MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
Petro Mohyla Black Sea National University
Medical institute
Department of pharmacy, pharmacology, medical, bioorganic and biological chemistry

"APPROVED"
The first vice-rector
N.M. Ishchenko
" " 2021

THE WORKING EDUCATIONAL PROGRAM IN THE DISCIPLINE

MEDICAL CHEMISTRY

in the field of knowledge 22 "Health care"
in the specialty 222 "Medicine"

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Description of the educational discipline (annotation)

Title of indices	Characterization of educational discipline	
Name of the discipline	Медична хімія	
Branch of knowledge	22 “Health care”	
Specialty	222 “Medicine	
Specialization (if any)		
Educational program	Medicine	
Higher education level	Master	
Discipline status	Normative	
Curriculum	1st	
Academic year	2021-2022	
Numbers of semesters:	Day form	Absentee form
	1st	
Total ECTS credits / hours	3 credits / 90 hours	
Course structure: - lectures - seminars (practical, laboratory, semi-group) - hours of independent work of students	Day form	Absentee form
	15 30 hours 45 hours	
Percentage of classroom load	50%	
Teaching language	English	
Intermediate control form (if any)		
Form of final control	1th semester – Exam	

2. Purpose, tasks and planned learning outcomes

The purpose of teaching: studying the discipline "Medical Chemistry" is to master students' elemental chemical composition of living cells, patterns of flow and energy of chemical reactions, features of conversion of chemicals in the body, properties of biological solutions, forming an idea of the body as a whole physico - chemical system..

Objectives of study: the student acquires competencies, knowledge, skills and abilities to carry out professional activities in the specialty by creating a fundamental scientific base of future doctors to understand the general physico-chemical, biochemical patterns that underlie the processes of human life.

Prerequisites for studying the discipline (interdisciplinary links). Medical chemistry as a discipline:

a) is based on students' understanding of the basic principles and knowledge of general, inorganic and organic chemistry, medical biology, medical physics and integrates with these disciplines;

b) creates a theoretical basis for students to master such medical - biological disciplines as: physiology, pathophysiology, biological chemistry, pharmacology, as well as some clinical, hygienic disciplines and ecology.

Expected learning outcomes. According to the requirements of the educational-professional program as a result of studying the discipline students have:

KNOW:

−structure of atoms, basic chemical properties of biogenic s-, p-, d-elements, forms of their finding in the body, biological role;

- principles of structure of complex compounds, features of structure of complex compounds as a basis for their application in chelation therapy;
- processes and patterns of dissolution of solids, gases, liquids in water; characteristics of solutions, expressions of quantitative composition of solutions;
- the relationship between the colligative properties and the concentration of solutions;
- basic properties of electrolyte solutions, their characteristics, determination of pH of basic body fluids, hydrolysis of salts; conditions of formation and dissolution of sediments, to explain the role of heterogeneous equilibria with the participation of salts in the general homeostasis of the organism;
- basics of titretric method of analysis; quantitative determination of the content of acids and bases in solutions using acid-base titration methods;
- the mechanism of action of buffer systems and their role in maintaining acid-base balance in biosystems;
- thermal effects of chemical and biochemical processes, thermodynamic functions to assess the direction of processes, to explain the energy conjugation in living systems;
- kinetic laws of biochemical processes;
- the mechanism of formation of electrode potentials;
- regularities of adsorption of substances from solutions on a solid surface, the adsorption equation and the limits of their use; features of the structure of the surface layer of adsorbed molecules of surfactants, principles of structure of biological membranes; physicochemical bases of adsorption therapy methods.
- principles of methods of obtaining and purification of colloidal dispersed solutions;
- physicochemical properties of proteins that are structural components of all body tissues.

BE ABLE:

- characterize the quantitative composition of solutions; be able to prepare solutions with a given quantitative composition; analyze the principles of titrimetric research methods;

- to analyze the quantitative content in the solution of acids and bases using acid-base titration methods;

- draw conclusions about the acidity of biological fluids on the basis of hydrogen;

- explain the mechanism of action of buffer systems and their role in maintaining acid-base balance in biosystems;

−analyze the relationship between the colligative properties and the concentration of solutions;

- to interpret chemical and biochemical processes from the standpoint of their thermal effects; be able to use thermodynamic functions to assess the direction of processes, to explain the energy conjugation in living systems;

- analyze the dependence of the reaction rate on concentration and temperature; interpret the dependence of the reaction rate on the activation energy;

-analyze the features of the action of catalysts and explain the mechanism of homogeneous and heterogeneous catalysis; explain the mechanism of action of enzymes and analyze the dependence of the rate of enzymatic processes on the concentration of enzyme and substrate;

- analyze chemical eq ilibrium and explain its condition from the standpoint of thermodynamics and kinetics; explain the influence of external factors on the chemical balance;

- to analyze the conditions of precipitation and dissolution of sediments, to explain the role of heterogeneous equilibria with the participation of salts in the general homeostasis of the organism;

- explain the mechanism of formation of electrode potentials;

- analyze the principles of the method of potentiometry and draw conclusions about its use in medical and biological research;

- be able to measure redox potentials and predict the direction of redox reactions;

- draw conclusions about the surface activity of substances on the basis of their structure;

- to analyze the features of the structure of the surface layer of adsorbed molecules of surfactants, to explain the principles of structure of biological membranes;

- to analyze the adsorption equations and the limits of their use, to distinguish between monomolecular and polymolecular adsorption; interpret the laws of adsorption of substances from solutions on a solid surface; explain the physicochemical basis of methods of adsorption therapy; distinguish between selective and ion exchange adsorption of electrolytes;

- interpret the methods of chromatographic analysis and their role in medical and biological research;

- analyze the principles of methods for obtaining and purifying colloidal dispersed solutions;

- explain the physicochemical basis of hemodialysis;

- interpret the physicochemical properties of proteins that are structural components of all body tissues; draw conclusions about the charge of dissolved biopolymers based on their isoelectric point.

