MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
MINISTRY OF EDUCATION AND SCIENCE OF THE KYRGYZ REPUBLIC

Government-run Educational Institution of Higher Professional Education
Kyrgyz-Russian Slavic University
School of Medicine

ENDORSED BY
Professor Anes Zarifyan
«23» 10.2015 г.

Chemistry

Course Outline (Module)

Assigned to Academic Curriculum	31050150_15_12ЛД.pli.xml 31.05.01. General Medicine
Qualification	Specialist
Mode of Study	Intramural
Total credit value	Credit points
Course Hours	144
including:	
in-class learning	108
individual work	36

Scope of testing semesters:
exam credits

Course hours scheduling (per semester)						
Semester Academic Year	1 (1.1)		2 (1.2)		Total	
Weeks	18		19			
Typeoftraining	AC	CO	AC	CO	AC	CO
Lectures	18	18	18	18	36	36
Lab practical	36	36	36	36	72	72
Practical session						
Including interactive session	2	2	3	3	5	5
Total in-class session	54	54	54	54	108	108
Individual work assessment						
Face-to-face learning	54	54	54	54	108	108
Individual work	18	18	18	18	36	36
Total	72	72	72	72	144	144

The Course outline developed by:

candidate of chemical sciences, associate professor Abdurashitova J. A.

Reviewers: candidate of medical sciences, Ibraeva I.G.

candidate of biological sciences, associate professor Karaeva R.R

candidate of chemical sciences, Dusheyeva B.M.

The Course Outline Chemistry
Developed in full compliance with FSES 3+:

Federal State Education Standards of Higher Professional Education for students trained for specialty 31.05.01. General Medicine (The Ministry of Education and Science of the Russian Order of «09» February 2016 № 95)

in accordance with Academic Curriculum:

Confirmed by KRSU Board of Academics in "29" 09. 2015 record № 2.

The Course Outline endorsed by Chemistry and Biochemistry Department Meeting

Record of 4 09 2015 № 2

Valid for: 2015-2021 academic years

The Head of Chemistry and biochemistry department
candidate of biological sciences, associate professor Matyushchenko N. S.

The Course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
16.11. 2016

The course outline has been revised, considered and endorsed for implementation in 2016-2017 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 2 09 2016 № 2
The Head of Department Matushenko N.S., associate professor, CBC

The Course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
15 12 2017

The course outline has been revised, considered and endorsed for implementation in 2017-2018 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 4 09 2017 № 2
The Head of Department Matushenko N.S., associate professor, CBC

The Course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
7 12 2018

The course outline has been revised, considered and endorsed for implementation in 2018-2019 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 6 06 2018 № 16
The Head of Department Matushenko N.S., associate professor, CBC

The Course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
04 09 2019

The course outline has been revised, considered and endorsed for implementation in 2019-2020 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 26 08 2019 № 1
The Head of Department Matushenko N.S., associate professor, CBC

The Course outline endorsed for the following academic year

Chairman of the Educational and Methodological Board
23 09 2020

The course outline has been revised, considered and endorsed for implementation in 2020-2021 Academic Year at the Staff Meeting of **Chemistry and Biochemistry** Department

Record of 14 09 2020 № 2
The Head of Department Matushenko N.S., associate professor, CBC

1. COURSE OUTLINE OBJECTIVES

- to acquire knowledge related to the structure, properties and mechanism of functioning of biologically active substances;
-to establish a solid foundation for studying such disciplines as biological chemistry, microbiology, physiology, pathological physiology;
- to form scientific vision of basic physical and chemical regularities in the behavior of biochemical processes;
- to develop integral perception of chemistry which allows to understand living organism functioning on the whole and its interactions with the environment.

2. PLACE OF THE COURSE IN THE EDUCATIONAL PROGRAM

Educational Program Units: B1.B

2.1. **Students' Preliminary Training Requirements:**

2.1.1. Biology

2.1.2. Chemistry

2.2. **Course Units and Practical Sessions imposing the prior Proficiency**

2.2.1. Biochemistry

2.2.2. Normal physiology

2.2.3. Pharmacology

2.2.4. Clinical biochemistry

3. STUDENTS' COMPETENCIES RESULTING FROM THE COURSE UNIT (MODULE)

OPK-7: readiness to use basic physical, chemical, mathematical and other natural science concepts and methods for solution of professional tasks.

Knowledge:

Level 1. General regularities of natural sciences for solution of professional tasks.

Skills:

Level 1. To use general laws of natural sciences, to apply methods of mathematical analysis in experimental investigations.

Expertise:

Level 1. General physical, chemical, mathematical and natural sciences laws.

Final Students' Competences.

3.1. Knowledge:

3.1.1. General chemical biological concepts and laws.

3.2. Skills:

3.2.1. To use general laws of chemistry, biology and other natural sciencesfor analysis of processes occurring in living organisms.

3.3. Expertise:

The knowledge of the basic principles of the natural sciences, experimental skills for studying biochemical processes.

4. COURSE (MODULE) STRUCTURE AND CONTENT							
Class code	**Subject Name /Type of Class/**	**Semes-ter / Acade-mic year**	**Hours**	**Compet encies**	***Litera-ture***	**Interac-tive sessions**	**Notes**
	Section 1. General and bioinorganic chemistry	1	2	OPK-7			
1.1.	Solutions /lec/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.11		
1.2.	Colligative properties of solutions /lec/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.11		
1.3.	Buffer solutions /lec/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.11		
1.4.	Equilibriums in aqueous solutions /lec/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.11		
1.5.	Coordination compounds /lec/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.11		
1.6.	Introduction to the subject of general chemistry. Safety regulations in a chemical laboratory. Methods of qualitative and quantitative analysis /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.9 L 1.11		
1.7.	Solutions. Properties of solutions /pr/	1	2	OPK-7	L 1.1		

					L 1.2 L 1.3 L 1.6 L 1.9 L 1.11		
1.8.	Colligative properties of electrolyte and nonelectrolyte solutions /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 1.11		
1.9.	Methods of quantitative analysis /pr/	1	2	OPK-7	L 1.2 L 1.3 L 1.7 L 1.9 L 1.11 L 2.1 L 2.2		
1.10.	Acids and bases. Acid-base concepts. Acid-base equilibrium /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.9 L 1.11		
1.11.	Properties of acids and bases /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.9 L 1.11		
1.12.	Buffer solutions and their properties. Buffer systems of the body /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.9 L 1.11 L 2.1 L 2.4		
1.13.	Red-ox reactions and processes /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.9 L 1.11 L 2.4		
1.14.	Chemistry of coordination compounds /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.9 L 1.11 L 2.4		
1.15.	Biogenic elements. S-elements and their compounds /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9		

					L 2.4		
1.16.	Biogenic elements. P-elements and their compounds /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 2.4	1	Interactive session (discussion, project, presentation)
1.17.	Biogenic elements. D-elements and their compounds /pr/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 2.4	1	Interactive session (discussion, project, presentation)
1.18.	Acid-base equilibrium. Acid-base concepts. The ion product of water (self-ionization). pH calculating and measuring /individual work/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.6 L 1.9 L 1.11 L 2.4		
1.19.	Red-ox reactions. Types. Oxidizing and reducing agents. Balancing red-ox equations. Methods of oxidation-reduction titration /individual work/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 1.11 L 2.4		
1.20.	Biogenic elements classification. General s-block elements characteristic. Properties of groups IA and IIA elements. Biological role, application of alkali metal and alkali earth compounds in medicine /individual work /	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 2.4		
1.21.	P-block elements and their compounds. General characteristic of groups IIIA, IVA, VA, VIA, VIIA elements. Biological role, application of their compounds in medicine /individual work /	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 2.4		
1.22.	D-block elements and their compounds. Properties of groups IB, VIB, VIIB, VIIIB elements. Biological role, application of their compounds in medicine. Complex nature of hemoglobin, cyanocobalamine and their analogs. Participation in metabolic processes /individual work /	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.9 L 2.4		
	Section 2. Physical and colloidal chemistry						
2.1.	Heterogeneous systems. Disperse systems classification. Methods of disperse system production /lec/	1	2	OPK-7	L 1.4 L 1.5 L 1.11 L 2.5		
2.2.	Colloids. Types of colloids. Methods of	1	2	OPK-7	L 1.4		

	purification. Properties /lec/				L 1.5 L 1.11 L 2.5		
2.3.	Stability and coagulation of colloids. Sol coagulation by electrolytes /lec/	1	2	OPK-7	L 1.4 L 1.5 L 1.11 L 2.5		
2.4.	Polymers. Synthetic and biological polymers /lec/	1	2	OPK-7	L 1.1 L 1.2 L 1.3 L 1.11 L 2.1		
2.5.	Dispersed systems. Colloidal state of substance. Colloids: methods of preparation and purification /pr/	1	2	OPK-7	L 1.4 L 1.5 L 1.9 L 1.11 L 2.5		
2.6.	Molecular, kinetic and optical properties of colloids /pr/	1	2	OPK-7	L 1.4 L 1.5 L 1.9 L 1.11 L 2.5		
2.7.	Stability and coagulation of colloids /pr/	1	2	OPK-7	L 1.4 L 1.5 L 1.9 L 1.11 L 2.5		
2.8.	Polymer materials: synthetic and biological /pr/	1	2	OPK-7	L 1.1 L 1.3 L 1.9 L 1.11 L 2.1		
2.9.	Polymers. Properties. Application /pr/	1	2	OPK-7	L 1.1 L 1.3 L 1.9 L 1.11 L 2.1		
2.10.	Chromatographic methods of analysis /individual work /	1	2	OPK-7	L 2.1		
2.11.	General characteristic of sorption processes /individual work /	1	2	OPK-7	L 2.1		
2.12.	Polymers. Types. Properties. Methods of preparation. Field of applications /individual work /	1	2	OPK-7	L 1.1 L 1.3 L 1.9 L 1.11 L 2.1		
2.13.	Gels and jellies. Properties /individual work /	1	2	OPK-7	L 1.4 L 1.5 L 2.5		
2.14.	Credit	1	0				
	Section 3. Organic chemistry						
3.1.	Introduction to bioorganic chemistry.	2	2	OPK-7	L 1.6		

	Classification, nomenclature, isomers. Mutual influence of atoms in the molecules of organic substances. Electronic effects of organic molecules. Type of organic reactions /lec/				L 1.7 L 1.8 L 1.10 L 2.6 L 2.8		
3.2.	Acidic-basic properties of organic compounds. Nucleophilic substitution and elimination reactions /lec/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.8		
3.3.	Carbonyl compounds. Nucleophilic addition reactions /lec/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
3.4.	Carboxylic acids and their derivatives /lec/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
3.5.	Lipids. Phospholipids /lec/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
3.6.	Organic chemistry. Theory of the chemical structure of organic compounds. Classification, nomenclature. Isomers. Electronic effects of organic molecules/pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.6.	Reactivity of hydrocarbons: saturated, unsaturated and aromatic /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.7.	Acid-base properties of organic compounds /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10		

					L 2.6 L 2.7 L 2.8		
3.8.	Nucleophilic substitution and elimination reactions /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.9.	Carbonyl compounds. Aldehydes and ketones. Nucleophilic addition reactions /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.10.	Carboxylic acids and their derivatives /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.11.	Lipids. Phospholipids /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.12.	Reactivity and biological significance of heterofunctional compounds /pr/	2	2	OPK-7	L 1.7 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.13.	Biologically active heterocyclic compounds. Heterofunctional derivatives of benzene series /pr/	2	2	OPK-7	L 1.7 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.14.	Biologically important heterocycles with one and two heteroatoms /pr/			OPK-7	L 1.7 L 1.9 L 2.6 L 2.7 L 2.8	1	Interactive session (discussion, project, presentation)
3.15.	Structure of a carbon atom. Orbital	2	2	OPK-7	L 1.6		

	hybridization (sp^3, sp^2, sp). σ-, π- bonds, bond lengths, bond strengths, and bond angles. Nomenclature (IUPAC). Functional groups. Isomerism. The ways of cleavage of covalent bonds. Radicals, electrophiles, nucleophiles. Mutual influence of atoms in the molecules of organic substances. Inductive electron donation, inductive electron withdrawal (+I). Mesomeric effect (M). π,π- and p,π-conjugation /individual work /				L 1.7 L 1.8 L 1.9 L 2.6 L 2.7 L 2.8		
3.16.	Reactivity of saturated and unsaturated hydrocarbons. General mechanism of S_R and A_E. Cyclic conjugated systems. Benzene and its derivatives. General mechanism of S_E /individual work /	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 2.6 L 2.7 L 2.8		
3.17.	Space structure of organic molecules /individual work /	2	2	OPK-7	L 1.7 L 1.9 L 2.6 L 2.7 L 2.8		
3.18.	Heterofunctional compounds. Some representatives of oxy acids: glycolic, lactic, oxybutyric, malonic, tartaric, citric, succinic acids. Aldehydes and ketoacids /individual work/	2	2	OPK-7	L 1.7 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
3.19.	Heterocycles. Classification. Five- and six - membered ring heterocycles (pyrrole, furan, thiophene, pyridine, quinoline, isoquinoline and their derivatives) /individual work/	2	2	OPK-7	L 1.7 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
	Section 4. Bioorganic chemistry			OPK-7			
4.1.	Carbohydrates. Monosaccharides. Di- and polysaccharides /lec/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
4.2.	α-Amino acids. Structure, properties, functions /lec/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
4.3.	Peptides and proteins /lec/	2	2	OPK-7	L 1.6		

					L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
4.4.	Nucleic acids /lec/	2	2		L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
4.5.	Carbohydrates. Monosaccharides /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
4.6.	Carbohydrates. Disaccharides and polysaccharides /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
4.7.	α-Amino acids. Structure, properties, functions /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
4.8.	Peptides and proteins. Structure, properties and biological functions /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.10 L 2.6 L 2.7 L 2.8		
4.9.	Nucleic acids. Structural components of nucleic acids. Nucleic bases. Purine derivatives (adenine and guanine) and pyrimidine derivatives (cytosine, thymine, uracil). Nucleosides and nucleotides /pr/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
4.10.	Nucleic acids. RNA and DNA:	2	2	OPK-7	L 1.6		

	structure, types of linkages, nomenclature, properties. Complementary pairs. Biological significance of nucleic acids /pr/				L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.7 L 2.8		
4.11.	Natural biologically active substances /pr/	2	2	OPK-7	L 1.9 L 2.1 L 2.7		Interactive session (discussion, project, presentation)
4.12.	Natural biologically active substances /pr/	2	2	OPK-7	L 1.9 L 2.1 L 2.7	1	Interactive session (discussion, project, presentation)
4.13.	Gomopolysaccharides: starch, glycogen, cellulose, dextranes. Composition, structure, chemical properties, hydrolysis reactions, biological functions /individual work/	2	2	OPK-7	L 1.4 L 1.7 L 1.8 L 1.9 L 1.10		
4.14.	Heteropolysaccharides: hyaluronic acid, heparin, chondroitin sulfate, their composition and structure of a disaccharide fragment, biological functions. Glycoproteins. /individual work/	2	2	OPK-7	L 1.8 L 1.9 L 1.10 L 2.1 L 2.7		
4.15.	Reactions of amino acids in vivo and in vitro /individual work/	2	2	OPK-7	L 1.8 L 1.9 L 1.10 L 2.1 L 2.7		
4.16.	Peptides. The main representatives /individual work/	2	2	OPK-7	L 1.8 L 1.9 L 1.10 L 2.1 L 2.7		
4.17.	Proteins /individual work/	2	2	OPK-7	L 1.6 L 1.7 L 1.8 L 1.9 L 1.10 L 2.6 L 2.8		
4.18.	Credit	2	0				

5. ASSESSMENT FUND.

5.1. Advancement Questions and Assignments.

Questions to check students' competence **knowledge:**

- Classification of solutions. The role of water and solutions in the body. Physical and chemical properties of water.
- Dependence of substance solubility in water on the ratio of hydrophilic and hydrophobic properties. Effect of external conditions on solubility. Thermodynamics of solubility.
- Solubility of gases in liquids. Henry's law, its medical and biological importance.
- Solubility of liquids and solids in liquids.
- Ways of expressing the concentration of solutions (mass fraction, molarity, molality, molar concentration of the equivalent, titer, normality).
- Biological significance of solutions.
- Diffusion in solutions. Osmosis. Osmotic pressure. Van't Hoff law.
- Measuring osmotic pressure. Osmometry. The role of osmosis and osmotic pressure in biological systems.
- Osmotic homeostasis. Isotonic, hypotonic and hypertonic solutions. Raoult's law. Consequences of Raoult's law.
- Ebulliometry and cryometry.
- Deviation of properties of diluteelectrolyte solutions according to Raoult's and Van't Hoff laws. Isotonic coefficient.
- Concepts of quantitative analysis.
- Classification of quantitative methods of analysis.
- Classification of volumetric analysis methods (neutralization, oxidation-reduction, precipitation, complex formation).
- Basics of the volumetric analysis. Measuring vessels. Volumetric analysis technique. The law of equivalent.
- Acid-base method of measure analysis. (Neutralization method).
- Theoretical grounds of neutralization method.
- Titration curves and acid-base indicators.
- Ways of calculating normality and titer of solutions.
- Acid-base concepts.
- Arrhenius theory of acids and bases.
- Brønsted-Lowry theory of acids and bases. Conjugate acids and bases.
- Lewis theory of acids and bases.

