FEDERAL STATE BUDGETARY
EDUCATIONAL INSTITUTION OF HIGHER EDUCATION
«AMUR STATE MEDICAL ACADEMY»
MINISTRY OF HEALTH OF THE RUSSIAN FEDERATION

AGREED
Vice-Rector for Academic Affairs,

_____ N.V. Loskutova

April 17, 2025

Decision of the CCMC
April 17, 2025

Protocol No. 7

APPROVED
by decision of the Academic Council of the FSBEI HE Amur SMA of the Ministry of Health of the Russian Federation
April 22, 2025

Protocol No. 15

Acting Rector of the FSBEI HE Amur SMA of the Ministry of Health of the Russian Federation

_____ I.V. Zhukovets

April 22, 2025

ДОКУМЕНТ ПОДПИСАН
ЭЛЕКТРОННОЙ ПОДПИСЬЮ

Сертификат: 50AB2242604E64520B52614FA420034A
Владелец: Жуковец Ирина Валентиновна
Действителен: с 15.04.2025 до 09.07.2026

EDUCATIONAL PROGRAM

discipline «Chemistry»

Specialty: 31.05.01 General Medicine
Course: I
Semester: 1
Total hours: 108 hrs.
Total credits: 3 credit units
Control form: - credit, 1 semester

Blagoveshchensk, 2025

The educational program of the discipline is designed in accordance with the requirements of the Federal State Educational Standard of Higher Education - specialist in specialty 31.05.01 General Medicine, approved by order of the Ministry of Education and Science of Russia dated 08.12.2020 № 988 (registered with the Ministry of Justice of Russia on 08.26.2020 No. 59493), BPEP HE (2021).

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Reviewers:
Head of the Department of Physiology and Pathophysiology of the FSBEI HE Amur SMA, Holder of an Advanced Doctorate in Biological Sciences, Ph.D. of Chemical Sciences, Associate Professor, T.A. Batalova
Professor of the Department of Ecology, Soil Science and Agrochemistry of the Far Eastern State Agrarian University, Holder of an Advanced Doctorate in Chemical Sciences, A.P. Pakusina

APPROVED at the meeting of the Department of Chemistry,
Protocol No. 14 dated April 09, 2025.

Head of Department,
Holder of the Advanced Doctorate (Doctor of Sciences)
in Medical Sciences, Professor _____ **E.A. Borodin**

Conclusion of the Expert Commission on the review of the Educational Programs:
Protocol No. 2 dated April 16, 2025.

Expert of the expert commission
Ph.D. of Engineering Sciences _____ **E.A. Utochkina**

APPROVED at the meeting of the CMC No. 1:
Protocol No. 7 dated April 16, 2025.

Chairman of the CMC No. 1
Holder of the Advanced Doctorate (Doctor of Sciences)
in Medical Sciences, Professor _____ **E.A. Borodin**

AGREED: Dean of the Faculty of Medicine,

Ph.D. of Medical Sciences
April 17, 2025. _____ **N.G. Brush**

CONTENT

I. EXPLANATORY NOTE

1.1. Characteristics of the discipline

In the process of preparing medical students for professional activity, the basic discipline "Chemistry" plays a major role. The purpose of the chemistry course is to ensure the initial chemical literacy and general theoretical chemical training of a doctor, the assimilation by students of fundamental ideas, concepts, laws, patterns, and theories necessary for the study of other chemical and professional disciplines. The study of chemistry stimulates students' interest in the chemical-biological essence and mechanisms of processes occurring in the human body. Students receive knowledge that is necessary in the practical activities of a doctor.

Specific features of studying chemistry in a medical university are: interdependence between the goals of chemical and medical education; universality and fundamentality of the course; the peculiarity of constructing their content depending on the nature and general goals of training a doctor and his specialization; the unity of studying chemical objects at the micro- and macrolevels with the disclosure of different forms of their chemical organization as a single system and the different functions it exhibits depending on their nature, environment and conditions.

1.2. Purpose and objectives of the discipline.

The purpose of teaching the discipline:

- formation of knowledge of the physical and chemical essence and mechanisms of interaction of substances occurring in the human body;
- formation of a complete system of ideas about the patterns of physical and chemical processes and phenomena, including surface ones, in various physical and chemical systems, including micro dispersed ones , based on the fundamental principles of chemistry and taking into account the specifics of training a specialist in the field of medicine;
- development of skills to perform calculations of parameters of physical and chemical processes, evaluate these processes at the cellular and molecular levels, correctly interpret the results of the impact of chemicals and other environmental factors on the body.

Learning objectives of the discipline:

- familiarization with the principles of organization and work in a chemical laboratory,
- familiarization with labor protection and safety measures in a chemical laboratory, with monitoring compliance and ensuring environmental safety when working with reagents;
- formation of ideas about physical and chemical aspects as the most important biochemical processes and various types of homeostasis in the body: theoretical foundations of bioenergetics, factors influencing the shift in the balance of biochemical processes;
- study of the properties of substances of organic and inorganic nature;
- study of the properties of solutions, various types of equilibria of chemical reactions and life processes;
- study of the mechanisms of action of the body's buffer systems, their interrelationships and role in maintaining acid-base homeostasis, the features of the acid-base properties of amino acids and proteins;
- study of the patterns of physical and chemical processes in living systems from the point of view of their competition, which arises as a result of the combination of equilibria of different types;
- study of the role of biogenic elements and their compounds in living systems;
- study of the physical and chemical foundations of surface phenomena and factors influencing free surface energy;
- study of the features of adsorption at various phase boundaries and the features of the physical chemistry of dispersed systems and solutions of biopolymers;

- development of skills in studying scientific chemical literature;
- development of skills for solving problematic and situational tasks;
- development of practical skills in setting up and carrying out experimental work.

1.3. The place of the discipline in the structure of the BPEP HE.

In accordance with the Federal State Educational Standard of Higher Education - a specialist in the specialty 31.05.01 General Medicine (2020), the discipline "Chemistry" refers to the disciplines of the Basic Part, Block 1. The total workload of the discipline is 108 hours (3 credits). Of these, 72 classroom hours, 36 hours are allocated for independent work of students. The form of control is a credit with a grade.

To study the academic discipline "Chemistry", knowledge, skills and abilities are required, which are formed by the chemistry program in institutions of secondary (complete) general education.

The discipline "Chemistry" is a prerequisite for studying the disciplines:

- biochemistry;
- histology, embryology, cytology;
- normal physiology, pathophysiology, clinical pathophysiology;
- pharmacology;
- microbiology, virology;
- other clinical disciplines.

Parallel subjects studied to ensure interdisciplinary links within the basic part of the curriculum: bioorganic chemistry in medicine; physics, mathematics; biology, anatomy, history of medicine, foreign language, Latin.

The discipline "Chemistry" consists of four sections, which present the most important and necessary information that determines the educational process:

1. Elements of chemical thermodynamics, thermodynamics of solutions and chemical kinetics.
2. The main types of chemical equilibria and processes in the functioning of living systems.
3. Physicochemistry of surface phenomena, dispersed systems and solutions of high-molecular compounds.
4. Biologically active low-molecular inorganic and organic substances (structure, properties) and their participation in the functioning of living systems.

1.4. Requirements for students

To study the discipline "Chemistry", a student must have the necessary knowledge, skills and abilities developed in institutions of secondary (complete) general education:

Mathematics
***Knowledge*:** algebraic operations, logarithmic and power functions.
Skills: perform calculations using mathematical formulas, solve algebraic equations.
Skills: works with mathematical apparatus and computer technology to perform calculations using a known formula, statistical processing of experimental results.
Physics
Knowledge: the fundamentals of the atomic-molecular theory of matter, the basic physical properties of biologically important inorganic and organic substances in various states of aggregation.
***Skills*:** predict changes in the energy state of substances during chemical interactions, properties of aqueous solutions.
Skills: works with mathematical apparatus and computer technology to perform calculations of physical quantities characterizing the behavior of substances.
Chemistry

Knowledge: the basic laws of chemical reactions, the properties of the main classes of inorganic and organic substances, the structure of molecules and the nature of chemical bonds.
Skills**:** predict the possibilities and results of chemical interactions between substances in aqueous solutions.
Skills: works with computer technology to calculate quantitative results of chemical reactions and quantitative composition of solutions.
Biology
Knowledge: chemical nature of biological processes, the most important substances involved in the structure and activity of a living organism.
Skills**:** traces the connection between biological and chemical processes occurring in nature and living organisms.
Skills: works with computer technology to search for necessary information about the chemical and biological role of substances.

