MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
Educational Institution
BELARUSIAN STATE MEDICAL UNIVERSITY

APPROVED
by Rector of the Educational Institution «Belarusian State Medical University»
_____ S.P.Rubnikovich
24.06.2023
Reg. # UD-091-35/23324 /edu.

GENERAL AND INORGANIC CHEMISTRY

Curriculum of the educational institution in the academic discipline for the specialty

7-07-0912-01 «Pharmacy»

2023

Curriculum is based on the educational program «General and Inorganic Chemistry», approved 27.06.2023, registration # УД-091-35/2324/уч.; on the educational plan in the specialty 7-07-0912-01 «Pharmacy», approved 27.06.2023, registration # 7-07-0912-01/2324/mf.

COMPILERS:

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RECOMMENDED FOR APPROVAL:

by the Department of General Chemistry of the Educational Institution «Belarusian State Medical University»
(protocol # 5 of 18.05.2023);

by the Scientific and Methodical Council of the Educational Institution «Belarusian State Medical University»
(protocol # 6 of 27.06.2023)

EXPLANATORY NOTE

«General and Inorganic Chemistry» is the educational discipline of the Chemical Module containing systematized scientific knowledge on structure and chemical transformations of inorganic substances, accompanied by the changes in their content and properties, new scientific knowledge in the field of the structure of atoms and molecules, of chemical thermodynamics and kinetics, theory of solutions and chemistry of the elements.

The aim of the discipline «General and Inorganic Chemistry» is the formation of basic professional competencies that are necessary for solving the problems on the production, qualitative and quantitative analysis of inorganic dosage forms used in medical practice and pharmaceutical analysis.

The objectives of the discipline «General and Inorganic Chemistry» are to form students' scientific knowledge about fundamental laws and theories of general and inorganic chemistry, skills and abilities needed to conduct a chemical experiment and to solve practical problems in professional activity.

The knowledge, skills, and abilities acquired during the study of the academic discipline «General and Inorganic Chemistry» are necessary for successful mastering of the following educational disciplines: «Analytical Chemistry», «Organic Chemistry», «Pharmaceutical Chemistry».

Studying the educational discipline «General and Inorganic Chemistry» should ensure the formation of students' basic professional competency:

BPC. Apply knowledge of the basic physical, chemical and biological laws for quality control of medicines and medicinal plant raw materials.

As a result of studying the discipline «General and Inorganic Chemistry» the student should

know:

the rules of safe work in chemical laboratory with inorganic substances;
types of chemical glassware and aims of its usage;
characteristics of chemical equilibrium and ways to calculate its constants;
fundamental principles of theories of strong and weak electrolytes;
basics of the modern view on the structure of atoms;
types and characteristics of chemical bonds;
structure of complex compounds and their properties;
chemical properties of the elements and their compounds;

be able to:

write equations of chemical reactions;
conduct calculations to determine the direction of chemical processes;
prepare solutions of the needed concentration;
predict chemical reactivity of compounds and their physical properties depending on the position of corresponding elements in the periodic table;
predict physical and chemical properties and the possibility of the usage in pharmacy for inorganic substances;

master:

skills of work with chemical glassware and conduction of simplest chemical reactions;

the technique of experimental determination of pH of solutions with a help of indicators;

nomenclature rules for inorganic substances.

Total number of hours for the study of the discipline is 232 academic hours. Classroom hours according to the types of studies: lectures – 30 hours (including 10 hours of supervised student independent work), laboratory studies - 105 hours, student independent work (self-study) – 97 hours.

Intermediate assessment is carried out according to the syllabus of the specialty in the form of a credit (1st semester) and exam (2nd semester).

Form of higher education – full-time.

ALLOCATION OF ACADEMIC TIME ACCORDING TO SEMESTERS OF STUDY

Code, name of the specialty	semester	Number of academic hours						Form of intermediate assessment
		total	in-class	including			out-of-class self-studies	
				lectures (including supervised independent work)	supervised student independent work	laboratory studies (practical classes and seminars)		
1-79 01 08 «Pharmacy»	1	112	66	12	4	54	46	credit
	2	120	69	18	6	51	51	exam

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	laboratory
1. Introduction into the discipline «General and Inorganic Chemistry»	**–**	**6**
2. Fundamental principles of chemical processes	**8**	**36**
2.1. Energetics, direction and depth of chemical reactions. Chemical equilibrium. Rate of chemical reactions	4	9
2.2. Doctrine on solutions	4	21
2.3. Reactions with electron transfer – redox reactions	–	6
3. Structure of matter	**4**	**12**
3.1. Electron layers of atoms and the periodic law of D.I.Mendeleev. The nature of chemical bonds and structure of chemical substances	2	9
3.2. Complex compounds	2	3
4. Chemistry of the elements	**18**	**51**
4.1. Introduction into chemistry of biogenic elements	2	3
4.2. General characteristic of s-elements. Elements of groups IA-IIA	1	6
4.3. General characteristics of d-elements. Elements of groups IIIB-VIB	1	3
4.4. Elements of VIIB group	1	3
4.5. Elements of VIIIB group	1	3
4.6. Elements of IB group	1	3
4.7. Elements of IIBgroup	1	6
4.8. General characteristics of p-elements. Elements of IIIA group	2	3
4.9. Elements of IVA group	2	6
4.10.Elements of VA group	2	6
4.11.Elements of VIA group	2	6
4.12.Elements of VIIA-VIIIA groups	2	3
Total hours	**30**	**105**

CONTENT OF THE EDUCATIONAL MATERIAL

1. Introduction into the discipline «General and Inorganic Chemistry»

The subject, purposes and methods of general and inorganic chemistry, its place in the system of natural sciences and pharmaceutical education, the role in the development medicine and pharmacy.

Main laws, principles and concepts of general and inorganic chemistry for the solution of professional tasks of a pharmacist.

Chemical properties of main classes of inorganic compounds, their nomenclature.

Calculations according to chemical formulas and equations.

Safety technique and rules of work in laboratories of chemical profile.

Analysis of the results of observations and measurements.

