MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
EDUCATIONAL INSTITUTION
BELARUSIAN STATE MEDICAL UNIVERSITY

APPROVED
by First Vice-Rector, Professor
_____I.N.Moroz
27.06.2023
Reg. # UD-091-007/2324/edu.

MEDICAL CHEMISTRY

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

7-07-0911-01 «General Medicine»

2023

Curriculum is based on the educational program «Medical Chemistry», approved 27.06.2023, registration # УД-091-007/2324/уч.; on the educational plan in the specialty 7-07-0911-01 «General Medicine», approved 27.06.2023, registration # 7-07-0911-1/2324/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

«Medical Chemistry» is the educational discipline of the Chemical Module containing systematized scientific knowledge of substances and their transformations, accompanied by the changes in content, in structure, and in properties, that is necessary for the understanding of the basis of new medicines design, as well as on physical and chemical methods of qualitative and quantitative analysis of biological fluids, solutions of medicines and biopolymers.

The aim of the discipline «Medical Chemistry» is the formation of basic professional competencies that are based on the knowledge on modern chemical and physical and chemical fundamentals of metabolism of human body, the use of modern chemical and physical and chemical methods of investigation of medical and biological problems, design of new medicines, determination of their molecular mechanisms of action, analysis of the content of biological fluids, solutions of biopolymers and medicines.

The objectives of the discipline «Medical Chemistry» are to form students' scientific knowledge about:

chemical thermodynamics and kinetics of chemical reactions, that are theoretical basis of bioenergetics and the study of rates and mechanisms of biochemical processes;

the basis of modern doctrine on water solutions, that is the scientific background for the study of electrolyte balance, acid-base equilibrium, diffusion and osmotic phenomena, physical chemistry of physiological and pathological homo- and heterogeneous systems in human organism;

main theoretical statements of electrochemistry as the background of bioelectrochemistry and electrochemical methods of investigations in biology and medicine;

the basis of physical chemistry of surface phenomena, dispersed systems and solutions of biopolymers, providing a key to understanding ligand-receptor interactions;

skills and abilities needed to:

interpret results of laboratory and physical and chemical methods of analysis;

develop personalized strategy of treatment by target medicines;

use modern materials in dentistry both for the treatment and prosthetics.

The knowledge, skills, and abilities acquired during the study of the academic discipline «Medical Chemistry» are necessary for successful mastering of the following modules: «Biomedical Module #1», «Biomedical Module #2», «Clinical Pathology and Clinical Diagnosis Module».

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

BPC. Use modern chemical, physical & chemical methods to analyze biological fluids, solutions of medicinal substances and biopolymers to make calculations based on the studies conducted.

As a result of studying the discipline «Medical Chemistry» the student should

know:

the basic concepts of acid-base equilibrium in blood (pH of blood, acidosis, alkalosis); mechanism of action of bicarbonate buffer system of blood plasma and hemoglobin buffer system of erythrocytes;

hypo-, hyper-, isotonic solutions and their usage in biology and medicine; major components determining the value of osmotic and oncotic pressure of blood plasma; distribution of water between cells and intercellular liquid (hemolysis, plasmolysis); distribution of water between vessels and intercellular space;

solubility of gases in blood: specific knowledge on solubility of oxygen, carbon dioxide and nitrogen in blood (hyperbaric oxygenation, decompression sickness);

chemical basis of mineralization and the prophylaxis of demineralization of bone tissue during calcium and phosphate deficiency conditions in human (rickets, pregnancy);

chemical basis of the formation and the dissolving of stones during urolithiasis and cholelithiasis;

physical and chemical basis of the usage of porous sorbents during hemo-, plasmo-, lymphosorbtion and enterosorbents for the removal of radionuclides, during the intoxication;

be able to:

predict the direction and the completeness of biochemical processes using thermodynamic calculations;

prepare solutions of the needed content;

analyze the content and physical and chemical properties of biological fluids;

make substantiated choice of a buffer solution with a needed pH and buffer capacity for the certain laboratory investigation;

master:

methods of the preparation of a solution with a given content;

methods of molecular and macromolecular docking;

methods of the determination of the order of a chemical reaction;

methods of titrimetric analysis.