1.5. Interdisciplinary links with subsequent disciplines

The knowledge, skills and abilities acquired in the chemistry course are necessary for studying subsequent disciplines:

No. p/p	**Name of subsequent disciplines**	**Section numbers of the discipline required for studying subsequent disciplines**			
		1	**2**	**3**	**4**
1	Biochemistry	+	+		+
2	Normal Physiology	+	+	+	+
3	Pathophysiology, clinical pathophysiology	+	+	+	+
4	Pharmacology	+	+	+	+
5	Hygiene	+	+	+	+
6	Propaedeutics of internal diseases, radiation diagnostics	+	+	+	+
7	Faculty therapy, occupational diseases	+		+	+
8	Hospital therapy			+	+
9	Faculty surgery, urology			+	+
10	Anesthesiology, resuscitation , intensive care		+	+	+
11	Ophthalmology		+		+
12	Microbiology, virology		+		+
13	Clinical pharmacology	+	+	+	+

1. 6 Requirements for the results of mastering the discipline

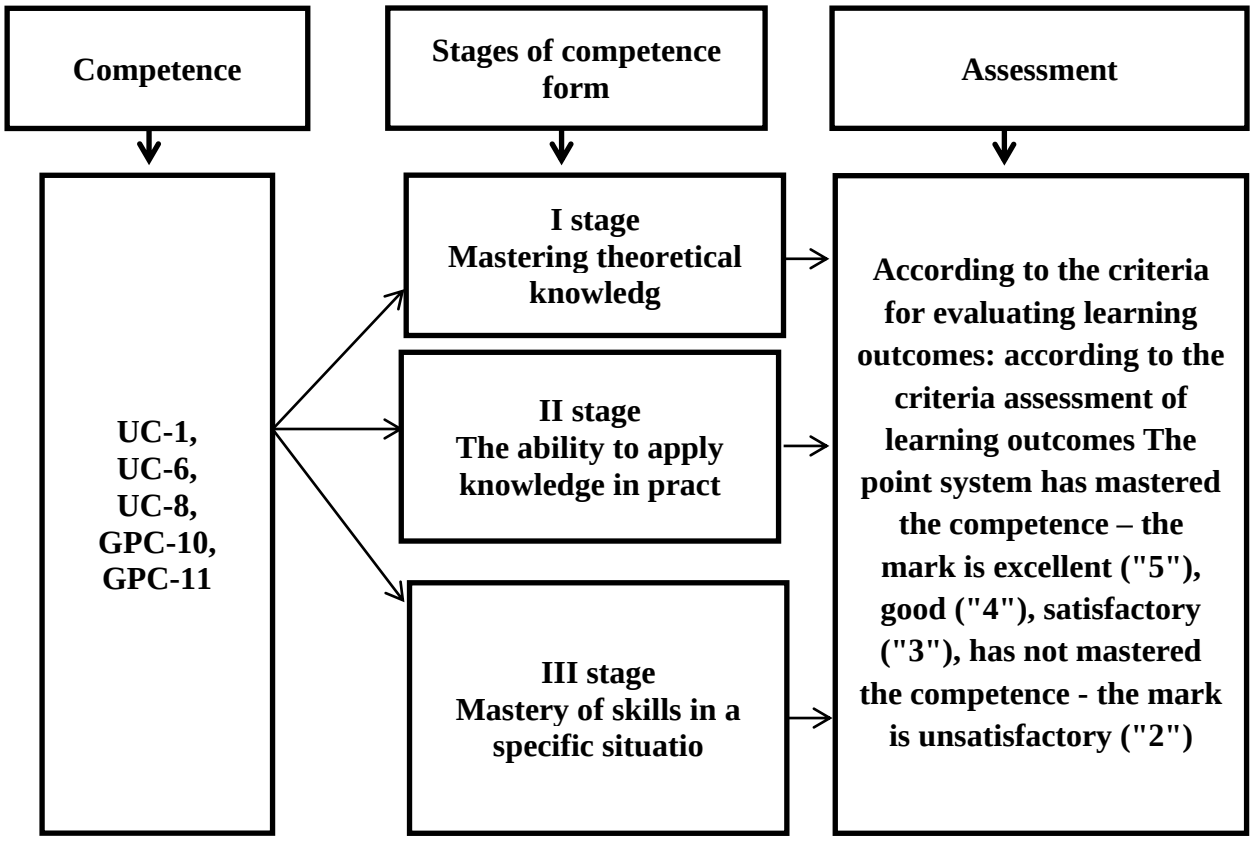
The process of studying the discipline is aimed at developing the following competencies:

No. p/p	Code and name of competence	Code and name of the indicator of achievement of competence
Universal competencies		
1	**UC-1** Able to carry out critical analysis of problematic situations based on a systems approach, develop an action strategy	**AI UC-1.1.** Analyzes the problem situation as a system, identifying its components and the connections between them. **AI UC-1.2.** Identifies gaps in information needed to solve problem situations and designs processes to eliminate them.
	UC-6 Able to define and implement priorities for one's own activities and ways to improve them based on self-assessment and lifelong learning	**AI UC-6.1.** Assesses his/her personal, situational, and time resources and uses them optimally to complete the assigned task. **AI UC-6.3.** Conducts critical self-analysis of the results of one's own activities.
	UC-8 Capable of creating and maintaining safe living conditions in everyday life and professional activities to preserve the natural environment, ensure sustainable development of society, including in the event of a threat or occurrence of emergency situations and military conflicts	**AI UC-8.4.** Possesses skills for safe work in chemical, physical, biological laboratories and the ability to handle caustic, poisonous, volatile organic compounds, work with burners, spirit lamps and electric heating devices, animals.
General professional competencies		
2	**GPC-10** Able to understand the principles of operation of modern information technologies and use them to solve problems of professional activity	**AI GPC-10.2.** Carries out effective search for information necessary for solving problems of professional activity, using legal reference systems and professional pharmaceutical databases.
	GPC-11 Capable of preparing and applying scientific, scientific-production, design, organizational-managerial and regulatory documentation in the healthcare system	**AI GPC-11.3.** Interprets and applies data from physical, chemical, mathematical and other natural science concepts and methods for solving professional problems. **AI GPC-11.4.** Conducts scientific and practical research, analyzes information using the historical method and prepares publications based on the research results.

Sections of the discipline and the code of the competence being formed

Item No.	Section name	Code of the competence being formed
1	Elements of chemical thermodynamics, thermodynamics of solutions and chemical kinetics.	UC-1, UC-6, UC-8, GPC-10, GPC-11
2	The main types of chemical equilibria and processes in the functioning of living systems.	UC-1, UC-6, UC-8, GPC-10, GPC-11
3	Physicochemistry of surface phenomena, dispersed systems and solutions of high-molecular compounds.	UC-1, UC-6, UC-8, GPC-10, GPC-11
4	Biologically active low-molecular inorganic and organic substances (structure, properties) and their participation in the functioning of living systems.	UC-1, UC-6, UC-8, GPC-10, GPC-11

1.7. Stages of competencies development and description of assessment scales



1.8. Forms of training organization and types of control

Form of organization of students' training	Brief characteristic
Lectures	Lecture material contains Key And most problematic questions disciplines, most significant V preparation specialist.
Practical classes	Intended For analysis (consolidation) of theoretical provisions And control over their assimilation With subsequent application received knowledge V in the course study of the topic.
Interactive forms of learning	- solution situational tasks and exercises followed by discussion , - interactive survey, discussions;

	- execution creative tasks, - small group method, - course of the discipline in the Moodle system , testing in the Moodle system https://educ-amursma.ru/course/view.php?id=849.
Participation in the department's research work, student circle and conferences	- participation in the work of the educational chemical laboratory of the department; - Preparation oral messages and poster presentations for speeches at a student club or scientific conference; - writing theses and abstracts on the chosen scientific field; - preparation of a literature review using educational, scientific, reference literature and Internet sources.
Types of control	**Brief description**
Incoming inspection	Testing theoretical knowledge and practical skills developed by the chemistry program in secondary (complete) general education institutions. The entrance knowledge control includes: - testing in the Moodle system (test of incoming knowledge control) https://educ-amursma.ru/course/view.php?id=849, - solving situational problems and exercises. The results of the incoming inspection are systematized, analyzed and used by the teaching staff of the department to develop measures to improve and update the teaching methods of the discipline.
Current control	Current knowledge control includes: - checking the solution of situational problems and exercises completed independently (extracurricular independent work); - assessment of the assimilation of theoretical material (oral survey and interview); - control over the technique of performing a chemical experiment during practical classes and drawing up a protocol; - testing in the Moodle system on all topics of the discipline https://educ-amursma.ru/course/view.php?id=849; - individual assignments (practical and theoretical) for each topic of the discipline studied.
Interim assessment	The midterm assessment is presented as a test with a grade, which students are renting out at the end of I semester a. The test includes the following stages: - assessment of knowledge of theoretical material - testing in the Moodle system (interim assessment test) https://educ-amursma.ru/course/view.php?id=849; - check of assimilation practical skills And skills; - solving situational problems and exercises on each topic of the discipline studied.

II. STRUCTURE AND CONTENT OF THE DISCIPLINE

2.1 Scope of the discipline and types of educational activities

No. p/p	Types of educational work	Total hours	Semester I
1	Lectures	20	20
2	Practical classes	52	52
3	Independent work of students	36	36
	Total labor intensity in hours	**108**	**108**
	Total workload in credit units	**3**	**3**

2.2 Thematic plan of lectures and their brief content

No.	Topics and content of lectures	Codes of formed competencies	Labor intensity (hours)
1	**Subject and methods of chemical thermodynamics. Basic concepts of thermodynamics. First and second laws of thermodynamics.** Subject and methods of chemical thermodynamics. Interrelation between processes of metabolism and energy in the organism. Chemical thermodynamics as a theoretical basis of bioenergetics. Basic concepts of thermodynamics. Intensive and extensive parameters. State function. Internal energy. Work and heat are two forms of energy transfer. Types of thermodynamic systems and thermodynamic processes. Standard state. First law of thermodynamics. Enthalpy. Standard enthalpy of formation of a substance, standard enthalpy of combustion of a substance. Standard enthalpy of reaction. Hess's law. Application of the first law of thermodynamics to biosystems.	UC-1, UC-6, GPC-10	2
2	**Subject and basic concepts of chemical kinetics. Kinetics of biochemical reactions. Catalysis.** Chemical kinetics as a basis for studying the rates and mechanisms of biochemical processes. Reaction rate, average reaction rate in an interval, true rate. Classifications of reactions used in kinetics. Molecularity of the elementary act of a reaction. Kinetic equations. Reaction order. Half-life. Dependence of reaction rate on concentration. Kinetic equations of reactions of the first, second and zero orders. Experimental methods for determining the rate and rate constant of reactions. Dependence of reaction rate on temperature. Temperature coefficient of reaction rate and its features for biochemical processes. Concept of active collision theory. Energy profile of reaction; activation energy; Arrhenius equation. Role of steric factor. Concept of transition state theory. Catalysis. Homogeneous and heterogeneous catalysis. Energy profile of catalytic reaction. Features of catalytic activity of enzymes. Michaelis - Menten equation and its analysis.	UC-1, UC-6, GPC-10	2
3	**Chemical equilibrium. Heterogeneous equilibria.** Reversible and irreversible reactions in direction.	UC-1, UC-6,	2

