Educational Establishment
«Vitebsk State Order of Peoples' Friendship Medical University»

APPROVED
First Vice-Rector of Educational Establishment «Vitebsk State Oder of Peoples' Friendship Medical University», Professor
_____ A.N. Shelumakova
«20» December 2023
Registration No. УД-[illegible]/англ/уч.

BIOORGANIC CHEMISTRY

Curriculum for the establishment of education in academic discipline for the specialty 7-07-0911-03 «Stomatology»

2023

The curriculum for the establishment of education in academic discipline «Bioorganic chemistry» is compiled on the basis of the sample curriculum «Bioorganic chemistry» in the specialty 7-07-0911-03 «Stomatology» (registry № УПД-091-024/пр./) input in force by the resolution of the First Deputy Minister of Health of the Republic of Belarus on 9 June 2023; the syllabus in the specialty 7-07-0911-03 «Stomatology» (registration № 131.2023/-уч.), approved by the rector of the educational establishment «Vitebsk State Order of Friendship of Peoples Medical University», April 20, 2023

COMPILED BY

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RECOMMENDED FOR APPROVAL:

By the Chair of General and Organic Chemistry of Educational Establishment «Vitebsk State Order of Peoples' Friendship Medical University» (the minutes № 1, 01.09.2023);

By the Scientific and methodological council of Educational Establishment «Vitebsk State Order of Peoples' Friendship Medical University» (the minutes № 3 dated 18 October 2023)

EXPLANATORY NOTE

Bioorganic chemistry is the academic discipline of chemical module containing systematized scientific knowledge for studying structure and mechanisms of functioning of biologically active molecules from the position of theoretical organic chemistry.

The purpose of the discipline «Bioorganic Chemistry» is to form the basic professional competence based on systematized scientific knowledge about the relationship of the structure and chemical properties of biologically important organic compounds as the basis for understanding the essence of metabolism and its regulation at a molecular level.

The objectives of the discipline «Bioorganic chemistry» are to form in students the scientific knowledge about:

structures of natural biologically significant organic compounds;

typical mechanisms of poly- and hetero-functional organic compounds chemical transformations in vitro as bases for subsequent understanding of processes enzymatic catalysis in vivo;

factors affecting thermodynamic stability of organic molecules;

principles of synthesis and self-organization (in vitro and in vivo) of biological macromolecules,

skills necessary for solving situations of predicting the properties of organic compounds, direction and results of their chemical transformations.

The knowledge and skills gained in the study of the academic discipline «Bioorganic chemistry» are necessary for the successful study of following academic disciplines: «Biological Chemistry», «Medical Biology and General Genetics», «Normal Physiology», «Pharmacology», «General Hygiene», «Microbiology, Virology, Immunology» and «Radiation and Environmental Medicine»

A student who has mastered the content of the academic discipline should be able to demonstrate the following basic professional competence: to evaluate the properties of natural and synthetic organic compounds, substances potentially dangerous for the human body, predict their activity in biological environments.

After completion of the discipline «Bioorganic chemistry», a student should

know:

the rules of the international chemical (IUPAC) nomenclature;

structures, chemical properties and the biological significance of major families of organic compounds involved in life processes;

modern physical and chemical research methods for study of organic compounds structure and properties;

latest achievements in the bioorganic chemistry and prospects for their use in the professional job of a dentist;

be able to:

classify organic compounds according to the structure of the carbon skeleton and the nature of functional groups; write formulas by name and give names to the

specific examples of biologically important organic compound and medicines according to the structural formula;

perform simple chemical experiments with the following analysis and registration of results in the form of the report;

use reference literature and obtain the necessary information on relevant sites on the Internet;

to carry out of heat-initiated polymerization reaction of acrylates;

choose the best methods or specific systems in separation, purification, analysis and utilization of natural and synthetic organic compounds;

master skills:

methods to perform qualitative tests for main functional groups of organic compounds;

safe work in a chemical laboratory: handling chemical glassware, a spirit-lamp, poisonous, volatile substances.

As a part of the educational process in the academic discipline, the student should acquire not only theoretical knowledge, practical skills in the specialty, but also develop his value-personal, spiritual potential, form the qualities of a patriot and a citizen who is ready to actively participate in economic, industrial, cultural and social life of the country.

In a total 90 academic hours are given for study the discipline «Bioorganic chemistry», of which 44 classroom hours (lectures – 8 hours, laboratory classes – 36 hours) and 46 hours for self-learning education.

Forms intermediate assessment: credit test (for one semester).