- Acid-base properties of water. The ion product of water (self-ionization).
- pH: a measurement scale for acids and bases. Definition of pH. Measuring, calculating pH. The importance of pH and pH control.
- Acid and base strength. Strong and weak acids. Strong and weak bases.
- Weak acids and acid ionization constants. Weak bases and base ionization constants.
- Reactions between acids and bases.
- Neutralization.
- Polyprotic substances. Reactions of polyprotic substances.
- Acid-base properties of salts.
- Salt hydrolysis. Types of salt hydrolysis.ATP hydrolysis.
- Role of hydrolysis in chemical and biochemical processes.
- Acidic-basic buffer solutions.
- The value of buffer solutions in chemistry, biology, medicine.
- Chemical composition ofbuffer systems. Acidic, basic, amphoteric buffer systems.
- Preparation of buffer solutions. Buffer curves.
- Henderson-Hasselbalch equations.
- Buffer system action after the addition of acid or base.
- Blood buffer systems. Buffer action as the main mechanism of protolytic homeostasis of an organism.
- Buffer capacity: dependence on various factors, methods of determination.
- Characteristics of oxidation-reduction reactions. Oxidizing and reducing agents. Oxidation numbers.
- Balancing oxidation-reduction equations. Oxidizing and reducing agent equivalent.
- Some common oxidation-reduction reactions.
- Methods of oxidation-reduction titration.
- Oxidation-reduction reactions in the body.
- Volumetric analysis using potassium permanganate as a standard solution.
- Applications of oxidation and reduction.
- Properties of transition metals. Electron configurations. Oxidation states.
- Coordination compounds. Oxidation number of metals in coordination compounds. Naming coordination compounds.
- The structure of coordination compounds. Werner's coordination theory. Inner and outer spheres of coordination compounds. The central atom, coordination number of metals, ligands, its dentation.
- Classification of coordination compounds.

- Bonding in coordination compounds. Crystal field theory. The nature of the chemical bond in coordination compounds.
- Geometry of coordination compounds. Isomerism in coordination compounds.
- Complex ion equilibrium and solubility. Dissociation of a complex in solutions. Stability constant of a coordination compound.
- Reactions of coordination compounds.
- Chelating agents. Chelates. Application in medicine. Complexometry.
- Coordination compounds in living systems. Hemoglobin and related compounds.
- Circulation of biogenic elements in nature.
- Classification of biogenic elements.
- General observations of s-elements. Electronic structure of s-element's atoms.
- Properties of group IA elements.
- The most important compounds, containing potassium and sodium. Biological action of K^+ and Na^+-ions.
- Lithium and beryllium. Their structures, properties and biological role.
- Properties of group IIA elements: calcium, magnesium, barium.
- Major compounds containing Ca, Mg and Ba. Their biological role.
- Application of alkali metal compounds and alkali earth compounds in medicine.
- General observation of p-elements.
- Properties of groups IIIA and IVA elements from the point of view of their position in the Periodic table. Structure of their atoms. Their acid-base properties. Major compounds, containing boron and aluminum (boric acid and borax). Their properties and biological action.
- Major compounds of group IVA elements: oxides, hydroxides, acids, salts, their properties. Carbon monoxide, carbon dioxide, their biological activity. Carbonic acid and its salts. Silicon dioxide and silicates. Application of silica glass in medicine.
- Major compounds containing carbon, silica, tin and lead. Their biological action. Toxicity of lead.
- Properties of group VA elements from the point of view of their position in the Periodic table. Atomic structure of the elements. Their acid-base and red-ox properties.
- Major compounds of nitrogen. Ammonia. Ammonium salts. Nitrogen oxides, nitrous acid, nitric acid. Nitrates, their toxicity.
- Major compounds of phosphorus. Phosphorus oxides and their properties. Ortho-, metha- and pyrophosphoric acids. Phosphates.

- Major compounds containing nitrogen, phosphorus, arsenic, tin and bismuth. Their biological action and application in medicine.
- Properties of group VIA elements from the point of view of their position in the Periodic table. Atomic structure of the elements. Their acid-base and red-ox properties. Oxygen. Molecular oxygen and ozone.
- Major compounds of sulfur. Sulfur oxides, sulfurous acid and sulfuric acid. The biological role of oxygen and sulfur. Application of oxygen and ozone in medicine.
- Properties of group VIIA elements from the point of view of their position in the Periodic table. Atomic structure of the elements. Their acid- base and red-ox properties.
- Halogens. Hydrogen halides. Halogen oxoacid. The biological role of fluorine, chlorine, bromine and iodine containing compounds.
- General observation of d-elements.
- Properties of group IB and IIB elements from the point of view of their position in the Periodic table. Atomic structure of the elements. Their acid-base and red-ox properties.
- Major compounds containing Cu, Ag, Au, Zn, Hg. Their biological action. Toxicity of these metals. Application of copper, silver, gold, zinc and mercury containing compounds in medicine.
- Properties of group VIB and VIIB elements from the point of view of their position in the Periodic table. Atomic structure of the elements. Their acid-base and red-ox properties.
- Major compounds, containing Cr (III), Cr (VI), Mo (VI), Mn (II). Their biological role. Application of chromium, molybdenum, and manganese containing compounds in medicine.
- Properties of group VIIIB elements from the point of view of their position in the Periodic table. Atomic structure of the elements. Their acid-base and red-ox properties. Major compounds containing Fe (II), Fe (III), Co (II), Co (III), Ni (II). Their biological action. Application of iron, cobalt, nickel, containing compounds in medicine.
- Complex nature of hemoglobin, cyanocobalamine and their analogs. Participation in the metabolic processes.
- Dispersed systems. Dispersed phase and dispersion medium.
- Suspensions, colloids and solutions.
- Different colloidal systems and their examples.
- Types of colloids: a) according to the state of the dispersed phase and dispersion medium; b) hydrophobic and hydrophilic colloids.
- Preparation of colloids: condensation and dispersion methods.

- Methods of colloid purification: dialysis, electro dialysis, compensation dialysis, ultra filtration.
- Electrical, optical and molecular-kinetic properties of colloids. Tyndall effect.
- Micellar theory of colloidal solutions. The structure of a colloidal micelle.
- The role of colloidal solutions in biology and medicine.
- Stability of colloidal solutions. Kinetic and aggregative stability of sols.
- Factors of sol stability. Change of the sol stability under the influence of temperature, concentration of sol, electrolytes.
- Coagulation. Causes and mechanism of coagulation. Kinetics of coagulation: fast, slow, dormant and evident coagulation. Coagulation by electrolytes. Coagulation threshold. Coagulating capacity. Schulze-Gardy's rule.
- Association colloids. Coagulation in biological systems.
- Colloidal protection. Protective number. Biological importance and application of colloidal protection.
- Polymers. Classification, properties, application.
- Synthetic organic polymers. Addition and condensation reactions.
- Natural polymers. Polysaccharides. Proteins. Nucleic acids.
- Swelling and dissolution of polymers. Mechanism of swelling. Influence of different factors on the process of swelling.
- Polymer solutions: sols and gels of organisms.
- The theory of the chemical structure of organic compounds. General principles of Butlerov's theory of the chemical structure of organic compounds.
- Structure of a carbon atom. Orbital hybridization (sp^3, sp^2, sp). σ-, π- bonds: bond lengths, bond strengths, and bond angles.
- Organic compounds classification. Nomenclature (IUPAC). Functional groups.
- Isomerism. Straight chain and branched-chain compounds, isomers of the position of double and triple bonds, stereoisomers.
- The ways of demolishing covalent bonds. Radicals, electrophiles, nucleophiles.
- Mutual influence of atoms in the molecules of organic substances. Inductive electron donation, inductive electron withdrawal (+I, -I). Mesomeric effect (+M, -M).
- Conjugation. π,π- and p,π-conjugation.
- Reactivity of hydrocarbons: saturated, unsaturated and aromatic.
- Saturated hydrocarbons. Alkanes and cycloalkanes. General characteristic. Structure, nomenclature, isomerism, physical properties.
- Reactions of alkanes and cycloalkanes.

- Radical substitution reactions (S_R). Halogenation.
- Medical use of polyhalogenated hydrocarbons (chloroethane, chloromethane, chloroform, halothane).
- Unsaturated hydrocarbons. Alkenes, alkynes, cycloalkenes. General characteristic: structure, nomenclature, isomerism, physical properties.
- Reactions involving alkenes, alkynes, cycloalkenes. Electrophilic addition reactions (A_E): hydrogenation; halogenation; hydration; hydrohalogenation. V.V. Markovnikov's rule.
- Oxidation reactions.
- Addition polymers of alkenes. Important addition polymers of alkenes.
- Aromatic hydrocarbons. Structure and properties. Nomenclature. Isomerism.
- Reactions involving benzene. Substitution reactions (S_E). Chemical properties of benzene and its homologues. Electrophilic substitution reactions: halogenation, nitration, sulfonation, alkylation. Oxidation reactions.
- The effect of substituents on orientation (ortho, para and meta- directing substituents).
- Heterocyclic aromatic compounds (pyridine, pyrimidine, purine, imidazole, furan, pyrrole, porphyrin and cimetidine).
- Acidic-basic properties of organic compounds. Brønsted acids and bases.
- Lewis acid-base theory. Semipolar linkage.
- Comparative characteristic of acidic-basic properties of organic compounds. Acidic-basic properties of alcohols, phenols, thiols, amines, carboxylic acid. Properties of mono- and polyatomic alcohols.
- C-H, S-H, N-H acidity. Factors which determine the acidity of organic compounds:
- a) electronegativity of the atom; b) size of the atom;
- c) electronic effects of the substituents.
- Nucleophilic substitution reactions (S_{N1}, S_{N2}). Action of HHal on primary and secondary alcohols (S_{N2}).Action of HHal on tertiary alcohols (S_{N1}).
- Substitution and elimination as competing reactions. The mechanism of the reaction.
- General characteristic of carbonyl compounds (aldehydes and ketones). Classification, nomenclature and isomers of aldehydes and ketones.
- The structure of a carbonyl group. Reactive centers in the molecules of aldehydes and ketones. Physical properties.Preparation of aldehydes and ketones.
- Reactions involving carbonyl compounds. Relative reactivity of aldehydes and ketones.
- Nucleophilic addition reactions of aldehydes and ketones (A_N):
  a) addition of water; cyanide, bisulfate;

b) addition of alcohols (formation of hemiacetals and acetals); hydrolysis of hemiacetals in acidic solutions;

c) addition of primary amines and their derivatives (formation of Schiff's bases, oximes, hydrazones, semicarbazones, phenylhydrazones).

- Reduction reactions of aldehydes and ketones.
- Oxidation reactions: Tollen's silver mirror test, Cannizzaro's reaction, Benedict's test.
- Polymerization and polycondensation. Aldol condensation, cyclotrimerization. Applications of carbonyl compounds.
- General characteristic of carboxylic acids. Classification, nomenclature, isomerism.
- Structure and physical properties of carboxylic acids. The structure ofa carboxylic group.
- Representatives of carboxylic acids:

  a) formic, acetic, propionic, butyric, valeric, caproic acids;

  b) oxalic, malonic, succinic acids;

  c) acrylic acid and its derivatives, crotonic, fumaric, maleic acids;

  e) benzoic, phtalic acids.
- Preparation of carboxylic acids.
- Reactions involving carboxylic acids. Acid-base reactions. Salt formation.
- General mechanism of nucleophilic acyl substitution reactions (S_N). Formation of acyl halides, acid anhydrides, esters, and amides. Ester hydrolysis.
- Halogenation of the α-carbon of carboxylic acids.
- Aromatic carboxylic acid derivatives.
- Chemical properties of dicarboxylic and aromatic carboxylic acids.
- Application of carboxylic acids in medicine.
- Lipids. Classification. Biological functions of lipids.
- Simple lipids: fats, oils, waxes. Structure and composition.
- Fatty acids. Common saturated and unsaturated fatty acids. Structure and properties. Configurational isomers of fatty acids.
- Chemical reactions of fatty acids. Reactions at the double bond (unsaturated fatty acids).
- Chemical properties of triglycerides. Hydrolysis and addition reactions. Oxidation of lipids.
- Complex lipids. Phospholipids and glycolipids. General characteristic, classification, chemical properties and biological functions.
- Heterofunctional derivatives of benzene series.
- Phenoloacids. Structure, nomenclature, isomers. Chemical properties.
- Analgetics on the basis of p-aminophenol: phenetidine, phenacetinum, paracetamol.

- Salicylic acid and its derivatives: sodium salicylate, phenylsalicylate, acetylcalicylate (aspirine), p-aminocalycylic acid (PAS-acid).
- Para-aminobenzoic acid and its derivatives with local anesthetic action: anaesthesin (benzocaine), novocaine.
- Sulfanilic acid, streptocide. Sulfonylamide drugs - etazolum, sulfapyridazinum, sulfadimethoxine.
- Heterocyclic compounds. Classification. Major classes of heterocyclic compounds. Biological role.
- The nature of heteroaromaticity. Aromaticity and acid-base properties of heterocyclic compounds.
- Five- and six-membered ring heterocycles.
- Five-membered ring compounds with one heteroatom: pyrrolidine, pyrrole, tetrahydrofuran, furan, tetrahydrothiophene, thiohene.
- Five-membered ring compounds containing two heteroatoms: imidazolidine, pyrazolidine, imidazole, pyrazole, oxazolidine, isoxazolidine, oxazole, isoxazole.
- Six-membered ring compounds with a single heteroatom: piperidine, pyridine, tetrahydropyran, pyran.
- Six-membered ring compounds with two heteroatoms: piperazine, oxazine, morpholine, oxazine.
- Synthesis and modification of heterocyclic rings.
- Chemical properties of five- and six-membered heterocyclic compounds.
- Electrophilic substitution reactions. Hydrogenation reactions.
- Some representatives of heterocyclic compounds: indole, benzofuran, benzothiophene, tryptophan, proline, porphyrin ring system, heme.
- Benzopirrol (indole) and its derivatives - tryptophane, tryptamine, serotonin skatole.
- Azoles - pyrazole, imidazole, thiazol. Compounds containing an imidazole ring: histidine, histamine.
- Pyrazolone (pyrazyl ketone) and its derivatives: antipyrine, amidopyrinum, analgin, butadion.
- Six-membered heterocycles with one or two nitrogen atoms. Pyridine, quinoline. Nicotinic acid and its amide (vitamin PP).
- Pyrimidine, its oxy-and amine derivatives. Barbituric acid. Tautomeric forms of barbituric acid. Barbiturates, application in medicine.