Total number of hours for the study of the discipline is 90 academic hours. Classroom hours according to the types of studies: lectures – 8 hours (including 3 hours of supervised student independent work), laboratory studies 36 hours, student independent work (self-study) – 46 hours.

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

Form of higher education – full-time.

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	laboratory
1. The aim and purposes of medical chemistry	–	**2**
2. Introduction to the coordination chemistry	–	**2**
3. Chemical thermodynamics and bioenergetics	**2**	**4**
3.1. Chemical thermodynamics as the basis of medical chemistry	2	–
3.2. Thermochemistry	–	1
3.3. Direction of biochemical processes	–	1
3.4. Thermodynamics of chemical equilibrium	–	2
4. Chemical kinetics and catalysis	**2**	**2**
4.1. Elements of chemical kinetics	2	1
4.2. Catalysis and catalysts	–	1
5. Doctrine on water solutions	**2**	**14**
5.1. Colligative properties of solutions	–	2
5.2. The theory of solutions of weak and strong electrolytes	–	1
5.3. Protolytic theory of acids and bases	–	1
5.4. Buffer solutions and systems	2	2
5.5. Titrimetric methods of analysis	–	2
5.6. Electrode and redox potentials	–	1
5.7. Potentiometry	–	1
5.8. Conductometry	–	2
5.9. Heterogeneous equilibria in healthy human organism and in pathology	–	2
6. Physical chemistry of surface phenomena	**2**	**4**
6.1. Surface phenomena	–	1
6.2. Theories of adsorption	–	1
6.3. Chromatography	2	2
7. Physical chemistry of dispersed systems and solutions of biopolymers	–	**8**
7.1. Dispersed systems	–	4
7.2. Solutions of biopolymers	–	4
Total hours	**8**	**36**

CONTENT OF THE EDUCATIONAL MATERIAL

1. The aim and purposes of medical chemistry

The aim and purposes of medical chemistry. The role of chemistry in the development medical science. The doctrine of V.I.Vernadsky on the biosphere. Macro- and microelements in the environment and in the human organism. The connection between endemic diseases and properties of biogeochemical provinces.

2. Introduction to the coordination chemistry

Modern views on the nature of chemical bonds. The concept of the method of valence bonds. The concept of the method of molecular orbitals. Three-dimensional structure of molecules. Dipole moment and polarity of molecules. Intermolecular interactions. Hydrogen bond.

Coordination theory of Verner. Classification and nomenclature of complex compounds. Intracomplex compounds. Chelates. Reactions of complexation. Stability and instability constants of complexes. Destruction of complex compounds. The nature of bonds in complexes from the point of view of the valence bonds method. Ability to form complex compounds of s-, p-, and d-elements. Dentality of ligands. Bioligands. Application of complex compounds in medicine. Cytotoxicity of platinum complexes.

3. Chemical thermodynamics and bioenergetics

3.1. Chemical thermodynamics as the basis of medical chemistry

Subject and purposes of chemical thermodynamics. Chemical thermodynamics as the basis of bioenergetics and medical chemistry. Systems: isolated, open and closed. The concept of the phase: homogeneous and heterogeneous systems. Processes: isochoric, isobaric, isothermal, adiabatic.

Internal energy. Heat and work as two forms of energy transfer. The first law of thermodynamics. Isobaric and isochoric heat effects. Enthalpy.

3.2 Thermochemistry

Hess's law. Consequences of the Hess's law. Standard enthalpies of formation and combustion. Thermochemical calculations and their usage for energetic characteristics of biochemical processes.

Connections between processes of matter and energy exchange. The calorage of main components of food and some nutrients. Energetic cost of different physical activities.

3.3 Direction of biochemical processes

Spontaneous and nonspontaneous processes. Thermodynamically reversible and irreversible processes. Statistic and thermodynamic meaning of entropy. The second law of thermodynamics. The calculation of standard entropy using the experimental data on the dependence between temperature and heat capacity of a substance. Criterions of spontaneous process possibility and the state of equilibrium in isolated systems.