THE CONTENT OF STUDIED MATERIAL

1. The theoretical bases of the structure and general principles of reactivity of organic compounds

1.1. Introduction. Classification and nomenclature of organic compounds

The brief historical essay of bioorganic chemistry development. The place of bioorganic chemistry in medical education as one of medico-biological cycle discipline. The goals of bioorganic chemistry as educational discipline in medical establishments of higher education. Contribution of Belarussian chemists to the development of bioorganic chemistry. Chemistry and ethical problems of medicine and pharmacy. The objects studied by bioorganic chemistry.

Classification of organic compounds according to the structure of a carbon chain and the nature of functional group. Main families of organic compounds.

The principal rules of IUPAC nomenclature of organic compounds: substitutive and radical-functional nomenclatures.

1.2. Chemical bonds and mutual influence of atoms in an organic molecule

The electron configuration of carbon atom and atoms organogens. Hybridization of atomic orbitals. Hybridization types. Types of chemical bonds in organic compounds. Main characteristics of σ - and π -bonds. Hydrogen bonds.

Conjugation. The kind of conjugation: π, π- and p, π-. Conjugated systems with an opened chain. Conjugated systems with a closed chain. Aromaticity. The Hückel aromatic criteria. Aromaticity of benzenoid and heterocyclic compounds. Conjugation energy. Thermodynamic stability of biologically important molecules with opened and closed conjugated systems.

Mutual influence of atoms in a molecule: inductive and mesomeric electronic effects of substituents. Electron-donating and electron-withdrawing substituents. The electron density distribution in a molecule. The reaction centers.

1.3. Stereochemistry of organic molecules and stereoisomerism

Configuration and conformation as the way of description of the three-dimensional structure of the molecule. The relationship of a spatial structure and hybridization type of a carbon atom. Molecular models, three-dimensional (stereo-chemical) formulas, Fisher projection formulas, Newman projection formulas.

Chirality. Chiral molecules. A stereocenter. Enantiomerism. Optical activity. The relative D-, L-system of a stereochemical designation. The concept of the R-, S – system of a stereochemical designation. Stereoisomerism of molecules with one, two and more than two stereocenters: enantiomerism and σ-diastereomerism. Meso compounds. Racemate, racemic mixtures. The concept of racemic mixtures separation methods. π-diastereomers of unsaturated compounds.

The relationship between the three-dimensional structure of a compound and its biological activity. The Fisher theory, the D.E. Koshland theory. The complementary interaction.

Conformations of open chain compounds. The kinds of strain in a molecule: torsional strain and Van der Waals strain. Energy characteristics of conformations of alkanes. Angle strain and conformations of six-member cyclic compounds, their

energy characteristics. Axial and equatorial bonds. 1,3-Diaxial interaction, inversion of the cycle.

2. Reactivity of hydrocarbons, alcohols, phenols, thiols, amines, aldehydes and ketones, carboxylic acids and their functional derivatives. Biologically important heterofunctional compounds

2.1. Reactivity of hydrocarbons

The concept of reaction mechanism. A substrate, a reagent, a reaction center. Classification of organic reactions according to the result (substitution, addition, elimination reactions; rearrangements; oxidation-reduction and acid-base reactions). The radical reactions, the ionic reactions, the coordinated reactions. The types of reagents: radicals, electrophiles, nucleophiles, acids, bases. The homolytic cleavage of a covalent bond and the concept of free radicals and chain reactions. The heterolytic cleavage of a covalent bond; carbocations and carbanions.

Reactivity of saturated hydrocarbons. Free–radical substitution reactions, a mechanism, region selectivity. The ways of free radicals' formation: a light promoted, a heat promoted fragmentation (photolysis, thermolysis), oxidation–reductions reactions with participation of metal ions with a changeable valency. The concept of chain processes. The role of free radical oxidation-reductions in biological processes.

Use of paraffin wax and ozokerite in orthopedic stomatology.

Electrophilic addition reactions to alkenes. The mechanism of hydration reaction, an acidic catalysis. The effect of static and kinetic factors on the region selectivity of addition reactions. Markovnikov's rule. The peculiarities of electrophilic addition to the conjugated dienes.

The qualitative tests for discovery of multiple bonds in examined object.

The polymerization reactions of unsaturated compounds. Application of polymers on base acrylic and methacrylic acids, gutta percha in stomatology.

Electrophilic substitution reactions of aromatic compounds. The mechanism of reaction, the role of catalysts in the electrophile formation. Effect of substituents in an aromatic ring to its reactivity in electrophilic substitution reactions. The alkylation and halogenation reactions *in vivo*.

Aromatic oxidation reactions *in vivo* as the ability to increase hydrophilicity and to remove foreign substances from the human body.

