stability of outgoing groups on the reactivity of compounds in nucleophilic substitution reactions. Stereochemistry of nucleophilic substitution. Reactions of hydrolysis of halogen derivatives. Alkylation reactions of alcohols, phenols, thiols, sulfides, ammonia and amines. The role of acid catalysis in the nucleophilic substitution of the hydroxyl group. Deamination of compounds with a primary amino group. The biological role of alkylation reactions. *Elimination reactions* (dehydrohalogenation, dehydration). Increased CH – acidity as a cause of elimination reactions. Nucleophilic addition reactions: heterolytic reactions involving a carbon–oxygen π bond (aldehydes, ketones). Reactions of carbonyl compounds with water, alcohols, thiols, amines and their derivatives. The influence of electronic and spatial factors, the role of acid catalysis. Reversibility of nucleophilic addition reactions. Hydrolysis of acetals. Formation and hydrolysis of imines as the chemical basis of pyridoxal catalysis. Reactions of aldol addition. Basic catalysis. The structure of the enolate ion. The presence of an α – CH – acid center in the molecules of carbonyl-containing compounds as a reason for the formation of a C-C bond in in vivo reactions. Aldol cleavage as the reverse reaction of aldol addition. The biological significance of these processes. Nucleophilic substitution reactions in sp^2–hybrid carbon atom (carboxylic acids and their functional derivatives). Acylation reactions – formation of anhydrides, esters, complex thioesters, amides – and reverse hydrolysis reactions. The role of acid and basic catalysis. Acylating reagents (anhydrides,

			carboxylic acids, esters, complex thioesters), the comparative activity of these reagents. Acylating reagents (anhydrides, carboxylic acids, esters, complex thioesters), the comparative activity of these reagents. Acylphosphates and acyl enzyme A are natural macroergic acylating reagents. The biological role of acylation reactions. Reactions by the type of aldol addition involving coenzyme A as a way of forming a carbon–carbon bond. Oxidation and reduction reactions of organic compounds. Oxidation reactions of alcohols, thiols, sulfides, carbonyl compounds, amines. Reduction reactions of carbonyl compounds, disulfides, amines. The concept of hydride ion transfer in the chemistry of the action of the NAD+ – NADH system. The concept of single-electron transfer and the chemistry of the action of the FAD-FADN2 system. Oxidation of the π bond and aromatic fragments (epoxidation, hydroxylation).
3	**EC-1, EC-4**	Biologically active low molecular weight organic substances (structure, properties, participation in the functioning of living systems).	Nucleophilic substitution reactions in sp3-hybridized carbon atom: heterolytic reactions due to the polarization of the σ-bond carbon – heteroate (halogen derivatives, alcohols). The influence of electronic, spatial factors and the stability of outgoing groups on the reactivity of compounds in nucleophilic substitution reactions. Stereochemistry of nucleophilic substitution. Reactions of hydrolysis of halogen derivatives. Alkylation reactions of alcohols, phenols, thiols, sulfides, ammonia and amines. The role of acid catalysis in the nucleophilic substitution of the hydroxyl group. Deamination of compounds with a primary amino group. The biological role of alkylation reactions. *Elimination reactions* (dehydrohalogenation, dehydration). Increased CH – acidity as a cause of elimination reactions. Nucleophilic addition reactions: heterolytic reactions involving a carbon–oxygen π bond (aldehydes, ketones). Reactions of carbonyl compounds with water, alcohols, thiols, amines and their derivatives. The influence of electronic and spatial factors, the role of acid catalysis. Reversibility of nucleophilic addition reactions. Hydrolysis of acetals. Formation and hydrolysis of imines as the chemical basis of pyridoxal catalysis. Reactions of aldol addition. Basic catalysis. The structure of the enolate ion. The presence of an α – CH – acid center in the molecules of carbonyl-containing compounds as a reason for the formation of a C-C bond in in vivo reactions. Aldol cleavage as the reverse reaction of aldol addition. The biological significance of these processes. Nucleophilic substitution reactions in sp^2–hybrid carbon atom (carboxylic acids and their functional derivatives). Acylation reactions – formation of anhydrides, esters, complex thioesters, amides – and reverse hydrolysis reactions. The role of acid and basic catalysis. Acylating reagents (anhydrides, carboxylic acids, esters, complex thioesters), the comparative activity of these reagents. Acylating reagents (anhydrides, carboxylic acids, esters, complex thioesters), the comparative activity of these reagents.