2. Fundamental principles of chemical processes

2.1 Energetics, direction and depth of chemical reactions. Chemical equilibrium. Rate of chemical reactions

Absorption and release of different types of energy during chemical transformations.

Internal energy (U) and enthalpy (H). Standard conditions. Heat effects of chemical reactions at the constant temperature and pressure (Q_p) or at the constant volume (Q_v). Thermochemical equations. Standard enthalpies of formation and combustion of substances (ΔH^o_f, ΔH°_c).

The law of Hess. Calculation of standard enthalpies of chemical reactions and physical and chemical transformations (processes of the dissolving of substances, dissociation of acids and bases, formation of molecules from atoms) according to the Hess law.

The concept of entropy (S) as the value of the disorder in a system (Boltzmann equation: $S = k\ln W$).

Gibbs energy (ΔG^o) as the criterion of spontaneous process (ΔG°_f) and thermodynamic stability of chemical compounds. Tables of standard Gibbs energies of formation for substances (ΔG°_f).

Reversible and irreversible chemical reactions according to their direction. The state of chemical equilibrium.

The law of mass action for the state of chemical equilibrium (the law of chemical equilibrium). The constant of chemical equilibrium and its connection with the standard change in Gibbs energy for a process. Determination of the direction of a reaction in a system in certain conditions by the way of the comparison of the ratio of products and reactants concentrations in those conditions with the value of the constant of equilibrium.

The dependence of Gibbs energy of a process and the constant of equilibrium on temperature.

The principle of Le-Chatelier-Braun.

Average and instantaneous (momentary) rate of a reaction. The concept of the mechanism of a reaction. Simple (one-step) and multiple-step reactions. Factors that influence rates of chemical reactions in homogeneous and heterogeneous systems.

The dependence of the rate of chemical reaction on concentration. The concept of the rate constant of a reaction. The dependence of the rate of a reaction on temperature, Arrhenius equation.

Energy of activation for a reaction. The dependence of the activation energy on the mechanism of a chemical reaction.

The energy of activation for catalytic reactions and the nature of the action of a catalyst. The concept of enzymatic catalysis in biological systems.

2.2. Doctrine on solutions

Main definitions: solution, solvent, solute. Solubility. Solutions of gaseous, liquid and solid substances. Water as one of the most abundant solvents. The role of water solutions in metabolism of organisms. Non-water solvents and solutions.

Main ways to describe the content of a solution.

The process of the dissolving as physical and chemical event (D.I.Mendeleev, N.S.Kurnakov). Thermodynamics of the process of the dissolving.

Solutions of gases in liquids. Laws of Henry, Henry-Dalton, I.M.Sechenov.

Solutions of solid substances in liquids. The concept of colligative properties of solutions. The decrease of the vapor pressure upon a solution (the 1st law of Raoult), boiling point elevation and freezing (crystallization) point depression for solutions compared to corresponding characterisctics of the pure solvent (the 2nd law of Raoult). Osmosis and osmotic pressure, the law of Van't Hoff. Theory of electrolytic dissociation (Arrhenius S., Kablukov I.A.). Isotonic coefficient. Hypo-, iso-, and hypertonic solutions. The role of osmosis and osmotic pressure in biosystems. Plasmolysis, hemolysis, turgor.

Solutions of weak electrolytes. The application of the law of mass action to the process of ionization of weak electrolytes. Constant of ionization (K_i). Stepwise nature of ionization. The law of dilution of Ostwald. Shift of equilibrium in solutions of weak electrolytes.

Theory of strong electrolytes. Ionic strength of solutions, activity coefficient and activity of ions.

The equilibrium between solution and precipitate of hardly soluble electrolyte. Concentrative and thermodynamic solubility constants, solubility product. Conditions of solubilization and precipitation.

Water ionization. Ionic product of water. Potential of hydrogen – pH; pH of weak and strong acids and bases.

Theories of acids and bases (Arrhenius, Bronsted and Lowry, Lewis). Acidity constant (K_a) and basicity constant ($K_в$). Processes of ionization, hydrolysis, neutralization from the point of view of different theories of acids and bases. pH of solutions of weak acids, bases, salts prone to hydrolysis. Hydrolysis constant for salts. Shift of equilibrium in protolytic reactions.

Amphoteric electrolytes (ampholytes). Dissolving of amphoteric hydroxides in strong acids and bases.

Basics of titrimetric analysis method.

The role of ionic, including acid-base interactions in the analysis of medicines and preparation of their mixtures. Chemical compatibility and incompatibility of medicines.

2.3. Reactions with electron transfer – redox reactions

Electron theory of reduction and oxidation (redox) reactions (L.V.Pisarzhevsky).

Redox properties of elements and their compounds depending on the position of the element in the periodic table of elements (PTE) and oxidation state of those elements in compounds.

Conjugate pairs of reducers and oxidizers. Redox amphotericity.

Standard change in Gibbs energy of redox reaction and standard redox potentials of half-reactions (electrode potentials). Determination of the direction of redox reactions using the difference of redox potentials. Electron-ion method of redox reactions balancing.

The influence of the medium (pH) and external conditions on the direction of redox reactions and the nature of products.

The usage of redox reactions in pharmacy.

3. Structure of matter

3.1. Electron layers of atoms and the periodic law of D.I.Mendeleev. The nature of chemical bonds and structure of chemical substances

Main steps and dialectics of the development of representations on the existence and structure of atoms. Atomic spectra as the source of information on their structure. Standard model. Overview of the string theory. Application of relativity theory to the description of the structure of atoms.

Quantum nature of absorption and emission of energy by atoms (Plank). Wave-particle duality of microparticles. De Broglie equation. Wave properties of particles and uncertainty principle. Schrodinger equation as the basis of quantum chemistry.

The character of movement of electrons in an atom. Electron cloud. Wave function. Quantum mechanical model of the structure of atom. Electron energetic levels of an atom. Principal quantum number. Shapes of s-, p-, d- orbitals of an atom. Orbital quantum number. Magnetic momentum quantum number and orientation of p- and d-orbitals in the space. Spin quantum number.

Pauli principle. Principle of the minimal free energy. Ground, excited, and ionized state of atoms. Electron formulas and electron structural schemes of atoms.

