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 «Bioinorganic and biophysical chemistry in medicine»

Specialty: 31.05.01 General Medicine
Course: I
Semester: 2
Total hours: 72 hours
Total credits: 2 credits units
Control form: credit-test, 2 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

The features of studying the discipline "Bioinorganic and biophysical chemistry in medicine" are: the interdependence between the goals of chemical and medical education; the universality and fundamental nature 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 systemic knowledge and skills to perform calculations of parameters of physical and chemical processes, when considering their physical and chemical essence;
- formation of knowledge about the mechanisms of interaction of substances occurring in the human body at the cellular and molecular level, as well as when exposed to environmental factors on a living organism.

Learning objectives of the discipline:

- continuing to develop students' skills in working in a chemical laboratory and in organizing occupational health 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 human body;
- study of the properties of inorganic substances, properties of solutions, various types of equilibria and life processes;
- continuation of the study of the patterns of physical and chemical processes in living systems;
- study and acquisition of knowledge about the chemical nature and properties of biogenic chemical elements and their compounds in living organisms, the use of their compounds in medical practice;
- study of the principles of chemical research methods used in biomedical research;
- developing students ’ 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 "Bioneorganic and Biophysical Chemistry in Medicine" refers to the disciplines of the elective part, Block 1. The total workload is 2 credit units (72 hours), of which 48 classroom hours, 24 hours are allocated for independent work of students. The discipline is taught in the 2nd semester in the 1st year. Form of control - credit.

To study the academic discipline "Bioneorganic and biophysical chemistry in medicine", knowledge, skills and abilities are required, formed by the chemistry program in institutions of secondary (complete) general education, as well as those obtained during the study of the discipline "Chemistry" in the first semester.

The discipline "Bioinorganic and biophysical chemistry in medicine" is a prerequisite for studying the disciplines: normal physiology, pathophysiology, clinical pathophysiology, pharmacology; microbiology, virology and other clinical disciplines.

Parallel subjects studied to provide interdisciplinary links within the basic part of the curriculum: biochemistry; histology, embryology, cytology; biology, anatomy, history of medicine, foreign language, Latin.

The discipline "Bioinorganic and biophysical chemistry in medicine" consists of four sections, which present the most important and necessary information that determines the educational process.

1. Quantum-mechanical model of the structure of the atom.
2. Solutions. Properties of solutions.
3. Chemical research methods in medical and biological practice.
4. Chemistry of biogenic elements.

1.4 Requirements for students

The initial level of knowledge, skills and abilities that a student must have when starting to study the discipline " Bioinorganic and biophysical chemistry in medicine".

Chemistry
***Knowledge*:** - the structure of matter: atoms and chemical elements, the structure of the atom and its electron shell, the periodicity of changes in the properties of elements with an increase in the charges of their atoms; - types of chemical bonds, behavior of substances with different types of chemical bonds in aqueous solutions; - water dissociation, ionic product, pH, types of aqueous electrolyte solutions; - the most important classes of inorganic substances: properties and methods of production; - types of chemical reactions and patterns of their occurrence; - methods of expressing solution concentrations (molar concentrations, mole fraction, molal concentration); - structure of complex compounds; - buffer solutions, their composition and properties, pH of buffer solutions (calculation formulas); - sorption phenomena, adsorption on stationary interfaces, Punnett -Fajans rules; - chemistry of metals and non-metals and their most important compounds.
Skills: - determine the order of the reaction based on the type of kinetic equation; - predict the shift in chemical equilibrium when various factors change; - calculate various ways of expressing the concentration of a solution; - calculate the concentration of hydrogen ions and hydroxide ions from the ionic product of water, pH of solutions; - calculate the pH of buffer solutions; - to make equations of oxidation-reduction reactions, ion exchange reactions.
Skills: - master the methodology of conducting chemical experiments; - calculations and formulate conclusions based on the results of the experiment.
Physics, mathematics
Knowledge: - the fundamentals of the atomic-molecular theory of matter, the main physical properties of biologically important inorganic and organic substances in various states of aggregation; - algebraic operations, logarithmic and power functions .
***Skills* :** - predict changes in the energy state of substances in the process of chemical interaction, properties of aqueous solutions; - carry out calculations using mathematical formulas, solve algebraic equations.
Skills: - proficiency in mathematical apparatus and computer technology to perform calculations using a known formula, statistical processing of experimental results, and physical quantities characterizing the behavior of substances.
Biology

Knowledge: - the chemical nature of biological processes, the most important substances involved in the structure and activity of a living organism.
***Skills*:**   - trace the connection between biological and chemical processes occurring in nature and living organisms.
Skills: - work on computer equipment 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 course “Bioinorganic and Biophysical Chemistry in Medicine” are necessary for studying the following disciplines:

№ 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		+	+	+
4	Pharmacology	+	+	+	+
5	Propaedeutics of internal diseases		+	+	+
6	Clinical pharmacology	+	+	+	+
7	Dermatovenereology		+		+
8	Psychiatry, medical psychology				+
9	Obstetrics and gynecology		+	+	+
10	Faculty therapy, occupational diseases		+	+	+
11	Hospital therapy, endocrinology		+	+	+
12	Oncology, radiation therapy	+	+	+	+
13	Laboratory diagnostics	+	+	+	+
14	Outpatient therapy		+	+	+
15	Ophthalmology		+	+	+