- Condensed heterocycles. Purine and its oxy- and amino derivatives: adenine, guanine, xanthine, uric acid. Examples of common methylated purines: caffein, theobromine, theophylline.
- Types of carbohydrates. Biological role.
- Monosaccharides. Classification: aldoses, ketoses, pentoses, hexoses. Some representatives: ribose, deoxyribose, xylose, glucose, mannose, galactose, fructose.
- Stereoisomerism. Stereoisomers. Stereoisomerism of monosaccharides. Fischer projections. Anomers. The D- and L-system of nomenclature.
- Rotation of plane-polarized light. The relationship between molecular structure and optical activity.
- Cyclic structure of monosaccharides: hemiacetal formation. Cyclo-oxo tautomerism. Haworth projections. Anomers.
- Reactions of monosaccharides:
  a) ester and ether formation; b) glycoside formation;
  c) reduction of monosaccharides; d) oxidation of monosaccharides.
- Derivatives of monosaccharides. Deoxy sugars, amino sugars, neuraminic and sialic acid.
- Biologically important monosaccharides and their biological functions.
- Biologically important disaccharides. Classification, composition, structure. Type of glycosidic linkage: α-1,4 and β-1,4.
- Reducing disaccharides: maltose, cellobiose, lactose. Chemical properties.
- Nonreducing sugars: sucrose. Chemical properties. Hydrolysis of sucrose. Inversion of sugar cane.
- Polysacharides. Classification. Biological role.
- Gomopolysaccharides: starch, glycogen, cellulose, dextranes. Composition, structure, chemical properties, hydrolysis reactions.
- Heteropolysaccharides: hyaluronic acid, heparin, chondroitin sulfate, their composition, biological significance.
- The concept of mixed carbohydrate containing biopolymers. Glycoproteins.
- Structure of α-amino acids. Nomenclature, isomerism. Biological role, application in medicine.
- Classification of biogenic amino acids according to acid-base properties and nature of the radical.
- Configuration of natural amino acids.
- Amino acids as dipolar ions. Isoelectric point (pI) of aminoacids.
- Reactions of amino acids.

- Reactions of carboxylic group: etherification, reactions with phosphorus halogenides (PCl_5, PCl_3).
- Reactions of amino group: reactions with formaldehyde, nitrous acid, acetic anhydride.
- Amphoteric properties of amino acids. Acid-base properties of amino acids. Types of salts.
- Biologically important reactions of amino acids: deamination, decarboxylation, transamination.
- Qualitative analysis of α-amino acids and their role in the diagnosis.
- Peptides and proteins. Composition and amino acid sequence. Electronic and spatial structure of peptide bond.
- Classification, properties and biological functions of proteins. Fibrous proteins. Collagen, α-keratins, myosin. β-pleated sheet. Silk fibroin. Globular proteins.
- Synthesis and structure of peptides. Dipeptides, tripeptides. Some representatives. Biological role.
- Insulin, vasopressin, oxytocin: their composition, structure, biological role.
- Levels of protein structural organization: primary, secondary (α-helix), tertiary, quaternary. Bond types.
- Methods of extraction, separation and purification of proteins. Methods of protein molar mass determination.
- Denaturation of proteins (temperature, pH, organic solvents, detergents, heavy metals, mechanical stress).
- Structure and biological functions of myoglobin and hemoglobin.
- Dietary protein and protein digestion.
- Structural components of nucleic acids. Nucleic bases. Purine derivatives (adenine and guanine) and pyrimidine derivatives (cytosine, thymine, uracil). Lactime-lactame tautomeric forms.
- Nucleosides: definition, structure, types of linkages, nomenclature, properties. Ribonucleosides and deoxyribonucleosides. Hydrolysis.
- Nucleotides: definition, structure, types of linkages, nomenclature, properties. Ribonucleotides and deoxyribonucleotides. Hydrolysis.
- RNA and DNA: structure, types of linkages, nomenclature, properties. Complementary pairs. Biological significance of nucleic acids.
- DNA structure: The Double Helix.
- Isoprenoids (nonsaponified lipids). Representative. Biological role.
- Terpane derivatives. Terpadienes. Mentol, terpin.

- Terpadienes. General characteristic. Representatives. Monocyclic terpadienes. (limonene).
- Hydrocarbons are ancestors of bicyclic terpenes: thujane, carane, pinane, camphane. Representatives of bicyclic terpenes: camphor, pinene.
- Carotinoids. Carotene. Retinol (vitamin A), retinal, biological role.
- Steroids. Ancestor of the steroid group. General characteristic. Classification. Biological role.
- Sterols. Cholestane and its derivatives. Cholesterol. Campesterol, sitosterol, stigmasterol, ergosterol. Vitamin D_2. Biological role.
- Sterols. Bile acids. Cholic acid. Biological role.
- Steroid hormones. Female sex hormones. Estrogenic hormones: estradiol, estrol, estriol. Biological role.
- Steroid hormones. Male sex hormones. Androgenic hormones: testosterone, androsterone. Biological role.
- Cardiac glycosides. General characteristic. Biological role.
- Vitamins. Classification. Biological role.
- Fat-soluble vitamins: A, D, E, K.
- Vitamin B group: B_1, B_2, B_6, B_{12}, biotin, folic acid.
- Alkaloids. General characteristic of alkaloids. Classification. Major groups of alkaloids. Representatives. Biological role.

Questions to check students' competences: **skills and expertise:**

Skills:

-knowledge of fundamental basis of natural sciences;

-knowledge of chemical laws and theoretical basis of chemistry;

-methods of scientific thinking and ability to percept information;

-general principles of solving standard and complex problems;

-regularities of the occurrence of chemical reactions;

-theoretical basis for different methods of quantitative and qualitative analysis;

-chromatography methods;

- technology of performing laboratory works;

-skills for weighing and measuring;

-skills to prepare solution of a given concentration;

- methods of preparation and purification of colloids;

-skills for research work;

-methods of mathematical, physical chemical analysis and model operation.

Expertise:

-to use fundamental laws of chemistry and analyze different chemical processes occurring in living organisms;

-to conduct a search for scientific and technical information;

-to systematize and generalize the obtained information;

-to work out equations of chemical reactions and predict possibility and direction of chemical processes;

-to use the laws of chemistry and natural sciences to acquire professional skills;

-to use scientific information, experimental results and professional knowledge taking part in different conferences, debates and competitions.

5.2. Course Papers Themes.

Discipline doesn't involve writing a term paper (course work).

5.3. List of Assessment Tools.

LABORATORY WORK. List of laboratory works.

TOPIC: «Introduction to general chemistry. Safety regulations in a chemical laboratory»

- Weighing metallic Al on techno-chemical, torsion and analytical balances.

TOPIC: «Solutions».

-Preparation of solutions with sodium chloride of a given mass percentage concentration.

-Preparation of solutions of a given concentration from a fixed weight (from a fixanal).

-Preparation of a standard solution from an initial substance with a given weight.

TOPIC: «Colligative properties of electrolyte and nonelectrolyte solutions»

- The growth of Traube "Artificial cell"
- Changing the state of red blood cells in sodium chloride solutions of different mass percentage concentrations.
- Determination of nonelectrolyte molar mass by Rast's method (on the example of an organic compound).
- Determination of nonelectrolyte molecular mass by cryometry.

TOPIC: «Methods of quantitative analysis»

- Determination of normality and titer of acid solution (H_2SO_4) by the titrant of alkali ($Na_2B_4O_7$).
- Determination of normality and titer of alkali solution by a standard solution of oxalic acid.

TOPIC: «Properties of acids and bases»

- Salt hydrolysis. Determining the pH of the salt solutions.
- Effect of temperature on hydrolysis.
- Complete hydrolysis.

TOPIC: «Buffer solutions and their properties. Buffer systems of the body»

- Determination of the buffer solution action.
- Preparing buffer solutions and studying their action.
- Determination of buffer capacity of blood serum.

TOPIC: «Oxidation-reduction reactions. Oxidation-reduction measure analysis»

- Determination of normality and titer of potassium permanganate solution by a standard solution of oxalic acid.

TOPIC: «Chemistry of coordination compounds»

- Determination of general hard water by complexometry.
- Determination of Fe^{3+}ion concentration by complexometry.

TOPIC: «Biogenic elements. S-elements and their compounds»

-Test-reactions for s-elements.

-Test - reactions for K^+- ion.

-Test - reactions for Mg^{2+}- ion.

-Test - reactions for Ca^{2+}- ion.

-Test - reactions for Ba^{2+}- ion.

TOPIC: «Biogenic elements. P-elements and their compounds»

-Test-reactions for P-elements.

-Test - reactions for Al^{3+}.

-Test - reactions for (HPO_4^{2-}) - ions.

-Test - reactions for NO_3^- -ion

-Test - reaction for Cl^- - ion.

-Test - reaction for Br^--ion.

-Test - reaction for I^- – ion.

-Test - reaction for $B_4O_7^{2-}$ -ion.

TOPIC: «Biogenic elements. D-elements and their compounds»

- Test - reactions for Cu^{2+} ion.

-Test - reactions for Ag^+ ion.

-Test - reactions for Zn^{2+} ion.

-Test - reactions for Cr^{3+} ion.

-Test - reactions for Fe^{2+} ion.

-Test - reactions for Co^{2+} ion.

-Test - reactions for Ni^{2+} ion.

TOPIC: «Dispersed systems. Colloids»

-Preparation of colloidal systems (sols).

-Formation of $Fe(OH)_3$ sol.

-Formation of sol of iron (II) hexacyanoferrate.

-Formation of $Fe(OH)_3$ sol by peptization method.

-Preparation of $Fe(OH)_3$ sol by hydrolysis method.

-Purification of $Fe(OH)_3$ sol by dialysis method.

-Determination of the charge of Prussian blue sols.

-Tyndall effect.

TOPIC: «Stability and coagulation of colloidal solutions»

-Coagulation of iron (III) hydroxide sol by the action of electrolytes.

-Determination of coagulation threshold of iron (III) hydroxide sol.

-The colloidal protection of solutions of macromolecular compounds.

-Synthesis of emulsion.

TOPIC: «Polymer materials: synthetic and biological»

- Heat emission from swelling starch at the time of swelling.

TOPIC: «Reactivity of hydrocarbons: saturated, unsaturated and aromatic»

-α- Pinene oxidation.

-α-Pinene bromination.

-Formation of tribromoaniline.

TOPIC: «Acidic-basic properties of organic compounds. Nucleophilic substitution and elimination reactions»

-Glycerol reaction with copper (II) hydroxide.

-Obtaining ethylene glycolate copper (II).

-Phenol acidity.

-Formation of sodium phenolate and its decomposition.

-Basicity of aliphatic and aromatic amines.

TOPIC: «Carbonyl compounds. Nucleophilic addition reactions»

-Ratio of acetone and formaldehyde for oxidation of alkaline solutions of heavy metal oxides.

-Disproportionation reaction of formaldehyde.

-Determination of acetone by iodoform reaction.

-Preparation of phenol-formaldehyde resin (pitch).

TOPIC: «Carboxylic acids and their derivatives»

-Formation and hydrolysis of iron (III) acetate.

-Formation of insoluble calcium salts of fatty acids.

-Calcium oxalate formation.

-Ethyl acetate preparation.

TOPIC: «Lipids and their functions in biochemical systems»

-Chemical properties of saponifiable lipids:

-Oxidation reaction.

-Formation of insoluble fatty acids of calcium salts.

-The solubility of fats.

-Test with bromine water.

-Test with potassium permanganate.

-Hydrolysis of fats and oils.

TOPIC: «Reactivity and biological significance of heterofunctional compounds»

- Demonstration of absence of phenolic hydroxyl in acetyl salicylic acid and its hydrolysis.

TOPIC: «Reactivity and biological significance of heterofunctional compounds» Biologically active heterocyclic compounds».

-Reaction of furacillin with sodium hydroxide.

-Pyridine properties. Basic properties.

-Reaction with iron (III) chloride.

-Oxidation reaction.

-Reaction of antipyrine, amidopyrinum with iron (III) chloride.

-Reaction of antipyrine and amidopyrinum with nitrous acid.

-Solubility of uric acid and its sodium salt.

-Detection of uric acid (Murexide test).

TOPIC: «Carbohydrates. Monosaccharides»

-Evidence for the presence of hydroxyl groups in monosaccharides.

- Reduction of copper (II) hydroxide with glucose in alkaline medium. (Trommer's test).

-The Tollens' silver mirror test.

-Test-reaction on hexoses (Selivanov's reaction for fructose).

TOPIC: «Carbohydrates. Disaccharides and polysaccharides»

-Demonstration of sucrose non-reducing ability

-Hydrolysis of sucrose.

-Reducing ability of lactose.

-Test-reactions on starch with iodine.

-Hydrolysis of starch.

TOPIC: «Structure and reactivity of α-amino acids»

-Interaction of glycine with ninhydrin (ninhydrin test).

-Interaction of glycine with formaldehyde.

-Interaction of glycine with nitrous acid.

-Reaction of glycine with copper (II) carbonate.

-Amphoteric properties of α-amino acids.

TOPIC: «Peptides and proteins»

-The Biuret test for peptide bonds.

-Xanthoproteic reaction.

-Foll's reaction.

-Protein settling.

TOPIC: «Nucleic acids»

-Benedict's reaction of carbohydrate skeleton detection.

-Hydrolysis of nucleoproteins.

-Molybdenic probe for detection of phosphoric acid residue.

-Detection of purine bases.

PROJECT. Themes of projects.

-Circulation of biogenic elements in nature.

-Classification of biogenic elements.

-General observations of s-elements. Atomic structure of the elements.

-Properties of Group IA elements.

-The most important compounds, containing potassium and sodium. Biological action of K^+ and Na^+-ions.

-Lithium and beryllium. Their structures, properties and biological role.

-Properties of Group IIA elements: calcium, magnesium, barium.

-Major compounds, containing Ca, Mg and Ba. Their biological role.

-Application of alkali metal compounds and alkali earth compounds in medicine.

-General characteristics of p-elements.

-Properties of group IIIA and IVA elements according to their position in the Periodic table. Atomic structure of the elements. Their acid-base properties. Major compounds, containing boronand aluminum (boric acid and borax). Their properties and biological action.

-Major compounds of group IVA elements: oxides, hydroxides, acids, salts, their properties. Carbon monoxide, carbon dioxide, their biological activity. Carbonic acid and its salts. Silicon dioxide and silicates. Application of silica glass in medicine.

-Major compounds containing carbon, silica, tin and lead. Their biological action. Toxicity of lead.

-Properties of group VA elements according totheir position in the Periodic table. Atomic structure of the elements. Their acid-base and red-ox properties.

-Major compounds of nitrogen. Ammonia. Ammonium salts. Nitrogen oxides, nitrous acid, nitric acid. Nitrates, their toxicity.

-Major compounds of phosphorus. Phosphorus oxides and their properties. Ortho-, metha- and pyrophosphoric acids. Phosphates.

-Major compounds containing nitrogen, phosphorus, arsenic, tin and bismuth. Their biological action and application in medicine.

-Properties of group VIA elements according to their position in the Periodic table. Structure of elements' atom. Their acid-base and red-ox properties. Oxygen. Molecular oxygen and ozone.

-Major compounds of sulfur. Sulfur oxides, sulfurous acid and sulfuric acid. The biological role of oxygen and sulfur. Application of oxygen and ozone in medicine

table. Structure of elements' atom. Their acid-base and red-ox properties.

-Halogens. Hydrogen halides. Halogen ox.

-Properties of group VIIA elements according to their positionin the Periodic oacids. The biological role of fluorine, chlorine, bromine andiodine containing compounds.

-General observation of d-elements.