			Acylphosphates and acyl enzyme A are natural macroergic acylating reagents. The biological role of acylation reactions. Reactions by the type of aldol addition involving coenzyme A as a way of forming a carbon–carbon bond. Oxidation and reduction reactions of organic compounds. Oxidation reactions of alcohols, thiols, sulfides, carbonyl compounds, amines. Reduction reactions of carbonyl compounds, disulfides, amines. The concept of hydride ion transfer in the chemistry of the action of the NAD+ – NADH system. The concept of single-electron transfer and the chemistry of the action of the FAD-FADN2 system. Oxidation of the π bond and aromatic fragments (epoxidation, hydroxylation).
4	**EC-1, EC-4**	Poly- and heterofunctionality as one of the characteristic features of organic compounds involved in the processes of vital activity and used as medicinal substances.	Features of the chemical behavior of poly- and heterofunctional compounds: acid-base properties (ampholytes), cyclization and chelation. Mutual influence of functional groups. Multifunctional compounds. Polyatomic alcohols. Chelate complexes. Polyatomic alcohols esters with inorganic acids (nitroglycerin, glycerin phosphates, inositol). Diatomic phenols: hydroquinone, resorcinol, pyrocatechin. Phenols as antioxidants. Polyamines: ethylenediamine, putrescine, cadaverine. Dibasic carboxylic acids: oxalic, malonic, succinic, glutaric, fumaric. The transformation of amber acid into fumaric acid as an example of a biological dehydration reaction. Heterofunctional connections. Amino alcohols: aminoethanol (colamine), choline, acetyl-choline. Aminophenols: dopamine, norepinephrine, adrenaline. The concept of the biological role of these compounds and their production. Hydroxy and amino acids. The influence of various factors on the process of cycle formation (steric, entropic). Lactones. Lactams. The idea of beta-lactam antibiotics. Monobasic (lactic, β- and γ-hydroxy-oil), dibasic (malic, wine), tribasic (citric) hydroxy acids. Oxoacids – aldehyde and ketonic acids: glyoxylic, pyruvic (phospho-enolpyruvate), acetoacetic, oxalic-acetic, α-oxoglutaric. Reactions of decarboxylation of β-ketonic acids and oxidative decarboxylation of ketonic acids. Ketoenolic tautomerism. Heterofunctional derivatives of the benzene series as medicinal products (salicylic, aminolbenzoic, sulfanylic acids and their derivatives).
5	**EC-1, EC-4**	Biologically important heterocyclic compounds.	Tetrapyrrole compounds (porphine, heme, etc.). Derivatives of pyridine, isonicotinic acid, pyrazole, imidazole, pyrimidine, purine, thiazole. Keto-enol and lactim-lactam tautomerism in hydroxyazote-containing heterocyclic compounds. Barbituric acid and its derivatives. Hydroxypurines (hypoxanthine, xanthine, uric acid). Folic acid, biotin, thiamine. The concept of structure and biological role. The idea of alkaloids and antibiotics.
6	**EC-1, EC-4**	Biologically active high-	Peptides and proteins Biologically important reactions of α-amino acids: deamination, hydroxylation. The role of hydroxyproline in stabilizing the collagen spiral of dentin and