1. 6 Requirements for the results of mastering the discipline

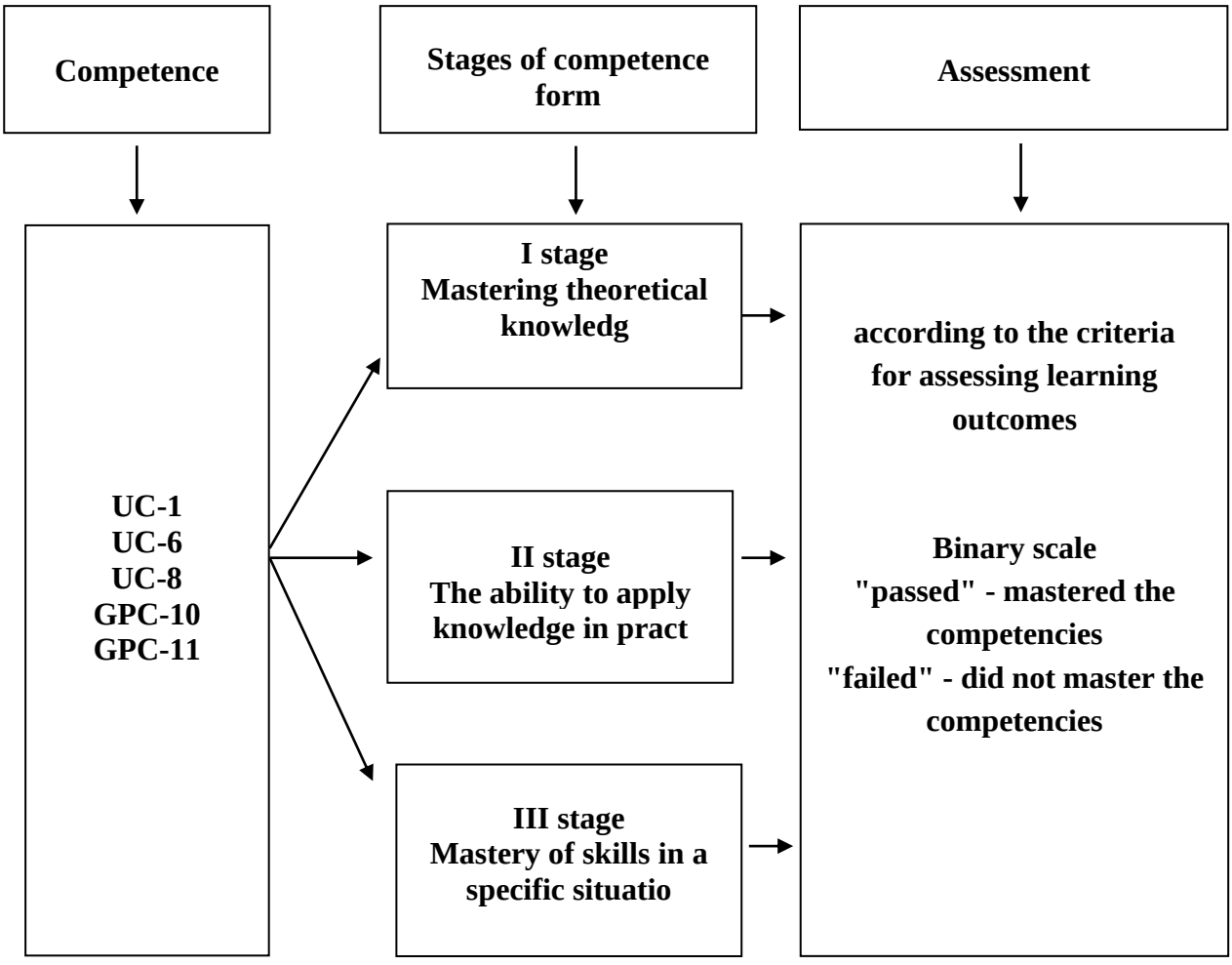
The process of studying the discipline is aimed at developing the following competencies:

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 GPC11.3.** 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

№ p /p	Section name	Code of the competence being formed
1	Quantum-mechanical model of the structure of the atom.	UC-1, UC-6, UC-8, GPC-10, GPC-11
2	Solutions. Properties of solutions.	UC-1, UC-6, UC-8, GPC-10, GPC-11
3	Chemical research methods in medical and biological practice.	UC-1, UC-6, UC-8, GPC-10, GPC-11
4	Chemistry of biogenic elements.	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 description
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 education	- 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=856.
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 program for the chemistry course in institutions of secondary (complete) general education and the discipline "Chemistry" studied in the first semester. The entrance knowledge control includes: - testing in the Moodle system (test of incoming knowledge control) https://educ-amursma.ru/course/view.php?id=856, - 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 the topics of the discipline https://educ-amursma.ru/course/view.php?id=856; - individual assignments (practical and theoretical) for each topic of the discipline studied.
Intermediate certification	The midterm assessment is represented by a test, which students are renting out at the end of II semester a. The test includes the following stages: - assessment of knowledge of theoretical material (oral survey and interview); - testing in the Moodle system (interim assessment test) https://educ-amursma.ru/course/view.php?id=856; - 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 II
1	Lectures	14	14
2	Practical classes	34	34
3	Independent work	24	24
	Total labor intensity in hours	**72**	**72**
	Total workload in credit units	**2**	**2**