2.2. Acid and base properties of organic compounds

Acidity and basicity according to the Bronsted-Lowry and the Lewis theories. Quantitative and qualitative characteristics of the acids and the bases strength of organic compounds. The general principles of relationship between change of acid and base properties and the nature of an atom of acid or a base center, electron effects of substituents at these centers and solvation effects. Toxic properties of the strong acids and bases. Amphoteric properties. The hydrogen bond as specific manifestation of acid and base properties. The hydrogen bond in the structure of biopolymers.

2.3. Reactivity of alcohols, phenols, thiols and amines

Reaction centers in molecules of alcohols, phenols, thiols and amines. The outline mechanism of nucleophilic substitution reactions at sp^3–hybrid carbon atom. Uni- and bimolecular reactions. Stereochemistry of nucleophilic substitution

reactions. The nucleophilic substitution of a hydroxyl group in alcohols. The acid catalysis. The competitive uni- and bimolecular elimination reactions of alcohols. Biologically important dehydration reactions of hydroxyl-containing compounds.

Oxidation reactions of alcohols, thiols, phenols. The biological oxidation with participation of coenzyme NAD^+. A hydride ion transfer in a system NAD^+-NADH. Compounds containing thiol group and phenol hydroxyl group as antioxidants.

2.4. Aldehydes and ketones reactivity

Reaction centers of aldehydes and ketones. Nucleophilic addition reactions. The outline mechanism of a reaction. The addition of the water, alcohols, amines. Formation of cyclic hemiacetals. The aldol addition reactions. Reversibility of nucleophilic addition reactions. The biological significance of acetal formation reactions, retro-aldol reactions, reactions with amines. The toxic properties of aldehydes. Using of aldehydes for disinfection and sterilization.

Oxidation and reduction reactions of carbonyl compounds *in vitro* and *in vivo*.

The qualitative tests for discovery of aldehyde group. The qualitative tests for discovery of acetone.

2.5. Reactivity of carboxylic acids and their functional derivatives

The reaction centers in molecules of carboxylic acids. Acidic properties of mono- and dibasic, saturated, unsaturated and aromatic carboxylic acids. The outline mechanism of nucleophilic substitution reactions at the sp^2–hybrid carbon atom of carboxylic acids and their functional group derivatives. The reactions of formation and hydrolysis of carboxylic acids functional group derivatives: anhydrides, acid chlorides, esters, amides. The reactivity of carboxylic acid functional group derivatives in acyl transfer reactions. The relative reactivity of esters and thioesters in acyl transfer reactions; their biological significance. Acyl coenzyme A. The biological important acyl transfer reactions with participation of acyl phosphates. The concept of phosphorylation reactions.

Amides of carboxylic acids, their acid and base properties. Functional derivatives of the carbonic acid: complete amide (urea) and *semi* amide (carbamic acid); their acid and base properties and biological significance. Biuret. Urethanes.

2.6. Poly- and heterofunctional compounds participating in the processes of ability to live and being origin of most important medicament groups

Classification of poly- and heterofunctional compounds. Acid and base properties. Typical reactivity of poly- and heterofunctional compounds. The specific properties conditioned by interference of groups: chelates formation of polyhydric alcohols, α-amino alcohols, α-amino acids, and intramolecular cyclization (of γ- and δ-hydroxyaldehydes, γ- and δ-hydroxy- and amino acids) and intermolecular cyclization (of α-hydroxy- and amino acids). Decarboxylation reactions. The elimination reactions of β-hydroxy- and β-amino acids. Tautomerization: keto–enol and lactim-lactam.

Polyhydric alcohols: ethylene glycol, glycerol, myoinositol, xylitol, sorbitol. The esters of polyhydric alcohols with the inorganic acids and fatty acids. The qualitative test for a diol fragment.

Dihydric phenols: hydroquinone, resorcinol, catechol. Phenols as antioxidants.

Dicarboxylic acids: oxalic acid, malonic acid, succinic acid, glutaric acid, fumaric acid. The dehydrogenation reaction of succinic acid to form fumaric acid.

Amino alcohols: 2-aminoethanol, choline. Formation of choline from L-serine. Acetylcholine. Catecholamines: dopamine, noradrenaline (norepinephrine), adrenaline (epinephrine).

Hydroxy acids: lactic acid, malic acid, tartaric acid, citric acid. Oxidation reactions of lactic and malic acids with participation of coenzyme NAD^+. Citric acid, using citrates for conservation of donor blood. Citric acid dehydration *in vivo*.