		molecular substances (structure, properties, participation in the functioning of living systems).	enamel. Decarboxylation of α-amino acids is the way to the formation of biogenic amines and bioregulators. Peptides. Acid and alkaline hydrolysis of peptides. Determination of amino acid composition using modern physico-chemical methods. Calcium-binding proteins of dentin and enamel. The change in the amino acid composition of the dentin collagen during the evolution of the dental germ into a permanent tooth. Carbohydrates. Homopolysaccharides: (amylose, amylopectin, glycogen, dextran, cellulose). Pectins. Monocarboxylcellulose, poly-acrylic cellulose is the basis of hemostatic dressing materials. Heteropolysaccharides: hyaluronic acid, chondroitin-sulfates. Heparin. The concept of mixed biopolymers (glycoproteins, glycolipids, etc.). The effect of mucopolysaccharides on the stabilization of the collagen structure of dentin and enamel. 6.3. Nucleic acids Nucleoside Mono- and polyphosphates. AMP, ADP, ATP. Nucleoside cyclophosphates (CAMP). Their role as macroergic compounds and intracellular bioregulators. Lipids. Saponified lipids. Natural fats as a mixture of tri-acylglycerols. The concept of the structure of waxes. The main natural higher fatty acids that make up lipids are palmitic, stearic, oleic, linoleic, linolenic, arachidonic. The effect of lipids on the mineralization of dentin.

5. Volume of the academic discipline and types of academic work

Type of educational work	Labor intensity		Labor intensity (AH) in semesters	
	volume in credit units (CU)	volume in academic hours (AH)		
Classroom work, including	4	144	54	90
Lectures (L)	0.61	22	12	10
Laboratory practicum (LP)*				
Practicals (P)	1,22	44	2	22
Seminars (S)				
Student's individual work (SIW)				
Mid-term assessment	1,17	42	20	22
credit/exam *(specify the type)*	1	36		36
TOTAL LABOR INTENSITY	4	144	54	90

6. Content of the academic discipline

6.1. Sections of the discipline and types of academic work

№	Name of the section of the academic discipline	Types of academic work* (in AH)					
		L	LP	P	S	SIW	total
1	Theoretical foundations of the structure of organic compounds and factors determining their reactivity.	2		9		4	15
2	General patterns of reactivity of organic compounds as a chemical basis for their biological functioning.	2		9		8	19

3	Biologically active low molecular weight organic substances (structure, properties, participation in the functioning of living systems).	8		10		8	26
4	Poly- and heterofunctionality as one of the characteristic features of organic compounds involved in the processes of vital activity and used as medicinal substances.	6		10		12	28
5	Biologically important heterocyclic compounds.	2		6		4	12
6	Biologically active high-molecular substances (structure, properties, participation in the functioning of living systems).	2				6	8
	credit/exam						36
	TOTAL	22		44		42	144

* - L – lectures; LP – laboratory practicum; P – practicals; S – seminars; SIW – student's individual work.

6.2. Thematic schedule of educational work types:

6.2.1 Thematic schedule of lectures

№	Name of lecture topics	Volume in AH	
		Semester 1	Semeste 2
1	Theoretical foundations of the structure of organic compounds and factors that determine their reactivity. Theory of the structure of organic compounds A.M.Butlerova.	2	
2	Comparison of the reactivity of hydrocarbons (alkanes, alkenes, alkynes, alkadienes, cycloalkanes).	2	
3	Aromatic hydrocarbons. Feature of reactivity.	2	
4	Acid-base properties of organic compounds. Comparison of the reactivity of alcohols, thioalcohols and phenols.	2	
5	carbonyl compounds. Aldehydes and ketones.	2	
6	Carboxylic acids and their derivatives.	2	
7	Fatty acid. Lipids.		2
8	Carbohydrates. Mono-, di-, homo- and heteropolysaccharides.		2
9	Amino acids. Peptides and proteins.		2
10	Heterocyclic compounds		2
11	Nucleosides. Nucleotides. Nucleic acids.		2
	TOTAL (total - AH) 22	12	10