The structure of PTE: periods, groups, families, s-, p-, d-, f-classification of chemical elements (blocks). Long-period and short-period variants of PTE. Periodical manner of changes of properties of atoms of the elements: radius, ionization energy, affinity to electron energy, relative electronegativity (REN). The determining role of outer electron layers for chemical properties of the elements. Periodic manner of changes of properties of elements, oxides, hydroxides, and hydrides of the elements.

Types of chemical bonds and physical and chemical properties of compounds with covalent, ionic and metallic bonds. Experimental characteristics of chemical bonds: the energy, the length, the direction. Experimental curve of potential energy of the molecule of hydrogen (dielectronic chemical bond according to Heitler-London with hydrogen molecule as a sample).

Description of molecules with a help of valence bond method. Mechanism of covalent bond formation. Maximal covalency of an element (saturation of covalent bonds). Direction of covalent bond as a consequence of the maximal overlap of

atomic orbitals. Formation of σ- and π-bonds due to the overlap of s-, p-, d-orbitals. The order of the bond in the valence bond theory. Polarization ability and polarity of covalent bonds. The usage of relative electronegativities of atoms for approximate estimation of the chemical bond polarity. Effective charges on atoms in molecules.

Hybridization of atomic orbitals. Stability of hybridized states for different atoms. Orientation of atoms in molecules (3D-shapes of molecules). Characteristic structures of tri-, tetra-, penta-, hexa-, and hepta-atomic molecules. Polarity of molecules.

Description of molecules by the molecular orbital method. Bonding, antibonding, and nonbonding molecular orbitals (MO), their energy and shape. Energetic diagrams for MO. Fulfilment of MO by electrons in molecules formed by atoms and ions of elements from the 1st and 2nd periods of PTE. The order of bonds in MO theory.

Intermolecular interactions and their nature. Energy of intermolecular interactions. Orientational, inductive, and dispersed interactions. Hydrogen bond and its nature. Different types of hydrogen bonds. Biological role of hydrogen bonds.

3.2. Complex compounds

Modern meaning of the term «complex compounds» (CC). Structure of coordination compounds: central atom (complex former), ligands, complex ion, inner and outer spheres, coordination number of the central atom, dentality of ligands.

Ability of atoms of different elements to form complex compounds. The nature of chemical bonds in CC. Formation and dissociation of CC in solutions, constants of formation and instability constants of complexes.

Classification and nomenclature of CC. Complex acids, bases and salts. Pi-complexes. Carbonyls of metals. Chelate and macrocyclic CC.

Biological role of CC. Metalloenzymes, the concept of the structure of their active centers. Chemical basis of the usage of CC in pharmacy and medicine.

4. Chemistry of the elements

4.1. Introduction into chemistry of biogenic elements

The doctrine of V.I.Vernadsky on the biosphere and biogeochemistry. The doctrine on biogenic elements. Macro- and microelements in the environment and in the human organism. Human and biosphere. The connection between endemic diseases and properties of biogeochemical provinces. Technical progress and ecology. Problems of the environmental protection.

4.2. General characteristic of s-elements. Elements of groups IA-IIA

Specific position of hydrogen in PTE, its reactions with oxygen, halogens, metals, oxides.

Water as the most important compound of hydrogen, its physical and chemical properties. Aquatic complexes and crystal hydrates. Distilled and apyrogenic water, their production and application in pharmacy. Natural waters, mineral waters.

Characteristics and reactivity of hydrogen with other widespread elements: oxygen, nitrogen, carbon, sulfur. Specific behavior of hydrogen in compounds with strongly and weakly polar bonds. Hydrogen ion, hydroxonium ion, ammonium ion.

General characteristic of elements from IA and IIA groups. The difference in properties of elements from IIA group and IA group. Characteristics of cations M^+ and M^{2+}. Ions M^+ and M^{2+} in water solutions, energy of hydration of those ions.

Reactions of metals with oxygen, formation of oxides, peroxides, hyperoxides (superoxides). Reactions of those compounds with water. Hydroxides of alkaline and alkaline-earth metals, amphotericity of beryllium hydroxide. Hydrides of alkaline and alkaline-earth metals, their reductive properties.

Reactions of alkaline and alkaline-earth metals with water and acids. Salts of alkaline and alkaline-earth metals: sulfates, halides, carbonates, phosphates.

Ions of alkaline and alkaline-earth metals as formers of complexes. Ionophores and their role in membrane transport of potassium and sodium. Ions of magnesium and calcium as complex formers. Reaction with complexions (on the sample of ethylenediamine acetate).

Biological role of metals that are s-elements in themineral balance of the organism. Macro- and micro-s-elements. Биологическая роль s-элементов-металлов в минеральном балансе организма. Макро- и микро-s-элементы. Entry into the body with water; hardness of water, its units, thresholds, an influence on living organisms and reactions in water solutions, methods of its elimination. Compounds of calcium in bone tissue, similarity between ions of calcium and strontium, isomorphic substitution (problem of strontium-90).

Toxicity of beryllium. Chemical basis of the usage of compounds of lithium, sodium, potassium, magnesium, calcium, barium in medicine and pharmacy.

4.3. General characteristics of d-elements. Elements of groups IIIB-VIB

General characteristic of d-elements (transition metals). Characteristic properties of d-elements: variable oxidation states, complex formation, color of compounds (causes of its appearance). Secondary periodicity in families of d-elements. Lanthanide contraction and similarity between d-elements from 5^{th} and 6^{th} periods of PTE.

Elements of IIIB group. General characteristic, similarity and difference from elements of IIIA group; f-elements as analogs of d-elements from IIIB group, similarity and difference on a sample of cerium, chemical basis of the usage of cerium (IV) sulfate in quantitative analysis.

Elements of IVB and VB groups. General characteristics. Chemical basis of the usage of titanium, niobium and tantalum in surgery, titanium dioxide and ammonium metavanadate in pharmacy.

General characteristics of VIB group of elements.

Chromium. General characteristics. The element and its chemical activity, ability to form complexes.

Chromium (II), acid-base (AB) and reduction-oxidation (redox) characteristics of its compounds.