Aldehyde and keto acids: pyruvic acid, acetoacetic acid, oxaloacetic acid, α-ketoglutaric acid. The condensation reaction of oxaloacetic acid and acetyl coenzyme A. The oxidative decarboxylation reactions of pyruvic acid. Keto–enol tautomerization of and oxaloacetic acid.

β-Hydroxybutyric acid, β-ketobutyric acid, acetone as representatives of «*ketone bodies*», their biological and their diagnostic importance.

Salicylic acid and its derivatives: acetylsalicylic acid, methyl-salicylate, phenyl-salicylate.

p-Aminobenzoic acid and its derivatives possessing anesthetizing action: benzocaine, procaine. Modern anesthetics.

Sulfanilic acid and its amide. Sulfa drugs. Antimetabolite concepts.

3. Biopolymers and their structural components. Low molecular weight bioregulators

3.1. Carbohydrates

Classification of monosaccharides: aldoses, ketoses; pentoses, hexoses. Stereoisomerism of monosaccharides. D- and L-families. An open-chain structure and cyclic forms. Furanoses and pyranoses; α- and β-anomers. Fischer projection and Haworth formulas. A cyclo-oxo tautomerization. Mutarotation. Conformations of pyranose forms of monosaccharides. The structures of most important representatives of pentoses (D-ribose, 2-deoxy-D-ribose, D-xylose); hexoses (D-glucose, D-mannose, D-galactose, D-fructose). Amino sugars (D-glucosamine, D-mannosamine, D-galactosamine), their properties.

Physical properties of monosaccharides.

Chemical properties. Glycosides. Hydrolysis of glycosides. Biologically important phosphorylation reactions of monosaccharides. Reducing properties of aldoses. Oxidation of monosaccharides: aldonic, aldaricand uronic acids. Reduction of monosaccharides to alditols: xylitol, glucitol (sorbitol), mannitol; their use in medicine. The nucleophilic addition to the carbonyl group of glucose (glycolation reactions of proteins). Ascorbic acid: the structure and properties.

Biological importance of monosaccharides and their derivatives.

Common characteristic and classification of polysaccharides. Oligosaccharides. The disaccharides: maltose, lactose, lactulose, sucrose, cellobiose. Structures, the cyclo-oxo tautomerization. Reducing properties. Hydrolysis.

Polysaccharides. Homo- and heteropolysaccharides. The homopolysaccharides: starch, glycogen, dextrans, cellulose. Primary structure, hydrolysis. The concept of a secondary structure (amylose, cellulose). Pectins (polygalacturonic acid).

The heteropolysaccharides: hyaluronic acid, chondroitin sulfates. Use alginic acid to make dental alginate impression materials. The concept of mixed biopolymers: proteoglycans, glycoproteins, glycolipids.

3.2. Amino acids

Amino acids obtained from proteins. Classification of proteinogenic amino acids taking into account different signs: acid and base properties, chemical nature of a side chain and its substituents (aliphatic, aromatic, heterocyclic, contained the hydroxyl, the amino, the carboxyl or the amide groups, the sulfur contained groups), character of a side chain (hydrophilic and hydrophobic). Structure, nomenclature. Stereoisomerism. Acid and base properties, a dipolar ion structure. Essential amino acids.

The methods of α-amino acids reception: hydrolysis of proteins, synthesis from α-halo carboxylic acids. Reductive amination reactions. Pyridoxal catalysis.

The qualitative tests for of α-amino acids.

Biologically important reactions of α-amino acids. Transamination reactions. Decarboxylation of α-amino acids - the way of formation of biogenic amines and biological regulators: 2-aminoethanol, histamine, tryptamine, serotonin, dopamine, γ-amino butyric acid, their biological role. Oxidative and not oxidizing deamination reactions. The hydroxylation reactions (phenylalanine → tyrosine, tyrosine → 3,4-dihydroxyphenylalanine, tryptophan → 5-hydroxytryptophan, proline → 4-hydroxyproline), participation of ascorbic acid in the amino acid hydroxylation reactions. Deamination of amino acids. Cysteine oxidation. Disulfide bond.

3.3. Polypeptides and proteins

Polypeptides. The electronic and the three-dimensional structure of a peptide bond. The hydrolysis of polypeptides. Individual representatives of polypeptides: aspartame, glutathione, neuropeptides, insulin.

Primary structure of proteins. The concept of secondary, tertiary and quaternary protein structures. Hemoglobin, heme.

3.4. Nucleic acids

Nucleic (heterocyclic) bases: pyrimidines (uracil, thymine, cytosine) and purines (adenine, guanine). Aromatic properties. A lactim–lactam tautomerization.