The developed program corresponds to the educational-professional program (EPP) and is focused on the formation of competencies:

- integrated (IC1): the ability to solve typical and complex specialized problems and practical problems in the learning process, which involves research, innovation and is characterized by complexity and uncertainty of conditions and requirements.

- general (GK):

- GK1:

  – Ability to abstract thinking, analysis and synthesis, the ability to learn and master modern knowledge.

- professional (PC):

PC2. Ability to determine the required list of laboratory and instrumental studies and evaluate their results.

PC3. Ability to establish a preliminary and clinical diagnosis of the disease.
PC5. Ability to determine the nature of nutrition in the treatment of diseases.
PC14. Ability to carry out sanitary and hygienic and preventive measures.

In particular, this applies to the following competencies:

1. Ability to evaluate the results of laboratory and instrumental research

2. Ability to experimentally and with the help of basic calculations to determine the pH of biological fluids

3. The ability to interpret the relationship between the biological role of s-, p- and d-elements and the form in which they are in the body, to calculate the daily requirement of various chemical elements, and accordingly the dosage of certain drugs, dietary norms of certain products in which they are contained.

4. Ability to explain the mechanism of action of buffer systems and their role in maintaining acid-base balance in biosystems.

5. Ability to use knowledge of physicochemistry of dispersed systems to interpret processes in biological systems.

6. Ability to explain the influence of external factors (temperature, pH, etc.) on the stability of biological systems;

7. Ability to apply knowledge about the physicochemical properties of dispersed systems to interpret the processes occurring in biological systems

8. Ability to explain the mechanisms of action of drugs, based on the properties of chemicals that are part of them.

9. Ability to determine the means of providing emergency medical care in case of poisoning, chemical burns by certain substances, based on knowledge of their chemical properties.

According to the educational-professional program, the expected programme result of study (PRS) of the EPP include the ability to:

-PRS1 Know the methods of analysis, synthesis and further modern learning. Be able to analyze information, make informed decisions, be able to acquire modern knowledge. Establish appropriate connections to achieve goals. Be responsible for the timely acquisition of modern knowledge.

PRS2 Have specialized conceptual knowledge acquired in the learning process. Be able to solve complex problems and problems that arise in professional activities. Clear and unambiguous communication of own conclusions, knowledge and explanations that substantiate them to specialists and non-specialists. Responsible for making decisions in difficult conditions

PRS8 Know the responsibilities and ways to perform the tasks. Be able to set goals and objectives to be persistent and conscientious in the performance of duties. Establish interpersonal relationships to effectively perform tasks and responsibilities. Responsible for the quality of the tasks.

PRS10 Know the problems of environmental protection and ways to preserve it. Be able to form requirements for themselves and others to preserve the environment.

3. THE PROGRAM OF THE DISCIPLINE

The educational process is organized according to the European Credit Transfer and Accumulation System (ECTS).

The curriculum consists of two blocks:

BLOCK 1. ACID-BASIC EQUILIBRIUM AND COMPLEX FORMATION IN BIOLOGICAL LIQUIDS

SECTIONS:

1. CHEMISTRY OF BIOGENIC ELEMENTS. COMPLEX FORMATION IN BIOLOGICAL LIQUIDS.
2. ACID-BASIC EQUILIBRIUM IN BIOLOGICAL LIQUIDS.

BLOCK 2. EQUILIBRIUM IN BIOLOGICAL SYSTEMS AT THE BOUNDARY OF THE PHASE SEPARATION

SECTIONS:

1. THERMODYNAMICS OF SOLUTIONS AND ELECTRODE PROCESSES.
2. SURFACE PHENOMENA ON THE BOUNDARY OF PHASE SEPARATION..

BLOCK 1. ACID-BASIC EQUILIBRIUM AND COMPLEX FORMATION IN BIOLOGICAL LIQUIDS

CHAPTER 1.
CHEMISTRY OF BIOGENIC ELEMENTS. COMPLEX FORMATION IN BIOLOGICAL LIQUIDS.

Topic 1. Introduction. Safety precautions. Periodic system DI Mendeleev. Biogenic s-, p -elements; biological role, application in medicine

Basic safety rules when working in a chemical laboratory. Periodic system DI Mendeleev and its structure.

General information about nutrients. Qualitative and quantitative content of nutrients in the human body. Macronutrients, micronutrients and impurities. Organogens. The concept of the teachings of VI Vernadsky on the biosphere and the role of living matter (living organisms). The relationship between the content of nutrients in the human body and their content in the environment. Endemic diseases, their connection with the features of biogeochemical provinces (areas with natural deficiency or excess of certain chemical elements in the lithosphere). Problems of pollution and purification of the biosphere from toxic chemical compounds of man-made origin. Electronic structure and electronegativity of s-elements. Typical chemical properties of s-elements and their compounds (reactions without changing the oxidation state). The relationship between the location of s-elements in the periodic table and their content in the body. Application in medicine.

Electronic structure and electronegativity of p-elements. Typical chemical properties of p-elements and their compounds. The relationship between the location of p-elements in the periodic table and their content in the body. Application in medicine. Toxic effect of compounds. Qualitative reactions to ions CO_3^{2-}, SO_4^{2-}, NO_2^-, $S_2O_3^{2-}$.

Topic 2. Biogenic d-elements, chemical properties, biological role, application in medicine.