	Thermodynamic conditions of equilibrium in isolated and closed systems. Chemical equilibrium constant. General constant of sequentially and parallel processes. Equations of isotherms and isobars of chemical reactions. Prediction of shifts in chemical equilibrium. Solubility constant. Competition for cation or anion: isolated and combined heterogeneous equilibria in electrolyte solutions. General constant of combined heterogeneous equilibrium. Conditions of formation and dissolution of precipitates. Reactions underlying the formation of an inorganic substance of bone tissue, calcium hydroxide phosphate. The mechanism of functioning of calcium phosphate buffer. The phenomenon of isomorphism: substitution of hydroxide ions for fluoride ions, calcium ions for strontium ions in calcium hydroxide phosphate. Osteotropy of metals. Reactions underlying the formation of stones: urates, oxalates, carbonates. The use of calcium chloride and magnesium sulfate as antidotes.	GPC-10	
4	**Colligative properties of dilute solutions.** **Complex compounds. Ligand exchange equilibria and processes.** Colligative properties of dilute solutions of non-electrolytes. Raoult's law and its consequences: lowering of the freezing point of a solution, increasing of the boiling point of a solution, osmosis. Osmotic pressure: Van't Hoff's law. The role of osmosis in biological systems. Ligand exchange equilibria and processes. Theory of complex compounds, stability of complex compounds in solution. Instability constant of a complex ion. Concepts of the structure of metalloenzymes and other biocomplex compounds (hemoglobin, cytochromes, cobalamins). Physicochemical principles of oxygen transport by hemoglobin.	UC-1, UC-6, GPC-10	2
5	**Protolytic reactions. Ionization of weak acids and bases. Buffer systems of the body. Mechanism of buffer action, buffer capacity.** Ionization of weak acids and bases. Acidity and basicity constant. Relationship between acidity constant and basicity constant in a conjugated protolytic pair. Competition for a proton: isolated and combined protolytic equilibria. General constant of combined protolytic equilibrium. The concept of buffer action, homeostasis and steady state of a living organism. Buffer action is the main mechanism of protolytic homeostasis of the organism. The mechanism of action of buffer systems. Buffer action zone and buffer capacity. Calculation of pH of protolytic systems. Buffer systems of blood: hydrocarbonate, phosphate, hemoglobin, protein. The concept of acid-base state of the organism. Application of neutralization reaction in pharmacotherapy: drugs with acidic and basic properties.	UC-1, UC-6, GPC-10	2
6	**Adsorption equilibria and processes at mobile phase boundaries. Adsorption equilibria at stationary phase boundaries.** Adsorption equilibria and processes at mobile phase	UC-1, UC-6, GPC-10	2

	boundaries. Gibbs surface energy and surface tension. Adsorption. Gibbs equation. Surface-active and surface-inactive substances. Change in surface activity in homologous series (Traube's rule). Adsorption isotherm. Orientation of molecules in the surface layer and structure of bio membranes. Physical adsorption and chemisorption. Adsorption of gases on solids. Adsorption from solutions. Langmuir isotherm equation. Freundlich isotherm equation. Dependence of adsorption value on various factors. Selective adsorption. Importance of adsorption processes for vital activity. Physicochemical principles of adsorption therapy, chemisorption, application of ion exchangers in medicine.		
7	**The concept of dispersed systems, their classification. Obtaining, properties and methods of purification of dispersed systems. Molecular-kinetic properties of colloidal-dispersed systems.** Classification of dispersed systems. Classification of dispersed systems by degree of dispersion; by state of aggregation of phases; by strength of intermolecular interaction between dispersed phase and dispersion medium. Nature of colloidal state. Obtaining and properties of dispersed systems. Obtaining suspensions, emulsions, colloidal solutions. Dialysis, electrodialysis, ultrafiltration. Physicochemical principles of functioning of artificial kidney. Molecular-kinetic properties of colloidal-dispersed systems: Brownian motion, diffusion, osmotic pressure, sedimentation equilibrium.	UC-1, UC-6, GPC-10	2
8	**Optical and electrokinetic properties of colloidal dispersed systems.** **Stability of dispersed systems. Coagulation.** Optical properties: light scattering (Rayleigh's law). Electrokinetic properties: electrophoresis and electroosmosis; streaming potential and sedimentation potential. Structure of the double electric layer. Electrokinetic potential and its dependence on various factors. Stability of dispersed systems. Sedimentation, aggregation and condensation stability of lyosols. Factors influencing the stability of lyosols. Coagulation. The coagulation threshold and its definition, the Schulze-Hardy rule, the phenomenon of habituation. Mutual coagulation. The concept of modern theories of coagulation. Colloidal protection and peptization.	UC-1, UC-6, GPC-10	2
9	**Colloidal surfactants.** **Properties of solutions of high-molecular compounds.** Colloidal surfactants; biologically important colloidal surfactants (soaps, detergents, bile acids). Micelle formation in surfactant solutions. Determination of critical micelle concentration. Liposomes. Properties of high-molecular-weight compounds solutions. Features of high-molecular-weight compounds dissolution as a consequence of their structure. Shape of macromolecules. Mechanism of high-molecular-weight compounds swelling and	UC-1, UC-6, GPC-10	2

	dissolution. Dependence of swelling value on various factors. Abnormal viscosity of high-molecular-weight compounds solutions. Viscosity of blood and other biological fluids. Osmotic pressure of biopolymer solutions. IEP and methods for its determination. Donnan membrane equilibrium. Oncotic pressure of blood plasma and serum. Stability of biopolymer solutions. Salting out. Coacervation. Gelling of high-molecular-weight compounds solutions. Syneresis.		
10	**Main classes of organic compounds** Poly- and heterofunctionality as one of the characteristic features of organic compounds participating in vital processes and used as medicinal substances. Polyfunctional compounds. Biologically important heterocyclic compounds. Concept of alkaloids and antibiotics. Peptides and proteins. Biologically important reactions αof amino acids: deamination, hydroxylation. Acid and alkaline hydrolysis of peptides. Establishment of amino acid composition using modern physicochemical methods. Carbohydrates. Homopolysaccharides: (amylose, amylopectin, glycogen, dextran, cellulose). Heteropolysaccharides: hyaluronic acid, chondroitin sulfates. Heparin. Concept of mixed biopolymers (glycoproteins, glycolipids, etc.). Nucleic acids. Nucleoside mono- and polyphosphates. AMP, ADP, ATP. Nucleoside cyclophosphates. Their role as macroergic compounds and intracellular bioregulators. Lipids. Saponifiable lipids. Natural fats as a mixture of triacylglycerol's. The structure of waxes. The main natural higher fatty acids that are part of lipids: palmitic, stearic, oleic, linoleic, linolenic, arachidonic.	UC-1, UC-6, GPC-10	2
Total hours			**20**

2.3 Thematic plan of practical classes and their content.

No. p/p	Name of the topics of practical classes	Contents of practical classes	Codes being formed competencies and indicators their achievements	Types of control	Labor intensity (hours)
1	Incoming inspection	Testing theoretical knowledge and practical skills developed by the chemistry program in secondary (complete) general education institutions.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. GPC-10: AI 10.2.	Solving problems and exercises, testing in the Moodle system .	3.25
2	Chemical thermodynamics	**Theoretical part:** Basic thermodynamic concepts and definitions. I law of thermodynamics. Isochoric and isobaric thermal effects. Enthalpy. Thermochemistry. Hess's law and its consequences. Heat of formation, heat of combustion. Standard heats of formation and combustion. II law of thermodynamics. Entropy. Gibbs free energy. **Practical part:** Calculation of thermal effects of reactions by heats of formation and combustion. Calculation of caloric content of food and daily energy requirements. Calculation of change in process entropy, Gibbs free energy.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. GPC -10: AI 10.2. GPC -11: AI 11.3.	Frontal survey, solving situational problems, testing in the Moodle system .	3.25
3	Chemical kinetics	**Theoretical part:** The subject of study of chemical kinetics. Dependence of reaction rate on various factors. ZDM. Physical meaning of rate constant. Half- life. Features of kinetics of heterogeneous processes. Classification of reactions by order and molecularity. Kinetic equations depending on reaction order. Van't Hoff's rule, Arrhenius equation. Activation energy. Catalysis and catalysts. Mechanism of homo- and heterogeneous catalysis. Enzymatic catalysis. Michaelis-Menten equation. Concept of complex chemical reactions. **Practical part:** Application of ZDM to calculate the rate of simple reactions.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC -10: AI 10.2. GPC -11: AI 11.3., 11.4.	Frontal survey, solving situational problems, carrying out an experiment, testing in the Moodle system .	3.25