Nucleosides. Nucleotides. Structure of mononucleotides that can be obtained from nucleic acids. Nomenclature. Nucleotides hydrolysis.

Primary structure of nucleic acids. The phosphate diester linkage. Ribonucleic and deoxyribonucleic acids. The nucleotides found in RNA, the nucleotides found in DNA. Hydrolysis of nucleic acids. The concept of the DNA secondary structure. The role of hydrogen bonds in formation of the DNA secondary structure. Complementarity of heterocyclic bases.

Nucleoside mono- and polyphosphates. AMP, ADP, ATP. The role of ATP as the accumulator and the carrier of free energy in cell. Macro energy bonds. Nucleoside cyclophosphates (c-AMP, c-GMP) as secondary mediators in the regulation of cell metabolism. Notion about coenzymes. Structures of NAD^+ and its phosphate ($NADPh^+$). NAD^+ - NADH system; hydride transfer as one of the stages of the biological oxidation–reduction reactions with participation of this system.

3.5. Lipids

Classification. Biological significance of lipids. Waxes: the structure, properties, use as dental impression materials. Neutral fats. The common natural fatty acids that can be obtained from lipids: palmitic, stearic, oleic, linoleic, linolenic, arachidonic acids. Features of unsaturated fatty acids, ω-nomenclature.

Phospholipids. Phosphatidylethanolamines, phosphatidylserines, phosphatidylcholines (lecithines), phosphatidylinositols as structural components of cellular membranes.

Rancidness of fats that is free radical chain process as the model of the peroxidation of polyunsaturated fatty acids in the cell membranes, its mechanism and its biological role.

3.6. Low-molecular weight bioregulators

The concept of biologically active compounds. The significance of the spatial structure and physical-chemical properties of bioregulators in their interaction with receptors and the implementation of action at the molecular level.

Steroids. Gonan (steran, perhydrocyclopentanophenanthrene), stereochemical structure of 5α, 5β series of steroids. Physical properties of steroids. Hydrocarbons that are parent structures of steroid groups: estrane, androstane, pregnane, cholane, cholestane.

Steroid hormones. Sex hormones: estrogens, androgens; progestins; adrenocortical hormones. Structure, biological role.

Bile acids: cholic, glycocholic and taurocholic acids, their structure. Reactions with taurine and glycine, the biological role.

Cholesterol as one of sterols, its conformational structure. Its properties, its role in metabolism and structure of cell membranes, in development of cardiac pathology. 7-Dehydrocholesterol, its transformation to vitamin D_3 (cholecalciferol).

Ergosterol, its transformation to vitamin D2 (ergocalciferol). The role of vitamin D in regulation of calcium-phosphorus metabolism.

Alkaloids. Botanical and chemical classification of alkaloids. Alkaloids as poisons in medicines. The structure and effect on the human body of nicotine, quinine, papaverine, morphine, atropine. Methylated xanthine derivatives (theobromine, theophylline, caffeine) and their use in medicine.

4. Organic compounds used in dentistry

The general characteristic of high-molecular compounds. The monomer, the simple repeating unit, the degree of polymerization. Polymers, oligomers, copolymers. Classification of polymers.

The types of polymerization: radical and ionic. The radical mechanism of polymerization reaction of acrylic and methacrylic acids esters. Activators, initiators and inhibitors of radical polymerization reactions.

Composite tooth restorative dental materials of chemical and light promoted hardening. The high-molecular monomers of the modern composite dental materials: Bis-GMA, NTG-GMA, HEMA, PMDM, UDMA.

Chemical compounds used for providing adhesion of a restorative material to the tooth and enamel tissues.

Ormokers and modern nanomaterials in stomatology.

EDUCATIONAL AND METHODICAL CHART OF THE DISCIPLINE

Section number, topics	Topic and its content	The number of academic hours			Forms of assessment
		Lectures	Laboratory classes	Self-directed learning	
1	2	3	4	5	6
1.	**The theoretical bases of the structure and general principles of reactivity of organic compounds**	**1,33**	**6**	**0,67**	
1.1.	Introduction. Classification and nomenclature of organic compounds	–	2	–	1,7,9 ,10,13,14,15,16
1.2.	Chemical bonds and mutual influence of atoms in an organic molecule	1,33	2	0,67	1,3,5-7,9,10-14,15,16
1.3.	Stereochemistry of organic molecules and stereoisomerism		2		1,2,7-10,13,14,15,16
2.	**Reactivity of hydrocarbons, alcohols, phenols, thiols, amines, aldehydes and ketones, carboxylic acids and their functional derivatives. Biologically important heterofunctional compounds**	–	**12**	–	
2.1.	Reactivity of hydrocarbons	–	2	–	1,5-7,10-14,15,16
2.2.	Acid and base properties of organic compounds	–	2	–	1,5-7,10-14,15,16
2.3.	Reactivity of alcohols, phenols, thiols and amines	–	2	–	1,5-7,10-14,15,16
2.4.	Aldehydes and ketones reactivity	–	2	–	1,5-7,10-14,15,16
2.5.	Reactivity of carboxylic acids and their functional derivatives	–	2	–	1,5-7,10-14,15,16
2.6.	Poly- and heterofunctional compounds participating in the processes of ability to live and being origin of most important medicament groups	–	2	–	1,5-7,10-16