2.2 Thematic plan of lectures and their brief content

№ p/p	Lecture topics	Codes of formed competencies	Labor intensity (hours)
1	**The structure of the atom. Nuclear reactions.** The structure of the atomic nucleus. Types of radioactive decay of the nucleus. Nuclear reactions. Isotopes. The effect of radioactivity on the body. The use of isotopes and radioactive decay in medicine. Structure of electron shells. Quantum-mechanical model of the atom. Characteristics of the energy state of the electron by the system of quantum numbers. Ground and excited states of the atom. Free radicals, their role in biological systems. Periodic law and the periodic table of D.I. Mendeleyev in light of the quantum-mechanical theory of atomic structure.	UC-1, UC-6, GPC-10	2
2	**Chemical bond. The nature and direction of oxidation-reduction reactions.** Main types of bonds. Main characteristics of bonds. Geometry of bonds and molecules. Hydrogen bond. Intermolecular interactions. Mechanism of occurrence of electrode and redox potentials. Nerst-Peters equation . Comparative strength of oxidizers and reducers. Forecasting of direction of redox processes by value of redox potentials. Importance of oxidation-reduction processes in biology and medicine.	UC-1, UC-6, GPC-10	2
3	**Solutions. Solubility of substances in water. Hydrolysis.** The role of water in life. Solubility of substances in water. Dependence of solubility on the ratio of hydrophilic and hydrophobic properties; influence of external conditions on solubility. Thermodynamics of dissolution. Solubility of gases in liquids and its dependence on various factors. Henry's and Dalton's laws. Sechenov's law. Elements of the theory of electrolyte solutions. Ostwald's dilution law. Ionic strength of a solution. Electrical conductivity of solutions. Body fluids and tissues as conductors of electricity of the second kind. Types of salt hydrolysis. Determination of the medium of a salt solution. Hydrolysis constant. Calculation of pH in a salt solution.	UC-1, UC-6, GPC-10	2

4	**Chemical research methods in medical and biological practice.** Methods of qualitative and quantitative analysis. Mass spectrometry. Atomic adsorption. Mass spectrometry with induced plasma. Conductometry. Redox electrodes, ion-selective electrodes. Application of biosensors. Chromatography, classification by the dominant mechanism of separation of substances. Identification of substances on chromatograms and their quantitative determination. Application of chromatography in medical and biological research.	UC-1, UC-6, GPC-10	2
5	**Introduction to the chemistry of biogenic elements.** **Chemistry of *s* - elements.** The concept of biogenicity of chemical elements. The teachings of V.I. Vernadsky on the biosphere and biogeochemistry. Macro- and microelements of the environment and in the human body. Man and the biosphere. Chemical aspects of environmental protection. Characteristics of s-block elements. Electronic structures of atoms and cations. Comparison of properties of elements of groups IA and IIA. Hydrogen peroxide: protolytic and redox -amphoteric properties, medical and biological significance. Biological role of sodium, potassium, calcium, magnesium. Chemical similarity and biological antagonism.	UC-1, UC-6, GPC-10	2
6	**Chemistry of *p* - elements.** *p- block* elements. Electronic structures of atoms and ions. Regularities in the manifestation of stable oxidation states. Features of complexation reactions. Protolytic properties. Biological role and application of their compounds in medicine. Chemistry of bactericidal action of chlorine and iodine. Mechanism of toxic action of lead, silicon, carbon, aluminum compounds. Silicosis, aluminosis, anthrocosis.	UC-1, UC-6, GPC-10	2
7	**Chemistry of *d* - elements.** *d- block* elements. Electronic structures of atoms and cations. The most important biogenic elements of *the d*-block. Redox properties of *d*- block elements. Stability of oxidation states in the body. Chromium, molybdenum, manganese in organisms and their biological significance. Application of compounds of groups VIB and VIIB in medicine. Complex nature of hemoglobin, catalase, cytochromes, cyanocobalamin and chemistry of action in metabolic reactions. Complex nature of copper- and zinc-containing enzymes and the mechanism of their action in metabolic reactions. Bactericidal action of silver and copper ions. Toxic action of mercury compounds.	UC-1, UC-6, GPC-10	2
Total hours			**14**

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	Input control	Testing theoretical knowledge and practical skills developed by the chemistry program in secondary (complete) general education institutions, as well as those obtained during the study of the discipline "Chemistry" in the first semester.	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.	2
2	Structure of electron shells. Chemical connection	**Theoretical part:** Quantum -mechanical model of the atom. Quantum numbers. Structure of electron shells of atoms. Minimum energy principle. Pauli exclusion principle. Hund's rule. Klechkovsky's rule . Electron and electron-graphic formulas of atoms. Ground and excited states of the atom. Energy characteristics of the atom. Ionization energy, electron affinity, electronegativity . Changes in these quantities in the periodic table in periods and groups. Periodic table and periodic law of D.I. Mendeleyev. Definitions of period and group. Definition of chemical bond. Types of chemical bond. Hybridization of atomic orbitals. **Practical part:** Revealing the structural patterns of electron shells of atoms. Determining the types of chemical bonds. Predicting the geometry of a molecule based on its electron structure.	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 and exercises, ongoing monitoring, testing in the Moodle system .	2
3	Structure of the nucleus. Nuclear reactions	**Theoretical part:** Structure of the atomic nucleus: protons, neutrons, mass number, nuclides and isotopes. Nuclear reactions and radioactivity. Effect of radioactive radiation on living organisms. Application of radioactive isotopes in research. **Practical part:** Forming nuclear reaction equations. Calculating the half-life of	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 and exercises, ongoing monitoring, testing	2