		Prediction of the effect of changes in concentrations of reactants and temperature on the rate of a chemical reaction. Experimental determination of the rate of a chemical reaction with the construction of a graph of the dependence of the reaction rate on external factors.			
4	Chemical equilibrium	**Theoretical part:** Irreversible and reversible reactions in direction. Constants of chemical equilibrium (methods of expression). Equation of isotherm and isobar of reversible chemical reaction. Conditions of shift of chemical equilibrium. Le principle Chatelier. **Practical part:** Forecasting with the help of ZDM and Le's principle Chatelier shift of physical and chemical equilibria under changing conditions. Experimental determination of shift of chemical equilibrium and interpretation of experimental results.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, solving situational problems, carrying out an experiment, testing in the Moodle system .	3.25
5	Heterogeneous equilibria. Solubility constant	**Theoretical part:** Heterogeneous equilibria in saturated solutions of sparingly soluble electrolytes. Solubility constant. Conditions of formation and dissolution of precipitates. Effect of like ions on the solubility of a sparingly soluble electrolyte. **Practical part:** Experimental determination of conditions for the formation or dissolution of precipitates in electrolyte solutions, with competition for a common cation or anion, with the most complete release of an ion from a solution. Calculation of electrolyte solubility, solubility constant, probability of precipitate formation when pouring solutions.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, solving situational problems, carrying out an experiment, testing in the Moodle system .	3.25
6	Colligative properties of solutions	**Theoretical part:** Methods of expressing solution concentration. Colligative properties of solutions (definition). Raoult's law and its consequences. Cryometry. Ebuliometry. Osmotic pressure of solutions of weak and strong electrolytes. Van't Hoff's law. Isotonic coefficient. Isotonic, hypertonic, hypotonic solutions. Phenomenon of lysis (hemolysis), plasmolysis. Role of osmosis in biological processes. **Practical part:**	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. GPC-10: AI 10.2. GPC-1 1: AI 11.3.	Frontal survey, solving situational problems, testing in the Moodle system .	3.25

		Calculation of quantities characterizing the colligative properties of solutions: osmosis, osmotic pressure, Van't Hoff's law, Mendeleev-Clapeyron equation, saturated vapor pressure of the solvent, change in boiling and freezing temperature of the solution.			
7	Complex compounds. Ligand exchange equilibria and processes	**Theoretical part:** Complex compounds (definition, structure). Werner's coordination theory. The nature of chemical bonding in complex compounds. Classification of complex compounds by the nature of coordinated ligands. Chelates. Constants of stability and instability of complex compounds. Medical and biological significance of complex compounds. **Practical part:** Calculation of ion concentrations in ligand exchange equilibria. Prediction of the structure, strength and properties of complex ions.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. GPC-10: AI 10.2. GPC-11: AI 11.3.	Frontal survey, solving exercises, testing in the Moodle system .	3.25
8	Properties of buffer solutions	**Theoretical part:** Dissociation and ionic product of water. pH - hydrogen index as a measure of active acidity. Total and active acidity. Buffer solutions (definition). Types of buffer systems in the body. Acidosis. Alkalosis. Mechanism of buffer action. Factors affecting the pH of a buffer solution. **Practical part:** Preparation of various types of buffer solutions and experimental study of their properties. Calculation of pH of buffer systems taking into account factors influencing pH of buffer systems.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, solving situational problems, conducting an experiment, testing in the Moodle system .	3.25
9	Buffer capacity	**Theoretical part:** Buffer capacity (definition, calculation formulas, units of measurement). Factors affecting buffer capacity. Buffer capacity of blood. **Practical part:** Preparation of buffer solutions and experimental determination of buffer capacity. Calculation of buffer capacity of systems. Calculation of volumes and/or concentrations of solutions causing changes in pH of buffer systems.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, solving situational problems, conducting an experiment, testing in the Moodle system .	3.25
10	Adsorption	**Theoretical part:**	UC-1: AI 1.1., 1.2.	Frontal survey,	3.25

		Surface tension, surface energy, surface activity. Calculation formulas, units of measurement; Structure of surfactant and PNW molecules. Duclos-Traube rule. Sorption phenomena. Adsorption on moving surfaces: gas-liquid, liquid-liquid. Gibbs equation. Adsorption on stationary interfaces. Freundlich equation, Langmuir equation. Adsorption at the gas-solid interface. Capillary condensation. Adsorption at the solid-solution interface. Molecular adsorption. Rehbinder rule. Adsorption of strong electrolytes. Selective adsorption. Paneth-Fajans rule. Ion-exchange adsorption. Ion exchangers. The importance of adsorption in medicine and biology. **Practical part:** Experimental determination of adsorption on a solid from an electrolyte solution. Construction of an adsorption isotherm. Calculation of adsorption values based on experimental data	UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	decision making, experiment execution, testing in the Moodle system .	
11	Production, properties and methods of purification of colloidal solutions	**Theoretical part:** Disperse systems and their classification. Methods of obtaining colloidal solutions. Methods of purifying colloidal solutions. Molecular-kinetic, optical and electrical properties of colloidal solutions. Electrophoresis and electroosmosis. Potentials: flow, sedimentation, electrokinetic or ζ-potential. **Practical part:** Obtaining colloidal solutions by chemical and physical condensation methods. Experimental study of the properties of colloidal solutions. Experimental purification of a colloidal solution. Compiling formulas for micelles of colloidal solutions. Predicting the properties of solutions based on the conditions of their preparation.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, solving exercises, performing an experiment, testing in the Moodle system .	3.25
12	Coagulation	**Theoretical part:** Stability of dispersed systems. Types of stability. Coagulation. Factors influencing the process of coagulation of colloidal solutions. Stages of the coagulation process: latent and obvious. The influence of electrolytes on the process of coagulation of colloidal particles. Coagulation threshold. Schulze-Hardy rule. Coagulation with mixtures of electrolytes. Mutual coagulation. Peptization. Colloidal	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, solving exercises, performing an experiment, testing in the Moodle system .	3.25

		protection, its importance. **Practical part:** Experimental determination of the coagulation threshold of a colloidal solution. Prediction of the coagulating capacity of electrolytes and the coagulation threshold in relation to colloidal solutions.			
13	Solutions of high-molecular compounds	**Theoretical part:** HMC (definition and classification). Swelling and dissolution of HMC; factors influencing swelling, mechanism of the swelling process. Importance of swelling in the life of the organism. Viscosity of HMC. Violation of the stability of HMC solutions. Gelatinization. Factors influencing gelling. Salting out of HMC; influence of electrolytes (ions). Coacervation, its role in biological systems. Properties of jellies: syneresis, thixotropy. Colloidal protection, its importance in biological systems. **Practical part:** Experimental determination of factors influencing polymer swelling. Experimental determination of swelling degree and its dependence on factors. Observation of colloidal protection and interpretation of results.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC-11: AI 11.3., 11.4.	Frontal survey, experiment execution, testing in the Moodle system .	3.25
14	Main classes of organic compounds, their properties	**Theoretical part:** Proteins, their composition, structure: classification of proteins; structure of the protein molecule; chemical properties of proteins, qualitative reactions for α-amino acids and proteins. Functions of proteins. Nucleic acids: nucleic bases, structure of nucleic acids, role of complementary interactions in the implementation of the biological function of DNA. Lipids (concept, classification, properties). Carbohydrates (concept, classification, properties). **Practical part:** Conducting qualitative reactions, experimental study of the physical and chemical properties of representatives of the main classes of organic compounds.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2. GPC11: AI 11.3., 11.4.	Frontal survey, solving situational problems and exercises, performing an experiment, testing in the Moodle system .	3.25
15	Biological important poly- and	**Theoretical part:** - reports prepared by students on the topic of the lesson;	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3.	Assessment of knowledge of	3.25

	heterofunctional compounds	**Practical part:** Interactive lesson includes: - discussion of reports, holding discussions.	GPC-10: AI 10.2. GPC-11: AI 11.4.	theoretical material	
16	Credit lesson	The interim assessment includes: - assessment of knowledge of theoretical material (testing in the Moodle system); - check of assimilation practical skills And skills ; - solving situational problems and exercises.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. UC-8: AI 8.4. GPC-10: AI 10.2.	Interview, problem solving and exercises, testing in the Moodle system .	3.25
Total hours					**52**

2. 4 Interactive forms of learning

No. p/p	Topic of the practical lesson	Labor intensity in hours	Interactive form of education	Labor intensity in hours, in % of the lesson
1	Incoming inspection	3.25	Testing in Moodle	90 min (61.5%)
2	Chemical thermodynamics	3.25	Interactive survey Testing in Moodle	15 min (0.1 hour) / 10% 15 min (0.1 hour) / 10%
3	Chemical kinetics	3.25	Interactive survey Small group method Testing in Moodle	15 min (0.1 hour) /10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
4	Chemical equilibrium	3.25	Interactive survey Work in pairs Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
5	Heterogeneous equilibria. Solubility constant.	3.25	Interactive survey Work in pairs Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
6	Colligative properties of solutions	3.25	Interactive survey Testing in Moodle	15 min (0.1 hour) / 10% 15 min (0.1 hour) / 10%
7	Complex compounds. Ligand exchange equilibria and processes.	3.25	Interactive survey Testing in Moodle	15 min (0.1 hour) / 10% 15 min (0.1 hour) / 10%
8	Properties of buffer solutions	3.25	Interactive survey Work in pairs Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
9	Buffer capacity	3.25	Interactive survey Work in pairs Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
10	Adsorption	3.25	Interactive survey Small group method Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
11	Production, properties and methods of purification of colloidal solutions	3.25	Interactive survey Work in pairs Testing in the Moodle system	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
12	Coagulation	3.25	Interactive survey Small group method Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
13	Solutions of high-molecular compounds	3.25	Interactive survey Small group method Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
14	Main classes of organic compounds, their properties	3.25	Interactive survey Work in pairs Testing in Moodle	15 min (0.1 hour) / 10% 40 min (0.25 hour) / 27.4% 15 min (0.1 hour) / 10%
15	Biologically important poly- and heterofunctional compounds	3.25	Interactive survey and discussion.	3.25 h / 100%
16	Passable class	3.25	Testing in Moodle	90 min (61.5%)

2.5 Criteria for assessing students' knowledge

The assessment of learning outcomes is carried out in accordance with the “Regulations on the system for assessing the learning outcomes of students of the Federal State Budgetary Educational Institution of Higher Education Amur State Medical Academy of the Ministry of Health of Russia.

The basis for determining the level of knowledge, skills, and abilities are the evaluation criteria - completeness and correctness: correct, accurate answer; correct, but incomplete or inaccurate answer; incorrect answer; no answer.