1	2	3	4	5	6
3.	**Biopolymers and their structural components. Low molecular weight bioregulators**	**2,66**	**16**	**1,34**	
3.1.	Carbohydrates	1,33	4	0,67	1,3,5-7,9,10-14,15,16
3.2.	Amino acids		2		1,3,5-7,9,10-14,15,16
3.3	Polypeptides and proteins		2		1,3,5-7,9,10-14,15,16
3.4.	Nucleic acids		2		1,3,4-7,9,10,12-14, 15,16
	Control test. «Theoretical bases of structure and general patterns of reactivity of organic compounds. Biopolymers and their structural units»	–	2	–	4,5,15
3.5.	Lipids	1,33	2	0,67	1,4-7,9,10,12-14,15,16
3.6.	Low-molecular weight bioregulators		2		1,4-7,9,10,12-14,15,16
4	**Organic compounds used in dentistry**	**1,33**	**2**	**0,67**	1,4-7,9,10,12-14,15,16
IN ALL:		**5,32**	**36**	**2,68**	

INFORMATION METHODICAL PART

THE EDUCATIONAL LITERATURE

Main:

1. Биоорганическая химия = Bioorganic Chemistry: учеб. пособие для иностр. студентов учреждений высш. образования по специальностям "Лечебное дело", "Стоматология" / О.Н. Ринейская [и др.]. – Минск: Новое знание, 2018, 2020. – 173 с.:ил. Number of books: 117, 169 copies.

Access mode (режим доступа): https://e.lanbook.com/book/109499

Stamp (document priority) (гриф (приоритет документа)): МО

2. Bioorganic chemistry: Lecture course for foreign student of the 1st year / Assembled by L.G. Hidranovich. – Vitebsk: VSMU Press, 2004. – 281 p.

Number of books: 126 copies

3. Hidranovich, L. G. Лабораторные занятия по биоорганической химии = Laboratory classes in bioorganic chemistry : учеб.-метод. пособие : для студентов учреждений высш. образования, обучающихся на англ. яз. по специальности 1-79 01 07 "Стоматология" / L. G. Hidranovich, O. A. Khodos ; М-во здравоохранения Республики Беларусь, УО "Витебский гос. мед. ун-т". - Витебск : [ВГМУ], 2017. - 171 с.

Access mode (режим доступа): http://elib.vsmu.by/handle/123/12848

Stamp (document priority) (гриф(приоритет документа)): УМО

Number of books: 71 copies

4. Hurynava, A.S. Restorative dental polymer materials: Manual. / A.S. Hurynava. – Vitebsk: VSMU, 2016. – 76 p.

Access mode (режим доступа): https://elib.vsmu.by/handle/123/11089

Number of books: 76 copies

Supplementary:

5. Solomons, T.W. Graham. Fundamentals of organic chemistry / T.W. Graham Solomons. 4th edition – John Willey and sons, inc., 1994. . – 1047 p.

Number of books: 5 copies

6. Daley, Richard F. Organic chemistry / Richard F. Daley, Sally J. Dalley Wm. C. – Brown Publishers, 1996. – 1396 p.

Number of books: 3 copies

7. Lewis, David E. Organic chemistry. A modern perspective: preliminary version / David E. Lewis. – Wm. C. Brown Publishers, 1996. - 1136 p.

Number of books: 23 copies

8. Schmid, George H. Organic chemistry / George H. Schmid. – Mosby, 1996. – 1208 p.

Number of books: 3 copies

9. Sakaguchi, Ronald L. Craig's restorative dental materials / Ronald L. Sakaguchi, John M. Powers. 13th edition – Elsevier Mosby, 2012.

Number of books: 2 copies

10. Stewart, Marsia. Clinical aspects of dental materials: theory, practice and cases / Marsia Stewart, Michael Badby. 5th edition – Wolters Kluwer, Lippincott Williams & Wilkins, 2018.