		an isotope. Calculating the number of isotopes based on the half-life.		in the Moodle system .	
4	Kinetic equations	**Theoretical part:** Simple and complex reactions by mechanism. The rate of chemical reaction. Molecularity and order of reaction. Classification of reactions by order and molecularity. Equations of reaction kinetics. Quantitative characteristic of the course of reactions in time - half-conversion time (half-life) of the reagent. **Practical part:** Determining the order of a reaction from kinetic data. Calculating the concentration of reactants, the time required for a reaction to occur, based on the half-life of the reaction , and the order of the reaction.	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, current control, testing in the Moodle system .	2
5	Oxidation-reduction reactions and processes	**Theoretical part:** Redox reactions. Oxidation and reduction processes. Oxidants and reducers. Types of redox reactions. Redox system. Redox potential, its calculation using the Nernst equation. Predicting the direction of redox reactions based on redox potential values. **Practical part:** Formulation of equations of oxidation-reduction processes by the method of ion-electron balance. Determination of oxidizers and reducers, direction of the redox process.	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, decision to carry out an experiment, ongoing control, testing in the Moodle system .	2
6	Calculation solution concentration	**Theoretical part:** Methods of expressing concentration. Mass fraction. Molar concentration. Molar fraction. **Practical part:** Calculation of solution concentrations, the amount or mass of a substance required to prepare a certain volume of solution.	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.	2
7	Calculation solution concentration	**Theoretical part:** Chemical equivalent. Concentration by equivalence factor (normal concentration). Titer. Conversion of different methods of expressing concentrations into others. **Practical part:**	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, current control.	2

		Calculation of solution concentrations, the amount or mass of a substance required to prepare a certain volume of solution.			
8	pH of solutions strong electrolytes	**Theoretical part:** Electrolytes, non-electrolytes . Electrolytic dissociation. Degree of dissociation. Strong electrolytes. Dissociation of water. Ionic product of water. p H-hydrogen index, its value in different environments. Operations with decimal logarithms . **Practical part:** Determination of pH in solutions of strong acids and alkalis.	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.	2
9	pH of solutions weak electrolytes	**Theoretical part:** Electrolytic dissociation. Degree of dissociation. Weak electrolytes. Dissociation constant. **Practical part:** Calculation of pH in solutions of weak electrolytes based on the degree of dissociation and dissociation constant.	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, current control.	2
10	Calculation of pH changes in buffer solutions	**Theoretical part:** Buffer solutions (definition), types of buffer solutions. Buffer systems of the body: name, composition. The importance of buffer systems in the life of organisms. The mechanism of buffer action (using each buffer system as an example). Factors affecting the pH of a buffer solution. **Practical part:** Calculation of the change in pH of buffer solutions upon introduction of a certain amount of acid or alkali.	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, current control, testing in the Moodle system .	2
11	Hydrolysis	**Theoretical part:** Electrolytic dissociation. Degree and constant of dissociation. Strong, weak electrolytes. Protolytic theory of acids and bases. Ionic product of water. p H and its values in different environments. Le principle Chatelier. Direction of shift of equilibrium of exchange reactions. Hydrolysis of salts. Cases of hydrolysis of salts of different types. Constant and degree of hydrolysis of salts. Factors influencing the degree and constant of hydrolysis. The role of hydrolysis in biochemical processes. **Practical part:**	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, ongoing control, testing in the Moodle system .	2

		Determination of factors influencing hydrolysis. Displacement of hydrolysis equilibrium. Hydrolysis constant. Calculation of pH in salt solutions.			
12	Control Job	**Practical part:** Solutions to variants of situational problems and exercises on previously studied topics.	UC-1: AI 1.1., 1.2. UC-6: AI 6.1., 6.3. GPC -10: AI 10.2. GPC -11: AI 11.3.	Solving situational problems and exercises.	2
13	Chromatography	**Theoretical part:** Paneth-Fajans rule. Biological significance of adsorption, adsorption therapy. Chromatography and types of chromatographic analysis. Application of chromatography in biology and medicine. **Practical part:** Experimental study of column and paper chromatography.	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 .	2
14	Chemistry *s* - elements	**Theoretical part:** General characteristics of *s*- elements. Hydrogen and its compounds. Biological role of the most important hydrogen compounds and their use in medicine. Characteristics, properties, biological role and use in medicine of elements of I A-group, IIA-group. **Practical part:** Conducting qualitative reactions of *s*- elements. Experimental study of the properties of compounds formed by *s*- elements.	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 .	2
15	Chemistry *p* - elements Chemistry *d* - elements	**Theoretical part:** General characteristics of *p*- elements. Characteristics, properties, biological role and application in medicine of compounds of *p*- block elements . General patterns of properties of *d*- elements. Characteristics and properties, biological role and application in medicine of compounds of *d*- block elements. **Practical part:** Experimental study of the properties of compounds formed by *p*- elements, *d*- elements. Conducting qualitative reactions on *d*- elements and *p*- elements.	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, ongoing control, testing in the Moodle system .	2