-Properties of group IB and IIB elements according to their position in the Periodic table. Structure of the elements' atoms. Their acid-base and red-ox properties.

-Major compounds containing Cu, Ag, Au, Zn, Hg. Their biological action. Toxicity of these metals. Application of copper, silver, gold, zinc and mercury containing compounds in medicine.

-Properties of group VIB and VIIB elements according to their position in the Periodic table. Structure of the elements' atoms. Their acid-base and red-ox properties.

-Major compounds containing Cr (III), Cr (VI), Mo (VI), Mn (II). Their biological role. Application of chromium, molybdenum, manganese-containing compounds in medicine.

-Properties of group VIIIB elements according to their position in the Periodic table. Structure of the elements' atoms. Their acid-base and red-ox properties.

- Major compounds, containing Fe (II), Fe (III), Co (II), Co (III), Ni (II).Their biological action. Application of iron, cobalt, nickel containing compounds in medicine.

-Complex nature of hemoglobin, cyanocobalamine and their analogs. Participation in metabolic processes.

Heterofunctional derivatives of benzene series.

-Phenoloacids. Structure, nomenclature, isomers. Chemical properties.

-Analgetics on the basis of p-aminophenol: phenetidine, phenacetinum, paracetamol.

-Salicylic acid and its derivatives: sodium salicylate, phenylsalicylate, acetylcalicylate (aspirine), p-aminocalycylic acid (PAS-acid).

-Para-aminobenzoic acid and its derivatives with local anesthetic action: anaesthesin (benzocaine), novocaine.

-Sulfanilic acid, streptocide. Sulfonylamide drugs - etazolum, sulfapyridazinum, sulfadimethoxine.

-Heterocyclic compounds. Classification. Major classes of heterocyclic compounds. Biological role.

-The nature of heteroaromaticity.

-Aromaticity and acid-base properties of heterocyclic compounds.

-Five- and six-membered ring heterocycles.

-Five-membered ring compounds with one heteroatom: pyrrolidine, pyrrole, tetrahydrofuran, furan, tetrahydrothiophene, thiohene.

-Five-membered ring compounds containing two heteroatoms: imidazolidine, pyrazolidine, imidazole, pyrazole, oxazolidine, isoxazolidine, oxazole, isoxazole.

-Six-membered ring compounds with a single heteroatom: piperidine, pyridine, tetrahydropyran, pyran.

-Six-membered ring compounds with two heteroatoms: piperazine, oxazine, morpholine, oxazine.

-Synthesis and modification of heterocyclic rings.

-Chemical properties of five- and six-membered heterocyclic compounds.

-Electrophilic substitution reactions. Hydrogenation reactions.

-Some representatives of heterocyclic compounds: indole, benzofuran, benzothiophene, tryptophan, proline, porphyrin ring system, heme.

-Benzopirrol (indole) and its derivatives - tryptophane, tryptamine, serotonin, skatole.

-Azoles - pyrazole, imidazole, thiazol. Compounds containing an imidazole ring: histidine, histamine.

-Pyrazolone (pyrazyl ketone) and its derivatives: antipyrine, amidopyrinum, analgin, butadion.

-Six-membered heterocycles with one or two nitrogen atoms. Pyridine, quinoline. Nicotinic acid and its amide (vitamin PP).

-Pyrimidine, its oxy- and amine derivatives. Barbituric acid. Tautomeric forms of barbituric acid. Barbiturates, application in medicine.

-Condensed heterocycles. Purine and its oxy- and amino derivatives: adenine, guanine, xanthine, uric acid. Examples of common methylated purines: caffein, theobromine, theophylline.

-Isoprenoids (nonsaponified lipids). Representatives. Biological role.

-Terpane derivatives. Terpadienes. Mentol, terpin.

-Terpadienes. General characteristic. Representatives. Monocyclic terpadienes (limonene).

-Hydrocarbons are ancestors of bicyclic terpenes: thujane, carane, pinane, camphane. Representatives of bicyclic terpenes: camphor, pinene.

-Carotinoids. Carotene. Retinol (vitamin A), retinal. Biological role.

-Steroids. Ancestor of steroid group. General characteristic. Classification. Biological role.

-Sterols. Cholestane and its derivatives. Cholesterol. Campesterol, sitosterol, stigmasterol, ergosterol. Vitamin D_2. Biological role.

-Sterols. Bile acids. Cholic acid. Biological role.

-Steroid hormones. Female sex hormones. Estrogenic hormones: estradiol, estrol, estriol. Biological role.

-Steroid hormones. Male sex hormones. Androgenic hormones: testosterone, and androsterone. Biological role.

-Cardiac glycosides. General characteristic. Biological role.

-Vitamins. Classification. Biological role.

-Fat-soluble vitamins: A, D, E, K.

-Vitamin B group: B_1, B_2, B_6, B_{12}, biotin, folic acid.

-Alkaloids. General characteristic. Classification. Major groups of alkaloids. Representatives. Biological role.

CONTROL WORK. List of questions.

-Solutions. Classification of solutions. The role of water and solutions in the body. Physical and chemical properties of water.

-Diffusion in solutions. Osmosis. Osmotic pressure. Van't-Hoff law.

-Arrhenius concept of acids and bases. Brønsted-Lowry concept of acids and bases. Give examples.

-Buffer solutions and their properties. Acetate buffer action after the addition of acid or base.

-Balance the following oxidation-reduction reaction using the half-reaction method. Identify the oxidizing and reducing agents and determine the type of reaction.

$$KMnO_4 + Na_2C_2O_4 + H_2SO_4 \rightarrow MnSO_4 + K_2SO_4 + Na_2SO_4 + CO_2 + H_2O.$$

-Solubility of gases in liquids. Henry's law, its medical and biological importance.

-Osmotic homeostasis. Isotonic, hypotonic and hypertonic solutions.

-Write the hydrolysis equations of salt NH_4NO_3 in full and reduced forms. Is this salt acidic, basic or neutral in aqueous solution?

-Balance the following oxidation-reduction reaction using the half-reaction method. Identify the oxidizing and reducing agents and determine the type of reaction.

$$CrCl_3 + KMnO_4 + KOH \rightarrow K_2CrO_4 + KCl + MnO_2 + H_2O$$

-Buffer systems of the body. Hydrocarbonate buffer action after the addition of acid or base.

-Ways of expressing the concentration of solutions (mass fraction, molarity, molality, molar concentration of the equivalent, titer, normality).

-Deviation of properties of dilute electrolyte solutions according to Raoult's and Van't-Hoff laws. Isotonic coefficient.

-Self-ionization of water. The pH of a solution. Solutions of strong acids or bases. Degree of electrolytic dissociation.

-Chemical composition of buffer systems. Acidic, basic, amphoteric buffer systems. Ammonia buffer action after the addition of acid or base.

-Balance the following oxidation-reduction reaction using the half-reaction method. Identify the oxidizing and reducing agents and determine the type of reaction.

$$HI + HNO_3 \rightarrow I_2 + NO + H_2O.$$

-Solubility of liquids and solids in liquids.

-Solutions of weak acids or bases. Acid-ionization equilibrium. Acid ionization constant, base-ionization constant.

-Buffer capacity: dependence on various factors, methods of determination.

-Balance the following oxidation-reduction reaction using the half-reaction method. Identify the oxidizing and reducing agents and determine the type of reaction.

$$Cr(OH)_3 + H_2O_2 + KOH \rightarrow K_2CrO_4 + H_2O.$$

-Give examples of neutralization reaction.

-Barium chloride (6g) is dissolved in 250 ml of water (density of water is 1g/ml). What is the mass fraction of salt in the obtained solution?

-Raoult's law. Consequences of Raoult's law. *Urea, $(NH_2)_2CO$, is dissolved in 100,0 g of water. The solution freezes at -0.085C. How many grams of urea were dissolved to make this solution?*

-Write the reactions of hydrolysis of the following salts in the molecular and net ionic forms: $NaNO_3$, K_2CO_3 , $CaCl_2$, CH_3COONa. Indicate reaction of the environment.

-Types of buffer solutions. Give the mechanism of action on the example of phosphatic buffer.

-Define solutions. Write their classification, general properties of solutions and their application. *Calculate how many grams of Na_2CO_3 is contained in 200 ml of solution with concentration 0,1mol/L.*

-Osmosis. Osmotic homeostasis. Changing the state of red blood cells in isotonic, hypotonic and hypertonic solutions.

-Give an example of hydrolysis reaction where a salt is formed between a strong base and a weak acid. Write the reactions in the molecular and net ionic forms.

-Balance the following oxidation-reduction reaction using the half-reaction method. Identify the oxidizing and reducing agents and determine the type of reaction.

$$\mathbf{KClO_3 \rightarrow KCl + O_2.}$$

-Hemoglobin buffer action after the addition of acid or base.

-Give an example of salt, which water solution is alkaline. Write the equation of chemical reactions.

-2 mol potassium sulfate was dissolved in 1000g of water. Calculate the mass fraction of solute.

-What is the boiling point of a solution of 0,150 g of glycerol, $C_3H_8O_3$, in 20,0 g of water? What is the freezing point?

-Balance the following oxidation-reduction reaction using the half-reaction method. Identify the oxidizing and reducing agents and determine the type of reaction.

$$\mathbf{P + HNO_3 + H_2O \rightarrow H_3PO_4 + NO.}$$

-Oxyhemoglobin buffer action after the addition of acid or base.

-Structure of coordination compounds. The inner and outer spheres of coordination compounds. The central atom, coordination number of metals, ligands, its dentation. Give examples. Give the names of the following coordination compounds:

$[Pt(NH_3)_2Cl_2]$; b) $[Co(NH_3)_6]Cl_3$; c) $K_3[Cu(CN)_4]$; d) $K[Au(CN)_2]$.

- Give formulas for following complex ions:

  a) tetrachloroferrate (III) ion; b) pentaammineaquaruthenium (III) ion;

  c) potassiumhexacyanoferrate (II); d) ammine trichloroplatinate (II) ion.

-Phenomena on the surface, general characteristics, their essence and significance in biology and medicine.

-Surface energy. Surface tension. Surface phenomena on the boundary of phases: liquid-gas, liquid-liquid, solid-gas, solid-liquid. Give examples.

-Adsorption. Adsorbent and adsorbate. The nature of adsorption forces. Specific adsorption. Adsorption at the solid/gas, solid/liquid interface. Give examples.

- Surface-inactive and surface-active (surfactant) agents. Traube's rule. Give the examples.

-Dispersed systems. Dispersed phase and continuous phase. Classification of dispersed systems.

-12 ml of 0,01M of $FeCl_3$ solution were added to 10 ml of 0,05N $K_4[Fe(CN)_6]$ solution to obtain sol of Berlin blue. Write down the formula of micelle for this sol. What is the charge of the granule?

-Stability of colloidal solutions. Kinetic and aggregative stability of sols.

-Types of colloids: according to the state of the dispersed phase and the continuous phase; according to the particle size of the dispersed phase. Hydrophobic and hydrophilic colloids.

-Write down the micellar structure of sol $Fe(OH)_3$ formed by condensation method (hydrolysis method).

-Methods of purification of colloidal solutions: dialysis, electro dialysis, compensation dialysis, ultra filtration.

-Coagulation by electrolytes. Coagulation threshold. Coagulating capacity. Schulze-Gardy's rule.

- Methods of obtaining colloidal solutions: condensation and dispersion methods.

-For preparing silver chloride sol 85 ml of 0,005M silver nitrate solution were added to 15 ml of 0,025M potassium chloride solution. Write down the formula of the obtained sol micelle. What is the charge of its granule?

-Adsorption. Adsorbent and adsorbate. The nature of adsorption forces. Preferential adsorption. Surface-inactive and surface-active substances. Medical and biological value of adsorption.

-Association colloids. Coagulation in biological systems.

- Polymers. Classification. Synthetic organic polymers. Addition reactions and condensation reactions. Give examples.

- Polymer solutions: sols and gels of organisms.

-Natural polymers. Polysaccharides. Proteins. Nucleic acids.

-Chromatography. The main point and notion of chromatography. Classification of chromatography methods. Chromatography in biology and medicine.

-Preparation of colloidal solutions (sols). Formation of sol of iron hexacyanoferrate (II) $Fe_4[Fe(CN)_6]_3$. Write the micellar structure of a dark-blue solution of Prussian blue sol.

-Factors of sol stability. Change of the sol stability under the influence of temperature, concentration of sol, electrolytes. Give the explanation.

-Optical and molecular kinetic properties of colloidal sols. Tyndall effect.

-12 ml of 0,01M of $FeCl_3$ solution were added to 10 ml of 0,05 N $K_4[Fe(CN)_6]$ solution to obtain sol of Berlin blue. Write down the formula of micelle of this sol. What is the charge of the granule?

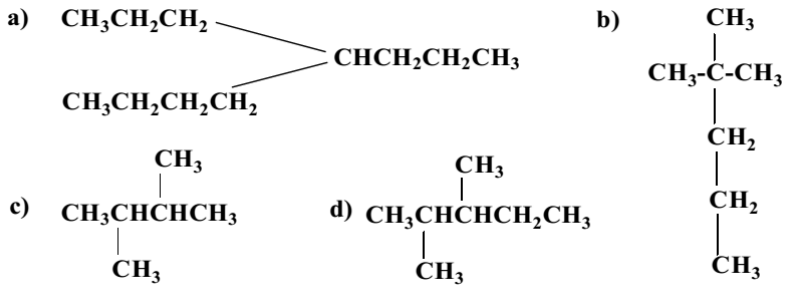
-Coagulation. Causes and mechanism of coagulation. Kinetics of coagulation: fast, slow, dormant and evident coagulation.

-Determination of the sols charge colored particles.

-Preparation of colloidal solutions (sols). Formation of sol of iron hexacyanoferrate (II) $Fe_4[Fe(CN)_6]_3$. Write the structure of a dark-blue solution of Prussian green sol.

-Coagulation threshold. Coagulating capacity. Determination of coagulation threshold of iron (III) hydroxide sol.

-Give the IUPAC name for each of the following compounds:



-What is the major product in the reaction of 2-methyl-2-butene with each of the following reagents?

a) HBr ; d) Br_2/CCl_4;

b) H_2/Pd ; e) $KMnO_4$ (H_2O).

-Write the reaction interaction of acetaldehyde with hydroxylamine and acetaldehyde with hydroxylamine.

-Write the complete structural formulas for each of the following carboxylic acids:

a) 2-bromopentanoic acid;

b) 2-bromo-3-methylbutanoic acid;

c) 2-bromocyclohexanecarboxylic acid;

d) 2,6-dichlorocyclohexanecarboxylic acid;

e) 2,4,6-trimethylstearic acid; f) propenoic acid.

-What are enantiomers? Give the enantiomers of lactic acid. Determine the configuration of these structures.

-Name the functional group in each of the following molecules:

a) CH_3-CH_2-CH_2-OH; d) CH_3-CH_2-CH_2-NH_2;

b) CH_3-CH_2-CH_2-COH; e) CH_3-CH_2-CH_2-COOH;

c) CH_3-CH_2-CH_2-$COOCH_2CH_3$; f) CH_3-CH_2-O-CH_2CH_3.

Name each of the following using the IUPAC nomenclature system.

- Give the mechanism for the following reaction.

$$CH_2CH_2CH=CH_2 + Br_2 \xrightarrow{AlBr_3} ?$$

-Write an equation of interaction of propionaldehyde with hydrogen cyanide.

-Write a complete structural formula and determine the IUPAC name for each of the carboxylic acids of molecular formular $C_4H_8O_2$.

-What compounds are called optically active compounds or optical isomers?

-Give an example, using structural formulas for each of the following families of organic compounds. Each of your examples should contain a minimum of three carbons:

1) a carboxylic acid; 2) an amine; 3) an alcohol; 4) an ether.

-What will the major product of the reaction of 1 mol of 2-butyne and each of the following reagents be?

a) HBr (1mol); c) excess H_2/Pt ;

b) HBr (2 mol); d) H_2O/Hg^{+2}; e) Br_2 (2 mol).