The combined equation of the first and the second laws of thermodynamics. Gibbs energy (the isobaric-isothermal potential). Enthalpic and entropic factors. Criterions of spontaneous processes and the state of equilibrium in nonisolated

systems. Exo- and endothermal processes in organism. Principle of energetic conjugation.

3.4. Thermodynamics of chemical equilibrium

The concept of chemical equilibrium. The constant of chemical equilibrium. Shifts in chemical equilibrium caused by changes in temperature, pressure and concentration. Le Chatelier principle. Equations of isotherm and isobar of a chemical reaction. The usage of thermodynamic calculations according to the Hess's law, the second law of thermodynamics, and the combined equation of the first and the second laws of thermodynamics in molecular and macromolecular docking. The basis of the design of medicines in terms of the determination of the nature of ligand-receptor interactions according to the principle of the minimum of the free energy. The calculation of the constant of inhibition. The concept of quantum chemical calculations, allowing to create realistic models of ligands and receptors for their usage in molecular and macromolecular docking.

4. Chemical kinetics and catalysis

4.1. Elements of chemical kinetics

The subject and purposes of chemical kinetics. Chemical kinetics as the basis of studies on rates and mechanisms of biochemical processes. Single-step and multiple-step, homogeneous and heterogeneous reactions. The rate of homogeneous chemical reactions and the ways to measure it.

The dependence of the rate of a reaction on concentration. Kinetic equations. The rate constant. The order of the reaction. The law of mass action for the rate of a reaction. Kinetic equations for reactions of the zeroth, first and second order. Half-elimination period: its importance for pharmacology and anesthesiology. Molecularity of reactions. Kinetic method for the determination of the activity of enzymes in blood serum: diagnostical meaning, fields of application.

The dependence of the rate of a reaction on temperature. Temperature coefficient of the rate of a reaction. Energetic diagrams of exo- and endothermal reactions. Energetic threshold of a reaction. Activation energy. Arrhenius equation. Overview of active collisions and trasition state complex theories. The basis of computational chemistry methods, allowing to predict the structure of a transition state complex.

Concept of the kinetics of multiple-step reactions: parallel, consequent, conjugated, reversible, and chain reactions. Photochemical reactions.

4.2. Catalysis and catalysts

Mechanisms of homogeneous and heterogeneous catalysis. Energetic diagram of a catalytic reaction. Enzymes as biological catalysts, specific features of their action. Overview of enzymatic catalysis mechanisms. Enzymes as targets for the development of medicines. Structure of active centers of metalloenzymes, the concept of metallotoxicosis.

5. Doctrine on water solutions

5.1. Colligative properties of solutions

Water as a universal solvent in biological systems. Physical and chemical properties of water making its role in metabolism so important. Thermodynamics of

the process of the dissolving. Enthalpic and entropic factors in the mechanism of the dissolving. Ideal solutions.

The ways to express the content of a solution: molar concentration, molality, mass fraction, mole fraction.

Colligative properties of dilute solutions. Osmosis. Osmotic pressure. The van't Hoff law. Semipermeable membranes in the human organism. Osmolarity and osmolality of biological fluids and solutions for perfusion. Osmotic pressure of blood plasma. Distribution of water between cells and intercellular fluid. Plasmolysis and hemolysis. Hypo-, hyper- and isotonic solutions in medicine. Colloid-osmotic (oncotic) pressure of blood plasma. Distribution of water between blood vessels and intercellular space.

Rault's laws: the decrease of the pressure of saturated vapor upon a solution, boiling point elevation and freezing point depression relatively to the pure solvent. Cryoscopy. Ebullioscopy.

Colligative properties of dilute solutions of electrolytes. Isotonic coefficient of van't Hoff and its physical sense.

5.2. The theory of solutions of weak and strong electrolytes

Elements of the theory of weak electrolytes. Ionization constant of a weak electrolyte. The law of dilution created by Ostwald. Main statements of the theory of strong electrolytes. Activity and coefficient of activity. Ionic strength of the solution as a physiological constant.

Dissociation of water. Ionic product of water. pH as a quantitative measure of active acidity and alkalinity. pH levels for the main biological fluids. Types of acidity of biological fluids. Acid-base indicators. Colorimetric methods of pH determination.