16	Biological role of elements and application their connections in medicine	**Theoretical part:** - reports prepared by students on the topic of the lesson. **Practical part:** Interactive lesson includes: - discussion of reports, holding discussions.	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.	Assessment of knowledge of theoretical material	2
17	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. GPC -11: AI 11.3., 11.4.	Interview, problem solving and exercises, testing in the Moodle system .	2
Total hours					**34**

2. 4 Interactive forms of learning

In order to activate students' cognitive activity, interactive teaching methods (interactive surveys, discussions, work in small groups, computer testing, etc.), participation in the work of the chemical laboratory, educational research and scientific research work are widely used in practical classes.

No. p /p	Topic	Labor intensity in hours	Interactive form of education	Labor intensity in hours, in % from the lesson
1	Incoming inspection	2	Testing in Moodle	45 min (0.5 hour) / 50%
2	The structure of electron shells. Chemical bond	2	Interactive poll and discussion Testing in Moodle	15 min (0.17 hour) / 16.7% 15 min (0.17 hour) / 16.7%
3	Structure of the nucleus. Nuclear reactions	2	Interactive poll and discussion Testing in Moodle	15 min (0.17 hour) / 16.7% 15 min (0.17 hour) / 16.7%
4	Kinetic equations	2	Interactive poll and discussion Testing in Moodle	15 min (0.17 hour) / 16.7% 15 min (0.17 hour) / 16.7%
5	Oxidation-reduction reactions and processes	2	Interactive poll and discussion Small Group Method Testing in Moodle	15 min (0.17 hour) / 16.7% 45 min (0.5 hour) / 50% 15 min (0.17 hour) / 16.7%
6	Calculation of concentration solution	2	Interactive poll and discussion	15 min (0.17 hour) / 16.7%
7	Calculation of concentration solution	2	Interactive poll and discussion	15 min (0.17 hour) / 16.7%
8	pH of solutions of strong electrolytes	2	Interactive poll and discussion	15 min (0.17 hour) / 16.7%
9	pH of weak solutions electrolytes	2	Interactive poll and discussion	15 min (0.17 hour) / 16.7%
10	Calculation of pH changes in buffer solutions	2	Interactive poll and discussion Testing in Moodle	15 min (0.17 hour) / 16.7% 15 min (0.17 hour) / 16.7%
11	Hydrolysis	2	Interactive poll and discussion Small group method Testing in Moodle	15 min (0.17 hour) / 16.7% 45 min (0.5 hour) / 50% 15 min (0.17 hour) / 16.7%
12	Test	2	-	-
13	Chromatography	2	Interactive poll and discussion Small Group Method Testing in Moodle	15 min (0.17 hour) / 16.7% 45 min (0.5 hour) / 50% 15 min (0.17 hour) / 16.7%
14	Chemistry of *s* - elements	2	Interactive poll and discussion Small Group Method Testing in Moodle	15 min (0.17 hour) / 16.7% 45 min (0.5 hour) / 50% 15 min (0.17 hour) / 16.7%
15	Chemistry of *p* - elements Chemistry of *d* - elements	2	Interactive poll and discussion Small Group Method Testing in Moodle	15 min (0.17 hour) / 16.7% 45 min (0.5 hour) / 50% 15 min (0.17 hour) / 16.7%
16	Biological role of	2	Interactive poll and	90 min / 100%

	elements and application of their compounds in medicine		discussion	
17	Credit	2	Testing in Moodle	45 min (0.5 hour) / 50%

2.5 Criteria for assessing students' knowledge

The assessment of learning outcomes is carried out in accordance with the “Regulations on the assessment system for 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, it is necessary to take into account the classification of errors and their quality: gross errors; similar errors; non-gross errors; shortcomings.

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=856. The test control includes 100 questions on the course of the discipline of chemistry, studied in institutions of secondary (complete) general education and the discipline "Chemistry", studied in the first semester.

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=856.

Table of criteria for assessing incoming and current control

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

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 mastery of the educational material by the student;

- 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 abstracts:

- 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 “Bioinorganic and biophysical chemistry in medicine”.

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 - is designed to assess the degree of achievement of planned learning outcomes upon completion of the study of a discipline and allows assessing the level and quality of its mastery by students. The subject of assessment of mastery is knowledge, skills, abilities.

The success of students in mastering the discipline is assessed as “passed” or “failed”.

A student can claim to receive a "pass" in a discipline automatically if he/she has won a prize in disciplinary or interdisciplinary Olympiads (university, regional) and has an average score 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=856).

Evaluation criteria

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

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

Question No.	1	2	3	4	5	6	7	8	9	10	11
Points	2	2	3	1	4.5	2.5	1.5	3	3	1	1.5

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"

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. The assessment for the current control of knowledge is taken into account during the midterm assessment. During the midterm assessment, the final assessment is established as the arithmetic mean result for all stages of the test.