-Write the equation of Cannizzaro reaction for formaldehyde and benzaldehyde.

-Write the acid-catalyzed ester hydrolysis of ethyl acetate.

-Write the scheme of decarboxylation of acetoacetic acid and give the name of the product.

-Write the structural formulas of alkanes given in the IUPAC names:

2,5-dimethyl-3-ethylhexane; 3-methyl-3-ethylpentane; 2-metyl-4-isopropylheptane; 2,2,4-trimethyloctane.

-Describe the Kekule model for benzene structure.

-Which of the following compounds would be expected to give a positive Tollen's test?

a) 3-pentanone; b) cyclohexanone;

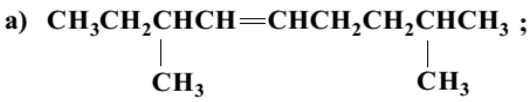
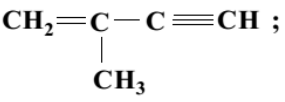
c) 3-methylbutanal; d) cyclopentanol;

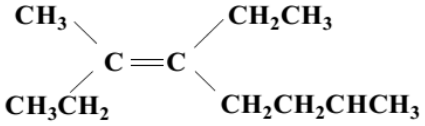
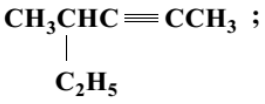
e) 2,2-dimethyl-1-pentanol; f) acetaldehyde.

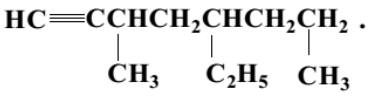
-Write the scheme of the acetamide formation from the acetyl chloride and ammonia.

-What are diastereomers? Write the Fischer projection of diastereomers of D-tartaric acid.

-Give the IUPAC name for each of the following compounds:

a)  ; b)  ;

c)  ; d)  ;

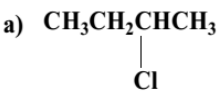
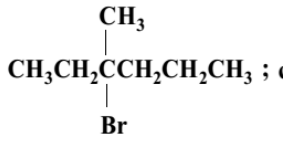
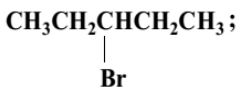
e)  .

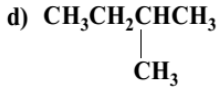
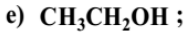
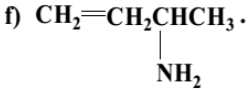
-Write an equation showing the reaction of benzene with Cl_2 in the presence of $FeCl_3$.

-Write an equation for the aldol condensation of two molecules of ethanal.

-What is saponification? Give an example using specific molecules.

-Which of the following compounds has a stereogenic center?

a)  ; b)  ; c)  ;

d)  ; e)  ; f)  .

-Draw the structure for each of the following hydrocarbons:

a) 2,2,4-trimethylheptene-3; b) 3-methyl-3-isopropylhexyne-1;

c) pentadiene-1,2; d) 1,3,5-tribromo-2-pentene;

e) trans-3-methyl-2-heptene; f) di-t-butylacetylene;

g) t-butyl-s-butylacetylene.

-Benzene, toluene bromination. Describe the mechanism for electrophilic aromatic substitution.

-An aldehyde can be oxidized to produce a carboxylic acid. Draw the carboxylic acid that would be produced by oxidation of each of the following aldehydes:

a) methanal; b) ethanal; c) propanal; d) butanal.

-Classification of lipids. Write the formation reaction of fat containing one residue of linoleic acid and two molecules of palmitic acid.

-Aminoalcohols. Structure, properties, biological role. Ethanolamine-colamin. Choline, acetylcholine. Biogenic amines. Noradrenaline, adrenaline.

-Write structural formulas and isomers for:

a) 1,2,3,-trimethylbenzene; b) p-diethylbenzene.

-Ortho-, para- directing substituents, and meta-directing substituents. Give examples.

-What is the general name for the product that is formed when an aldehyde reacts with one molecule of alcohol? Write the reaction equation.

-Classification of lipids. Describe the differences between fat, oil and waxes. Write the configuration of linoleic acid.

-What is the major structural feature that distinguishes between saturated and unsaturated hydrocarbons?

-Write an equation representing oxidation of propene in aqueous $KMnO_4$ solution.

-Draw the generalized equation for oxidation of primary and secondary alcohols.

-Write the scheme of hydrolysis for 1,2-dipalmito-3-oleoglycerol in acidic and basic solutions.

-Oxy- and aminoacids. Structure, nomenclature, isomers.α-, β-, γ-oxy and aminoacids. Chemical properties. Dehydration reactions.

-Using structural formulas draw a typical alcohol, aldehyde, ketone, carboxylic acid and amine.

-Give the mechanism of benzoic acid nitration.

-List several aldehydes and ketones that are used as food or fragrance chemicals.

-Composition, structure, properties and biological role of phospholipids. Give the structural formula for lecithin, containing parts of stearic and linolenic acids. What are the products of hydrolysis of this lipid?

-Some representatives of oxy acids: glycolic, lactic, oxybutyric, malonic, tartaric, citric, succinic acids.

-Give the structures and the IUPAC names for all alkenes with the molecular formula C_6H_{12}.

-Describe the geometry of ethylene and ethyne. What are the bond angles in molecules of ethylene and ethyne?

-Ethanal is produced by oxidation of ethanol. Where does this reaction occur in the body? Write the equation.

-Saturated and unsaturated fatty acids. Configurational isomers of fatty acids. Write the structural and configurational formulas of fatty acids: palmitic, stearic, oleic, linoleic, linolenic acids.

-Aldehydes and ketoacids. Structure, nomenclature, isomers. Keto-enol-tautomerism. Representatives: pyruvic, acetoacetic, oxalacetic, α-ketoglutaric acids.

-Give the scheme of oxidation of D-glucose and D-galactose by the action of mild (Br_2) and strong (HNO_3) oxidizing agents.

-Classification of disaccharides. The structure of disaccharides, monosaccharide composition.α-1,4 and β-1,4-glycosidic linkage.

-Structure of α-amino acids. Nomenclature, isomerism. Biological role, application in medicine.

-How do ribonucleotides and deoxyribonucleotides differ in structure? Do they form polymers in the same way?

-Write the structural formula for the nucleotide adenosine-5′-monophosphate.

-Draw the following sugars using Haworth projections:

a) β-D-galactopyranose; b) α-D-glucofuranose;

c) α-D-fructofuranose; d) β-D-ribofuranose.

-Reducing and nonreducing sugars. Representatives: maltose, cellobiose, lactose and sucrose.

-Predict the products of the treatment of glycine with:

a) aqueous NaOH; b) aqueous HCl;

c) acetic anhydride; d) $NaNO_2$+HCl; e) $C_2H_5OH + H_2SO_4$.

-Write the structural formulas of two tripeptides formed in the reaction of L-tryptophan, L-glutamic acid, and L-tyrosine. How many tripeptides are possible?

-Write a structural formula for nucleotide deoxyadenosine-5′-monophosphate.

-Write the structures of:

a) penta-O-acetyl-β-D-glucopyranose; b) D-glucuronic acid;

c) ethyl β-D-glucopyranoside; d) ethyl α-D-fructofuranoside.

-What products would be obtained if maltose itself were subjected to methylation and hydrolysis? What would this tell us about the structure of maltose?

-Give the scheme of dehydration of:

a) glycine; b) γ-amino butyric acid; c) β-amino isobutyric acid.

-Write the structural formulas of all possible tripeptides with the composition of two glycine and one serine.

-RNA and DNA: structure, types of linkages, nomenclature, properties. Complementary pairs. Biological significance of nucleic acids.

-Give structures and names of the principal products of the reaction of D(+)-galactose with: a)bromine water; b)HNO_3; c)acetic anhydride; d)CH_3OH, HCl; e)$NaBH_4$.

-Sucrose is a disaccharide formed by linking α-D-glucose and β-D-fructose by an α (1→2) bond. Draw the structure of this disaccharide.

-Give the schemes of decarboxylation of histidine, aspartic acid, glycine, lysine.

-Predict the product of the reaction of valine with the following reagents:

a) CH_3CH_2OH, acid; b) HCl; c) KOH, H_2O; d) CH_3COCl, pyridine; then H_2O.

-Give the structure of deoxythymidilic acid, uridilic acid, deoxyguanilicacid. Give their names as phosphates of nucleosides.

-Write equations to show how D(+)-glucose could be converted into:

a) methyl-β-D-glucoside; b) methyl-β-2,3,4,6-tetra-O-methyl-D-glucoside;

c) D-glucuronic acid; d) sorbitol.

-Maltose is a disaccharide isolated from amylase that consists of two glucose units linked by α(1→4). Draw the structure of this molecule.

-Classification of biogenic amino acids according to acid-base properties and nature of the radical. Draw the structure for each of the following compounds:

a) N-ethylethanamine; b) 3-ethyl-1-(methylamino)pentane;

c) 4-amino-2-methylhexane; d) 5-methyl-1-hexanamine;

e) methyldipropylamine; f) N,N-dimethyl-3-pentanamine;

g) cyclohexylethylmethylamine.

-Draw a dipeptide composed of glycine and alanine. Begin by drawing glycine with its amino group on the left. Circle the amide bond.

-Nucleotides. Definition, structure, types of linkages, nomenclature, properties. Ribonucleotides and deoxyribonucleotides.

-Draw the structure of the open-chain form of D-fructose, and show how it cyclizes to form α- and β-D-fructose.

-Show the product you would obtain from the reaction of cellobiose with the following reagents:

a) $NaBH_4$; b) Br_2, H_2O; c) CH_3COCl, pyridine.

-Draw the zwitterion structure for the amino acid serine, leucine. Using the behavior of hydroxy acids as a pattern, predict structures for the products obtained when the following amino acids are heated:

a) α-amino acid, glycine $\rightarrow C_4H_6O_2N_2$ (diketopiperazine);

b) β-amino acid, $CH_3CH(NH_2)CH_2COOH \rightarrow C_4H_6O_2$;

c) γ-amino acid, $CH_3CH(NH_2)CH_2CH_2COOH \rightarrow C_5H_9ON$ (a lactam);

d) δ-amino acid, $NH_2CH_2CH_2CH_2CH_2COOH \rightarrow C_5H_9ON$ (a lactam).

-Describe the primary structure of a protein. What makes one protein different from another one of the same size? What is the basis of the unique conformation of a protein?

-Nucleosides: definition, structure, types of linkages, nomenclature, properties. Ribonucleosides and deoxyribonucleosides. Hydrolysis.

-Carbohydrates. Classification. Biological role. Distinguish between simple and complex sugars. What are some sources of complex carbohydrates?

-What are homopolysaccharides? Give examples.

-Amino acids as dipolar ions. Isoelectric point (pI) of amino acids. Show the structures of the following amino acids in their zwitter ionic forms: a) Trp; b) Ile; c) Cys; d) His.

-Predict the products of the treatment of glycine with:

a) aqueous NaOH; b) aqueous HCl; c) acetic anhydride;

d) $NaNO_2$+HCl; e) $C_2H_5OH + H_2SO_4$.

-Proteins. Classification. Structure. Distinguish between secondary and tertiary structures of proteins.

-Nucleic acids. Name the complementary base pairs. Describe the DNA double helix, structure.

-Carbohydrates. Classification. Structure. Monosaccharides. Refer to the linear structure of D-galactose. Draw the Haworth projections of α- and β-D-galactose.

-Polysaccharides. Write the structure of cellulose disaccharide fragment and show the bond type between two monosaccharide units.

-Methods of extraction, separation and purification of proteins. Methods of protein molar mass determination.

-Structural components of nucleic acids. Nucleic bases. Purine derivatives (adenine and guanine) and pyrimidine derivatives (cytosine, thymine, uracil). Lactime-lactame tautomeric forms.

-Carbohydrates. Classification. Monosaccharides. Refer to the linear structure of D-ribose. Draw Haworth projections of α- and β-D-ribose. Note that D-ribose is a pentose.

-Hyaluronic acid is a component of connective tissue and is the fluid that lubricates the joints. It is an alternating polymer of N-acetyl-D-glucosamine and D-glucuronic acid joined by β-1,3'-glycosidic linkages. Draw a short segment of hyaluronic acid.

- Amino acids reactions on carboxylic group: etherification reaction, reactions with phosphorus halogenides (PCl_5, PCl_3).

-Structure and biological functions of myoglobin and hemoglobin.

-Carbohydrates. Types of carbohydrates. Biological role. What is the difference between a monosaccharide and a disaccharide?

-Pectin is a polysaccharide obtained from fruits that is used as a jelling agent in making jams and jellies. It can be synthesized by reacting amylose with nitric acid. Draw a short segment of pectin.

-Amino acids. Reactions of amino group with formaldehyde, nitrous acid, acetic anhydride.

-Levels of protein structural organization: primary, secondary (α-helix), tertiary, quaternary. Bond types.

-Draw the complete structure of the RNA dinucleotide UA.

-Monosaccharides. Properties. Draw the products you would obtain by reaction of β-D-ribofuranose with:

a) CH_3I, Ag_2O; b)$(CH_3CO)_2O$, pyridine; c) HNO_3; d) Br_2, H_2O.

-What are polysaccharides? Types of polysaccharides. Give examples. Write the formula of disaccharide fragment of amylose. Point the linkage type.

-Structure of α-amino acids. Nomenclature, isomerism. Biological role, application in medicine.

-Amino acids are metabolized by transamination reaction in which the-NH_2 group of the amino acid changes places with the keto group of an α-keto acid. The products are a new amino acid and a new α-keto acid. Show the product from transamination of isoleucine.

-Classification, properties and biological functions of proteins. Fibrous proteins. Collagen, α-keratins, myosin.β-pleated sheet. Silk fibroin. Globular proteins.

-Draw the complete structure of the DNA dinucleotide AG.

-Monosaccharides. Properties. Draw all of the different possible aldotetroses of molecular formula $C_4H_8O_4$.

-Write the formula of disaccharide fragment of amylopectin. Point the linkage type. Write the equation of starch hydrolysis in the presence of acid.

-Amphoteric properties of amino acids. Acid-base properties of amino acids. Types of salts. Write the equations of the formation of all types of salts for alanine.

-Levels of protein structural organization: primary, secondary (α-helix), tertiary, quaternary. Bond types.

-Nucleic acids. The structure of nucleotides. Base pairing in DNA. The Watson-Crick model.

Test.

Module 1. General and bioinorganic chemistry.

Solutions are:

a) isolated systems, separated from the surroundings by an interface surface;

b) homogeneous systems which do not exchange by mass with the surroundings;

c) homogeneous systems which contain at least two components;

d) heterogeneous systems which contain at least two components.

A solution of a salt and 100 grams of water that can still dissolve more solute at a given temperature is classified as:

a) unsaturated; b) supersaturated; c) diluted; d) saturated.

Which substance is most likely to be soluble in a nonpolar solvent?

a) glucose; b)graphite; c) lithium fluoride; d)sulfur.

110 grams of KF are dissolved in water to make 850 ml of solution. What is the molarity of the solution?

a) 0,129 M; b) 0,620 M; c) 0,002 M; d) 2,23 M.

The effect of the nature of a solvent and a solute on solubility is described by the following rule:

a) «like dissolves like»;

b) the solubility of a gas in a liquid is proportional to the partial pressure of a gas above the solution;

c) the larger the concentration of reactant molecules, the faster the reaction;

d) the mass of the substances entering into a reaction equals the mass of the substances formed as a result of the reaction.

The statement that solubility of a gas in a liquid is proportional to its partial pressure above the solution is defined as:

a) the Henry's law; b)the Sechenov equation;

c) the Ostvald's dilution law; d) the Paul's principle.