6.2.2. The thematic plan of laboratory practicums (*if this type of classes is stipulated in the curriculum*)

№	Name of laboratory practicums	Volume in AH	
		semester 1	semester 2
1	Classification, nomenclature of organic compounds. The electronic structure of the carbon atom and the characteristics of the C-C, C=C, C-H bonds. Isomerism. Types of isomerism. Spatial structure. Conformations, configurations. Electronic structure and mutual influence of atoms in organic molecules. electronic effects. Inductive and mesomeric effects. Pairing. Conjugated open circuit systems. Laboratory work: 1. “Chemical properties of saturated hydrocarbons. Getting ethane. 2. “Chemical properties of unsaturated hydrocarbons. Addition Reactions.	3	
2	Conjugate systems with a closed circuit. Aromaticity. Reactivity of hydrocarbons. Halogen derivatives of organic compounds. Laboratory work: "Relation to the oxidation reactions of some aromatic hydrocarbons of the benzene series." Colloquium.	3	
3	Acid-base properties of organic compounds on the example of the properties of alcohols, phenols, thiols, amines and their derivatives. Laboratory work: "Comparison of the acid-base properties of alcohols, phenols."	3	
4	Биологически важные карбонильные соединения. Строение и химические свойства альдегидов и кетонов. Лабораторная работа: «Химические свойства альдегидов и кетонов».	3	
5	Carboxylic acids and their functional derivatives. Laboratory work: "Some chemical properties of carboxylic acids".	2	
6	Saponifiable lipids. Laboratory work: “Hydrolysis of fats. Fat hydrolyzate analysis.	3	
7	Heterofunctional organic compounds - metabolites and bioregulators. Laboratory work: "Some properties of hydroxy-, keto- and phenolic acids".	3	
8	Carbohydrates. Monosaccharides. Carbohydrates. Di-, homo-, heteropolysaccharides. Laboratory work: 1. “Chemical properties of monosaccharides. Oxidation." 2. "Chemical properties of homopolysaccharides".		3
9	Biogenic amines. Amino acids. Laboratory work: "Comparison of the acid-base properties of aliphatic and aromatic amines."		3
10	peptide bond. Forms of organization of the protein molecule.		3

	Laboratory work: "Some chemical properties of proteins." Colloquium		
11	Biologically active heterocyclic compounds. Structure, aromaticity, chemical properties of 5- and 6-membered heterocyclic compounds with one heteroatom. Laboratory work: "Some chemical properties of pyridine".		3
12	Biologically active heterocyclic compounds. Structure, aromaticity, chemical properties of 5- and 6-membered heterocyclic compounds with two heteroatoms. Imidazole. Pyrimidine. The most important derivatives of purine. Laboratory work: "Some chemical properties of pyrazole derivatives".		3
13	Nucleosides and nucleotides. Nucleic acids. Control work.		3
14	Credit.		4
	TOTAL (total - AH)	22	22

6.2.3. Thematic plan of practicals. This type of training is not included in the curriculum)

6.2.4. Thematic plan of seminars. This type of training is not included in the curriculum.

6.2.5. Types and topics of student's individual work (SIW)

№	Types and topics of SIW	Volume in AH	
		Semester 1	Semester 2
	Preparation for practical exercises and laboratory work, writing a report on the completed laboratory work. Independent solution of thematic situational problems.	10	8
	Preparation of abstracts on topics.	4	6
	TOTAL (total - AH)		

7. Types of assessment formats for ongoing monitoring and mid-term assessment

№	Semester No.	Types of control		Name of section of academic discipline	Competence codes	Assessment formats		
						types	number of test questions	number of test task options
1.		Current monitoring	Control of mastering the topic	Theoretical foundations of the structure of organic compounds and factors determining their reactivity.	**EC-1, EC-4**			Classroom testing (option is formed by the teacher)
			Monitoring the student's individual work			Control	3	18

2		Current monitoring	Control of mastering the topic	Mono- and polyfunctional derivatives of hydrocarbons.	**EC-1, EC-4**	Test tasks	60	Classroom testing (option is formed by the teacher)
			Monitoring the student's individual work			Control	5	18
3		Current monitoring	Control of mastering the topic	heterofunctional compounds. Carbohydrates. Amino acids.	**EC-1, EC-4**	Test tasks	60	Classroom testing (option is formed by the teacher)
			Monitoring the student's individual work			Control	5	18
4			Control of mastering the topic	heterocyclic compounds. Nucleosides. Nucleotides. Nucleic acids	**EC-1, EC-4**	Test tasks	30	Classroom testing (option is formed by the teacher)
			Monitoring the student's individual work			Control	3	18
2.		Mid-term assessment	Exam/ Credit					