5.3 Protolytic theory of acids and bases

Main statements of protolytic theory of acids and bases. Molecular and ionic acids and bases. Acid-base conjugate pares. Classification of solvents: protogenic, protophylic, amphiprotic. Water as amphiprotic solvent. Reactions of neutralization, hydrolysis, ionization from the point of view of protolytic theory. Hydrolysis of adenosine triphosphate (ATP) as the universal source of energy in organism.

Theory of acids and bases of Lewis. Reactions of neutralization, hydrolysis, ionization, formation and stability of complex compounds from the point of view of Lewis theory.

Acid-base equilibrium in the oral cavity: consequences of the shifts in equilibrium, ways of pH corrections.

5.4. Buffer solutions and systems

Classification of buffer systems and mechanism of their action: an equilibrium between processes of electrolytic dissociation and hydrolysis in the pare conjugated acid and base. Calculation of pH in buffer systems according to Henderson-Hasselbalch equation. Buffer capacity and factors that determine its value. Buffer systems of blood: bicarbonate, hemoglobin, phosphate and protein buffer systems. The concept of acid-base equilibrium in biological fluids. Respiratory and metabolic acidosis and acidemia, alkalosis and alkalemia.

5.5. Titrimetric methods of analysis

Classification of titrimetric analysis methods. Calculations in volumetric analysis. The law of equivalence. Main techniques and methods of titration in volumetric analysis. General characteristic of acid-base titration methods: titrants and their standardization, point of equivalence fixation. The choice of an indicator. Importance of titrimetric analysis in medical and biological investigations.

5.6. Electrode and redox potentials

Electrode and redox potentials. Mechanism of electrode potential formation. Nernst equation. Nernst-Peters equation. Standard hydrogen electrode. Calculation of electrode potentials. Chemical and concentration based galvanic elements. The calculation of electromotive force. Prediction of redox processes direction with the help of Gibb's energy and redox potentials. Electron-ion method of the balancing of redox reactions. General description of methods of redox titration.

5.7. Potentiometry

Electrodes for the comparison and for the detection. Silver chloride electrode. Ion-selective electrodes: the glass electrode. Construction of the pH-meter. Potentiometric titration, its essence and usage in quantitative analysis and medical and biological investigations.

5.8. Conductometry

Liquids and tissues of human organism as conductors of electricity of the second order. Specific and molar electric conductivity and their dependence on concentration of substances in a solution. Limited molar electric conductivity. Absolute rate of ion movement and mobility of ions. The law of Kohlrausch.

Conductometry. Conductometric titration, its essence and applications in quantitative analysis, medical and biological investigations. Electric conductivity of biological tissues and liquids in healthy persons and during pathological processes.

5.9. Heterogeneous equilibria in healthy human organism and in pathology

The concept of solubility of solid substances, liquids and gases in liquid solvents, its dependence on different factors. Laws of Henry and Dalton. The influence of electrolytes on solubility of gases, liquids and solids. Solubility of gases in blood.

Heterogeneous equilibria in the system: «saturated solution – precipitate of slightly soluble electrolyte». Constant of solubility (thermodynamic and concentration ones). Criterions of precipitation and precipitate dissolving. Combined homogeneous and heterogeneous concurrent chemical equilibriums in heterogeneous systems. Processes of the formation of osseous tissue, structure of hydroxyapatite. Heterogeneous equilibria in the metabolism of human organism: formation of concrements during kidney stone disease and cholelithiasis, the ways of their treatment and prevention.

6. Physical chemistry of surface phenomena

6.1. Surface phenomena

Surface processes and their importance in biology and medicine. Surface energy and surface tension. Surface active and surface inactive substances. Isotherm of surface tension. Surface activity. The rule of Ducklo-Traube. Adsorption on the

borders: «liquid-gas» and «liquid-liquid». Gibbs equation. Orientation of molecules in the surface layer. The structure of biomembranes.

6.2 Theories of adsorption

Adsorption on the «solid-gas» and «solid-liquid» borders (in a solution). Langmuir and Freundlich equations. Monomolecular and polymolecular adsorption. Isotherms of polymolecular adsorption on a solid phase. The basis of enzyme-linked immunosorbent assays. Chemisorption. Adsorption of strong electrolytes (equivalent, partial, exchanging). Importance of adsorption processes in biosystems. The concept of adsorption therapy. Ionits and their applications in medicine.