When assigning marks, the classification of errors and their quality is taken into account: gross errors; similar errors; non-gross errors; shortcomings.

The success of students in mastering the topics of the discipline "Chemistry" is determined by the quality of mastering knowledge, skills and practical abilities; the assessment is given on a five-point scale: "5" - excellent, "4" - good, "3" - satisfactory, "2" - unsatisfactory.

Evaluation criteria

Quality of development	Mark on a 5-point scale
90 - 100%	"5"
80 - 89%	"4"
70 - 79%	"3"
less than 70%	"2"

Incoming inspection

Conducted at the first lesson, includes: solving problems and exercises; testing in the Moodle system https://educ-amursma.ru/course/view.php?id=849. The test control includes 100 questions on the course of the discipline chemistry, studied in institutions of secondary (complete) general education.

Current control

Current control includes initial and final control of knowledge.

Initial control is carried out by the teacher at the beginning of each lesson in the form of a frontal survey, solving problems and exercises, and testing.

Final control - includes control over the technique of performing a chemical experiment and drawing up a protocol, written work on options, testing in the Moodle system (https://educ-amursma.ru/course/view.php?id=849).

The assessment during the current knowledge control is given on the day of the lesson, as the arithmetic mean result for all types of activities provided for in this lesson of the discipline's work program. Based on the assessments for the current control of knowledge, skills, and abilities in practical classes, the average score of current academic performance is calculated, which is recorded in the educational (electronic) journal and taken into account during midterm assessment.

Criteria for assessing the oral response

“5” (excellent) – the student demonstrates deep and complete knowledge of the educational material, does not allow inaccuracies or distortions of facts when presenting, presents the material in a logical sequence, is well oriented in the presented material, and can provide justification for the judgments expressed.

“4” (good) - the student has mastered the educational material in full, is well oriented in the educational material, presents the material in a logical sequence, but makes inaccuracies when answering.

“3” (satisfactory) - the student has mastered the basic principles of the topic of the practical lesson, but when presenting the educational material, he/she makes inaccuracies, presents it incompletely and inconsistently, requires leading questions from the teacher to present it, and has difficulty substantiating the judgments expressed.

“2” (unsatisfactory) - the student has fragmented and unsystematic knowledge of the educational material, is unable to distinguish between the main and the secondary, makes mistakes in defining basic concepts, distorts their meaning, and cannot independently present the material.

Assessment criteria for the practical part

“5” (excellent) - the student has fully mastered the practical skills and abilities provided for by the course work program.

“4” (good) - the student has fully mastered the practical skills and abilities provided for in the course program, but makes some inaccuracies.

“3” (satisfactory) - the student has only some practical skills and abilities.

“2” (unsatisfactory) - the student demonstrates the performance of practical skills and abilities with gross errors.

Criteria for assessing independent extracurricular work:

- the level of student mastery of the educational material;

- the completeness and depth of general educational concepts, knowledge and skills on the topic being studied, to which this independent work relates;

- development of universal and general professional competencies (ability to apply theoretical knowledge in practice).

- the problems were solved correctly, the exercises were completed, and the test assignments were answered accurately - “passed”.

- problems were not solved correctly, exercises were not completed correctly, inaccurate answers were given to test assignments - “failed”.

Preparation of the abstract:

- the abstract is written quite competently, the material is presented in detail, the abstract is formatted according to the requirements - “passed”.

- the abstract is not written correctly enough, the material is not presented in detail, the abstract design does not meet the requirements - “failed”.

A student who has not prepared an abstract or who has received a “fail” for it will not be admitted to the final midterm assessment in the discipline “Chemistry”.

Working off disciplinary debts.

If a student misses a class for a valid reason, he/she has the right to make it up and receive the maximum grade provided for by the course work program for that class. A valid reason must be documented.

If a student misses a class for an unjustified reason or receives a "2" mark for all activities in the class, he/she is required to make it up. In this case, the mark received for all activities is multiplied by 0.8.

If a student is excused from a class at the request of the dean's office (participation in sports, cultural and other events), then he is given a grade of "5" for this class, provided that he submits a report on the completion of mandatory extracurricular independent work on the topic of the missed class.

Criteria for assessing midterm assessment.

Midterm assessment (test with grade) is designed to assess the degree of achievement of planned learning outcomes upon completion of the course and allows for an assessment of the level and quality of its mastery by students.

The students’ success in mastering the discipline is assessed on a 5-point scale: “5” – excellent, “4” – good, “3” – satisfactory, “2” – unsatisfactory.

"Excellent" - for the depth and completeness of mastery of the content of the educational material, in which the student easily navigates, for the ability to connect theoretical questions with practical ones, express and justify their judgments, correctly and logically present the answer; when testing, allows up to 10% of erroneous answers. Practical skills and abilities provided for by the working program of the discipline are fully mastered.

"Good" - the student has fully mastered the educational material, is oriented in it, correctly states the answer, but the content and form have some inaccuracies; during testing allows up to 20% of erroneous answers. Completely practical skills and abilities provided by the working program of the discipline, but allows some inaccuracies

"Satisfactory" - the student has mastered the knowledge and understanding of the main provisions of the educational material, but presents it incompletely, inconsistently, does not know how to express and justify his/her judgments; during testing, allows up to 30% of erroneous answers. Has only some practical skills and abilities.

"Unsatisfactory" - the student has fragmented and unsystematic knowledge of the educational material, is unable to distinguish between the main and secondary, makes mistakes in defining concepts, distorts their meaning, presents the material in a disorderly and uncertain manner, and makes more than 30% of erroneous answers during testing. Performs practical skills and abilities with gross errors.

A student can claim to receive an "excellent" grade automatically if he/she has won a prize in disciplinary or interdisciplinary Olympiads (university, regional) and has an average grade for the current academic performance of at least 4.8 points**.** A student can refuse the "automatic" grade and take the test together with the group on a general basis.

Interim assessment is carried out through a 3-stage test system:

1. The midterm assessment test in the Moodle system includes 100 theoretical questions (https://educ-amursma.ru/course/view.php?id=849).

2. Completion of the practical part of the discipline in full: involves attending all practical classes, performing experiments and completing a protocol.

3. Delivery of practical skills (control of the level of development of competencies). Includes 10 options containing 15 practical questions each.

Evaluation criteria

In 1	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	1	3	1	3	4	1	4	1	1	1	1	1	1	1	1

In 2	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	1	3	1	3	4	1	4	1	1	1	1	1	1	1	1

At 3	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	1	3	1	3	4	1	4	1	1	1	1	1	1	1	1

At 4	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	1	3	1	3	4	1	4	1	1	1	1	1	1	1	1

At 5	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	4	3	1	3	1	1	4	1	1	1	1	1	1	1	1

At 6	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	4	3	1	3	1	1	4	1	1	1	1	1	1	1	1

At 7	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	4	3	1	3	1	1	4	1	1	1	1	1	1	1	1

At 8	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	4	3	1	3	1	1	4	1	1	1	1	1	1	1	1

At 9	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	1	3	1	3	4	1	4	1	1	1	1	1	1	1	1

At 10	Task number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Score	1	3	1	3	4	1	4	1	1	1	1	1	1	1	1

Practical Skills Rating Scale

Number of points	Mark on a 5-point scale
23 - 25 points	5
20 – 22 points	4
13 – 19 points	3
12 points or less	2

During the midterm assessment, the final grade is determined as the arithmetic mean result for all stages of the assessment.

Assessment criteria for midterm assessment

Stages	Mark out of 5 point scale	Binary scale
Interim assessment test in the Moodle system	2 - 5	5 - "excellent" 4 - "good" 3 - “satisfactory” 2 - “unsatisfactory”
Complete completion of the practical part of the course	2 - 5	
Delivery of practical skills (control of the formation of competencies)	2 - 5	

2.6 Independent work of students: in-class and out-of-class.

The organization of independent classroom work of students is carried out with the help of methodological instructions for students, which contain educational goals, a list of the main theoretical questions for study, a list of practical work and the methodology for conducting it, instructions for the presentation of the results obtained, their discussion and conclusions, assignments for self-control with standard answers, a list of recommended literature.

From 1/4 to 1/2 of the practical lesson time is allocated for independent work of students: conducting research, recording results, discussing them, formulating conclusions, completing individual assignments. The preparatory stage, or the formation of an approximate basis for actions, begins for students outside of class time when preparing for the practical lesson, and ends in class.

All subsequent stages are carried out in class. The stage of materialized actions (solving problems using an algorithm or without an algorithm, with an unknown answer in advance) is carried out independently. The teacher, if necessary, provides consultation, provides assistance and simultaneously monitors the quality of students' knowledge and their ability to apply existing knowledge to solve assigned problems.