Chromium (III), AB and redox characteristics, ability to form complexes.

Compounds of chromium (VI): oxide and chromium acids, chromates and dichromates, AB and redox characteristics; oxidative properties of chromates and dichromates depending on pH of the medium; oxidation of organic compounds (for example, alcohols). Peroxocompounds of chromium (VI).

General dependencies of AB and redox properties of compounds of d-elements on the oxidation state on a sample of chromium compounds.

Molybdenum and tungsten, general characteristics, ability to form isopoly- and heteropolyacids; comparative redox characteristic of molybdenum and tungsten compounds relative to chromium compounds.

Biological significance of d-elements from VI group. Chemical basis of the usage of chromium, molybdenum and tungsten compounds in pharmacy (pharmaceutical analysis).

4.4. Elements of VIIB group

General characteristic of elements from VIIB group.

Manganese. General characteristic. Chemical activity of the element, ability to form complexes (manganese carbonyls).

Compounds of manganese (II) and manganese (III): AB and redox properties, ability to form complexes.

Manganese (IV) oxide, AB and redox properties, the influence of pH on redox properties.

Compounds of manganese (VI): manganates, their formation, thermal stability, disproportioning in a solution and conditions for stabilization.

Compounds of manganese (VII): oxide, manganese acid, permanganates, AB and redox properties, products of permanganates reduction at different levels of pH, oxidation of organic compounds, thermal decomposition. Chemical basis of the usage of potassium permanganate and its solution as an antiseptic in medicine, as well as in pharmaceutical analysis.

4.5. Elements of VIIIB group

General characteristic of elements from VIIB group. Division of elements from VIIIB group into elements from iron family and platinum family.

General characteristic of elements from iron family.

Iron. Chemical activity of the element, ability to form complexes.

Compounds of iron (II) and iron (III): AB and redox characteristics, ability to form complexes. Complex compounds of iron (II) and iron (III) with cyanide and thiocyanide ions. Hemoglobin and iron containing enzymes, chemical basis of their functioning.

Iron (VI). Ferrates, their production and oxidative properties.

Chemical basis of the usage of iron and iron containing preparations in medicine and pharmacy (including pharmaceutical analysis).

Cobalt and nickel. Chemical activity of the elements in comparison with that of iron. Compounds of cobalt (II) and (III), nickel (II), AB and redox properties, ability to form complexes (Chugaev reaction). Nickel and cobalt as microelements, co-enzyme B12. Chemical basis of the usage of cobalt and nickel compounds in medicine and pharmacy.

General characteristic o elements from the family of platinum.

4.6. Elements of IB group

General characteristic of elements from IB group. Physical and chemical properties of the elements.

Compounds of copper (I) and (II), their AB and redox characteristics, ability to form complexes. Complex compounds of copper (II) with ammonia, amino acids, polyatomic alcohols. Complex nature of copper containing enzymes and chemistry of their action in metabolic reactions. The nature of the color of copper. Chemical basis of the usage of copper compounds in medicine and pharmacy.

Compounds of silver, their AB and redox properties (bactericide properties of silver ion). Ability to form complexes, coordination compounds of silver with halogens, ammonia, thiosulfates. Chemical basis of the usage of silver compounds as medicine and in pharmaceutical analysis.

Gold. Comparison of gold (I) and gold (III) compounds, their AB and redox characteristics, ability to form complexes. Chemical basis of the usage of gold and its compounds in medicine and pharmacy.

4.7. Elements of IIB group

General characteristic of elements from IIB group.

Zinc. General characteristic, chemical activity of the element, AB and redox characteristics of zinc. Complex compounds of zinc. Complex nature of zinc containing enzymes and chemistry of their action. Chemical basis of the usage of zinc compounds in medicine and pharmacy. Cadmium and its compounds in comparison with analogous compounds of zinc.

Mercury. General characteristic, distinguishing properties in comparison with zinc and cadmium: low chemical activity of the element, covalent nature of bonds with soft ligands, formation of a bond between atoms of mercury. Oxidation of mercury by sulfuric and nitric acids. Compounds of mercury (I) and mercury (II), their AB and redox characteristics, ability of mercury (I) and mercury (II) to form complexes. Chemistry of mercury and cadmium compounds toxicity. Chemical basis of the usage of mercury compounds in medicine and pharmacy.

4.8. General characteristics of p-elements. Elements of IIIA group

General characteristic of elements from IIIA group. Electron deficiency and its influence on properties of those elements and their compounds. The changes in stability of compounds of elements from IIIA group in oxidation states of +1 and +3.

Boron. General characteristic. Allotropic modifications of boron and their activity. Borides. Compounds with hydrogen (boranes), specific features of their stereochemistry and the nature of bonds (tricentric bonds). Borohydrides. Halides of boron, hydrolysis and complexation. Boric anhydride and boric acids, equilibrium in water solution. Borates as derivatives of different monomeric and polymeric boric acids. Sodium tetraborate. Esters of boric acid. Test reaction for boron and its usage in pharmaceutical analysis. Biological role of boron. Antiseptic properties of boric acid and its salts.

Aluminum. General characteristic of aluminum. The element and its chemical activity. Polymorphic variants of aluminum oxide. The usage of aluminum compounds in medicine. Amphoteric properties of aluminum hydroxide. Aluminates. Aluminum ion as complex former. Anhydrous salts of aluminum and salt hydrates. Specific properties of their structures. Aluminum halides and hydride, alanates. Alums. Physical and chemical basis of the usage of aluminum compounds in medicine and pharmacy.

4.9. Elements of IVA group

General characteristic of elements from IVA group.

General characteristic of carbon. Allotropic modifications of carbon: their physical and chemical properties. Types of hybridization for carbon atom and structure of carbon containing molecules. Carbon as the main component of all organic molecules. Activated coal as an adsorbent.

Carbon in negative oxidation states. Carbides of active metals and production of hydrocarbons from them.

Carbon (II). Carbon oxide (II), its AB and redox characteristics, properties as ligand, chemical basis of its toxicity. Prussic acid, simple and complex cyanides. Chemical basis of toxicity of cyanides.