6.3. Chromatography

Classification of chromatographic methods of analysis according to the main mechanism of substances separation and to the states of matter of phases. Adsorptive, distributive, exclusion (gel-filtration), ion-exchange, affine (biospecific) chromatography: principles of methods, their distinguishing properties. Characteristic features of high pressure liquid chromatography (HPLC) and gas chromatograph, detectors used in those methods. The usage of chromatographical methods in medicine and biology.

7. Physical chemistry of dispersed systems and solutions of biopolymers

7.1. Dispersed systems

Classification of disperse systems according to their dispersion degree, state of matter, strength of interactions between disperse phase and disperse medium. Colloid solutions. Methods of creation and purification of colloid solutions. Filtration, dialysis, electrodialysis, ultrafiltration. Molecular and kinetic properties of colloid solutions: Brownian movement, diffusion, osmotic pressure. Ultracentrifugation. Optic features of disperse systems. Faraday-Tyndall effect. Rayleigh's equation. Electric properties of disperse systems. Electrophoresis and electroosmosis. Charge and structure of double electric layer of a colloid particle. Micelle structure.

Kinetic and aggregative stability of colloid solutions. Coagulation. Coagulation threshold. Schulze-Hardy rule. Co-coagulation and stabilization of soles. Theories of coagulation. Peptization. Colloid protection. Medical and biological role of coagulation, peptization and colloid protection.

Classification and common properties of coarsely dispersed systems. Specific molecular kinetics and electric features of aerosols. Usage of aerosols in medicine. Industrial aerosols as a cause of lungs diseases development (silicosis, antrackosis, aluminosis).

The ways to produce and stabilize suspension. Molecular kinetics and optic properties of suspensions in comparison with colloid solutions. Sedimentational and aggregative stability. Highly concentrated suspensions (pastes).

Methods of production and properties of emulsions. Stability of emulsions. Emulsifiers, their nature and mechanism of action. Types of emulsions. Reversion of emulsion phases. Destruction of emulsions. Emulsion as a dosage form in medicine.

Colloid surface active substances: soaps and detergents. Formation of micelles in solutions of colloid surface active substances. Critical concentration of micelle formation. Solubilization. Liposomes.

7.2. Solutions of biopolymers

Classification of biopolymers. Chemical structure and three-dimensional shape of macromolecules. The concept of the structure of biopolymers: proteins, nucleic acids, polymeric carbohydrates, lipids, their complexes. Types of bonds in biopolymers. Spectral methods of the structure of biopolymers and their water solutions investigation: infrared spectroscopy, circular dichroism spectroscopy, spectrofluorimetry, Raman spectroscopy, X-ray structural analysis, nuclear magnetic resonance.

Mechanism of gelatination and solubilization of biopolymers. Influence of different factors on gelatination degree. Viscosity of biopolymers. Shtaudinger and Mark-Hauwinck-Koon equations. Viscosity of blood and other biological fluids as a diagnostic criterion.

Concept of polyelectrolytes, isoelectric point of a biopolymer and methods of its calculation and determination. Colligative properties of high molecular weight compounds solutions. Galler's equation.

Stability of biopolymers solutions and factors determining it. Gelatination. Salting out. Coacervation. Gels. Diffusion in gels. Properties of gels: syneresis and tixotropy.

Electrophoresis of proteins and nucleic acids, isoelectric point focusing. The usage of electrophoresis in diagnostics of hemoglobinopathies, in qualitative and quantitative analysis of solutions of biopolymers.