No. p/p	Subject of the discipline section	Time for student preparation for the lesson	Forms of extracurricular independent work	
			Mandatory and the same for all students	At the student's choice (abstract on topics)
1	Elements of chemical thermodynamics, thermodynamics of solutions and chemical kinetics.	6 hours	Preparation on theoretical issues (lectures, basic and additional literature, methodological recommendations), solving problems and exercises, solving a test assignment in writing and in the Moodle system.	Chemical thermodynamics as a theoretical basis for bioenergetics. Main kinetic features of heterogeneous catalytic reactions. Features of the kinetics of enzymatic reactions. The role of catalysts in the vital activity of living organisms.
2	The main types of	6 hours	Preparation on theoretical	Combined equilibria,

	chemical equilibria and processes in the functioning of living systems.		issues (lectures, basic and additional literature, methodological recommendations), solving problems and exercises, solving a test assignment in writing and in the Moodle system.	competing processes of different types. Ligand substitution reactions.
3	Physicochemistry of surface phenomena, dispersed systems and solutions of high-molecular compounds.	8 hours	Preparation on theoretical issues (lectures, basic and additional literature, methodological recommendations), solving problems and exercises, solving a test assignment in writing and in the Moodle system.	Physicochemistry of surface phenomena in the functioning of living organisms. Structural and mechanical properties and rheological method for studying dispersed systems. Determination of the molecular weight of high-molecular compounds by the viscosimetric method.
4	Biologically active low-molecular inorganic and organic substances (structure, properties) and their participation in the functioning of living systems.	8 hours	Preparation on theoretical issues (lectures, basic and additional literature, methodological recommendations), solving problems and exercises, solving a test assignment in writing and in the Moodle system.	Heterogeneous reactions in electrolyte solutions. The most important representatives of amines and their medical and biological significance. Heterofunctional derivatives of the benzene series as drugs. The role of carbohydrates and their derivatives in living nature as biologically active substances used as medicinal preparations.
5	Interim assessment	4 hours	Preparation on theoretical issues (lectures, basic and additional literature, methodological recommendations), solving problems and exercises.	-
Labor intensity in hours		32 hours	32 hours	4 hours
Total labor intensity in hours			36 hours	

2.7 Research (project) work of students

Research (project) work students is a mandatory section of the discipline and is aimed at the comprehensive formation of universal and general professional competencies of students. It involves the study of specialized literature and other scientific and technical information on the achievements of domestic and foreign science and technology in the relevant field of knowledge, participation in scientific research, etc. The topics of research are determined by students independently or in consultation with the teacher.

List of some recommended topics for research (project) work:

- features of living organisms as objects for thermodynamic research and the scientific basis of bioenergetics;

- history of discovery, concept and types of catalytic reactions, opinions of prominent figures in chemistry about the phenomenon of catalysis, its physicochemical aspects;

- the role of catalysis in the vital activity of living organisms and the features of the kinetics of enzymatic reactions;

- acid-base balance in the human body;

- reactivity of complex compounds;

- complex compounds in medicinal forms;

- surface-active and surface-inactive substances;

- adsorption of volatile solvent vapors, examples of designs of adsorption-catalytic apparatuses;

- proteins in human nutrition, the problem of protein deficiency on Earth.

Criteria for assessing students' research work:

- the material on the research results in the report is presented in detail, the specialized literature is well-developed, scientific and technical information on the achievements of domestic and foreign science and technology in the relevant field of knowledge is studied - “passed”.

- the material on the research results in the report is not presented accurately enough, the special literature is poorly studied, scientific and technical information on the achievements of domestic and foreign science and technology in the relevant field of knowledge is not studied - "failed".

III. EDUCATIONAL, METHODOLOGICAL, MATERIAL, TECHNICAL AND INFORMATION SUPPORT OF THE DISCIPLINE

3.1 Main literature

1. Ershov Yu.A. General Chemistry. Biophysical Chemistry. Chemistry of Biogenic Elements: textbook for universities. / Yu.A. Ershov, V.A. Popkov, A.S. Berlyand et al.; edited by Ershov Yu.A. - 3rd ed., reprinted - M: Vysshaya shkola, 2002 - 560 p.

2. Zholnin A.V. General Chemistry: textbook / A.V. Zholnin; edited by V.A. Popkov, A.V. Zholnin. - Moscow: GEOTAR-Media, 2014. - 400 p. - ISBN 978-5-9704-2956-3. - Text: electronic // Electronic Library System "Student Consultant": - URL: https://www.studentlibrary.ru/ru/book/ISBN9785970429563.html - Access mode: by subscription.

3. Zurabyan S.E. Fundamentals of bioorganic chemistry / Zurabyan S.E. - M.: GEOTAR-Media, 2015. - 304 c. - URL: http://www.studentlibrary.ru/book/ISBN9785970434437.html

3.2 Further reading

1. Popkov V.A. General chemistry: textbook / Zholnin A.V. Ed. V.A. Popkova. - Moscow: GEOTAR-Media, 2012. - 400 p. - ISBN 978-5-9704-2108-6. - Text: electronic // EBS "Student Consultant": - URL: https://www.studentlibrary.ru/book/ISBN9785970421086.html - Access mode: by subscription.

2. Glinka N.L. General Chemistry: a textbook for bachelors. / N.L. Glinka. - M.: Yurait, 2013. - 900p.

3. Mushkambarov N.N. Physical and Colloid Chemistry: a textbook for medical universities (with problems and solutions) / Mushkambarov N.N. - 5th ed., reprinted. - Moscow: FLINTA, 2020. - 455 p. - ISBN 978-5-9765-2295-4. - Text: electronic // Electronic Library System "Student Consultant": - URL: https://www.studentlibrary.ru/book/ISBN97859765229541.html - Access mode: by subscription.

4. Lensky A.S. Biophysical and bioinorganic chemistry: Textbook for students of medical universities / A.S. Lensky, I.Yu. Belavin, S.Yu. Bylikin . - 2nd ed., and add. - Moscow: OOO "Izdatelstvo" Medical Information Agency, 2020. - 416 p.

3.3 Educational and methodological support of the discipline prepared by the staff of the department

1. Kupriyanova G.A. Solutions. Properties of solutions (textbook) / G.A. Kupriyanova, E.A. Utochkina // - Blagoveshchensk, 2020. – 142 p. Recommended by UMO RAE https://educ-amursma.ru/course/view.php?id=849.

2. Kokina T.V. Colloid-dispersed systems (tutorial) - Blagoveshchensk. 2008. - 77 p. Recommended UMO https://educ-amursma.ru/course/view.php?id=849.

3. Utochkina E.A. Bioenergetics and kinetics of chemical reactions (study guide) / E.A. Utochkina, G.A. Kupriyanova // - Blagoveshchensk, 2023. - 137 p. Recommended by UMO RAE https://educ-amursma.ru/course/view.php?id=849.

4. Utochkina E.A. Complex compounds. Biological role, structure and properties (study guide) / E.A. Utochkina, G.A. Kupriyanova // - Blagoveshchensk, 2024. - 120 p. Recommended by UMO RAE https://educ-amursma.ru/course/view.php?id=849.

5. Multimedia presentations for lecture-type classes, according to the thematic plan of lectures. https://educ-amursma.ru/course/view.php?id=849.

6. Course on the subject "Chemistry" in the EIS FSBEI HE Amur SMA https://educ-amursma.ru/course/view.php?id=849.

7. Reference material, tables of standard values necessary for practical classes: https://educ-amursma.ru/course/view.php?id=849.

3.4 Equipment used for the educational process

No. p/p	Name	Quantity
1	Personal computer	2
2	Multifunctional device	1
3	**Classroom No. 1** - special furniture, - visual aids, handouts, - tables - shifts according to the topics of the lesson	in stock 15 sets 15 sets
4	**Classroom No. 2** - special furniture, - visual aids, handouts, - tables - shifts according to the topics of the lesson	in stock 15 sets 15 sets
5	**Classroom No. 3** - special furniture, - visual aids, handouts, - tables - shifts according to the topics of the lesson	in stock 7 sets 7 sets
6	**Educational laboratories of the department:** equipped with special furniture	in stock
	Chemical glassware	
	Chemical test tubes	1500
	Centrifuge tubes	200
	Glass sticks	100
	Flasks of different volumes	200
	Large volume flasks	15
	Chemical beakers of various volumes	150
	Large volume beakers	10

	Glasses of various volumes	2000
	Funnels of different diameters	100
	Alcohol lamps	30
	Droppers for indicators	80
	Porcelain tableware	
	Glasses of different volumes	30
	Mortars and pestles	5
	Crucibles	25
	Evaporating cups	20
	Measuring utensils	
	Volumetric flasks of various volumes	250
	Measuring cylinders of various volumes	30
	Beakers of various volumes	100
	Pipettes for different volumes	2000
	Burettes	100
	Equipment	
	Test tube racks	500
	Pipette stands	15
	Metal tripods	63
	Drying cabinets	2
	Electric stove	1
	Water distiller	1
	pH meters	5
	Hydrometer set	1
	Thermometers	10
	Photoelectric colorimeters	3
	Scales VLTE-150	1
	Chemical reagents	
	Acids: sulfuric, hydrochloric, nitric, acetic, oxalic	in stock
	Hydroxides of potassium, sodium, ammonium, etc.	in stock
	Simple substances and compounds of elements IA - VIIA , IB - VIIIB groups	in stock