Compounds of carbon (IV). Carbon (IV) oxide, stereochemistry and the nature of bonds, equilibrium in water solution. Carbonic acid, carbonates and hydrogencarbonates (bicarbonates), hydrolysis and thermal decomposition.

Compounds of carbon with halogens and sulfur. Carbon (IV) chloride (carbon tetrachloride), carbon (IV) oxodichloride (phosgene), freons, carbon disulfide, thiocarbonates. Cyanates and thiocyanates. Physical and chemical properties, their usage.

Biological role of carbon. Chemical basis of the usage of inorganic compounds of carbon in medicine and pharmacy.

Silicon. General characteristics. The main difference from carbon: the absence of π-bonds in compounds. Tetrafluoride and tetrachloride of silicon, hydrolysis. Hexafluorosilicates. Oxygen containing compounds of silicon. Silicon (IV) oxide. Silica gel. Silicic acid. Silicates. Solubility and hydrolysis. Natural silicates and alum silicates, cyolites. Silicon containing organic compounds. Silicones and siloxanes. The usage of silicon compounds in medicine.

Elements of germanium family. General characteristic. Stability of compounds with hydrogen. Compounds with halogens of EH_2 and EH_4 types, their behavior in water solutions. Hydrogen hexaclorostannate. Oxides. Lead (IV) oxide as a strong oxidizer. Amphoteric properties of hydroxides. Soluble and insoluble salts of tin and lead. Redox reactions in solutions. Chemistry of toxicity of lead compounds. The usage in medicine of lead containing preparations (lead (II) acetate, lead (II) oxide). Chemical basis of the usage of tin and lead in pharmaceutical analysis.

4.10. Elements of VA group

General characteristic of elements from VA group. Nitrogen, phosphorus, arsenic in organisms, their biological role.

Nitrogen. General characteristic. Diversity of compounds with different oxidation states of nitrogen. The cause of low chemical activity of dinitrogen. Molecule of dinitrogen as ligand.

Compounds of nitrogen with negative oxidation states. Nitrides (covalent and ionic). Ammonia, AB and redox characteristics, substitution reactions. Amides. Ammoniates. Properties of amino acids as derivatives of ammonia. Ammonium ion and its salts, acidic properties, thermal decomposition. Hydrazine and hydroxylamine, AB and redox characteristics. Hydrazoic acid and azides.

Compounds of nitrogen in positive oxidation states. Oxides. Stereochemistry and nature of bonds. Production ways. AB and redox properties. Nitrous acid and nitrites. AB and redox properties. Nitric acid and nitrates. AB and redox characteristics. Aqua regia.

Phosphorus. General characteristic. Allotropic modifications of phosphorus, their chemical activity.

Phosphides. Phosphine. Comparison with corresponding compounds of nitrogen.

Compounds of phosphorus in positive oxidation states. Halides, their hydrolysis. Oxides: stereochemistry and nature of bonds, reactions with water and alcohols. Hypophosphorous and phosphorous acids, structure of molecules, AB and redox properties. Isopoly- and heteropolyacids. Metaphosphoric acids, comparison with nitric acid. Derivatives of phosphoric acid in living organisms.

Elements of arsenic family. Their general characteristic.

Hydrogen compounds of arsenic, antimony and bismuth in comparison with ammonia and phosphine. Marsh method of analysis for the presence of arsenic.

Compounds of arsenic, antimony and bismuth with positive oxidation states. Sulfides, thiosalts. Halides and changes of their properties in the group (from nitrogen to bismuth). Oxides and hydroxides E(III) and E(V), their AB and redox characteristics. Arsenites and arsenates, their AB and redox properties. Salts of antimony (III) and bismuth (III) cations, their redox properties and hydrolysis. Antimonic acid and its salts. Bismuthates. Instability of bismuth (V) compounds.

Chemical basis of the usage in medicine and pharmacy of ammonia, nitrogen (I) oxide (dinitrogen monoxide), nitrite and nitrate of sodium, oxides and salts of arsenic, antimony, and bismuth. Chemical basis of the usage of compounds of p-elements from group V in pharmaceutical analysis.

4.11. Elements of VIA group

General characteristic of elements from VIA group.

Oxygen. Its general characteristic. The role of oxygen as one of the most widespread elements and as a part of the most inorganic compounds. Specific features of the electron structure of dioxygen molecule. Chemical activity of dioxygen. Molecule of O_2 as a ligand in oxyhemoglobin. Trioxygen (ozone), stereochemistry and nature of bonds. Chemical activity in comparison with dioxygen. Reaction with solutions of iodides. Classification of oxygen containing compounds and their common properties (including those of binary compounds: superoxides, peroxides, oxides, ozonides).

Hydrogen peroxide (H_2O_2), its AB and redox characteristics, the usage in medicine. Compounds of oxygen with fluorine. Biological role of oxygen. Chemical basis of the usage of dioxygen and ozone, as well as oxygen compounds in medicine and pharmacy.

Sulfur. Its general characteristic. Ability to form homochains.

Compounds of sulfur in negative oxidation states. Hydrogen sulfide, AB and redox properties. Sulfides of metals and nonmetals, their solubility in water and hydrolysis. Polysulfides, AB and redox characteristics, stability.

Compounds of sulfur (IV): oxide, chloride, oxochloride (thionyl chloride), sulfurous acid, sulfites and hydrogensulfites. Their AB and redox properties. Reduction of sulfites to dithionic acid and dithionates. Reactions of sulfites with sulfur that produce thiosulfates. Properties of thiosulfates: reactions with acids, oxidizers (including diiodine), complex forming cations. Polythionates, specific features of their structure and properties.

Compounds of sulfur (VI): oxide, hexafluoride, dioxydichloride (sulfuryl chloride), sulfuric acid and sulfates, AB and redox properties. Oleum. Disulfuric (pyrosulfuric) acid. Peroxymono- and peroxydisulfuric acid and their salts. Oxidative properties of peroxysulfates.

Biological role of sulfur (sulfhydryl groups and disulfide bridges in proteins). Chemical basis of the usage of sulfur and its compounds in medicine, pharmacy, pharmaceutical analysis.