Assessment criteria for midterm assessment

Stages	**Mark out of 5 point scale**	**Binary scale**
Interim assessment test in the Moodle system	3-5	**passed**
Complete completion of the practical part of the course	3-5	
Delivery of practical skills (control of the formation of competencies)	3-5	
Interim assessment test in the Moodle system	2	**not credited**
Complete completion of the practical part of the course	2	
Delivery of practical skills (control of the formation of competencies)	2	

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 basic theoretical questions for study, a list of laboratory work and the methodology for conducting them, 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 action, begins with students outside of class time when preparing for a practical lesson, and ends during class. All subsequent stages are carried out during class.

The stage of materialized actions (solving situational problems and exercises) 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	Quantum-mechanical model of the structure of the atom.	7	Solving problems, exercises and tests, preparation for oral examination.	The periodic law and the periodic table of D.I. Mendeleev in light of the quantum-mechanical theory of the structure of atoms. The method of molecular orbitals, energy schemes for the formation of molecular orbitals during the interaction of s -orbitals of two identical atoms. Neutralization of oxygen, hydrogen peroxide and superoxide ion. Using redox reactions for detoxification .
2	Solutions. Properties of solutions.	5	Solving problems, exercises and tests, preparing for oral examination.	pH values of various fluids of the human body in norm and pathology Buffer solutions, conditions for maintaining their buffering action. Acid-base indicators. Acid-base balance in the human body. Neutralization reactions. Exchange reactions in electrolyte solutions. The role of hydrolysis in life processes.
3	Chemical research methods in medical and biological practice.	2	Solving exercises and tests, preparing for oral examination.	Application of gas-liquid, high-performance liquid, molecular sieve chromatography in medical and biological research. Electrodes used in voltammetry. Polarography. Application of voltammetry in medicine. Determination of oxygen in a small area deep within a tissue or organism. Experiments to study the transport and utilization of oxygen.
4	Chemistry of biogenic elements.	4	Solving exercises and tests, preparing for oral examination.	Medical and biological significance of elements: I A-group, II A-group, III B-group, IV B-group, V B-group, VIII B-group, III A-group, VI A-group, V A-group, VII A-group, IVA-group. Medical and biological significance of manganese, copper, silver and gold, zinc and cadmium, mercury. Organomercury compounds.
5	Interim assessment	2	Preparation for testing, solving problems, exercises.	-
Labor intensity in hours		20 hours	20 hours	4 hours
Total labor intensity in hours			24 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 topic is chosen in accordance with the scientific direction of the department or by the student independently in consultation with the teacher.

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

- natural - scientific and philosophical significance of the periodic law of D.I. Mendeleev:
- toxic effects of oxidants (nitrates, nitrites, nitrogen oxides);
- the concept of polarization in an electrochemical cell. Depolarizers;
- mechanism of action of redox buffer systems;
- Arrhenius' theory of electrolytic dissociation and its development in the works of Russian scientists;
- application of the law of mass action in the processes of dissociation of weak electrolytes;
- the relationship between the structure of molecules of substances and their physiological effects;
- the importance of oxidation-reduction processes in biology and medicine
- the relationship between endemic diseases and the characteristics of biogeochemical provinces;
- technical progress and the environment;
- topography of the most important biogenic elements in the human body;
- prevalence of chemical elements in nature.

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. Primary literature

1. 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.

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. 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.

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.

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

1. Course on the subject "Bioinorganic and biophysical chemistry in medicine" in the EIS FSBEI HE Amur State Medical Academy https://educ-amursma.ru/course/view.php?id=856.

Characteristics of modules
in electronic information and educational course

Educational	Controlling
Theoretical (lecture) material, video experiments, scientific and educational films	Methodological recommendations for students on independent extracurricular work.
Methodological recommendations for students for practical classes. Methodological recommendations for solving problems and exercises on the topics of the discipline.	List of recommended topics for abstracts and guidelines for abstract design.
Reference material, tables of standard values.	Tests of entrance, current and final knowledge control.

1. Multimedia presentations for lecture-type classes, https://educ-amursma.ru/course/view.php?id=856 according to the thematic plan of lectures.
2. 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=856
3. Kokina T.V. Colloid-dispersed systems (tutorial) - Blagoveshchensk. 2008. - 77 p. Recommended UMO https://educ-amursma.ru/course/view.php?id=856.
4. 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=856
5. 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=856
6. Kupriyanova G.A. The doctrine of solutions (electronic textbook) / G.A. Kupriyanova, E.A. Utochkina // - Blagoveshchensk, 2020. https://educ-amursma.ru/course/view.php?id=856
7. Course on the subject https://educ-amursma.ru/course/view.php?id=856
8. Reference material, tables of standard values necessary for practical classes.

3.4 Equipment used for the educational process

	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 electronic educational, educational and methodological publications of medical universities of Russia and the CIS countries	Remote access after registration under the university profile	https://www.books-up.ru/
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.	with 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 , the electronic versions of which are constantly updated.	with 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 (FEMB)	The Federal Electronic Medical Library is part of the unified state information system in the field of healthcare as a reference system. FEMB was created on the basis of the funds of the Central Scientific Medical Library named after I.M. Sechenov.	with free access	https://femb.ru/
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.	with 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 branches of medicine and health care.	free access	http: // www .edu.ru/
Polpred.com	Electronic library system Business media.	free access	https://polpred.com/news

	Media Review		
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 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.	free access	https :// pubmed . ncbi . nlm . nih . gov /
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.	with 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/physiology/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 system "Moodle" https://educ-amursma.ru/course/view.php?id=856
Total number of tests - 100.