3.5. Professional databases, information and reference systems, electronic educational resources.

Resource name	Resource Description	Access	Resource address
Electronic library systems			
"Student consultant. Electronic library of the medical university"	For students and teachers of medical and pharmaceutical universities. Provides access to electronic versions of textbooks, teaching aids and periodicals.	Remote access after registration under the university profile	https://www.studentlibrary.ru/
Reference and information system "MedBaseGeotar".	The reference and information system "MedBaseGeotar" is intended for practicing medical specialists, researchers, teachers, postgraduate students, residents, senior students, and healthcare managers for the rapid search, selection, and reading of medical literature necessary for work in a single data source.	Remote access after registration under the university profile	https://mbasegeotar.ru/pages/index.html
EBS "Bookup"	Large medical library - information and educational platform for the joint use of	Remote access after registration	https://www.books-up.ru/

	electronic educational, educational and methodological publications of medical universities of Russia and the CIS countries	under the university profile	
EBS "Lan"	Network electronic library of medical universities - an electronic database of educational and scientific works on medical topics, created for the purpose of implementing network forms of professional educational programs, open access to educational materials for partner universities	Remote access after registration under the university profile	https://e.lanbook.com/
Scientific electronic library "CyberLeninka"	CyberLeninka is a scientific electronic library built on the paradigm of open science (Open Science), the main objectives of which are the popularization of science and scientific activity, public control over the quality of scientific publications, the development of interdisciplinary research, a modern institute of scientific review, increasing the citation of Russian science and building a knowledge infrastructure. Contains more than 2.3 million scientific articles.	free access	https://cyberleninka.ru/
Oxford Medicine Online	A collection of Oxford medical publications, bringing together over 350 titles into a single, cross-searchable resource. Publications include The Oxford Handbook of Clinical Medicine and The Oxford Textbook of Medicine, electronic versions of which are constantly updated.	free access	http://www.oxfordmedicine.com
Human Biology Knowledge Base	Reference information on physiology, cell biology, genetics, biochemistry, immunology, pathology. (Resource of the Institute of Molecular Genetics of the Russian Academy of Sciences.)	free access	http://humbio.ru/
Medical online library	Free reference books, encyclopedias, books, monographs, abstracts, English-language literature, tests.	free access	https://www.medlib.ru/library/library/books
Information systems			
Clinical Guidelines Rubricator	A resource of the Russian Ministry of Health that contains clinical recommendations developed and approved by medical professional non-profit organizations of the Russian Federation, as well as methodological guidelines, nomenclatures and other reference materials.	link to download the application	https://cr.minzdrav.gov.ru/#!/
Federal Electronic Medical Library	The Federal Electronic Medical Library is part of the unified state information system in the field of healthcare as a	free access	https://femb.ru/

	reference system. FEMB was created on the basis of the funds of the Central Scientific Medical Library named after I.M. Sechenov.		
Russian Medical Association	Professional Internet resource. Objective: to promote effective professional activity of medical personnel. Contains the charter, personnel, structure, rules of entry, information about the Russian Medical Union.	free access	http://www.rmass.ru/
Web -medicine	The site presents a catalog of professional medical resources, including links to the most authoritative subject sites, journals, societies, as well as useful documents and programs. The site is intended for doctors, students, employees of medical universities and scientific institutions.	free access	http: //webmed.irkutsk.ru/
Databases			
World Health Organization	The site contains news, statistics on countries that are members of the World Health Organization, fact sheets, reports, WHO publications and much more.	free access	http://www.who.int/ru/
Ministry of Science and Higher Education of the Russian Federation	The website of the Ministry of Science and Higher Education of the Russian Federation contains news, newsletters, reports, publications and much more	free access	http://www.minobrnauki.gov.ru
Ministry of Education of the Russian Federation	The website of the Ministry of Education of the Russian Federation contains news, newsletters, reports, publications and much more	free access	https://edu.gov.ru/
Federal portal "Russian education"	A single window for access to educational resources. This portal provides access to textbooks on all areas of medicine and health care.	free access	http: // www .edu.ru/
Polpred.com	Electronic library system Business media. Media Review	free access	https://polpred.com/news
Bibliographic databases			
Database "Russian Medicine"	It is created in the Central Scientific and Methodological Library and covers the entire collection, starting from 1988. The database contains bibliographic descriptions of articles from domestic journals and collections, dissertations and their abstracts, as well as domestic and foreign books, collections of institute proceedings, conference materials, etc. Thematically, the database covers all areas of medicine and related areas of biology, biophysics, biochemistry, psychology, etc.	free access	https://rucml.ru/
PubMed	A text database of medical and biological publications in English. The PubMed	free access	https :// pubmed . ncbi . nlm . nih . gov /

	database is an electronic search engine with free access to 30 million publications from 4,800 indexed journals on medical topics. The database contains articles published from 1960 to the present day, including information from MEDLINE, PreMEDLINE, NLM. Each year, the portal is replenished with more than 500 thousand new works.		
eLIBRARY.RU	Russian information portal in the field of science, technology, medicine and education, containing abstracts and full texts of more than 13 million scientific articles and publications. The eLIBRARY.RU platform provides electronic versions of more than 2,000 Russian scientific and technical journals, including more than 1,000 open access journals.	Full functionality of the site is available after registration	http://elibrary.ru/defaultx.asp
Electronic library of dissertations (RSL)	Currently, the Electronic Library of Dissertations of the Russian State Library contains more than 919,000 full texts of dissertations and abstracts.	free access	http://diss.rsl.ru/?menu=disscatalog/
Medline .r u	Medical and biological portal for specialists. Biomedical journal.	free access	https://journal.scbmt.ru/jour/index
Official Internet portal of legal information	The single official state information and legal resource in Russia	free access	http://pravo.gov.ru/

3.6 . Licensed and freely distributed software used in the educational process.

List of software (commercial software products)

No. p /p	List of software (commercial software products)	Details of supporting documents
1.	MS Operating System Windows 7 Pro	License number 48381779
2.	MS Operating System Windows 10 Pro	CONTRACT No. UT-368 from 09.21.2021
3.	MS Office	License number: 43234783, 67810502, 67580703, 64399692, 62795141, 61350919
4.	Kaspersky Endpoint Security for business – Standard Russian Edition . 50-99 Node 1 year Educational Renewal License	Agreement No. 7 AA dated 02/07/2025
5.	1C Accounting and 1C Salary	LICENSE AGREEMENT 612/L dated 02.02.2022 (additional licenses)
6.	1C: PROF University	LICENSE AGREEMENT No. KrTsB-004537 dated 12/19/2023
7.	PROF Library	LICENSE AGREEMENT No. 2281 dated 11.11.2020
8.	Consultant Plus	Contract No. 41AA dated 12/27/2024
9.	Contour.Tolk	Agreement No. K213753/24 dated 13.08.2024
10.	E-learning environment 3KL(Russian Moodle)	Agreement No. 1362.5 dated November 20, 2024

11.	Astra Linux Common Edition	Agreement No. 142 A dated September 21, 2021
12.	Information system "Plans"	Agreement No. 2873-24 dated June 28, 2024
13.	1C: Document Management	Agreement No. 2191 dated 10/15/2020
14.	R7-Office	Agreement No. 2 KS dated 12/18/2020
15.	License "OS ROSA CHROME workstation"	Agreement No. 88A dated 08/22/2024
16.	Alt Virtualization Server 10 (for secondary specialized and higher professional education)	Agreement No. 14AK dated 09/27/2024
17.	Dr.Web Desktop Security Suite Comprehensive protection + Control Center for 12 months.	Agreement No. 8 dated October 21, 2024
18.	Software "Schedule for educational institutions"	Agreement No. 82A dated July 30, 2024

List of freely distributed software

No. p /p	List of freely distributed software	Links to license agreement
1.	Yandex Browser	Freely distributed License agreement for the use of Yandex Browser programs https://yandex.ru/legal/browser_agreement/
2.	Yandex.Telemost	Freely distributed License Agreement for the Use of Programs https://yandex.ru/legal/telemost_mobile_agreement/
3.	Dr.Web CureIt !	Freely distributed License Agreement: https://st.drweb.com/static/new-www/files/license_CureIt_ru.pdf
4.	OpenOffice	Freely distributed License: http://www.gnu.org/copyleft/lesser.html
5.	LibreOffice	Freely distributed License: https://ru.libreoffice.org/about-us/license/
6.	VK Calls	Freely distributed https://vk.com/license
7.	Kaspersky Free Antivirus	Freely distributed https://products.s.kaspersky-labs.com/homeuser/Kaspersky4Win2021/21.16.6.467/english-0.207.0/3830343439337c44454c7c4e554c4c/kis_eula_en-in.txt

3.7. Resources of the information and telecommunications network "Internet"

- Library of the Amur State Medical Academy: https://amurgma.ru/obuchenie/biblioteki/biblioteka-amurskoy-gma/

- Electronic library system “Student consultant” – https://www.studentlibrary.ru

- Types of buffer systems of the body. Chemical buffer systems: https://dommedika.com/phisiology/528.html

IV. ASSESSMENT TOOLS FUND

4.1. Current test control (input, initial, output), final.

4.1.1 Examples of entrance control test tasks (with standard answers)

Tests in the Moodle system https://educ-amursma.ru/course/view.php?id=849. Total number of tests - 100.

1. THE INTERACTION OF SODIUM HYDROXIDE WITH SULFURIC ACID IS
    1) exothermic substitution reaction
    2) endothermic exchange reaction
    3) exothermic exchange reaction
    4) endothermic substitution reaction
2. EACH OF THE TWO SUBSTANCES REACTS WITH A SOLUTION OF SULFURIC ACID:
    1) copper, potassium hydroxide
    2) barium chloride, carbon monoxide (IV)
    3) sodium chloride, phosphoric acid
    4) magnesium, barium chloride
3. SCIENCE OF THE REGULARITIES OF CHEMICAL REACTIONS OVER TIME
    1) chemical kinetics
    2) chemical kinematics
    3) physical chemistry
    4) chemical analysis

Answer standards**:** 1 - 3; 2 - 4; 3 - 1.

4.1.2 Examples of test tasks for initial control (with standard answers)

1. INCREASE IN THE RATE OF A CHEMICAL REACTION WHEN A CATALYST IS INTRODUCED OCCURRES AS A RESULT OF A DECREASE IN …
    1) activation energy
    2) thermal effect
    3) collision energy
    4) the speed of particle movement
2. TO SHIFT THE EQUILIBRIUM IN THE SYSTEM $SO_2(g) + Cl_2 \leftrightarrows SOCl_2(g)$, $\Delta H° < 0$, TOWARDS THE REACTION PRODUCTS IT IS NECESSARY….
    1) introduce a catalyst
    2) reduce pressure
    3) reduce the concentration of SO_2
    4) lower the temperature
3. A MORE SEVERE THERMAL BURN CAN BE CAUSED BY BOILING SUGAR SYRUP WITH A MASS FRACTION OF SUCROSE EQUAL TO
    1) 0.9%
    2) 5%
    3) 18%
    4) 10%

Answer standards**:** 1 - 1; 2 - 4; 1 - 3.