Electronic structure and electronegativity of d-elements. Typical chemical properties of d-elements and their compounds (reactions with changing the degree of oxidation, complexation). Biological role. Application in medicine. Toxic effect of d-elements and their compounds. Qualitative reactions to ions MnO_4^-, Fe^{3+}, Cu^{2+}, Ag^+.

Topic 3. Complexation in biological systems.

Complexation reactions. A. Werner's coordination theory and modern ideas about the structure of complex compounds. The concept of complexing agent (central ion). Nature, coordination number, hybridization of complexing orbitals. The concept of ligands. Coordination capacity (dentance) of ligands. Internal and external spheres of complexes. Geometry of a complex ion. The nature of the chemical bond in complex compounds. Classification of complex compounds by the charge of the internal sphere and by the nature of ligands. Intracomplex compounds. Polynuclear complexes. Iron-, cobalt-, copper- and zinc-containing biocomplex compounds. The concept of metalligand homeostasis. Violation of homeostasis. Complexones and their use in medicine as antidotes for heavy metal poisoning (chelation therapy) and as antioxidants in the storage of drugs.

SECTION 2.
ACID-BASIC EQUILIBRIUM IN BIOLOGICAL LIQUIDS.

Topic 4. Solutions

The role of solutions in the life of organisms. Classification of solutions. The mechanism of dissolution processes. Thermodynamic approach to the dissolution process. Solubility of substances.

Solubility of gases in liquids. Dependence of gas solubility on pressure (Henry-Dalton's law), nature of gas and solvent, temperature. Influence of electrolytes on gas solubility (Sechenov's law). Solubility of gases in the blood. Bends. Solubility of liquids and solids in liquids. Dependence of solubility on temperature, nature of solute and solvent. Distribution of the substance between two immiscible liquids. Nernst distribution law and its significance in the phenomenon of permeability of biological membranes.

Topic 5. Methods of expressing the concentration of solutions. Preparation of solutions.

Preparation of solutions Values that characterize the quantitative composition of solutions. Mass fraction of solute, molar, molar, normal solution concentration (molar equivalent concentration), molar fraction, solution titer. Preparation of solutions with a given quantitative composition

Topic 6. Acid-base balance in the body. Hydrogen index of biological fluids.

Electrolyte solutions. Electrolytes in the human body. Degree and constant of dissociation of weak electrolytes. Properties of solutions of strong electrolytes. Activity and activity rate. Ionic strength of the solution. Water-electrolyte balance is a necessary condition for homeostasis.

Water dissociation. Ionic product of water. Hydrogen pH. PH values for various fluids of the human body in normal and pathology. Theories of acids and bases. Types of protolytic reactions: neutralization, hydrolysis and ionization reactions. Hydrolysis of salts. Degree of hydrolysis, its dependence on concentration and temperature. Hydrolysis constant. The role of hydrolysis in biochemical processes.

Deposition and dissolution reactions. The product of solubility. Conditions of formation and dissolution of sediments. The role of heterogeneous equilibrium with the participation of salts in the general homeostasis of the organism.

Topic 7. Buffer systems, classification and mechanism of action. Buffer capacity.

Buffer solutions, their classification. Henderson-Hasselbach equation. The mechanism of buffer action.

The role of buffer solutions in biosystems Buffer capacity. Blood buffer systems. Bicarbonate buffer, phosphate buffer. Protein buffer systems. The concept of acid-base state of blood

Topic 8. Colligative properties of solutions. Osmosis.

Colligative properties of dilute solutions of non-electrolytes. The relative decrease in saturated vapor pressure of the solvent over the solution. Raoul's law. Ideal solutions. Decrease in freezing point and increase in boiling point of solutions in comparison with solvents. Osmosis and osmotic pressure. Vant-Goff's law. Colligative properties of dilute electrolyte solutions. Isotonic coefficient. Hypo-, hyper- and isotonic solutions**.**

Cryometry, ebuliometry, osmometry, their application in medical and biological research. The role of osmosis in biological systems. Osmotic pressure of blood plasma. Haller's equation. Oncotic pressure. Plasmolysis and hemolysis.

Topic 9. Alkalimetry. Fundamentals of titrimetric analysis. **Method of neutralization. Acidimetry**

Neutralization method. Alkalimetry. The concept of titrimetric analysis, the method of alkalimetry, the method of acidimetry. Acid and basic indicators. Methods of analysis. Application of this type of chemical analysis in medicine.

BLOCK 2. EQUILIBRIUM IN BIOLOGICAL SYSTEMS AT THE BOUNDARY

SECTION 3.
THERMODYNAMICS OF SOLUTIONS AND ELECTRODE PROCESSES.

Topic 10. Thermal effects of chemical reactions, the direction of processes.

The subject of chemical thermodynamics. Basic concepts of chemical thermodynamics: thermodynamic system (isolated, closed, open, homogeneous, heterogeneous), state parameters (extensive, intensive), thermodynamic process (reversible, irreversible). Living organisms are open thermodynamic systems. Irreversibility of life processes.

The first law of thermodynamics. Enthalpy. Thermochemical equations. Standard heat of formation and combustion. Hess's law. Calorimetry method. Energy characteristics of biochemical processes. Thermochemical calculations to assess the caloric content of food and the preparation of rational and therapeutic diets.

Spontaneous and non-spontaneous processes. The second law of thermodynamics. Entropy. Thermodynamic potentials: Gibbs energy, Helmholtz energy. Thermodynamic equilibrium conditions. Criteria for the direction of spontaneous processes.