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	
1	**The aim and purposes of medical chemistry** Laboratory work (L.w.) «Obtaining skills of the work with volumetric glassware»	–	–	**2**	–	interview, written accounts of laboratory work
2	**Introduction to the coordination chemistry** L.w. «Production of complex compounds»	–	–	**2**	**3**	written accounts of laboratory work, electronic tests, written classroom (home) practical exercises
3	**Chemical thermodynamics and bioenergetics**	**2**	**0.5**	**2**	**6**	
3.1 3.4	Chemical thermodynamics as the basis of medical chemistry. The use of the apparatus of thermodynamics of chemical equilibrium in molecular and macromolecular docking	2	0.5	–	2	
3.2 3.3	Thermochemistry. Direction of biochemical processes. L.w. «Determination of the heat effect of neutralization reaction»	–	–	2	4	written accounts of laboratory work, electronic tests, control work
4	**Chemical kinetics and catalysis**	**2**	**0.5**	**2**	**2**	
	Elements of chemical kinetics: the order of the reaction, the half-elimination period, kinetic method for the determination of enzyme activity in blood serum. Theory of active collisions. Theory of transition state complex	2	0.5	–	–	

4.1 4.2	Elements of chemical kinetics. Catalysis and catalysts L.w. «The study of the dependence of the rate of chemical reaction on concentration of reacants»	–	–	2	2	interview, written accounts of laboratory work, electronic tests
5	**Doctrine on water solutions**	**2**	**1**	**14**	**16**	
5.1	Colligative properties of solutions. Doctrine on water solutions. L.w. «Hemolysis of red blood cells in hypotonic solution»	–	1	2	4	interview, written accounts of laboratory work, electronic tests
5.2 5.3	The theory of solutions of weak and strong electrolytes. Protolytic theory of acids and bases L.w. «The measurement of active acidity of biological fluids»	–	–	2	2	written accounts of laboratory work, electronic tests, written classroom (home) practical exercises
	Chemical basics of the maintenance of osmotic pressure and acidity in human orgamism: colligative properties of solutions, buffer systems.	2	–	–	–	
5.4	Buffer solutions and systems L.w. «Preparation of buffer solutions and investigation of the mechanism of buffering action»	–	–	2	4	written accounts of laboratory work, electronic tests
5.5	Titrimetric methods of analysis L.w. «Standardization of a titrant (HCl solution) with a solution primary standard»	–	–	2	4	written accounts of laboratory work, electronic tests
5.6 5.7	Electrode and redox potentials. Potentiometry. L.w. «Potentiometric determination of the constant of dissociation for a weak electrolyte»	–	–	2	–	written accounts of laboratory work, electronic tests, written classroom (home) practical exercises
5.8	Conductometry L.w. «Conductometric determination of the constant of dissociation for a weak electrolyte»	–	–	2	–	written accounts of laboratory work, electronic tests
5.9	Heterogeneous equilibria in human body: normal and pathological L.w. «Preparation of heterogeneous systems «precipitate-solution» and the shift of equilibrium in those systems»	–	–	2	2	written accounts of laboratory work, electronic tests

6	**Physical chemistry of surface phenomena**	**2**	**1**	**4**	**8**	
6.1 6.2	Surface phenomena. Theories of adsorption. L.w. «The dependence of surface tension of a solution on the length of hydrocarbon chain of surface active substances»	–	–	2	4	written accounts of laboratory work, electronic tests
	Theories of adsorption, the usage of chromatographic methods of analysis in medicine	2	1	–	–	
6.3	Chromatography L.w. «Analysis of chromatograms and mass-spectra»	–	–	2	4	visual laboratory work, electromic tests
7	**Physical chemistry of dispersed systems and solutions of biopolymers**	–	–	**8**	**8**	
7.1	Dispersed systems. Introduction to colloid chemistry L.w. «Preparation of colloid solutions with a method of condensation and investigation of their optical properties»	–	–	2	2	written accounts of laboratory work, electronic tests
	Dispersed systems. Colloid and coarsely dispersed systems in medicine. L.w. «Stability of colloid solutions»	–	–	2	2	written accounts of laboratory work, electronic tests
7.2	Solutions of biopolymers. Physical and chemical properties of biopolymers. L.w. «Determination of the swelling degree of gelatin at different pH values»	–	–	2	2	written accounts of laboratory work, electronic tests
3	**Chemical thermodynamics and bioenergetics**	–	–	**2**	**3**	
3.4	The use of the apparatus of thermodynamics of chemical equilibrium in molecular and macromolecular docking. L.w. «Molecular docking»	–	–	2	3	written accounts of laboratory work, visual laboratory work, electromic tests
7.2	Solutions of biopolymers: physical and chemical properties of biopolymers. Final lesson. L.w. «Salting gelatin out»	–	–	2	2	electronic tests, colloquium, credit
	Total hours	**8**	**3**	**36**	**46**	

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 IN 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;
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 classroom (home) practical exercises;
written accounts of laboratory work;
colloquium.