4.1.3 Examples of test tasks for final control (with standard answers)

Tests in the Moodle system https://educ-amursma.ru/course/view.php?id=849. on all topics of the discipline studied. Total number of tests - 195.

1. THE TEMPERATURE COEFFICIENT OF THE REACTION IS EQUAL TO 2. WHEN THE SYSTEM IS COOLED FROM 100°C TO 80°C THE REACTION RATE…
   1) increases by 2 times
   2) decreases by 2 times
   3) increases 4 times
   4) decreases by 4 times
2. THE RELATIVE DECREASE IN THE VAPOR PRESSURE OF THE SOLVENT ABOVE THE SOLUTION IS PROPORTIONALLY
   1) molar fraction of the dissolved substance
   2) molar concentration of the dissolved substance
   3) molal concentration of the dissolved substance
   4) molar fraction of solvent
3. WHEN FORMING A COORDINATION CONNECTION, THE COMPLEX-FORMING AGENCY ACT IN THE ROLE
   1) electron pair acceptor
   2) electron pair donor
   3) carrier of negative charge
   4) source of unpaired electrons

Answer standards**:** 1 - 4; 2 - 1; 3 - 1.

4.1.4 Examples of test tasks for assessing practical skills (with standard answers)

The test assignments consist of 10 options, including 15 practical tasks.

1. SOLUBILITY CONSTANT (K_s)$CaSO_4$ $1.3 \cdot 10^{-4}$. SOLUBILITY OF $CaSO_4$ IS
   1) $0.65 \cdot 10^{-2}$ mol/l
   2) $1.14 \cdot 10^{-2}$ mol/l
   3) $1.28 \cdot 10^{-2}$ mol/l
   4) $1.03 \cdot 10^{-2}$ mol/l
2. OSMOTIC PRESSURE OF 0.5 M ETHANOL SOLUTION AT 20°C
   1) 1217 kPa
   2) 4970 kPa
   3) 609 kPa
   4) 2435 kPa
3. THE REACTION RATE WILL INCREASE 27 TIMES WITH A 30 DEGREES INCREASE IN TEMPERATURE. THE TEMPERATURE COEFFICIENT IS
   1) 3
   2) 2.7
   3) 2
   4) 9

Answer standards**:** 1 - 2; 2 - 1; 3 - 1.

4.1.5 Examples of test tasks for the final assessment (with standard answers)

Tests in the Moodle system https://educ-amursma.ru/course/view.php?id=849. Total number of tests - 100.

1. A FUNCTION WHOSE INCREASE IS EQUAL TO THE HEAT RECEIVED BY THE SYSTEM IN AN ISOBARIC PROCESS
   1) enthalpy
   2) entropy
   3) Gibbs energy
   4) activation energy
2. WHEN EXCESS PRECIPITATION AGENT NaOH APPLYS TO THE PRECIPITATE OF $Al(OH)_3$, A COMPLEX SALT IS FORMED
   1) $Na[Al(OH)_2]$
   2) $Na[Al(OH)_4]$
   3) $Na_2[Al(OH)_{2]}$
   4) $Na_2[Al(OH)_3]$
3. SURFACE-ACTIVE ARE SUBSTANCES THAT BELONGS TO THE CLASS
   1) salts of higher carboxylic acids
   2) inorganic oxides
   3) mineral acids
   4) inorganic salts

Answer standards**:** 1 - 1; 2 - 2; 3 - 1.

4.2 Situational tasks, exercises

1. Calculate the pH and $C(H^+)$ of an acetate buffer solution in which the ratio of salt to acid is 4.5:1.5. $K(CH_3COOH) = 1.85 \cdot 10^{-5}$.
   Answer standard**:** pH = 5.21; $[H^+] = 6.17 \times 10^{-6}$ mol/l

2. To change the pH from 7.2 to 7.4, 1.5 ml of 0.02 mol/l NaOH must be added to 20 ml of blood. What is the buffer capacity of blood for alkali?
   Answer standard**:** 0.0075 mol/l.

3. 100 g of cod contains on average 11.6 g of protein and 0.3 g of fat. Using the heat of combustion values (the heat of combustion of carbohydrates and proteins in the body is 18 kJ/g and 17 kJ/g, fats - 38 kJ/g), calculate the caloric content of a 220 g portion of cod.
   Standard answer a**:** 458.92 kJ.

4. By how many degrees should the temperature be increased so that the reaction rate increases by 64 times if the temperature coefficient of the reaction is 2?
   Standard answer a**:** the temperature must be increased by 60°C.

5. The osmotic pressure of blood at normal body temperature (36.6°C) is 8.08 x 10^5 N/m^2. Calculate the mass fraction in % of physiological sodium chloride solution that is isotonic with human blood (the degree of ionization of NaCl is taken as 100%). The density of the isotonic solution is 1.01 g/ml.
   Answer: 0.91%

4.3 List of practical skills that a student should have after mastering the discipline.

1. Calculation of the thermal effect of the reaction using standard enthalpies of formation and combustion.
2. Determining the probability of a reaction based on the change in entropy and the change in Gibbs free energy.
3. Calculation of food calorie content and daily energy requirements.
4. Application of the law of mass action to calculate the rate of simple reactions.
5. Predicting the impact of changes in concentrations of reactants and temperature on the rate of a chemical reaction.
6. Prediction of shifts in physical and chemical equilibria under changing conditions.
7. Calculation of quantities characterizing the colligative properties of solutions: osmosis, osmotic pressure, Van't Hoff's law, Mendeleev-Clapeyron equation, saturated vapor pressure of the solvent, change in boiling and freezing temperature of the solution.
8. Calculation of pH of buffer systems.
9. Calculation of the buffer capacity of systems. Calculation of volumes and/or concentrations of solutions that cause a change in the pH of buffer systems.
10. Calculation of electrolyte solubility, solubility constant, probability of sediment formation when pouring solutions.
11. Calculation of ion concentrations in ligand exchange equilibria.
12. Prediction of the structure, strength and properties of complex ions.
13. Calculation of adsorption values on stationary surfaces.
14. Compilation of formulas for micelles of colloidal solutions. Prediction of properties of solutions based on the conditions of production.
15. Determination of coagulating ion, coagulating capacity of electrolytes.
16. Classification of high-molecular compounds and properties of solutions of high-molecular compounds.
17. Classification and properties of biologically active low-molecular organic substances.
18. Compilation of formulas and chemical equations describing the properties of low-molecular biologically active compounds.
19. Drawing up equations that describe the basic chemical properties of proteins, carbohydrates, lipids, and nucleic acids.

4.4 List of questions for the test

1. Chemical thermodynamics as a basis for bioenergetics. Basic concepts of thermodynamics. Types of thermodynamic systems.
2. The first and second laws of thermodynamics. Criteria for the direction of processes.
3. Classification of reactions in kinetics. Molecularity of reactions. Order of reaction. Dependence of reaction rate on concentration.
4. Dependence of reaction rate on temperature. Arrhenius equations. Catalysis Features of catalytic activity of enzymes.
5. Thermodynamic conditions of equilibrium. Chemical equilibrium constant. Prediction of the shift of chemical equilibrium.
6. Colligative properties of dilute solutions of non-electrolytes. Raoult's law and its consequences: lowering of the freezing point of the solution, increasing of the boiling point of the solution, osmosis. Osmotic pressure: Van't Hoff's law.
7. The role of water and solutions in life. Physical and chemical properties of water. Anomaly of water properties.
8. Dissociation of water. Hydrogen index. Concentration of hydrogen ions, pH values in various environments.
9. Buffer solutions, types of buffer systems. Mechanism of buffer action. Buffer capacity.

10. Solubility constant. Conditions of formation and dissolution of sediment. Competition for cation or anion. Reactions underlying the formation of inorganic substance of bone tissue, stones.

11. Complex compounds, structure, dissociation. Instability constant of a complex ion. Concept of biocomplex compounds.

12. Redox processes. Redox potentials, mechanism of occurrence. Measurement. Forecasting the direction of redox processes.

13. Adsorption equilibria and processes at mobile phase boundaries. Surface energy, surface tension. Gibbs equation. Surface-active substances. Duclos-Traube rule.

14. Adsorption of gases on solid surfaces. Adsorption from solutions. Langmuir equation . Dependence of adsorption on various factors. Paneth-Fajans rule.

15. Classification of dispersed systems. Nature of the colloidal state. Methods of obtaining and purifying colloidal-dispersed systems.

16. Optical properties of disperse systems. Electrokinetic properties. Structure of the double electric layer. Electrokinetic potential.

17. Molecular-kinetic properties of dispersed systems: Brownian motion, diffusion, osmotic pressure, sedimentation equilibrium.

18. Stability of dispersed systems. Coagulation. Coagulation threshold. Schulze-Hardy rule. Mutual coagulation. Colloidal protection, its importance for the organism.

19. Colloidal surfactants. Micelle formation in solutions of colloidal surfactants. Determination of critical micelle concentration . Liposomes.

20. Biologically active low-molecular organic compounds. Poly- and heterofunctional compounds.

21. Amino acids. Peptides. Biologically important reactions. Establishment of composition. Nucleic acids. Their role as macroergic compounds and intracellular bioregulators.

22. Carbohydrates. Homopolysaccharides. Pectins. Heteropolysaccharides. Heparin. Lipids. Saponifiable lipids. Natural fats as a mixture of triacylglycerols. Concept of wax structure. Main natural higher fatty acids that are part of lipids.

23. Properties of HMC solutions. Features of HMC dissolution as a consequence of their structure. Swelling mechanism. Osmotic pressure of biopolymer solutions. Haller equation.

24. Polyelectrolytes, isoelectric point. Donnan membrane equilibrium . Stability of biopolymer solutions. Salting out, coacervation. Gelling of high-molecular-weight solutions. Properties of jellies: syneresis and thixotropy.