Application of the basic provisions of thermodynamics to living organisms. ATP as an energy source for biochemical reactions. Macroergic compounds. Energy conjugations in living systems: exergonic and endergonic processes in the body

Topic 11. Kinetics of biochemical reactions. Chemical equilibrium.

Chemical kinetics as a basis for studying the rates and mechanism of biochemical reactions. Reaction rate. Dependence of reaction rate on concentration. The law of active masses for the reaction rate. Speed constant. The order of the reaction. Molecularity of the reaction. Kinetic equations of first, second and zero order reactions. The concept of the reaction mechanism. Activation energy.

Dependence of reaction rate on temperature. Vant-Goff's rule. Features of the temperature coefficient of the reaction rate for biochemical processes.

Catalysis and catalysts. Features of catalysts. Homogeneous, heterogeneous and microheterogeneous catalysis. Acid-base catalysis. Autocatalysis. Mechanism of action of catalysts. Promoters and catalytic poisons.

The concept of antioxidants. Free radical reactions in a living organism.

Enzymes as biological catalysts. The concept of the mechanism of action of enzymes.

Chemical equilibrium. Chemical equilibrium constant and methods of its expression. Displacement of chemical equilibrium with changes in temperature, pressure, concentration of substances. Le Chatelier's principle.The product of solubility.

SECTION 4.

SURFACE PHENOMENA ON THE BORDER OF PHASE DIVISION.

Topic 12. Sorption of biologically active substances at the liquid-gas interface. Sorption of biologically active substances at the interface between solid and solution. Chromatography.

Surface phenomena and their significance in biology and medicine. Surface tension of liquids and solutions. Surface tension isotherm. Surfactants and surfactants. Surface activity. Duclos-Traube rule.

Adsorption at the liquid-gas and liquid-liquid interface. Gibbs equation. Orientation of surfactant molecules in the surface layer. Representation of the structure of biological membranes. Adsorption at the solid-gas interface. Langmuir's equation.

Adsorption from solution on the surface of a solid. Physical and chemical adsorption. Regularities of adsorption of solutes, vapors and gases. Freundlich equation.

Physico-chemical bases of adsorption therapy (hemosorption, plasma sorption, lymphosorption, enterosorption, application therapy). Immunosorbents.

Electrolyte adsorption: specific (optional) and ion exchange. Panetta-Faience rule. Natural and synthetic ion exchangers. The role of adsorption and ion exchange in the vital processes of plants and organisms.

Chromatography. Classification of chromatographic methods of analysis on the basis of the physical state of the phases, the technique of execution and the mechanism of distribution. Adsorption, ion exchange and distribution chromatography. Application of chromatography in biology and medicine.

Topic 13. Obtaining, purification, properties, coagulation of colloidal solutions

The body as a complex set of dispersed systems. Classification of dispersed systems by degree of dispersion. Colloidal state. Lyophilic and lyophobic colloidal systems. The structure of colloidal particles. Double electric layer.

Methods of obtaining and purifying colloidal solutions. Dialysis, electrodialysis, ultrafiltration, compensatory dialysis. Hemodialysis and the device "artificial kidney".

Molecular kinetic properties of colloidal systems. Brownian motion, diffusion, osmotic pressure. Optical properties of colloidal systems.

Electrokinetic phenomena. Electrophoresis. Helmholtz-Smoluchowski equation. Application of electrophoresis in research and clinical and laboratory practice.

Kinetic (sedimentation) and aggregative stability of dispersed systems. Stability factors. Coagulation. The mechanism of coagulating action of electrolytes. Coagulation threshold. Schultze-Hardy rule. Mutual coagulation. Coagulation processes in the treatment of drinking water and wastewater. Colloidal protection.

Disperse systems with gaseous dispersion medium. Classification of aerosols, production methods and properties. Application of aerosols in clinical and sanitary practice. Toxic effects of some aerosols. Powders. Coarsely dispersed systems with liquid dispersion medium. Suspensions, production methods and properties. Pastes, their medical use.

Emulsions, production methods and properties. Types of emulsions. Emulsifiers. The use of emulsions in clinical practice. Biological role of emulsification.

Semi-colloidal soaps, detergents. Micelle formation in solutions of semi-colloids.

Topic 14. Properties of solutions of biopolymers

Macromolecular compounds are the basis of living organisms. Globular and fibrillar structure of proteins. Comparative characteristics of solutions of macromolecular compounds, true and colloidal solutions.

Swelling and dissolution of polymers. The mechanism of swelling. Influence of medium pH, temperature and electrolytes on swelling. The role of swelling in the physiology of the body. Jeweling of Navy solutions. The mechanism of dragging. Influence of pH, temperature and electrolytes on the rate of dragging. Thixotropy. Syneresis. Diffusion in gems. Salting of biopolymers from solutions. Coacervation and its role in biological systems. Abnormal viscosity of IUD solutions. Blood viscosity. Donnan's membrane equilibrium.

Isoelectric state of protein. Isoelectric point and methods of its determination. Ionic state of biopolymers in aqueous solutions.

Topic 15. Generalization of knowledge from the course.