Solutions which are applied in medicine for intravenous injections are characterized by their osmolarity or osmolality. These concentration units express:

a) concentration of water;

b) concentration of substances unable to diffuse through cell membranes;

c) concentration of substances able to diffuse through cell membranes;

d) concentration of electrolytes.

In order to increase solubility of gases in water it is necessary:

a) to increase gas pressure above water solution; to decrease temperature;

b) to add some electrolytes into a solution;

c) to add some nonelectrolytes into a solution;

d) to increase temperature.

Osmolarity is:

a) the molarity of particles in a solution;

b) the amount of solute dissolved in a specified amount of solution;

c) mass percentage concentration;

d) the concentration in parts per thousand.

Solubility of solids depends upon:

a) the nature of solutes and solvents and temperature;

b) pressure;

c) heat of solution;

d) all answers are right.

The density of an aqueous solution containing 10 percent of ethanol by mass is 0,984 g/ml. The molarity of this solution will be:

a) 2,41mol/kg; b) 2,13M; c) 0,059ℓ; d) 36%.

Generally, solubility is defined as:

a) ability of substances to be dissolved in a particular solvent;

b) diffusion of solute particles throughout a solution;

c) heat amount absorbed or released when one mole of a solute is dissolved in the endless amount of a solvent under the standard conditions.

d) destruction of solute's crystal lattice.

An erythrocyte placed into 10% NaCl solution undergoes:

a) hemolysis; b) plasmolysis; c) swelling; d) precipitation.

Point out solutions which are isotonic with blood plasma:

a) 3 % sodium chloride; 4,5 % glucose;

b) 0,9 % glucose; 0,9 % sodium chloride;

c) 0,9 % sodium chloride; 4,5 % glucose;

d) 20 % glucose; 10% $CaCl_2$.

Osmosis is a spontaneous process defined as:

a) a reversible thermodynamic process of water diffusion through semipermeable membrane from a solution of a weak electrolyte into a solution of a strong electrolyte;

b) a reversible thermodynamic process of water diffusion through semipermeable membrane from a true solution to a colloidal solution;

c) a reversible thermodynamic process of solute diffusion through semipermeable membrane from pure water to a solution;

d) a reversible thermodynamic process of water diffusion through semipermeable membrane from a dilute solution into a more concentrated one.

Normal osmotic pressure of blood plasma is:

a) 740-780 kPa; b) 140-240 kPa; c) 840-980 kPa; d) 60-70 kPa.

The osmolarity of $5 \cdot 10^{-3}$ M Na_3PO_4 is:

a) $5 \cdot 10^{-3}$osmol; b) $2 \cdot 10^{-2}$ osmol; c) $4 \cdot 10^{-3}$ osmol; d) $2 \cdot 10^{-3}$osmol.

In accordance with the state of aggregation solutions are:

a) liquid, transparent, colored;

b) solid, liquid, turbid;

c) gaseous, liquid, solid;

d) liquid, turbid, colored.

Which substance produces an acidic solution when it is bubbled into water?

a) CO_2; b)Ar; c) NH_3; d)CH_4.

The molality of the solution containing 7,2 mole of ethylene glycol ($C_2H_6O_2$) in 3546 g of water is:

a) 0,03mol/kg; b) 0,03mol/l; c) 0,03mol; d) 30%.

Point out a solution with the highest boiling point:

a) 0,01M sucrose; b) 0,01 M sodium phosphate;

c) 0,01M potassium chloride; d) 0,01 M sodium carbonate.

Molar concentration is expressed in:

a) mol/kg; b) percentage; c) mol/l; d) g/ml.

Define the Raoult's cryoscopic law:

a) freezing points of solutions containing nonvolatile solutes are always lower than those of pure solvents;

b) freezing points of solutions containing nonvolatile solutes are always higher than those of pure solvents;

c) freezing points of pure solvents are always lower than those of solutions**;**

d) freezing points of pure solvents are always higher than those of solutions.

Cryoscopy and ebullioscopy are experimental methods to determine:

a) density; b) molar mass; c) viscosity; d) osmotic pressure.

Osmotic pressure can be calculated according to the following equation:

a) $\pi = MRT$; b) $\Delta T_f = K_f C_m$; c) $\Delta T_b = K_b C_m$; d) $\Delta T_f = iK_f C_m$.

Colligative properties of solutions depend upon:

a) the number of the solute particles; b) the chemical structure of solute;

c) catalysts; d) pH scale.

The mathematical expression of cryoscopic Raoult's law is defined as:

a) $\Delta T_f = K_f \cdot C_m$; b) $\pi = MRT$; c) $\Delta T_b = K_b \cdot C_m$; d) $pH = -\log[H^+]$.

The molality of the solution containing 14,3 g of sucrose ($C_{12}H_{22}O_{11}$) in 676 g of water is:

a) 0,08mol/kg; b) 0,08mol/l; c) 0,008 mol; d) 80%.

A 10 % solution of NaCl means that in 100 grams of the solution there is:

a) 5,85 g of NaCl; b) 10 g of NaCl; c) 10 g of NaCl d) 58,5 g ofNaCl.

The Raoult's ebullioscopic law can be defined as:

a) boiling points of solutions containing nonvolatile solutes are always lower than those of pure solvents;

b) boiling points of solutions containing nonvolatile solutes are always higher than those of pure solvents;

c) boiling points of pure solvents are always higher than those of solutions containing nonvolatile solutes;

d) boiling points of pure solvents are always lower than those of solutions containing nonvolatile solutes.

The osmolarity of $5{,}0\times10^{-2}$ M NaCl is equal to:

a) $2{,}0\times10^{-2}$osmol; b) $1{,}0\times10^{-1}$osmol;

c) $3{,}0\times10^{-2}$osmol; d) $5{,}0\times10^{-3}$osmol.

The osmotic pressure of a 5×10^{-2} M solution of NaCl at 25^0 is:

a) 7,7atm; b) 2,7 atm; c) 2,4 atm; d) 6,9 atm.

Give the name to positively charged particles:

a) radicals; b) molecules; c) anions; d) cations.

Gastric juice pH is approximately 1. The hydrogen ions molarity in it is:

a) 0,01M; b) 0,001M; c) 0,1M; d) 1,0M.

Strong electrolytes are characterized by:

a) ionic strength of solution; activity coefficient of electrolytes;

b) ionization constant of water;

c) acid ionization constant;

d) all answers are right.

Which pair of solutes could be used to prepare an aqueous buffer solution with a pH>7?

a) HCl-NH_4Cl; b) HF-NaF; c) NH_3-NH_4Cl; d) NaOH-NaCl.

Which substance below is expected to be the strongest electrolyte?

a) water; b) acetic acid; c) hydrofluoric acid; d) hydrochloric acid.

The Henderson-Hasselbalch equation allows the calculation of:

a) a buffer pH; b) pH of acids; c) pH of bases; d) pH of salts.

Condition of high blood CO_2 level and low pH is termed as:

a) alkalosis; b) hemolysis; c) acidosis; d) homeostasis.

What substance is applied in medicine to treat acidosis?

a) $NaNO_2$; b) $NaHCO_3$; c) Na_2CO_3; d) $KMnO_4$.

Buffer capacity of a solution depends upon:

a) nature of components; the ratio of concentrations of buffer components.

b) atmospheric pressure;

c) boiling point;

d) vapor pressure.

According to the Brønsted-Lowry theory, an acid is:

a) a proton donor; b) a proton acceptor;

c) an electron donor; d) an electron acceptor.

The acid-base state of blood is determined by:

a) pH value, HCO_3^- concentration and pressure of CO_2;

b) pOH value, H^+ and OH^- concentration;

c) pH value, CH_3COO^- and H^+ concentration;

d) concentration of H^+ and OH^-.

The point at which a titration is complete is called the:

a) end point; b) equilibrium point;

c) calibrated point; d) chemical point.

The pH of a $1{,}0\times10^{-3}$ M solution of HCl is:

a) 1; b) 6; c) 3; d) 8.

Weak electrolytes are characterized by:

a) ionization percent; acid ionization constant; base ionization constant;

b) ionic strength;

c) concentration of a gas in a solution;

d) ion product for water.

Specify which of the following systems can be classified as a buffer system:

a) KCl/HCl; b) NaH_2PO_4/Na_2HPO_4;

c) $KHSO_4/H_2SO_4$; d) NH_3/NH_4Cl.

The reaction: **HI (aq) + LiOH (aq) → LiI (aq) + H_2O (l)** is classified as:

a) a single replacement; b) a neutralization reaction;

c) the process of hydrolysis; d) an oxidation-reduction reaction.

What reactions occurring in aqueous solutions are redox?

a) Fe_2O_3 + HCl; b) $FeCl_3+H_2S$; c) Fe+ HCl; d) SO_3+NaOH.

An oxidizing agent is an atom, a molecule or an ion, which:

a) accepts electrons;

b) donates electrons;

c) increases its oxidation number;

d) decreases its concentration.

The most important reducing agents are:

a) metals, H_2, HCl, HBr and their salts;

b) halogens, O_2, $KMnO_4$;

c) H_2SO_4 (concentrated), HNO_3;

d) none of the above.

In the chemical cell reaction **$2Cr + 3Ni^{2+} \rightarrow 2Cr^{3+} + 3Ni$**, which species is reduced?

a) Cr; b) Ni^{2+}; c) Cr^{3+}; d) Ni.

What is the oxidation number of As in the compound **$K(NH_4)_2AsO_4 \cdot 6H_2O$**?

a) -3; b) +1; c) +3; d) +5.

What is the oxidation number of C in formaldehyde, CH_2O?

a) 2; b) 0; c) +2; d) +4.

The half-reaction **$I_2 + 2e^- \leftrightarrow 2I^-$** is a basis for:

a) permanganatometry; b) iodometry;

c) chelatometry; d) acid-base titration.

Pick the coefficients and specify their sum in the following equation:

$KMnO_4 + H_2S \rightarrow MnO_2 + S + K_2S + H_2O$

a) 6; b) 10; c) 16; d) 20.

In a balanced equation the number of electrons gained and lost must be:

a) equal; b) high; c) low; d) equilibrium.

Point out the disproportionation reaction:

a) $2H_3PO_4 + 5KOH \rightarrow K_3PO_4 + K_2HPO_4 + 5H_2O$;

b) $4HNO_2 \rightarrow 2HNO_3 + NO + H_2O$;

c) $2NaNO_3 \rightarrow 2NaNO_2 + O_2$;

d) $2KMnO_4 + 5H_2O_2 + 3H_2SO_4 \rightarrow 2MnSO_4 + 5O_2 + K_2SO_4 + 8H_2O$.

In which of the following compounds an element exhibits two different oxidation states:

a) NH_2OH; b) NH_4NO_3; c) NH_3; d) N_2H_4.

What is the coefficient for O_2 when the following reaction:

$\_\_As_2S_3 + \_\_O_2 \rightarrow \_\_As_2O_3 + \_\_SO_2$

is correctly balanced with the smallest integer coefficients?

a) 5; b) 6; c) 8; d) 9.

Pick the coefficients in the following reaction scheme and specify the coefficient before sulfuric acid:

$K_2Cr_2O_7 + KNO_2 + H_2SO_4 \rightarrow KNO_3 + K_2SO_4 + Cr_2(SO_4)_3 + H_2O$

a) 6; b) 8; c) 10; d) 4.

In redox reactions HNO_2 exhibits:

a) only oxidizing properties;

b) only reducing properties;

c) neither oxidizing nor reducing properties;

d) oxidizing and reducing properties (redox duality).

What is the purpose of the salt bridge in an electrochemical cell?

a) it allows ion migration; b) it allows neutron migration;

c) it allows electron migration; d) it prevents ion migration;

Hydrogen peroxide is used as:

a) antiseptic; b) antioxidant;

c) acidifying agent; d) protectant.

What are the products of the reduction reaction of $KMnO_4$ in the presence of a base?

a) $Mn(OH)_2$; b) MnO_4^{2-}; c) MnO_2; d) Mn^{2+}.

A group of atoms can function as a ligand only when:

a) it is a small molecule;

b) it is capable of acting as a donor of electron pair;

c) it is a negatively charged ion;

d) it is a positively charged ion.

The IUPAC name of **$[Co(NH_3)_3(NO_2)_3]$** is:

a) trinitrotriammine cobalt (III); b) trinitrotriammine cobalt (III) ion;

c) trinitrotriammine cobalt (II); d) trinitrotriamminecobaltate (III);

Ethylenediaminetetraacetate ion ($EDTA^{4-}$) is commonly referred to as a _____ ligand:

a) hexadentate; b) bidentate; c) monodentate; d) none of these.

Which is the central ion in **$[Cu(H_2O)_4]^{2+}$** ion :

a) Cu^{2+}; b) H_3O^+; c) Cu^+; d) none.

The primary and secondary valences of chromium in the complex ion, dichlorodioxalatochromium (III), are:

a) 4, 4; b) 4, 3; c) 3, 6; d) 6, 3.

According to Lewis the ligands are:

a) acidic in nature; b) basic in nature;

c) neither acidic nor basic; d) some are acidic and other are basic.

The coordination number of cobalt in the complex **$[Co(en)_2Br_2]Cl_2$** is:

a) 2; b) 6; c) 5; d) 4.

How many ions are produced in aqueous solution of **$[Co(H_2O)_6]Cl_2$** ?

a) 2; b) 3; c) 4; d) 6.

In **$K_4[Fe(CN)_6]$** the number of unpaired electrons in iron are:

a) 0; b) 2; c) 3; d) 5.

Correct formula of diammine silver (I) chloride is:

a)$Ag(NH_3)Cl$; b) $Ag(NH_2)Cl$; c) $[Ag(NH_3)_2]Cl$; d) $[Ag(NH_2)_2]Cl$.

Ligands in a complex salt are:

a) anions linked by coordinate bonds to a central metal atom or ion;

b) cations linked by coordinate bonds to a central metal atom or ion;

c) molecules linked by coordinate bonds to a central metal atom or ion;

d) ions or molecules linked by coordinate bonds to a central metal atom or ion.

Bidentate and polydentate ligands are also called:

a) chelating agents; b) blood agents;

c) reducing agents; d) oxidizing agents.

Which of the following can function as a bidentate ligand?

a) NH_3, b) $C_2O_4^{2-}$; c) CO; d) OH^-.

EDTA is used to treat:

a) metal poisoning; b) heart disease; c) purulent wounds; d) headache.

The tetrahedral complexes have coordination number:

a) 3; b) 6; c) 4; d) 8.

Which is the example of hexadentate ligand?

a) 2,2-dipyridyl; b) water;

c) amino diacetate ion; d) ethylene diamine tetraacetate ion.

Module 2. Physical and colloidal chemistry

Mixtures in which particles settle out upon standing are defined as:

a) suspensions; b) electrolytes; c) molecular solutions; d) alloys.

Colloidal dispersion of liquids in liquids is defined as:

a) aerosol; b) emulsion; c) sol; d) foam.

Aggregate stability is defined as ability of disperse systems to counteract:

a) coalescence of particles; b)sedimentation of particles;

c) destruction of particles; d) subdivision of particles.

Disperse phase of sparkling drinks is:

a) N_2; b) H_2O; c) CO_2; d) O_2.

Suspension is similar to emulsion in the following way:

a) they are heterogeneous systems;

b) their particles are visible with the naked eye;

c) they easily precipitate;

d) all answers are right.

Define the disperse phase in fog:

a) liquid; b) solid; c) gas; d) all answers are right.

What are condensation methods of obtaining colloidal systems based on?

a) on the crushing of solid materials or liquids and dispersion of their particles throughout a liquid;

b) on the integration of particles at the aggregation of molecules and ions;

c) on the crushing of solid materials or liquids and dispersion of their particles throughout a gas;

d) on the sol obtained by precipitation with peptizator.

Optical properties of dispersed systems are:

a) viscosity, flow ability;

b) opalescence, light absorption;

c) diffusion, Brownian motion;

d) dissolution, swelling.