Number of books: 10 copies

ORGANIZATION AND FULFILMENT OF STUDENTS` SELF-DIRECTED LEARNING IN THE ACADEMIC SUBJECT

The time allocated for self-assessed learning is used by students to:

preparation for lectures and laboratory works;

preparation for colloquiums and credit test in discipline;

study of themes given for self-directed study;

study of themes and problems, that are not planned to the lectures and laboratory classes;

performance of research and creative assignments;

preparation of thematic reports, abstracts and presentations;

preparation of reports;

compiling the review of a scientific literature on a given theme;

compiling the information and demonstration materials (stands, posters, graphics, tables, newspapers etc.)

compiling the thematic collection of literature sources and internet sources;

The main methods of organization of self-assessed learning are:

writing and presentation of abstract;

appearance with the report;

study of themes and problems, that are not planned to the lectures and laboratory classes;

computer testing.

Assessment of self-assessed work may be in the form of:

the control test work;

the result work, colloquium in the form of the oral interview writing work or testing;

discussion of abstracts;

assessing of the oral answer to the question in the laboratory classes;

checking the abstracts;

checking the educational protocols of the laboratory works;

individual conversation.

LIST OF USED METHODS OF DIAGNOSTIC.

Oral:

1. Interviews.
2. Reports at conferences.

Written:

3. Control interviews.
4. Control test works.
5. Written reports on home-works.
6. Written reports on laboratory works.
7. Abstracts, essays.
8. Publications of articles and reports.
9. Standardized tests.

Oral-written:

10. The assessment based on module-rating system.
11. Reports on classroom practical exercisers and problems with their oral defence.
12. Reports on homework exercise and problem solutions with their oral defence.
13. Reports on laboratory works with their oral defence.
14. Credit test.

Technical form:

15. Computer testing.
16. Visual laboratory works.

LIST OF PRACTICAL SKILLS

1. Classification of organic compounds according to the structure of carbon skeleton and the nature of a functional group
2. Drawing up the structural formulas and systematic names of biologically important organic compounds and medicinal substances based on chemical nomenclature.
3. Selection of functional groups and definition of reaction centers, conjugated and aromatic fragments in molecules to predict the chemical behavior of organic compounds.
4. Determination of hydrophilic and hydrophobic portions in the structure of biologically significant molecules and the ability of these molecules to distribute in environments of the human body.
5. Qualitative assessment of the acid-base properties of organic compounds involved in life processes, drugs, as well as drugs that are potentially dangerous to the human body.
6. Prediction of reactivity of organic compounds based on the electronic and spatial structure and writing of chemical reaction schemes.
7. Performing a planned chemical experiment followed by analysis and recording of results.
8. Carrying out qualitative reactions on most important functional groups of organic compounds.

9. Safe work in the chemical laboratory: handling chemical glassware, spirit lamps, toxic and volatile substances.

THE LIST OF LABORATORY CLASSES

№	Themes of laboratory classes	Volume in hours
1	Introduction. Classification and nomenclature of organic compounds	2
2	Chemical bonds and mutual influence of atoms in an organic molecule	2
3	Stereochemistry of organic compounds and stereoisomerism.	2
4	Reactivity of hydrocarbons. *Laboratory work:* 1. Reaction of alkanes with bromine water. 2. Reaction of alkenes with bromine water. 3. Reaction of phenol with bromine water. 4. Reactivity of benzene and toluene in oxidation reactions.	2
5	Acid-base properties of organic compounds. *Laboratory work:* 1. Reaction of glycerol with copper hydroxide. 2. Formation of sodium phenoxide. 3. Comparison of methylamine and aniline base properties.	2
6	Reactivity of alcohols, phenols, thiols and amines. *Laboratory work:* 1. Oxidation reaction of ethanol. 2. Colored reactions of phenol with ferric chloride.	2
7	Aldehydes and ketones reactivity. *Laboratory work:* 1. Oxidation of formaldehyde by copper hydroxide in alkaline solution. 2. Formaldehyde disproportionation in water solutions. 3. Iodoform test for acetone. 4. Reaction of acetone with sodium nitroprussiate.	2
8	Reactivity of carboxylic acids and their functional derivatives. *Laboratory work:* 1. Carboxylic acids dissociation reaction. 2. Formation of sodium benzoate. 3. Formation of ethyl acetate. 4. Discover of oxalic acid. 5. Decarboxylation of oxalic acid.	2
9	Poly- and heterofunctional compounds participating in the processes of ability to live and being origin of most important medicament groups. *Laboratory work:* 1. Qualitative test for discovery of lactic acid. 2. Qualitative test for presence of 2 carboxy groups in tartaric acid. 3. Qualitative test for presence of 2 hydroxyl groups in tartaric acid. 4. Discovery of two tautomeric forms of acetoacetic ester.	2