The structure of the discipline

Topic	Lectures	Practical training	IW, independent work of students	
BLOCK 1. ACID-BASIC EQUILIBRIUM AND COMPLEX FORMATION IN BIOLOGICAL LIQUIDS				
Section 1. Chemistry of nutrients. Complexation in biological liquids.				
1. Introduction. Safety precautions. Periodic system DI Mendeleev. Biogenic s,p-elements; biological role, application in medicine	2	2	3	The program does not provide individual tasks
2. Biogenic d-elements, chemical properties, biological role, application in medicine	2	2	3	
3. Complexation in biological systems.	2	2	4	
Розділ 2. Кислотно-основні рівноваги в біологічних рідинах.				
4. Solutions	1	2	3	
5. Methods of expressing the concentration of solutions. Preparation of solutions.	1	2	3	
6. Acid-base balance in the body. Hydrogen index of biological fluids.	2	2	3	
7. Buffer systems, classification and mechanism of action. Buffer capacity.	-	2	2	
8. Colligative properties of solutions. Osmosis.	-	2	3	
9. Fundamentals of titrimetric analysis. Method of neutralization. Acidimetry. Alkalimetry.	-	2	2	
BLOCK 2. EQUILIBRIUM IN BIOLOGICAL SYSTEMS AT THE BOUNDARY				
Section 3. Thermodynamics of solutions and electrode processes.				The program does not provide individual tasks
10. Thermal effects of chemical reactions, the direction of processes.	2	2	3	
11. Kinetics of biochemical reactions.. . Chemical equilibrium	2	2	3	
Section 4. Surface phenomena at the phase boundary				
12. Sorption of biologically active substances at the liquid-gas interface, at the interface between solid and solution.	1	2	4	
13. Obtaining, purification, properties of colloidal solutions. Coagulation	-	2	4	
14. Properties of solutions of biopolymers	-	2	4	
15. Generalization of knowledge from the course.	-	2	2	
Total hours - 90 ECTS Credits - 3	**15**	**30**	**45**	**-**

4. The content of the discipline

4.1. Lecture plan

BLOCK 1

№	TOPIC	Number of hours
1.	**Topic 1. Biogenic s, p-elements.** 1. Chemical elements in the environment 2. Biological classification of chemical elements 3. Properties and characteristics of organogenic elements 4. Elements of the electrolyte background	**2**
2.	**Topic 2. Biogenic d-elements.** 1. Chemical properties of d-elements 2. Reactions of complexation. 3. Biological role of d-elements and their compounds	**2**
3.	**Topic 3. Complex compounds** 1. General information about complex compounds 2. Nomenclature of complex compounds 3. Classification of complex compounds 4. The structure of complex compounds 5. Spatial structure geometry) of complex compounds 6. Isomerism of complex compounds 7. Properties of complex compounds	**2**
4.	**Topic 4. General theory of solutions** 1. The concept of solutions. 2. Classification of solutions. 3. Methods of expressing the concentration of solutions 4. Water in biological systems	**2**
5.	**Topic 5. Acid-base balance in the body. Hydrogen index of biological fluids** 1. General concepts of the theory of electrolyte solutions 2. Theories of acids and bases 3. Dissociation of water 4. Hydrogen index 5. The product of solubility 6. Hydrolysis of salts	**2**

BLOCK 2

№	TOPIC	Number of hours
6.	**Topic 7. Thermodynamics and bioenergy.** 1. The concept of thermodynamic system. 2. The first law of thermodynamics in bioenergy. 3. Fundamentals of thermochemistry. 4. The second law of thermodynamics. 5. Energy balance of the body.	**2**
7.	**Topic 8. Chemical kinetics** 1. The concept of the rate of a chemical reaction and the factors influencing it. 2. The reaction rate constant. Order and molecularity of the reaction.	**2**

	3. Mechanisms of chemical reactions. Activation energy. 4. The concept of catalysis. 5. Chemical equilibrium. Le Chatelier principle.	
8.	**Topic 9. Adsorption.** 1. General ideas about surface phenomena in dispersed systems. 2. The concept of surface tension. 3. General ideas about adsorption. 4. Adsorption from solutions on the interfacial surface liquid - gas or liquid - liquid. 5. Adsorption on solids. 6 Ionic adsorption from solutions.	**1**
Total hours		**15**

4.2. Plan of practical classes
BLOCK 1

№	TOPIC	Number of hours
1.	Topic 1. Introduction. Safety precautions. Periodic system DI Mendeleev. Biogenic s-, p-elements; biological role, application in medicine	2
2.	Topic 2. Biogenic d-elements, chemical properties, biological role, application in medicine	2
3.	Topic 3. Complexation in biological systems.	2
4.	Topic 4. Solutions	2
5.	Topic 5. Methods of expressing the concentration of solutions. Preparation of solutions.	2
6.	Topic 6. Acid-base balance in the body. Hydrogen index of biological fluids.	2
7.	Topic 7. Buffer systems, classification and mechanism of action. Buffer capacity.	2
8.	Topic 8. Colligative properties of solutions. Osmosis.	2
9.	Topic 9. Alkalimetry. Fundamentals of titrimetric analysis. Method of neutralization. Acidimetry	2
Total hours of practical classes		**18**

BLOCK 2.

№	TOPIC	Number of hours
1.	Topic 10. Thermal effects of chemical reactions, the direction of processes.	2
2.	Topic 11. Kinetics of biochemical reactions.. Chemical equilibrium. The product of solubility	2
3.	Topic 12. Sorption of biologically active substances at the liquid-gas interface, at the interface between solid and solution.	2
4.	Topic 13. Obtaining, purification, properties, coagulation of colloidal solutions	2
5.	Topic 14. Properties of solutions of biopolymers	2
6.	Topic 15. Generalization of knowledge from the course.	2
Total hours of practical classes		**12**

Note. * - Plan of each practical lesson:
1) Test control of students' knowledge to check the quality of mastering the previous topic.
2) Discussion of theoretical issues on the topic of practical work: updating the knowledge of lecture material, issues submitted for independent study, oral interview of students, group work - elaboration of examples of solving computational problems required for this formulas expressing the relevant patterns, the most complex reaction equations, etc.

3) Performing tasks of practical work
4) Assessment of knowledge.