8. Educational, methodological and informational support for mastering the academic discipline (printed, electronic publications, the Internet and other network resources)

8.1. Key literature references

№	Name according to bibliographic requirements	Number of copies	
		at the department	in the library
1	Zurabyan, S. E. Fundamentals of bioorganic chemistry ; Основы биоорганической химии : textbook for medical students / S. E. Zurabyan. – Moscow : GEOTAR-Media, 2012. – 304 c. – ISBN 978-5-9704-2140-6.	50	
2	Zurabyan, S. E. Fundamentals of bioorganic chemistry : учебник / S. E. Zurabyan ; Zurabyan S. E. – Москва : ГЭОТАР-Медиа, 2021. – 304 с. – ISBN 978-5-9704-6206-5. – Текст : электронный. - URL: https://www.studentlibrary.ru/book/ISBN9785970462065.html (дата обращения: 11.11.2022). - Режим доступа: по подписке.	0+e	
3	Zurabyan, S. E. Fundamentals of bioorganic chemistry	48	

	: textbook for medical students / S. E. Zurabyan ; Zurabyan S. E. – 2nd ed. – Moscow : GEOTAR-Media, 2006. – 320 c. – ISBN 5-9704026-7-2.	

8.2. Further reading

№	Name according to bibliographic requirements	Number of copies	
		at the department	in the library
1	Zimina, S. V. Practical manual on bioorganic chemistry / S. V. Zimina, A. S. Gordetsov, I. V. Zhdanovich ; Zimina, S. V. ; Zhdanovich, I. V. ; Gordetsov, A. S. – N. Novgorod : Nizhny Novgorod State Medical Academy, 2005. – 100 c. : мяг.	205	
2			
3			

9. Material and technical support for mastering an academic discipline

9.1. List of premises for classroom activities for the discipline

1. Lecture hall equipped with multimedia equipment and a microphone.
2. Rooms for practical training

9.2. List of equipment for classroom activities for the discipline

1. Multimedia complex
2. Information stands.
3. Tables
4. Slides and multimedia presentations of lectures.
5. Chemical glassware
6. Chemical reagents
7. Microscopes, glass slides
8. Calorimeters
9. Analytical balance

9.3. A set of licensed and freely distributed software, including domestic production

Item no.	**Software**	**number of licenses**	**Type of software**	**Manufacturer**	**Number in the unified register of Russian software**	**Contract No. and date**
1	Wtware	100	Thin Client Operating System	Kovalev Andrey Alexandrovich	1960	2471/05-18 from 28.05.2018
2	MyOffice is Standard. A corporate user license for educational organizations, with no expiration date, with the right to	220	Office Application	LLC "NEW CLOUD TECHNOLOGIES"	283	without limitation, with the right to receive updates for 1 year.

	receive updates for 1 year.					
3	LibreOffice		Office Application	The Document Foundation	Freely distributed software	
4	Windows 10 Education	700	Operating systems	Microsoft	Azure Dev Tools for Teaching Subscription	
5	Yandex. Browser		Browser	«Yandex»	3722	
6	Subscription to MS Office Pro for 170 PCs for FGBOU VO "PIMU" of the Ministry of Health of Russia	170	Office Application	Microsoft		23618/HN10030 LLC "Softline Trade" from 04.12.2020

10. List of changes to the working program (to be filled out by the template)

Federal State Budgetary Educational Institution of Higher Education
"Privolzhsky Research Medical University"
Ministry of Health of the Russian Federation
(FSBEI HE "PRMU" of the Ministry of Health of Russia)

Department of
Name of the department

CHANGE REGISTRATION SHEET

working program for the academic discipline
NAME OF THE ACADEMIC DISCIPLINE

Field of study / specialty / scientific specialty: _____
(code, name)

Training profile: _____
(*name) - for master's degree programs*

Mode of study: _____
full-time/mixed attendance mode/extramural

Position	Number and name of the program section	Contents of the changes made	Effective date of the changes	Contributor's signature
1				

Approved at the department meeting
Protocol No. _____of _____20__

Head of the Department
_____ _____/_____
department name, academic title signature print name