As_2S_3 sol has a negative charge. Capacity to precipitate is the highest in:

a) $AlCl_3$; b) Na_3PO_4; c) K_2SO_4; d) $CaCl_2$.

Smoke is an example of:

a) solid dispersed in gas; b) solid dispersed in solid;

c) gas dispersed in liquid; d) gas dispersed in solid.

Colloids can be purified by:

a) peptization; b) coagulation; c) dialysis; d) Bredig's arc method.

Electro-kinetic phenomenon is:

a) opalescence; b) electro dialysis;

c) light absorption; d) electrophoresis and electro osmosis.

Which colloid is used for treating eye disease?

a) colloidal silver; b) colloidal antimony;

c) colloidal gold; d) colloidal platinum.

The colloidal system consisting of a liquid as the dispersed phase in a solid as the dispersion medium is termed as:

a) aerosol; b) gel; c) emulsion; d) foam.

In which of the following Tyndall effect is not observed?

a) suspension; b) emulsion; c) sugar solution; d) gold sol.

Heterogeneous mixtures containing particles that are intermediate in size are:

a) colloids; b) gas mixtures; c) saturated solutions; d) alloys.

Fog and smoke are:

a) aerosols; b) emulsions; c) gels; d) foams.

The structure of ironic hydroxide sol is:

a) $\{m\ [Fe(OH)_3]n\ Fe^{3+}\ 3(n-x)\ Cl^-\}^{3x+}\ 3xCl^-$;

b) $\{m[BaSO_4]\ n\ Ba^{2+}\ 2(n-x)NO_3^-\}^{2x+}\ 2xNO_3^-$;

c) $\{m[BaSO_4]\ n\ SO_4^{2-}2(n-x)K^+\}^{2x-}\ 2xK^+$;

d) $\{m[Au]\ n\ AuO_2^-\ (n-x)K^+\}^{x-}\ x\ K^+$.

Aerosols with a liquid disperse phase are called:

a) fog; b) dust; c) smoke; d) steam.

Suspensions according to the degree of dispersity are:

a) coarse dispersed; b) colloidal; c) molecular; d) true.

Dialysis is the process of separation of:

a) suspended particles from colloids;

b) colloidal particles from crystalloids;

c) colloidal particles from gel;

d) suspended particles from crystalloids.

Soap essentially forms a colloidal solution in water and removes grease by:

a) emulsification;b) absorption; c) none of these; d) coagulation.

The method usually employed for the destruction of a colloidal solution is:

a) dialysis; b) addition of electrolytes;

c) diffusion through animal membrane; d) condensation.

The migration of colloidal particles under the influence of an electric field is known as:

a) electro osmosis; b) Brownian movement; c) centrifugation; d) dialysis.

Which of the following is not a colloidal solution?

a) smoke; b) ink; c) blood; d) air.

The scattering of visible light in all directions is called:

a) coagulation; b) Tyndall effect; c) peptization; d) dialysis.

Sol consists of:

a) liquid droplets dispersed throughout a gas;

b) solid particles dispersed throughout a gas;

c) solid particles dispersed in a liquid;

d) liquid droplets dispersed throughout another liquid.

Chromatography is:

a) the method of separation of heterogeneous mixtures;

b) a type of disperse systems;

c) a continuous phase;

d) the method of separation of homogeneous mixtures.

Electro-kinetic phenomenon is:

a) opalescence; b) light absorption;

c) electro dialysis; d) electrophoresis and electro osmosis.

The charge on colloidal particles is due to:

a) very small size of particles; b) adsorption of ions from the solution;

c) none of these; d) presence of electrolyte.

When a colloidal solution is observed under an ultra microscope, we can see:

a) light scattered by colloidal particles; b) size of the particle;

c) shape of the particle; d) relative size.

Chaotic movement of colloidal particles is:

a) osmosis; b) diffusion; c) Brownian motion; d) coagulation.

Biological gel is:

a) cartilage; b) air; c) cloud; d) river water.

Sols are:

a) gelatin; jelly; marmalade; b) blood; lymph;

c) gelatin; lymph; d) blood; jelly; marmalade.

Module 3. Organic chemistry

What is a hydrocarbon?

a) an inorganic compound that contains carbon and hydrogen;

b) an organic compound that contains carbon and hydrogen;

c) an inorganic compound that contains hydrogen;

d) an organic compound that contains carbon.

Name the following compound: C_2H_4:

a) ethyne; b) ethane; c) ethene; d) ethanol.

What is the arrangement in space of the hybrid orbitals of an atom with sp^2 hybridization?

a) linear; b) bent; c) pyramidal; d) trigonal planar.

All of these are aromatic compounds *except:*

a) hexene; b) toluene;

b) p-dichlorobenzene; d) naphthalene.

Compounds that have the same composition but differ in their structural formulas:

a) are called isomers; b) are called polymers;

c) are usually alkanes; d) are used for substitution products.

The simplest hydrocarbons are called:

a) alkanes; b) alkenes; c) alkynes; d) alcohols.

If a certain polymer has the formula $(–CH_2CCl_2CH_2CCl_2–)n$, from which monomer is it made?

a) $HC≡CCl$; b) $ClHC=CHCl$; c) $Cl_2C=CH_2$; d) $H_2C=CHCl$.

Which of the following contains sp^3-hybridized carbon atoms?

a) benzene; b) ethane; c) ethene; d) ethyne.

Which two of the following are propagation steps in the free-radical chlorination of methane shown below?

$$I.\ Cl_2 \xrightarrow{light} 2Cl^{\cdot};$$

II. $CH_4 + Cl^{\cdot} \rightarrow CH_3^{\cdot} + HCl;$

III. $CH_3^{\cdot} + Cl_2 \rightarrow CH_3Cl + Cl^{\cdot};$

IV. $2\ CH_3^{\cdot} \rightarrow C_2H_6.$

a) I and IV; b) II and III; c) II and IV; d) I and III.

Alkanes contain _____covalent bonds.

a) triple; b) quadruple; c) single; d) double.

Hydrogenation of an alkene converts it to an:

a) alkane; b) alkyne; c) alcohol; d) aldehyde.

Which class of organic compounds does not contain oxygen?

a) alcohol; b) amide; c) amine; d) ketone.

What is the position of the bromine atom relative to the methyl group in 3-bromotoluene?

a) meta; b) ortho; c) para; d) trans.

What is the difference between the covalent bonding structure of alkenes and alkynes?

a) alkenes have no covalent bonds and alkynes have one;

b) alkenes have one covalent bond and alkynes have two;

c) alkenes have two covalent bonds and alkynes have three;

d) alkenes have three covalent bonds and alkynes have four.

Slight oxidation of a primary alcohol forms:

a) a ketone; b) an organic acid; c) an ester; d) an aldehyde.

Tollen's reagent is used to:

a) distinguish amines from aldehydes; b) reduce aldehydes;

c) distinguish aldehydes from ketones; d) reduce ketones.

Carboxylic acids are generally:

a) weak acids; b) weak bases; c) strong acids; d) amphoteric.

The two principal contractile proteins found in skeletal muscles are:

a) actin and troponin; b) actin and myosin;

c) troponin and tropomyosin; d) myosin and tropomyosin.

Sodium or potassium salts of fatty acids are called:

a) proteins; b) terpenes; c) carbohydrates; d) soaps.

An ester can be prepared by the reaction of :

a) two alcohols; b) an alcohol and an aldehyde;

c) an alcohol and an organic acid; d) an acid and a ketone

Carboxylic acids produce salts and water by reacting with:

a) acids; b) bases; c) alkalis; d) alcohols.

Clicaric acids are produced from aldoses by:

a) oxidation; b) reduction; c) esterification; d) transamination.

A _____is a triglyceride that has a fatty acid which has been replaced by a polar phosphate group:

a) phospolipid; b) steroid; c) tridlyceride; d) fatty acid.

Which of the following is an unsaturated carboxylic acid?

a) succimic acid; b) acetic acid; c) stearic acid; d) oleic acid.

Base catalyzed hydrolysis of oils and fats is called:

a) saponification; b) fermentation; c) rancidification; d) glycolisis.

The characteristic group of an organic ester is:

a) –CO-; b) –COOH; c) –COH; d) –COO-.

A lipid with a four-ring structure is known as a:

a) steroid; b) fatty acid; c) wax; d) triglyceride.

A long chain carboxylic acid is known as a:

a) steroid; b) fatty acid; c) wax; d) triglyceride.

When 3 fatty acids are bonded to a glycerol backbone through ester bonds, a _____ is formed:

a) steroid; b) fatty acid; c) wax; d) triglyceride.

Unsaturated fatty acids have _____ covalent bonds:

a) triple; b) double; c) single; d) none of the above.

Fats and oils are:

a) monoesters of glycerol; b) diesters of glycerol;

c) triesters of glycerol; d) diesters of glycol.

A _____ is a large nonpolar biological molecule:

a) nucleotide; b) carbohydrate; c) lipid; d) protein.

Combining a fatty acid with a long chain alcohol produces_____:

a) steroids; b) fatty acids; c) waxes; d) triglycerides.

Plant fats are ____ at room temperature:

a) solid; b) liquid; c) none of the above; d) gaseous.

Module 4. Bioorganic chemistry

Invert sugar is:

a) starch; b) glucose; c) fructose; d) hydrolytic product of sucrose.

Maltose is composed of:

a) glucose and glucose; b) glucose and galactose;

c) glucose and fructose; d) fructose and galactose.

Glycogen, a polysaccharide, in your liver may be broken down to glucose by the process of ___:

a) hydrolysis; b) dehydration synthesis;

c) condensation; d) isomerization.

Large molecules formed when many monosaccharides are bonded together are ____:

a) calcium; b) sugars; c) monosaccharides; d) polysaccharides.

Which of the following is an amino acid found in proteins:

a) adenosine; b) adenine; c) alanine; d) linoleic acid.

Which of the following releases most energy when completely oxidized in the body?

a) one gram of glucose; b) one gram of palmitic acid;

c) one gram of leucine; d) one gram of alcohol.

The carbohydrate that provides structural support in plants is called___:

a) chitin; b) cellulose; c) dextrose; d) lipids.

Choose the keto triose:

a) glyceraldehydes; b) erythrose; c) dihydroxyacetone; d) arabinose.

Galactose and glucose are:

a) epimers; b) isomers; c) anomers; d) none of the above.

Single sugars, called monosaccharides supply_____to cells:

a) energy; b) health; c) calcium; d) hydrolysis.

Which of the following are anomers?

a) D-glucose and L-glucose; b) D-glucose and D- fructose;

c) α,D-glucose and β,D-glucose; d) α,D-glucose and β,L-glucose;

The process of breaking down triacylglycerol into free fatty acids and glycerol is called:

a) beta oxidation; b) lipogenesis; c) lipolysis; d) none of the above.

A disaccharide produced by hydrolysis of starch is called:

a) sucrose; b) lactose; c) maltose; d) trehalose.

Which of the following is NOT classified as a biopolymer?

a) collagen; b) glucose; c) cellulose; d) chitin.

Which of the following molecules is not an aldose?

a) ribose; b) fructose; c) glucose; d) glyceraldehyde.

Which of the following is not true about the disaccharide lactose:

a) lactose is a reducing sugar; b) lactose undergoes mutarotation;

c) lactose is optically active; d) lactose has a $1,1^{/}$-α-glycosidic linkage.

Carbohydrates and lipids have many carbon-hydrogen bonds, therefore they both___:

a) store energy in these bonds; b) dissolve in water;

c) dissolve in salts; d) are similar to water.

The three types of carbohydrates are:

a) monosaccharide; polysaccharide; disaccharide;

b) glycerol, polysaccharide; monosaccharide;

c) disaccharide; monosaccharide; glycerol;

d) glycerol; monosaccharide; polysaccharide.

Reduction of D-xylose with $NaBH_4$ yields a product that is:

a) D-sorbitol; b) D-xylitol; c) D-gluconic acid; d) D-frucrose.

Which of the following molecules is a monosaccharide?

a) C_6H_6; b) $C_6H_{12}O_6$; c) $C_{12}H_{22}O_{11}$; d) C_2H_6O.

What elements make up a carbohydrate?

a) hydrogen, calcium, oxygen; b) hydrogen, oxygen, carbon;

c) carbon, potassium, oxygen; d) calcium, potassium, oxygen.

Which of the following is a polymer of fructose?

a) inulin; b) dextrin; c) cellulose; d) glycogen.

Common table sugar is:

a) glucose; b) sucrose; c) fructose; d) maltose.

One function of a carbohydrate is _____:

a) to provide the body with immediate energy;

b) keep heart functioning smoothly;

c) store and transport genetic material; d) control the rate of reactions.

Determine a type of α-amino acid –phenylalanine:

a) aliphatic; b) aromatic; c) heterocyclic; d) complex.

Biogenic amines are produced under reaction of:

a) transamination; b) oxidation; c) reduction; d) decarboxylation.

Glycine is a unique amino acid because it:

a) has no chiral carbon; b) cannot form a peptide bond;

c) has a sulfur containing group; d) is an essential amino acid.

A chain of at least 10 amino acids is:

a) polysaccharide; b) polypeptide; c) protein; d) peptide.

Many proteins function as:

a) polymers; b) hormones; c) substrates; d) enzymes.

Which protein carries oxygen throughout the blood:

a) gonadotropin; b) hemoglobin; c) insulin; d) chitin.

Which amino acid is represented by the abbreviation «Glu»?

a) glycine; b) glutamine; c) glutamic acid; d) cysteine.

Bonds stabilizing the secondary structure of peptides are:

a) coordination; b) ionic; c) hydrogen; d) hydrophobic.

An α-amino acid exists in the form of a cation in:

a) acidic medium; b) basic medium;

c) neutral medium; d) none of the above.

The amide bond that joins two amino acids is called_____:

a) polypeptide bond; b) peptide bond; c) amine bond; d) carboxyl bond.

What is the abbreviation for the amino acid asparagine?

a) asp; b) arg; c) ala; d) asn.

Determine the type of α-amino acid – tyrosine:

a) aliphatic; b) aromatic; c) heterocyclic; d) complex.

The sequence of amino acids in a protein is known as its:

a) primary structure; b) secondary structure;

c) tertiary structure; d) quaternary structure.

Which of the following is not an amino acid?

a) glutamic acid; b) aspartic acid; c) glutamine; d) palmitic acid.

An α-amino acid exists in the form of a zwitter-ion in:

a) acidic medium; b) basic medium;

c) neutral medium; d) any medium.

Collagen is a _____protein:

a) structural; b) hormonal;

c) transport; d) enzymatic.

_____are messenger molecules:

a) proteins; b) enzymes;

c) hormones; d) vitamins.

Which protein do diabetics lack?

a) collagen; b) gonadotropin; c) insulin; d) chitin.

Which of the following molecules does not form part of DNA?

a) purine; b) deoxyribose; c) amino acid; d) phosphate.

Proteins are:

a) polyamides; b) polymers of ethylene;

c) polymers of propylene; d) polyalcohols.

What is the number of different kinds of nucleotides present in any RNA or DNA molecule?

a) four; b) five; c) six; d) seven.

What is the abbreviation for the amino acid methionine?

a) pro; b) met; c) val; d) phe.

What type of covalent bonds link amino acids in a protein?

a) peptide bonds; b) hydrogen bonds;

c) ionic bonds; d) ester bonds.

A chain of two or more amino acids is called a _____:

a) peptide; b) polypeptide; c) protein; d) polysaccharide.

What is the abbreviation for the amino acid tryptophan?

a) thr; b) ser; c) tyr; d) trp.

Which of the following are the three "single ring" bases that are present in nucleic acids?

a) adenine, guanine and uracil; b) adenine, cytosine and uracil;

c) cytosine, thymine and uracil; d) cytosine, guanine and thymine.

How many parts does a nucleotide have?

a) 1; b) 2; c) 3; d) 4.