Selenium and tellurium. General characteristic. AB and redox properties of hydrogen compounds and their salts. Oxides and acids, their AB and redox properties (in comparison with similar sulfur compounds). Biological role of selenium.

4.12. Elements of VIIA-VIIIA groups

General characteristics of elements from VIIA group. Specific features of fluorine as the most electronegative element. The elements and their chemical activity.

Compounds of halogens with hydrogen. Solubility in water; AB and redox properties. Ionic and covalent halides, their interactions with water, oxidizers and reducers. Ability of fluoride ion to replace oxygen (for example, in compounds of silicon). Halide ions as ligands in complex compounds.

Halogens in positive oxidation states. Compounds with oxygen and with each other. Interactions of halogens with water and water solutions of alkalis. Oxygen containing acids of chlorine and their salts, stereochemistry and nature of bonds. Stability in pure state and in solutions, changes of acidic and redox properties depending on oxidation state of a halogen. Bleaching powder. Chlorates, bromates, and iodates, their properties. Biological role of fluorine, chlorine, bromine and iodine compounds.

Chemistry of bactericide action of chloride and iodine. The usage in medicine, sanitation and pharmacy of bleaching powder, chlorine water, preparations of active chlorine, iodine, as well as those of hydrochloric acid, fluorides, chlorides, bromides, and iodides.

Elements from VIIIA group. General characteristic, physical and chemical properties of inert (noble) gases. Compounds of inert gases. The usage of inert gases in medicine.

EDUCATIONAL DISCIPLINE CURRICULAR CHART

Section, topic #	Section (topic) name	number of hours				Form of control
		Lectures (including supervised student independent work)	supervised student independent work	laboratory	Self-studies	
	1st semester					
1.	**Introduction into the discipline «General and Inorganic Chemistry»**	**–**	**–**	**6**	**6**	
	Introduction into the discipline «General and Inorganic Chemistry». Fundamentals of bioinorganic chemistry	–	–	3	3	Interview, electronic tests, control work
	Main classes of inorganic compounds Laboratory work (L.w.) «Production and properties of oxides, hydroxides, acidic and basic salts»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work
2.	**Fundamental principles of chemical processes**	**4**	**2**	**6**	**4**	
2.1.	Energetics, direction and depth of chemical reactions. Chemical equilibrium. Rate of chemical reactions	**4**	**2**	**6**	**4**	
	Basics of chemical thermodynamics. Energetics, direction and depth of chemical reactions. Chemical equilibrium	2	1	–	–	
	Energetics, direction and depth of chemical reactions. Chemical equilibrium. L.w. «Estimation of the heat effect of neutralization reaction»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work

	Basics of chemical kinetics. Rate of chemical reactions	2	1	–	–	
	Energetics and rate of chemical reactions: basics of chemical kinetics. L.w. «The study of the dependence of the rate of chemical reaction on concentration of reactants»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work
3.	**Structure of matter**	**4**	**1**	**12**	**18**	
3.1	Electron layers of atoms and the periodic law of D.I. Mendeleev. The nature of chemical bonds and structure of chemical substances	**2**	**1**	**9**	**6**	
	Structure of matter: electron layers of atoms	–	–	3	2	Interview, electronic tests, control work
	The nature of chemical bonds and structure of chemical substances	2	1	–	–	
	Structure of matter: the nature of chemical bonds	–	–	3	2	Interview, electronic tests, control work
	Structure of matter: theories of valence bonds and molecular orbitals	–	–	3	2	Interview, electronic tests, control work
3.2	Complex compounds. L.w. «Production of complex compounds and study of their properties»	–	–	3	12	Interview, electronic tests, control work, written accounts of laboratory work
	Basics of coordination chemistry. Complex compounds	2	–	–	–	
2.	**Fundamental principles of chemical processes**	**4**	**1**	**24**	**18**	
2.1	Energetics and rate of chemical reactions: doctrine on the structure of matter and chemical equilibrium	–	–	3	2	Interview, colloquium, electronic tests, control work, written accounts of laboratory work
2.2	Doctrine on solutions	**4**	**1**	**21**	**16**	
	Doctrine on solutions: the ways to express the content of a solution. L.w. «Acquisition of skills of the work with laboratory glassware»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work

	Doctrine on solutions: colligative properties of solutions. L.w. «Hemolysis of red blood cells in hypotonic solution»	2	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work
	Doctrine on solutions: theories of strong and weak electrolytes. L.w. «Measurement of active acidity of biological fluids»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work
	Doctrine on solutions. Theories of acids and bases.	2	1	–	–	
	Doctrine on solutions: hydrolysis of salts. L.w. «Hydrolysis of salts and the influence of different factors on the degree of hydrolysis»	–	–	3	1	Interview, electronic tests, control work, written accounts of laboratory work
	Doctrine on solutions: methods of preparation of solutions. L.w. «Preparation of a solution from fixanal and from the hitch, preparation of hydrochloric acid of a needed concentration by the dilution method»	–	–	3	1	Interview, electronic tests, control work, written accounts of laboratory work
	Doctrine on solutions: basics of the titrimetric method of analysis. L.w. «Determination of the molar concentration of the equivalent of oxalic acid»	–	–	3	1	Interview, electronic tests, control work, written accounts of laboratory work
	Doctrine on solutions: heterogenous equilibria. L.w. «Study on the conditions of precipitation and dissolving in heterogeneous systems»	–	–	3	1	Interview, electronic tests, control work, written accounts of laboratory work
2.3.	Reactions with electron transfer – redox reactions. L.w. «Study on the influence of different factors on redox reactions»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work
	Chemistry of acid-base and redox reactions in solutions	–	–	3	3	Interview, colloquium, credit