4.3. Tasks for independent work

№	TOPIC	Number of hours
BLOCK 1,2		
1.	Preparation for practical classes (theoretical training, development of practical skills)	**15**
2.	Independent elaboration of topics that are not included in the classroom plan Block 1 (list attached)	**15**
3.	Independent elaboration of topics that are not included in the lesson plan Block 2 (list attached)	**15**
Total independent work hours		**45**

BLOCK 1

1. Application of osmometry in medical and biological research.
2. Complex compounds in biological systems.
3. Complexones and their use in medicine.
4. Toxic effect of compounds of s-, p-, d-elements.
5. The relationship between the location of s-, p-, d-elements in the periodic table and their content in the human body.
6. The use of alkalimetry in medical practice.
7. The use of acidimetry in medical practice.
8. Acid-base indicators.
9. Osmosis, semipermeable membranes, osmotic pressure.
10. Cryometry. ebuliometry
11. Application of osmometry in medical and biological research.

BLOCK 2

1. Macroergic compounds. ATP as a universal source of energy for biochemical reactions. Characteristics of macroergic connections.
2. Photochemical reactions and their role in life.
3. Exergonic and endergonic processes that occur in the body.
4. The role of heterogeneous equilibrium with the participation of salts in the general homeostasis of the organism.
5. Redox reactions in the body. Predicting their direction by standard Gibbs energy values and by values of redox potentials.
6. Determination of redox potential
7. Orientation of molecules in the surface layer and structure of biological membranes.
8. Disperse systems and their classification.
9. Methods of obtaining and purifying colloidal solutions.
10. Dialysis, electrodialysis, ultrafiltration. "Artificial kidney".
11. Molecular kinetic properties of colloidal systems (Brownian motion, diffusion, osmotic pressure).
12. Classification of chromatographic research methods on the basis of the mechanism of distribution of substances, the physical state of the phases and the technique of execution.

Individual tasks

The program does not provide individual tasks

Typical control work for intermediate control of knowledge in practical classes

Topic 8. Colligative properties of solutions

(tests - 0.5 points for the correct answer, tasks - 2 points for the correct answer)
(execution time - up to 10 minutes)

Variant 0.

1. For which of the following substances the degree of dissociation is the smallest: a) sugar; b) hydrochloric acid; c) copper (II) hydroxide; d) ethanoic acid?
2. Emphasize the signs of ideal solutions: a) the dependence of properties on temperature; b) the dependence of the properties on the number of particles; interaction between components; d) small particle size of the solute.
3. Determine the mass of sucrose to be dissolved in 100 ml of water to increase the boiling point by1 degrees Celsius if the ebulioscopic water constant Keb (H2O) = 0.516.
4. At what temperature will a solution containing a non-electrolyte of 0.062 mol in water with a volume of 200 ml boil at Keb (H2O) = 0.516?

4.4. Ensuring the educational process

1. Multimedia projectors, computers, screens for multimedia presentations, lecture presentations.

2. Demonstration screens, laptops, files in Power Point and Word with theoretical materials for lectures and practical classes, examples of numerical calculations of the course of biochemical and physicochemical processes in the body (according to the discipline program.).

3..Chemical equipment for demonstration experiments (utensils, chemical reagents, electronic scales, pH meter, galvanometer, FEC, etc.).

4. Examination tickets

4. Final control

List of final control (exam) questions

1. Biogenic elements: their electronic structure; typical chemical properties of elements and their compounds
2. The relationship between the location of s-, p-, d-elements in the periodic table and their content in the human body.
3. Macro-, micro- and impurity elements in the human body. Application in medicine.
4. Toxic effect of compounds of s-, p-, d-elements.
5. Complex compounds: Werner's theory, the nature of the chemical bond, classification, intracomplex compounds.
6. Complex compounds in biological systems.
7. Complexones and their use in medicin Solutions and their role in life.
8. Methods of expressing the concentration of solutions.
9. Solubility of gases in liquids and its dependence on various factors. Henry Dalton's law.
10. Solubility of gases in the blood.
11. Solubility of solids and liquids, its dependence on various factors
12. Distribution of substances between two immiscible liquids. Nernst distribution law and its significance in the phenomenon of permeability of biological membranes.
13. Solutions of electrolytes.
14. Ostwald's breeding law.
15. Properties of strong electrolyte solutions, activity and activity coefficient.