	5. Hydrolysis of acetylsalicylic acid.	
10	Carbohydrates. Monosaccharides. *Laboratory work:* 1. Qualitative test for presence of hydroxyl groups in glucose. 2. Redaction of copper hydroxide by glucose in alkaline solution. 3. Qualitative reaction of fructose with resorcinol. 5. Qualitative test for pentoses.	2
11	Carbohydrates. Oligosaccharides and polysaccharides. *Laboratory work:* 1. Qualitative test for presence of hydroxyl groups in sucrose and lactose. 2. The test of lactose and sucrose on reducing power. 3. Proof of sucrose hydrolysis. 4. Discovery of starch. 5. Starch has no reducing power. 6. Acidic hydrolysis of starch.	2
12	Amino acids. *Laboratory work:* 1. Glycine solution does not have acidic pH value. 2. Reaction of formaldehyde with α-amino acid (the formol titration principle). 3. Formation of copper and α-amino acid complex compound. 4. Reaction of ninhydrin with α-amino acid.	2
13	Polypeptides and proteins. *Laboratory work:* 1. Biuret test on peptide linkage. 2. Xanthoprotein test on aromatic α-amino acids and proteins contained them. 3. Sulfosalicylic acid concretes protein. 4. Dehydrating agents concretes protein.	2
14	Nucleic acids. *Laboratory work:* 1 Discovery of purine bases («silver test») in the products of nucleotides hydrolysis. 2 Discovery of five-carbon monosaccacharide in the products of nucleotides hydrolysis.	2
15	Control test. «Theoretical bases of structure and general patterns of reactivity of organic compounds. Biopolymers and their structural units»	2
16	Lipids. *Laboratory work:* 1. Oleic acid reacts with bromine water. 2. Oleic acid reacts with potassium permanganate solution. 3. Saponification of fats.	2

	4. Extraction of free fatty acids from soap.	
17	Low-molecular weight bioregulators. *Laboratory work:* General qualitative test for alkaloids	2
18	Organic compounds used in dentistry. Credit test. *Laboratory work:* 1. Preparation and hardening of forming mass from polymers using for prosthetics. 2. The depolymerisation reaction of polymethylmethacrylat and proof the unsaturated structure of its monomer.	2
	TOTAL	**36**

THE LIST OF VISUAL AIDS.

1. Ball-and-stick models of molecules.
2. The tables and charts of bioorganic chemistry.

LIST OF TABLES AND CHARTS:

1) The IUPAC system for naming of alkanes.
2) Alkyl groups.
3) Functional groups priority range. Functional groups work in prefixes.
4) Radico-functional nomenclature.
5) Electronegativity of some of elements
6) The valence state of a carbon atom.
7) The valence state of a nitrogen atom.
8) The valence state of an oxygen atom.
9) The periodic table of elements (fragment).
10) Electronic structures and characteristics of σ- and π-bonds. Electronic structures of multiple bonds.
11) Structures and characteristics of conjugated system; π,π-conjugation.
12) Structures and characteristics of conjugated systems; p,π-conjugation.
13) Electron effects of substituents.
14) Newman projection formulas.
15) Conformations of butane and their potential energy.
16) Chair conformations of cyclohexane; ring inversion.
17) Cyclohexane conformations and their potential energy.
18) Enantiomers and diastereomers. Fischer projection formulas.
19) Reaction centers in organic compounds structures.
20) Nomenclature of di- and polysaccharides.
21) Nomenclature of amino acids.
22) pKa of side-chains of acidic and basic amino acids.
23) pKa values for the 20 common amino acids.
24) Nomenclature of nucleic base. The general structure of a nucleotide found in DNA and RNA.
25) Nomenclature of fatty acids.
26) Saturated fatty acids of waxes.

27) Saturated alcohols of waxes.
28) Monomers of dental polymers.
29) Compounds – regulators of restorative dental materials polymerization reactions: initiators.
30) Compounds – regulators of restorative dental materials polymerization reactions: activators.
31) Compounds – regulators of restorative dental materials polymerization reactions: inhibitors.
32) Compounds used for adhesion of restorative materials to tooth tissues.

LIST OF COMPUTER PROGRAMS

3. Multimedia presentation of the lectures № 1–4 in bioorganic chemistry.
4. Hidranovich, L.G. Bioorganic chemistry (Electronic resource): multimedia textbook for foreign students of the 1-st year. / L.G. Hidranovich, – Vitebsk: VSMU, 2005.