1. HOW MANY OF THE FOLLOWING SUBSTANCES ARE STRONG ELECTROLYTES: SODIUM CHLORIDE, HYDROCHLORIC ACID, SULFURIC ACID, AMMONIUM HYDROXIDE, ACETIC ACID, SODIUM HYDROXIDE
   1) 4
   2) 5
   3) 3
   4) 2

2. PARTICLES IN THE NUCLEUS OF AN ATOM
   1) only protons
   2) only electrons
   3) protons and electrons
   4) protons and neutrons

3. ALUMINUM CHLORIDE SOLUTION ENVIRONMENT
   1) sour
   2) slightly alkaline
   3) neutral
   4) highly alkaline

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

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

1. IN THE HYDROGEN SULFIDE MOLECULE THERE IS A CHEMICAL BOND
   1) covalent polar
   2) covalent non-polar
   3) hydrogen
   4) donor-acceptor

2. THE MOLAR CONCENTRATION OF EQUIVALENTS IS EQUAL TO THE MOLARITY OF THE SOLUTION

1) $CaCl_2$
2) H_2SO_4
3) $ZnSO_4$
4) KNO_3

3. REDUCING AGENT IN THE REACTION $H_2S + SO_2 \rightarrow S + H_2O$ IS

1) H_2S
2) SO_2
3) S
4) H_2O

Standards answers **:** 1 - 1; 2 - 4; 3 - 1.

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=856 on all topics of the discipline. Total number of tests - 90.

1. MAGNETIC QUANTUM NUMBER CAN TAKE VALUES

1) 0,…(n - 1)
2) -l,..0,…l
3) 1,2,3…∞
4) ±1/2

2. THE ORDER OF REACTION CHARACTERIZES

1) elementary mechanism of a simple reaction
2) formal kinetic dependence of the reaction rate on concentration reaction products
3) formal kinetic dependence of the reaction rate on concentration reactants
4) the elementary mechanism of individual stages of a complex process

3. TYPICAL RESTORERS INCLUDE

1) hydrogen sulfide and alkali metals
2) potassium permanganate, potassium manganate and potassium chromate
3) water, aqua regia and oleum
4) manganese(IV) oxide, carbon(IV) oxide and silicon(IV) oxide

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

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

The test assignments consist of 10 options, including 11 practical tasks.

1. THE HALF-LIFE OF RADIOACTIVE PHOSPHORUS IS 14.3 DAYS. AFTER HOW LONG WILL THE ACTIVITY OF THE PHOSPHORUS-LABELLED ATP DECREASE BY 5 TIMES

1) 33.3 days
2) 43.3 days
3) 3.3 days
4) 23.3 days

2. IN THE EQUATION OF THE REACTION OF OBTAINING CHLORINE FROM MANGANESE (IV) OXIDE AND HYDROCHLORIC ACID, THE SUM OF THE COEFFICIENTS ON THE LEFT SIDE OF THE EQUATION

1) 8
2) 2
3) 5
4) 4

3. TITER OF A SOLUTION CONTAINING 5 G OF SUBSTANCE IN ONE LITRE
1) 0.005 g/ml
2) 0.5 g/ml
3) 0.05 g/ml
4) 0.025 g/ml

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

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

Tests in the system "Moodle" https://educ-amursma.ru/course/view.php?id=856
Total number of tests - 100.

1. THE RADIUS OF ATOMS OF ELEMENTS INCREASES IN THE SERIES…
1) Si, Ge , Sn , Pb
2) Al, Si, Mg, Na
3) O, S, Te , Se
4) Mg, Ca , Ba, Sr

2. BONDING THAT ARISES BETWEEN ATOMS DUE TO THE FORMATION OF COMMON ELECTRON PAIRS
1) ionic
2) covalent
3) hydrogen
4) metal

3. SEPARATION OF SUBSTANCES ASSOCIATED WITH THE DIFFERENCE IN THERMODYNAMIC CONSTANTS OF ION EXCHANGE OF THE IONS TO BE DETERMINED IS THE BASIS OF CHROMATOGRAPHY
1) chemisorption
2) ion exchange
3) molecular sieve
4) distribution

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

4.2 Situational tasks, exercises

1. How will the pH of a buffer solution consisting of 50 ml of a 0.1 M solution of CH_3COOH and 15 ml of a 1 M solution of CH_3COONa change after adding 15 ml of HCl to it?
$K(CH_3COOH) = 1.74 \times 10^{-5}$.
Standard answer a **:** pH will decrease by 0.3

2. Calculate the pH and the concentration of hydrogen ions in an ammonium hydroxide solution with a concentration of 0.02 mol/l. $K(NH_4OH) = 1.85 \cdot 10^{-5}$.
Answer standard: pH = 10.78; $C(H^+) = 1.66 \cdot 10^{-11}$ mol/l.