Oral-written form:

credit.

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 specific concentration.
2. Measurement of pH with a help of colorimetric and potentiometric methods.
3. Estimation of concentration of a substance in a solution with a help of titrimetric analysis.
4. Determination of the constant of inhibition with the help of molecular docking.
5. Measurement of pH in isoelectric point of a biopolymer in water solution.
6. Estimation of overall, active and potential acidity of biological fluids.

LIST OF EQUIPMENT USED

1. Laboratory glassware.
2. Chemical reactants.
3. Personal computer.
4. Calorimeter.
5. Centrifuge.
6. pH-meter.
7. Potentiometer.
8. Conductometer.
9. Stalagmometer.

10. Liquid chromatograph.
11. Spectrofluorometer.
12. Viscometer.
13. ATR-FTIR spectrograph.
14. Vertical electrophoresis chamber.

LIST OF LECTURES

1. Chemical thermodynamics as the basis of medical chemistry. The usage of the apparatus of thermodynamics of chemical equilibrium in molecular and macromolecular docking.
2. Elements of chemical kinetics: the order of the reaction, the half-elimination period, kinetic method for the determination of enzyme activity in blood serum. Theory of active collisions. Theory of transition state complex.
3. Chemical basics of the maintenance of osmotic pressure and acidity in human organism: colligative properties of solutions, buffer systems.
4. Theories of adsorption, the usage of chromatographic methods of analysis in medicine.

LIST OF LABORATORY STUDIES

1. The aim and purposes of medical chemistry.

L.w. «Obtaining skills of the work with volumetric glassware».

2. Introduction to the coordination chemistry.

L.w. «Production of complex compounds».

3. Thermochemistry. Direction of biochemical processes.

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

4. Elements of chemical kinetics. Catalysis and catalysts.

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

5. Colligative properties of solutions. Doctrine on water solutions.

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

6. The theory of solutions of weak and strong electrolytes. Protolytic theory of acids and bases.

L.w. «The measurement of active acidity of biological fluids».

7. Buffer solutions and systems.

L.w. «Preparation of buffer solutions and investigation of the mechanism of buffering action».

8. Titrimetric methods of analysis.

L.w. «Standardization of a titrant (HCl solution) with a solution of primary standard».

9. Electrode and redox potentials. Potentiometry.

L.w. «Potentiometric determination of the constant of dissociation for a weak electrolyte».

10. Conductometry.

L.w. «Conductometric determination of the constant of dissociation for a weak electrolyte».

11. Heterogeneous equilibria in human body: normal and pathological.

L.w. «Preparation of heterogeneous systems «precipitate-solution» and the shift of equilibrium in those systems»

12. Surface phenomena. Theories of adsorption.

L.w. «The dependence of surface tension of a solution on the length of hydrocarbon chain of surface active substances»

13. Chromatography.

L.w. «Analysis of chromatograms and mass-spectra».

14. Dispersed systems. Introduction to colloid chemistry.

L.w. «Preparation of colloid solutions with a method of condensation and investigation of their optical properties».

15. Dispersed systems. Colloid and coarsely dispersed systems in medicine.

L.w. «Stability of colloid solutions».

16. Solutions of biopolymers. Physical and chemical properties of biopolymers.

L.w. «Determination of the swelling degree of gelatin at different pH values».

17. The use of the apparatus of thermodynamics of chemical equilibrium in molecular and macromolecular docking.

L.w. «Molecular docking».

18. Solutions of biopolymers: physical and chemical properties of biopolymers. Final lesson.

L.w. «Salting gelatin out».

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. Bioorganic Chemistry	Bioorganic Chemistry	-	protocol # 5 of 18.05.2023
2. Biological Chemistry	Biological Chemistry	-	protocol # 5 of 18.05.2023

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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

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