	2nd semester					
4.	**Chemistry of the elements**	**18**	**6**	**51**	**51**	
4.1	Introduction into chemistry of biogenic elements. L.w. «Comparative analysis of water of different origin using several indices»	2	1	3	5	Interview, electronic tests, control work, written accounts of laboratory work
4.2	General characteristic of s-elements.	**2**	**0.5**	**6**	**6**	
	General characteristic of s-elements. Elements of groups IA-IIA.	2	0.5	–	–	
	Chemistry of s-elements: elements from IA group. L.w. «Investigation of chemical properties of compounds of elements from IA group»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	Chemistry of s-elements: elements from IIA group. L.w. «Investigation of chemical properties of compounds of elements from IIA group»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
4.3	Elements of groups IIIB-VIB. L.w. «Investigation of chemical properties of compounds of elements from IIIB – VIB groups»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	General characteristic of d-elements. Elements from IIIB – VIB groups.	2	0.5	–	–	
4.4	Elements of VIIB group. L.w. «Investigation of chemical properties of compounds of elements from VIIB group»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	Elements from VIIB-VIIIB, IB-IIB groups	2	0.5	–	–	
4.5	Elements of VIIIB group. L.w. «Investigation of chemical properties of compounds of elements from VIIIB group»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works

4.6	Elements of IB group. L.w. «Investigation of chemical properties of compounds of elements from IB group»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
4.7	Elements of IIB group. L.w. «Investigation of chemical properties of compounds of elements from IIB group»	–	–	3	6	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	General characteristic of s- and d-elements	–	–	3	–	Colloquium, electronic test
4.8	Elements from IIIA group. L.w. «Investigation of chemical properties of compounds of elements from IIIA group»	–	–	3	3	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	General characteristic of p-elements. Elements from IIIA group	2	0.5	–	–	
4.9	Elements from IVA group	**2**	**0.5**	**6**	**4**	
	Elements from IVA group	2	0.5	–	–	
	Elements from IVA group: compounds of carbon. L.w. «Investigation of chemical properties of carbon containing compounds»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	Elements from IVA group: compounds of silicon and elements from the family of germanium. L.w. «Investigation of chemical properties of compounds of silicon, tin, and lead»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
4.10	Elements of VA group	**2**	**0.5**	**6**	**4**	
	Elements of VA group	2	0.5	–	–	
	Elements of VA group: compounds of nitrogen and phosphorus. L.w. «Investigation of chemical properties of compounds of nitrogen and phosphorus»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works

	Elements of VA group: compounds of elements from arsenic family. L.w. «Investigation of chemical properties of compounds of arsenic»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
4.11	Elements of VIA group	**2**	**0.5**	**6**	**4**	
	Elements of VIA group	2	0.5	–	–	
	Elements of VIA group: compounds of oxygen. L.w. «Investigation of chemical properties of compounds of oxygen»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
	Elements of VIA group: compounds of sulfur and selenium. L.w. «Investigation of chemical properties of compounds of sulfur and selenium»	–	–	3	2	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works
4.12	Elements of groups VIIA-VIIIA. General characteristic of p-elements. L.w. «Investigation of chemical properties of compounds from VIIA group»	2	1	3	5	Interview, electronic tests, control work, written accounts of laboratory work, visual laboratory works. Colloquium, exam
	Total hours	**30**	**10**	**105**	**97**	

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic (relevant):

1. Medical chemistry : textbook / V. O. Kalibabchuk, V. I. Halynska, L. I. Hryshchenko et al.; edited by V. O. Kalibabchuk. – Kyiv: «Medicina», 2018. – 224 p.

Additional:

2. Colloquium in medical chemistry / V. V. Khrustalev et al. – Minsk : BSMU, 2023. – 50 p.
3. Essential chemistry for foreign students / S. V. Tkachev, T. V. Latushko, S. R. Kazulevich, E. V. Barkovsky – Minsk : BSMU, 2019. – 168 p.
4. Physical and colloid chemistry of real and colloid solutions / V. V. Khrustalev, V. V. Kantsiava, S. R. Kazulevich – Minsk : BSMU, 2018.– 138 p.
5. Laboratory works and home tasks in general chemistry / V. V. Khrustalev, T. A. Latushko, S. V. Tkachev, S. R. Kazulevich.– Minsk : BSMU, 2020. – 162 p.
6. Introduction to the general chemistry / V. V. Khrustalev, T. V. Latushko, T. A. Khrustaleva. – Minsk : BSMU, 2022. – 144 p.
7. Introduction to the inorganic chemistry / V. V. Khrustalev, T. V. Latushko, T. A. Khrustaleva. – Minsk : BSMU, 2022. – 96 p.
8. Introduction to the organic chemistry / V. V. Khrustalev, T. V. Latushko, T. A. Khrustaleva. – Minsk : BSMU, 2022.– 112 p.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF STUDENT INDEPENDENT WORK (SELF-STUDY ON THE ACADEMIC DISCIPLINE

Time for independent work (self-study) can be used by students for:
preparation for lectures and laboratory studies;
preparation for the colloquium, credit, exam;
solving problems;
note-taking of educational literature.

METHODOLOGICAL RECOMMENDATIONS FOR THE ORGANIZATION AND PERFORMANCE OF SUPERVISED SELF-STUDY ON THE ACADEMIC DISCIPLINE

Main forms of supervised self-study:
studying topics and problems that have not been discussed at the lectures;
computer testing;

Control of supervised self-study is carried out in the forms of:
control work;
colloquium;
tests.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:

Oral form:

interview.

Written form:

control work;

written accounts of laboratory work.

Oral-written form:

credit;

exam.

Technical form:

electronic tests;

visual laboratory work.

LIST OF AVAILABLE TEACHING METHODS

Traditional method (lecture, laboratory practicals);

Active (interactive) methods:

Problem-Based Learning (PBL);

Team-Based Learning (TBL);

Research-Based Learning (RBL).

LIST OF PRACTICAL SKILLS

1. Preparation of a solution of a given volume with a specified concentration.
2. Measurement of pH with a help of colorimetric method in a solution of a salt, to write protolytic reactions of salt hydrolysis (in molecular and ionic form).
3. Selection of reactants and chemical glassware for the conduction of reactions of complex compounds production. Ability to compose equations of reactions of complex compound formation, to name it, and to write the instability constant equation.
4. Selection of reactants and laboratory glassware for the conduction of redox reactions. Ability to compose redox reactions and to balance them with a help of electron-ion method.