3. To determine the volume of erythrocyte mass, a preparation of human erythrocytes labeled with the radionuclide chromium-51 is used. How much time must pass from the moment the preparation is introduced into the bloodstream for 1/10 of the introduced chromium isotope to remain in the body?
Standard answer : 92.45 days.

4. The rate constant of the reaction A + 2B → C + D is equal to 0.3 mol $l^{-1} \cdot s^{-1}$. Write the kinetic equation of the reaction if it is zero-order for substance A and second-order for substance B. Determine the initial reaction rate when mixing equal volumes of solutions with concentrations of each of the starting substances of 0.02 mol/l.

Answer standard : $V = 3 \cdot 10^{-5} mol\ l^{-1} s^{-1}$

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

1. Calculation of the half-life of an isotope.
2. Calculation of the amount of isotope during decay after a certain period of time.
3. Determination of the electron configuration of an atom, quantum numbers of an electron.
4. Determination of the type of chemical bond, configuration of the molecule.
5. Drawing up equations of qualitative chemical reactions and reactions characterizing the properties of compounds formed by *s* - elements.
6. Drawing up equations of qualitative chemical reactions and reactions characterizing the properties of compounds formed by *p* - elements.
7. Drawing up equations of qualitative chemical reactions and reactions characterizing the properties of compounds formed by *d* - elements.
8. Determining the order of a reaction using kinetic data.
9. Calculation of the concentration of a substance based on kinetic data.
10. Calculation of changes in pH of buffer systems when adding electrolytes.
11. Calculation of pH of solutions of strong and weak electrolytes.
12. Drawing up equations of oxidation-reduction processes. Determining the direction of the redox process.
13. Determination of the environment in a salt solution, calculation of pH in salt solutions.
14. Chromatographic analysis of a mixture of substances.
15. Calculation of solution concentrations, calculation of the mass of a substance required to prepare a solution, conversion of one method of expressing concentration to another using the mass fraction of the dissolved substance.
16. Calculation of solution concentrations, calculation of the mass of a substance required to prepare a solution, conversion of one method of expressing concentration to another using molar concentration.
17. Calculation of solution concentrations, calculation of the mass of a substance required to prepare a solution, conversion of one method of expressing concentration to another using the molar concentration of the equivalent (normal concentration).
18. Calculation of solution concentrations, calculation of the mass of a substance required to prepare a solution, conversion of one method of expressing concentration to another using a titer.

4.4 List of questions for the test

1. Quantum -mechanical model of the atom. Quantum numbers. Structure of electron shells of atoms. Minimum energy principle. Pauli exclusion principle. Hund's rule. Klechkovsky's rule. Electron and electron-graphic formulas of atoms. Ground and excited states of the atom. Energy characteristics of the atom: ionization energy, electron affinity, electronegativity.
2. The periodic table and the periodic law of D.I. Mendeleev. Definitions of period and group.
3. Chemical bond. Definition of chemical bond. Types of chemical bond. Hybridization of atomic orbitals.
4. Structure of the atomic nucleus: protons, neutrons, mass number, nuclides and isotopes. Nuclear reactions (definition) and radioactivity (definition). Half-life (definition), its dependence on various factors. Effect of radioactive radiation on living organisms. Use of radioactive isotopes in research.
5. Simple and complex reactions by mechanism. Rate of chemical reaction. Molecularity and order of reaction. Classification of reactions by order and molecularity. Equations of reaction kinetics.

6. Redox reactions. Oxidation and reduction processes. Oxidants and reducers. Types of redox reactions. Redox system. Redox potential, its calculation using the Nernst equation. Predicting the direction of redox reactions based on redox potential values.

7. Solutions. Solubility of substances in water, dependence on various factors. Solubility of gases in liquids. Laws of Henry, Dalton, Sechenov.

8. Methods of expressing the concentration of solutions. Mass fraction. Molar concentration. Molar (molar) fraction. Chemical equivalent. Concentration by equivalence factor (normal concentration). Titer. Conversion of different methods of expressing concentrations into others.

9. Electrolytes, non-electrolytes. Electrolytic dissociation. Degree of dissociation. Strong and weak electrolytes. Dissociation of water. Ionic product of water. pH-hydrogen index, its value in different environments.

10. Buffer solutions (definition), types of buffer solutions. Buffer systems of the body: name, composition. Mechanism of buffer action (using each buffer system as an example). Factors influencing the pH of a buffer solution.

11. Hydrolysis of salts. Types of hydrolysis. Cases of hydrolysis of different types of salts. Constant and degree of hydrolysis of salts. Factors influencing the degree and constant of hydrolysis. The role of hydrolysis in biochemical processes.

12. Surface phenomena. Concepts of sorption, adsorption, absorption, chemisorption. Types of ion adsorption. Paneth-Fajans rule. Chromatography and types of chromatographic analysis. Application of chromatography in biology and medicine.

13. General characteristics of *s*- elements. Hydrogen and its compounds. Biological role of the most important hydrogen compounds and their use in medicine. Characteristics, properties, biological role and use in medicine of elements of IAA -group, IIA-group.

14. General characteristics of *p* -elements. Characteristics, properties, biological role and application in medicine of compounds of *p* -block elements.

15. General patterns of properties of *d* -elements. Characteristics and properties, biological role and application in medicine of compounds of *d* -block elements.