16. Ionic strength of the solution.
17. Water-electrolyte balance a necessary condition for homeostasis.
18. Dissociation of water. Ionic product of water.
19. Hydrogen pH of solutions of strong and weak electrolytes
20. pH of biological fluids in normal and pathology.
21. Theories of acids and bases.
22. Hydrolysis of salts.
23. The degree of hydrolysis, its dependence on concentration and temperature,
24. The hydrolysis constant.
25. The role of hydrolysis in biochemical processes.
26. Methods of titrimetric analysis. Method of acid-base titration of alkalimetry.
27. Method of acid-base titration of acidimetry.
28. Acid-base indicators.
29. Buffer systems, their classification, mechanism of action.
30. Calculations related to buffer systems, Henderson-Hasselbach equation
31. Buffer capacity, its practical definition.
32. Buffer capacity of blood, Buffer systems of the human body, their mechanism of action. Acid-base balance and alkaline blood reserve.
33. Colligative properties of solutions.
34. Decrease in freezing point and increase in boiling point of solutions. Raoul's law.
35. Cryometry and ebuliometry, their application in medical and biological research.
36. Osmosis, semipermeable membranes, osmotic pressure.
37. Vant-Hoff's law and its equations for non-electrolytes and electrolytes.
38. Isotonic coefficient. Hypo- hyper- and isotonic solutions.
39. Plasmolysis, hemolysis, turgor.
40. Osmotic pressure of blood plasma. Haller's equation. Oncotic pressure.
41. Application of osmometry in medical and biological research.
42. The first law of thermodynamics. Internal energy. Enthalpy.
43. Heat of isobaric and isochoric processes.
44. Thermochemistry. Hess's law. Thermochemical transformations. Standard heat of formation and combustion of substances.
45. The second law of thermodynamics. Entropy. Gibbs energy.
46. Macroergic compounds. ATP as a universal source of energy for biochemical reactions. Characteristics of macroergic connections.
47. The rate of chemical reactions. Law of acting masses for the rate of chemical reactions.
48. Reaction rate constant.
49. Reactions are simple and complex (sequential, parallel, conjugate, reversible, chain).
50. Photochemical reactions and their role in life.
51. The order of the reaction. Reactions of zero, 1st and 2nd order. Half-life.
52. Dependence of reaction rate on temperature. Temperature coefficient. Vant-Goff's rule. Features of the temperature coefficient of the reaction rate for biochemical processes
53. Arrhenius equation. Activation energy. The concept of the theory of active collisions and the theory of transition state.
54. Homogeneous and heterogeneous catalysis. Features of the catalyst.
55. The mechanism of catalysis and its role in metabolic processes.
56. Enzymes as catalysts for biochemical reactions. Dependence of enzymatic action on the concentration of enzyme and substrate, temperature and reaction of the medium.
57. Chemical equilibrium. Thermodynamic equilibrium conditions. Forecasting the direction of spontaneous processes.
58. Exergonic and endergonic processes that occur in the body.
59. Chemical equilibrium constant. Ways of its expression.
60. The principle of Le Chatelier. Predicting the shift of chemical equilibrium.

61. Deposition and dissolution reactions. The product of solubility. Conditions for precipitation and dissolution of sediments.
62. The role of heterogeneous equilibrium with the participation of salts in the general homeostasis of the organism
63. Electrode potentials and the mechanism of their occurrence. Nernst's equation.
64. Normal (standard) electrode potential. Determination electrodes.
65. Redox electrode potentials (redox potentials). The mechanism of their occurrence, biological significance. Peters equation.
66. Redox reactions in the body. Predicting their direction by standard Gibbs energy values and by values of redox potentials.
67. Redox reactions in the body. Predicting their direction by the values of redox potentials.
68. Potentiometric titration, its use in medical and biological research.
69. Diffusion and membrane potentials, their role in the genesis of biological potentials.
70. Surface activity. Duclos-Traube rule. Gibbs equation.
71. Orientation of molecules in the surface layer and the structure of biological membranes.
72. Adsorption from solutions on the surface of a solid. Equations of Langmuir, Freundlich.
73. Physico-chemical bases of adsorption therapy.
74. Adsorption of electrolytes (selective and ion exchange). Panetta-Faience rule. Ion exchange resins and their use in medicine.
75. Classification of chromatographic research methods on the basis of the mechanism of distribution of substances, the physical state of the phases and the technique of execution.
    The use of chromatography in biomedical research.
76. Disperse systems and their classification. Methods of obtaining and purifying colloidal solutions.
77. Dialysis, electrodialysis, ultrafiltration. "Artificial kidney".
78. Molecular kinetic properties of colloidal systems (Brownian motion, diffusion, osmotic pressure).
79. Optical properties of colloidal systems. Ultramicroscopy.
80. The structure of colloidal particles (micelles).
81. Electrokinetic potential. Electrophoresis, its use in medicine and biomedical research.
82. Kinetic and aggregative stability of lyozoles. Stability factors.
83. The mechanism of coagulating action of electrolytes. Coagulation threshold, its definition. Schultze-Hardy rule.
84. Coagulation processes during drinking water and wastewater treatment. Colloidal protection, its biological role
85. Coarse systems (aerosols, suspensions, emulsions) - production, properties, medical application. Semi-colloids.
86. Features of solutions of the Navy. The mechanism of swelling and dissolution of the IUD, depending on various factors. The role of swelling in the physiology of organisms.
87. Isoelectric point of protein and methods of its determination.
88. Jeweling of solutions of the Navy. Properties of gems. Gems in the human body.

Types of calculation tasks for exam tickets

1. Calculation of Gibbs energy., Enthalpy, entropy
2. Calculations according to Raoul's laws.
3. Thermochemical calculations.
4. Calculation of the rate of a chemical reaction.
5. Calculation of the equilibrium constant and determining the direction of equilibrium shift.
6. Calculations of the product of solubility.
7. Calculation of electrode and redox potentials.

8. Calculations of concentration of solutions
9. The structure of the micelle. Coagulation threshold.
10. Calculation of pH of electrolyte solutions
11. Calculations of the constant and degree of dissociation of the electrolyte.
12. Calculation of pH of buffer systems.

"0" Ticket option for theexam
Petro Mohyla Black Sea National Uni versity
Medical institute
Department of pharmacy, pharmacology, medical, bioorganic and biological chemistry
Level of higher education: Master
Field of knowledge: 22 "Health"
Specialty: 222 "Medicine"
Discipline: "Medical chemistry"

TICKET № 0

1. Test tasks (maximum number of points - 20)

1.1. Electrodialysis is one of the methods of purification of colloidal solution from: a) excess electrolyte; b) coarse impurities; c) excess dispersion medium; d) excess Navy.

1.2. Chemical processes are: a) the transformation of substances inside cells; b) the supply of nutrients from the environment; c) suction, d) condensation.