LIST OF EQUIPMENT USED

1. Laboratory glassware.
2. Chemical reactants.
3. Calorimeter.
4. Centrifuge.
5. pH-meter.
6. Potentiometer.
7. Spectrofluorometer.
8. ATR-FTIR spectrograph.

LIST OF LECTURES

Semester 1

1. Basics of chemical thermodynamics. Energetics, direction and depth of chemical reactions. Chemical equilibrium.
2. Basics of chemical kinetics. Rate of chemical reactions.
3. The nature of chemical bonds and structure of chemical substances.
4. Basics of coordination chemistry. Complex compounds.
5. Doctrine on solutions. Colligative properties of solutions.
6. Doctrine on solutions. Theories of acids and bases.

Semester 2

1. Introduction into chemistry of biogenic elements.
2. General characteristic of s-elements. Elements of groups IA-IIA.
3. General characteristic of d-elements. Elements from IIIB – VIB groups.
4. Elements from VIIB-VIIIB, IB-IIB groups
5. General characteristic of p-elements. Elements from IIIA group.
6. Elements of IVA group.
7. Elements of VA group.
8. Elements of VIA group.
9. Elements of VIIA-VIIIA groups.

LIST OF LABORATORY STUDIES

Semester 1

1. Introduction into the discipline «General and Inorganic Chemistry». Fundamentals of bioinorganic chemistry.
2. Main classes of inorganic compounds.

L.w. «Production and properties of oxides, hydroxides, acidic and basic salts»

3. Energetics, direction and depth of chemical reactions. Chemical equilibrium.

L.w. «Estimation of the heat effect of neutralization reaction»

4. Energetics and rate of chemical reactions: basics of chemical kinetics.

L.w. «The study of the dependence of the rate of chemical reaction on concentration of reactants»

5. Structure of matter: electron layers of atoms.
6. Structure of matter: the nature of chemical bonds.
7. Structure of matter: theories of valence bonds and molecular orbitals.
8. Complex compounds.

L.w. «Production of complex compounds and study of their properties»

9. Energetics and rate of chemical reactions: doctrine on the structure of matter and chemical equilibrium.
10. Doctrine on solutions: the ways to express the content of a solution.

L.w. «Acquisition of skills of the work with laboratory glassware»

11. Doctrine on solutions: colligative properties of solutions.

L.w. «Hemolysis of red blood cells in hypotonic solution»

12. Doctrine on solutions: theories of strong and weak electrolytes.

L.w. «Measurement of active acidity of biological fluids»

13. Doctrine on solutions: hydrolysis of salts.

L.w. «Hydrolysis of salts and the influence of different factors on the degree of hydrolysis»

14. Doctrine on solutions: methods of preparation of solutions.

L.w. «Preparation of a solution from fixanal and from the hitch, preparation of hydrochloric acid of a needed concentration by the dilution method»

15. Doctrine on solutions: basics of the titrimetric method of analysis.

L.w. «Determination of the molar concentration of the equivalent of oxalic acid»

16. Doctrine on solutions: heterogenous equilibria.

L.w. «Study on the conditions of precipitation and dissolving in heterogeneous systems»

17. Reactions with electron transfer – redox reactions.

L.w. «Study on the influence of different factors on redox reactions»

18. Chemistry of acid-base and redox reactions in solutions.

Semester 2

1. Introduction into chemistry of biogenic elements.

L.w. «Comparative analysis of water of different origin using several indices»

2. Chemistry of s-elements: elements from IA group.

L.w. «Investigation of chemical properties of compounds of elements from IA group»

3. Chemistry of s-elements: elements from IIA group.

L.w. «Investigation of chemical properties of compounds of elements from IIA group»

4. Elements of groups IIIB-VIB.

L.w. «Investigation of chemical properties of compounds of elements from IIIB – VIB groups»

5. Elements of VIIB group.

L.w. «Investigation of chemical properties of compounds of elements from VIIB group»

6. Elements of VIIIB group.

L.w. «Investigation of chemical properties of compounds of elements from VIIIB group»

7. Elements of IB group.

L.w. «Investigation of chemical properties of compounds of elements from IB group»

8. Elements of IIB group.

L.w. «Investigation of chemical properties of compounds of elements from IIB group»

9. General characteristic of s- and d-elements.

10. Elements from IIIA group.

L.w. «Investigation of chemical properties of compounds of elements from IIIA group»

11. Elements from IVA group: compounds of carbon.

L.w. «Investigation of chemical properties of carbon containing compounds»

12. Elements from IVA group: compounds of silicon and elements from the family of germanium.

L.w. «Investigation of chemical properties of compounds of silicon, tin, and lead»

13. Elements of VA group: compounds of nitrogen and phosphorus.

L.w. «Investigation of chemical properties of compounds of nitrogen and phosphorus»

14. Elements of VA group: compounds of elements from arsenic family.

L.w. «Investigation of chemical properties of compounds of arsenic»

15. Elements of VIA group: compounds of oxygen.

L.w. «Investigation of chemical properties of compounds of oxygen»

16. Elements of VIA group: compounds of sulfur and selenium. L.w. «Investigation of chemical properties of compounds of sulfur and selenium»

17. Elements of groups VIIA-VIIIA.

L.w. «Investigation of chemical properties of compounds from VIIA group»

18. General characteristic of p-elements.

PROTOCOL OF THE CURRICULUM APPROVAL BY OTHER DEPARTMENTS

Title of the discipline requiring approval	Department	Amendments to the curriculum in the academic discipline	Decision of the department, which designed the curriculum (date, protocol #)
1. Organic Chemistry	Bioorganic Chemistry	-	protocol # 5 of 18.05.2023
2. Analitical Chemistry	Pharmaceutical Chemistry	-	protocol # 5 of 18.05.2023

COMPILERS/AUTHORS:

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Senior Teacher of the Department of General Chemistry of the Educational Institution «Belarusian State Medical University» _____ S.R.Kaziulevich

Curriculum content, composition and accompanying documents comply with established requirements.

Dean of the Medical Faculty of International Students of the Educational Institution «Belarusian State Medical University» O.S.Ishutin
26. 06. 2023

Methodologist of Educational Institution
«Belarusian State Medical University» S.V.Zaturanova
26. 06. 2023