Which of the following statements concerning the double helix structure present in DNA molecules is *correct*?

a) the two nucleotide strands are identical;

b) hydrogen bonds between sugar units hold the two nucleotide strands together;

c) base pairing between strands always involves one purine base and one pyrimidine base;

d) base pairing combinations are always A–C and G–T.

Which of the following statements concerning tRNA molecules is *incorrect*?

a) they are carriers of the amino acids needed for protein synthesis;

b) they have a "cloverleaf" shape with four hairpin loops;

c) they interact with mRNA at the site of protein synthesis;

d) an anticodon is present within their structure.

In which of the following pairs of nucleic acid bases are both members of the pair "single ring" bases?

a) A and C; b) G and T;

c) T and U; d) more than one correct response.

Which of the following types of RNA is paired with a correct piece of information about that type of RNA?

a) tRNA; contains exons; b) mRNA; contains codons;

c) rRNA; contains anticodons; d) more than one correct response.

A nucleoside is composed of:

a) a base+ a sugar; b) a base+ a sugar+ a phosphate;

c) a base+ a phosphate; d) none of these.

Adjacent nucleotides are joined by:

a) a covalent bond; b) a phosphor diester bond;

c) an ionic bond; d)a peptide bond.

The transcription of DNA into a molecule of messenger RNA occurs:

a) on the ribosomes; b) in the nucleus;

c)only during cell division; d) when amino acids are made by transfer RNA.

The instructions in a DNA molecule are carried in the form of a specific sequence of:

a) nucleotides; b) nitrogen bases; c) triglycerides; d) oxygen bases.

RNA is usually:

a) single-stranded; b) double-stranded; c) single helix; d) double helix.

Which of the following nucleotide bases is not found in RNA?

a) thymine; b) adenine; c) uracil; d) guanine;

Any given nucleotide in a nucleic acid contains:

a) two bases and a sugar;

b) one sugar, two bases and one phosphate;

c) two sugars and one phosphate;

d) one sugar, one base and one phosphate.

The "backbone" of a nucleic acid molecule consists of an alternating sequence of:

a) sugar and phosphate groups; b) sugar and base groups;

c) phosphate and base groups; d) sugar, phosphate and base groups.

The backbone of a DNA molecule always has a free –OH group on a:

a) ribose molecule at the 3' end; b) deoxyribose molecule at the 3' end;

c) ribose molecule at the 5' end; d) deoxyribose molecule at the 5' end.

In a dinucleotide the linkage between nucleotide units involves:

a) carbon 3' of a sugar; b) carbon 5' of a sugar;

c) both carbons 2' and 3' of a sugar; d) more than one correct response.

Which of the following elements is *not* present in the "backbone" of a nucleic acid molecule?

a) phosphorus; b) nitrogen; c) oxygen; d) none of the above.

DNA is the genetic material in:

a) viruses, prokaryote and eukaryote; b) prokaryote and eukaryote;

c) only in eukaryotes; d) in some viruses, prokaryotes and eukaryotes.

In a DNA double-helix, guanine and cytosine bases are paired together by:

a) covalent bonds; b) hydrogen bonds;

c) peptide bonds; d) hyper conjugation.

The double helical structure of DNA is held together by:

a) peptide bonding; b) hydrogen bonding;

c) glycosidic bonds; d) sulfur-sulfur linkages.

In addition to the standard organic elements carbon, hydrogen and oxygen, nucleic acids also contain_____:

a) phosphorus; b) calcium; c) nitrogen; d) sulfur.

The order of nitrogen bases in RNA determine the sequence of:

a) amino acids in a nucleotide; b) amino acids in a protein;

c) phosphate groups in a nucleotide; d) phosphate groups in a protein.

35% of the bases in a certain DNA molecule are found to be T. What percent of the bases in this molecule is G?

a) 15%; b) 25%; c) 35%; d) 65%.

Which of the following is a correct structural characteristic of a nucleotide?

a) the base unit is bonded to the phosphate unit;

b) the phosphate unit is bonded to the sugar unit;

c) the sugar unit is bonded to the base unit;

d) more than one correct response.

Genetic mutation occurs in:

a) protein; b) RNA; c) DNA; d) nucleus.

The length of one turn of DNA is:

a) 3,4A^{o}; b) 34 A^{o}; c) 20 A^{o}; d) 3,04A^{o}.

Sugar bonds to _____to form the backbone:

a) phosphate; b) carbonate; c) oxalate; d) sulfate.

The main function of DNA is:

a) instigating mitosis; b) sitting in the nucleus;

c) storing genetic information; d) none of the above.

Which of the following is not part of a nucleotide?

a) nitrogen base; b) monosaccharide sugar;

c) phosphate group; d) oxygen base.

Replication of DNA produces two daughter DNA molecules in which:

a) one daughter molecule contains both parent strands and one daughter molecule contains both newly synthesized strands;

b) each daughter molecule contains one parent strand and one newly synthesized strand;

c) each daughter molecule contains two newly synthesized strands;

d) each daughter molecule contains a segment of both parent strands.

The genetic code is a listing that gives relationships between codons and:

a) anticodons; b) amino acids; c) exons; d) genes.

In which of the following sets of nucleic acid "building blocks" are all members of the set possible components of a DNA molecule?

a) phosphate, ribose, and thymine;

b) adenine, ribose, and 2-deoxyribose;

c) cytosine, guanine, and uracil;

d) no correct response.

Which of the following events occurs during the ***translation*** phase of protein synthesis?

a) mRNA interacts with a chromosome; b) codon-anticodon base pairing occurs;

c) rRNAs carry amino acids to the site for protein synthesis;

d) no correct response.

The two strands in a DNA double is joined by:

a) covalent bond; b) hydrogen bond; c) ionic bond; d) phosphor diester bond.

The basic repeating unit of a DNA molecule is:

a) nucleoside; b) nucleotide; c) histones; d) amino acids

Thymine is never found in :

a) DNA; b) RNA; c) none of the above.

5.4. Assessment fund.

Laboratory work (in-process monitoring).

Project (in-process monitoring).

Control work (midterm examination).

Test (midpoint monitoring).

Assessment scale (appendix 2).

6. COURSE (MODULE) METHODOLOGICAL AND INFORMATIONAL SUPPORT.

6.1. Recommended Reading.

1. 1. Ebbing D.D. General Chemistry/ D.D. Ebbing, M.S. Wrighton.- Boston. Third edition. Houghton Mifflin Company.11th Edition. 2015.
2. Raymond Chang, Janson Overby. General chemistry. The essential concepts. Sixth edition. New York. 2011. https://www.twirpx.com
3. Ralph H. Petrucci. General Chemistry. Principles and modern application. Tenth edition. Canada. 2011. https://www.twirpx.com
4. Krister Holmberg. Handbook of applied surface and colloid chemistry. Volume 1. 2002. http://www.wiley.co.uk
5. Krister Holmberg. Handbook of applied surface and colloid chemistry. Volume 2. 2002. http://61.188.205.38:8081/hxgcx/hcjs/UploadFiles/pdf/%E6%96%87%E7%8C%AE%E5%BA%93/%E6%A8%A1%E5%9D%972%E8%A1%A8%E9%9D%A2%E6%B4%BB%E6%80%A7%E5%89%82/Handbook%20of%20applied%20surface%20and%20colloid%20chemistry%20-%20Volume%202.pdf
6. Katherine J. Denniston. General, Organic and BioChemistry. Ninth edition. New York. 2017. https://rapidgator.net/file/fa69c4feef0763ffa960ebee7af145f7/geneorgbi9.rar.html
7. John Mcmurry. Organic Chemistry. Cornell university. 8th edition. Canada. 2010.
8. Laura Frost. General Organic and Biological Chemistry. 3rd. Edition. USA. 2017. https://vk.com/doc187961010_461601880?hash=261207166fbb89d57f&dl=0bb9c54954e7b33f71
9. J.A. Abdurashitova, J.A. Djamanbaev. General and bioorganic chemistry. Study guide. 2018.
10. John McMurry. Organic chemistry. 9th-Edition. 2019.
11. Raymond Chang, Kenneth A. Goldsby. Chemistry. 2016.

6.1.1. Required Reading List.

1. Lister T. Chemistry for Advanced Level / T. Lister, J. Renshaw; - Third edition. Stanley Thornes (Publishers) Ltd. 2000. – 680 p.
2. DrWalfgangSchärtl / Basic physical chemistry.-Bookboon.com.-2014.
3. Linus Pauling. General chemistry. W. H. Freeman and company. San-Francisco.-1970.
4. Roman Elsair. Fundamentals of chemistry. 2012. Bookboon.com.
5. Robert J. Hunter. Foundation of colloid Science. Oxford university press. 2001.
6. William H. Brown. Introduction to Organic Chemistry. 6th. Edition. USA. 2016. https://vk.com/doc348852382_456866825?hash=1f43b3c8faa7804a82&dl=1e6abadf8dcee1535a
7. Daniel Bloch. Organic chemistry. McGraw Hill, USA. 2006.

8. Zurabyan S. E. Fundamentals of bioorganic chemistry/ S.E. Zurabyan,-M.: Geotar-med.-2003.

12. Andrew L. Ternay J. R. Contemporary organic chemistry. W. B. Saunders company. Philadelphia, London. Toronto.

13. Burger A., ed. Medicinal chemistry. V. 1-2. Second edition. Sohn Wiley and Sons. New York, 1970.

6.3. List of information and education technologies.

6.3.1 Competence-based educational technologies.

6.3.1.1. For the organization of course discipline studying traditional educational technologies are used.

Traditional educational technologies include lectures, practical sessions, lab practical.

6.3.1.2. Innovative educational technologies are interactive sessions which form systemic thinking and ability to generate ideas to solve different situational problems.

Innovative educational technologies include debates, discussions, solution of situational tasks.

Monitoring is made in the form of individual work assessment.

6.3.1.3. Informational educational technologies mean individual work of students with different resources including computer equipment and internet to solve practical problems and do individual work.

7. COURSE (MODULE) LOGISTICS.

7.1. Teaching facilities should be study halls for lectures, seminar classes, group and individual consultations, in-process monitoring, mid-term examination, individual work and storage facilities for preventive maintenance of educational equipment.

7.2. Study halls should be equipped with specialized furniture and technical training tools serving to present educational information to a large audience.

7.3. For conducting lectures sets of demonstration materials and educational visual aids are offered. They provide thematic illustrations corresponding to the course outline (Module): interactive board, projector, microphone, tables and schemes.

7.4. List of material support which is necessary for realization of course outline (module) includes: chemical laboratories and their equipment: balances: techno-chemical, torsion and analytical; exhaust hoods; distillers; calorimeters; thermometers; cryometers; photoelectrocalorimeters; pH-meters; potentiometer; microscopes; stalagmometers; viscosimeters; thermostats; drying chambers; rangettes; chemical supports; areometers;

chemical utensils: test tubes, beakers, burettes, pipettes, cylinders, flasks, porcelain mortars, water bathes, exsiccators, spirit-lamps, weighing bottle; manipulative material; stands: Periodic table of chemical elements, pH of biological liquids, name and structure of functional groups of organic compounds, electronic effects of different substituents, chemistry reference books.

7. COURSE (MODULE) PROFICIENCY METHODICAL GLUIDELINES (FOR STUDENT).

The planning sheet of discipline «Chemistry». Appendix 1.

Appendix 1

The planning sheet of discipline «Chemistry»

Discipline: **Chemistry**

Field of study/specialization: **31.05.01. General Medicine**

Course/semester: **1/1, 2**

Credit units (CU): **4**

Title of module according to WPD	Type of control	Forms of control	Minimal credit points	Maximal credit points	Week of control
Module 1					
General and bioinorganic chemistry	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work, discussion of situational tasks, writing of reports	25	40	
	Midterm examination	Evaluation test	5	10	13
Module 2					
Physical and colloidal chemistry	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work, discussion of situational tasks, writing of reports	5	10	
	Midterm examination	Evaluation test	5	10	17
Total			40	70	
Midpoint assessment			20	30	
Summative assessment			60	100	
Module 3					
Organic chemistry	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual work , discussion of situational tasks, reports	16	27	
	Midterm examination	Tests	5	10	31
Module 4					
Bioorganic chemistry	Formative assessment	Activity, attendance, lecture notes, performance and presentation of lab works, individual works, discussion of situational tasks, reports	14	23	
	Midterm examination	Evaluation test	5	10	38
Total			40	70	
Midpoint assessment			20	30	
Summative assessment			60	100	

Appendix: For each missed and unfinished class 0,5 points are removed

Appendix 2

Assessment scale

Types of control and attestation, forms of estimation tools

№	Semester	Types of control	Section name COURSE (MODULE)	Estimating tools		
				Form	Number of questions in a task	Number of independent options
1.	1	Formative assessment, midterm examination,	**Section 1. General and bioinorganic chemistry** (Midterm examination)	Evaluation test	5	12
2.	1	Midterm examination, midterm assessment	**Section 2. Physical and colloidal chemistry** (Midterm examination)	Evaluation test	5	12
3.	2	Midterm examination	**Section 3. Organic chemistry** (Midterm examination)	Evaluation test	5	12
4.	2	Midterm examination, midterm assessment	**Section 4. Bioorganic chemistry** (Midterm examination)	Evaluation test	5	12
5.	2	midpoint assessment	**Midpoint assessment**	Test	20	12

Laboratory assessment scale

- *Preparation for laboratory work:* goals and leaning objectives are formulated; the expected results are explained; equations of chemical reactions are correctly worked out (40%);
- *Performance of laboratory work:* the laboratory work is fully done by the student; the necessary sequence of experiments is observed; safety regulations are observed; all necessary measurements and calculations are carried out; relevant conclusions are drawn (40%);
- *Protocol design:* correct and accurate keeping of records, tables, graphs, calculations, chemical equations and design of conclusions (20%).

Examination (evaluation test) assessment scale (midterm examination)

- All necessary definitions, laws and their mathematical expressions are formulated (20%);
- The purpose and requirements of laboratory works are established, the conclusions are correctly made (20%);
- Analysis and explanations for solving problems using theoretical knowledge, calculated formulas and equations of chemical reactions are made, explanations of the choice of the method for solving the problem are given, alternative methods are offered (40%);
- The exact accounting is carried out, the corresponding conclusions are made and answers are accurately issued (20%).

Project assessment scale

- *Problem solving:* relevance to the topic of the essay, the content of the subject and the plan; completeness and depth of disclosure of basic concepts (30%);
- Ability to work with literature, systematize and structure the material (20%);
- *Project design:* title page, plan, introduction, the main part, conclusion, list of literature (15%);
- Literacy and manner of presentation, compliance with the volume requirements of the abstract (15%);
- Answers on questions: comprehensive and in-depth knowledge of the material (20 %);

Structure of the project

1. Title page;
2. Content (a work plan indicating the pages of each question, sub question paragraph, subparagraph);
3. Introduction;
4. Textual presentation of the material using references to literary sources;
5. Conclusion;
6. List of literature;
7. Appendices including tables, schemes, drawings, graphs.

Requirements for the implementation of the report

The report is carried out on one of the proposed topics in accordance with the chemistry course program. The content of the report should include a detailed written answer. The structure of the report should include definitions of the main categories and concepts, their meaning, different approaches to the definition of the phenomenon. When writing a report it is necessary to use 3-4 various literature sources.

Report assessment scale

- The subject is disclosed, analysis of the problem with references to specialized literature is made (10%);
- Presented information is systematized, consistently and logically stated using scientific concepts and terms (30%);
- Information technologies such as presentations, visual aids in the form of tables, figures and schemes (20%);
- Basic concepts, conclusions, generalizations are competently, convincingly and demonstratively formulated using specific examples and references to literature sources (30%);
- Complete and informative answers to additional questions (10%);

Criteria for assessing the performance of tests (Midpoint monitoring)

- One test task contains 20 questions;
- Each question includes 4 variants of answer, one of which is correct;
- For each correct answer 1,5 % is awarded.