1.3. Determine gases that are lighter than air: a) H_2S; b) CO; c) H_2; d) Cl_2.

1.4. The surface of the solid adsorbent: a) is homogeneous; b) has the same adsorption properties; c) contains active centers; d) contains small areas with increased stock ΔG.

2. Level I tasks (maximum number of points - 30)

2.1. For complex compounds $[Co(NH_3)_4(H_2O)_2]SO_4$

determine the complexing agent and ligands, the coordination number and degree of oxidation of the complexing agent, the charge of the complex ion. Give the name of the CC. Write the equation of the two types of dissociation and the expression for the instability constant.

2.2. Write electronic and electronic-graphic formulas of a chemical element under serial number 13 in stable and excited states

2.3.

Calculate the Gibbs energy of thermal denaturation of pepsin at 750 ^oC, if ΔH^0 = +245 kJ / mol; $\Delta S^0_{\text{р-ції}}$ = +311 kJ / mol ·K. Evaluate the contribution of enthalpy and entropy factors.

3. Level II tasks (maximum number of points - 30)

3.1 In human gastric juice, the mass fraction of hydrochloric acid averages 0.5%. How many moles of HC1 fit in 500 g of gastric juice?

3.2. Calculate the concentration of hydrogen ions in venous blood with pH = 7.36.

Approved at the meeting of the Department of Pharmacy, Pharmacology, Medical, Bioorganic and Biological Chemistry, Minutes № ___ of _____ 2021.

Head of the Department _____ Ogloblina M.V.

The teacher who carries out
knowledge control _____ Lebed S.G.

6. Evaluation criteria and diagnostic tools for learning outcomes

Control methods

• Survey (testing of theoretical knowledge and practical skills).

• Tests on each topic, containing test questions and calculation problems (or equations of chemical reactions).

Current control. Checking the quality of theoretical knowledge and practical skills in practical classes, including the results of independent work of students. Supervised by teachers according to the specific purpose of the curriculum. Assessment of the level of preparation of students is carried out by: oral questioning of students, checking the design of the results of practical work, the correctness of writing the equations of chemical reactions, interpretation of the results of chemical experiments and more.

Intermediate control. Provides verification of the degree of assimilation of theoretical knowledge by students for use in practice, ie conducting specific calculations related to the processes of life, explaining the mechanisms, directing the course of reactions; preparation of solutions, etc. Carried out by conducting small-scale tests (up to 10 minutes), on each topic, which includes test questions and calculation tasks.

Final control of knowledge is carried out on completion of studying of a course in the form of examination. less than the minimum - 40 points.

Distribution of points received by students

During the semester, a positive assessment in a practical lesson can be from 3 to 8 points. A score below 3 points means "unsatisfactory", the lesson is not credited and is subject to practice in the prescribed manner. The assessment for the practical lesson consists of two components:

1. Evaluation of the results of practical work (the student must draw up protocols of experiments, write the appropriate chemical equations, draw conclusions, perform appropriate calculations, solve calculation problems according to the tasks of a particular practical lesson and present the results of this work to the teacher (maximum positive grade - 3 points);

2. Grade for the test on the topic of the lesson (maximum positive grade - 5 points).

The class is considered credited if the student received points for both components of assessment. If only the control test is performed even for the maximum score of 5, and the practical part of the work is not performed, the lesson will not be considered credited.

Assessment of student performance

Type of activity (task)	Maximum number of points
Block 1	
Topic1	8
Topic 2	8
Topic 3	8
Topic 4	8
Topic 5	8
Topic 6	8
Topic 7	8
Topic 8	8
Topic 9	8
Total point	72
Block 2	
Topic 10	8
Topic 11	8
Topic 12	8

Topic 13	8
Topic 14	8
Topic 15	8
Total point	48
Total grade for the semester	120
Exam	80
Total for the course	200

Criteria for assessing knowledge

A student's answer is evaluated with a score of 5 points and 71-80 points on the exam (A on the ECTS scale and "5" on the national scale) if it demonstrates deep knowledge of all theoretical positions and ability to apply theoretical material to perform practical tasks and no inaccuracies.

A grade of 4 points and 61-70 points on the exam (B and C on the ECTS scale and "4" on the national scale) the answer is evaluated if it shows knowledge of all theoretical principles, the ability to apply them in practice, but some fundamental inaccuracies are allowed.

A score of 3 points and 50-60 points on the exam (D and E on the ECTS scale and "3" on the national scale) the student's answer is evaluated provided that he knows the main theoretical principles and can use them in practice.

7. Recommended sources of information

7.1. Basic

1. Medical chemistry: textbook / V.O. Kalibabchuk, V.I. Halynska, L.I. Hryshchenko et al. — 7th edition.- K. : Medicine. - 2020.- 224

2. Zaichko N.V., Smirnova O.V., Chervyak M.M., Shunkov V.S. Medical chemistry. – Vinnytsia, Nilan-LTD, 2017.- 299.

7.2. Supporting

1. General and Inorganic Chemistry: textbook / V.O. Kalibabchuk, V.V. Ohurtsov, V.I. Halynska et al. - K. : Medicine. - 2019.-456 p.

2. Medical Chemistry. Adapted Concise Course: manual for students self-work / A. O. Syrovaya, E. R. Grabovetskaya, L. G. Shapoval. – X.: Вид-во «Цифрова друкарня №1», 2014. – 158 p.

3. Masterton, William L. Chemistry Principles and Reactions / William L. Masterton, Cecile N. Hurley. – Brooks/Cole Cengage Learning, 2004. – 727 p.

7.3 Information resources on the Internet

1. ДО «Центр тестування» : [офіц. сайт]. - URL : testcentr.org.ua