PRIVATE HIGHER EDUCATIONAL ESTABLISHMENT
«INTERNATIONAL ACADEMY OF ECOLOGY AND MEDICINE»

Department of fundamental disciplines with a course of pharmacology

SYLLABUS OF THE EDUCATIONAL DISCIPLINE

" Medical chemistry "

LEVEL OF HIGHER EDUCATION The second (master's) level
DEGREE OF HIGHER EDUCATION Master
AREA OF KNOWLEDGE 22 "Health care"
SPECIALTY 221 "Dentistry"

Reviewed and approved
at the meeting of the Department of fundamental disciplines with a course of pharmacology

Protocol № 1 of « 01 » 09 2020
Head of the department Doctor of Biological Sciences, associate professor
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Kiev 2020

1. General information	
Subject	**Medical chemistry**
Lector	Shimanskyi O
Teacher's contact phone number	
Teacher's e-mail	kaffund@ukr.net
Discipline format	Normative discipline.
The volume of the discipline	90 hours
Link to the distance learning site	maem.kiev.ua
Consultations	
2. Annotation to the course	
The subject of study of the discipline are: chemical bases of vital processes of an organism which obey the basic chemical laws. Medical chemistry studies the structure and reactivity of the most important biologically active molecules. the theory of chemical bonding in complex compounds of biometals with bioligands and the role of nutrients in the body. It studies the physicochemical processes that occur at the molecular and submolecular levels. because this is where the causes of various forms of disease and the specificity of hereditary traits.	**Interdisciplinary links:** the discipline "Medical Chemistry" is integrated with the following disciplines: "Histology, Cytology and Embryology", "Biological and Bioorganic Chemistry", "Microbiology", "Pathological Physiology", "Medical Genetics", "Obstetrics and Gynecology" Infectious diseases "," Pediatrics ". The study of the discipline "Medical Chemistry" is directly based on the basics of chemistry in secondary education, as well as the basics of elementary mathematics and physics. Knowledge of the theoretical foundations of medical chemistry is necessary for a deeper study of physiology, pathophysiology, biological chemistry, general and molecular pharmacology and toxicology, hygienic disciplines and ecology.
3. Purpose and objectives of the course	
The purpose of teaching the discipline "Medical Chemistry" is the formation of scientific worldview of students, the development of modern forms of theoretical thinking and the ability to analyze phenomena, skills and abilities to apply chemical and physicochemical laws and processes in the study of other disciplines and future practice. The purpose of teaching the discipline "Medical Chemistry" follows from the objectives of the educational-professional training program for applicants for the second educational (master's) level of higher education and are determined by the content of those systemic knowledge and skills that must be mastered by	The **goals** of studying the discipline "Medical Chemistry" are: to teach students to use the basic concepts of chemistry, basic laws of chemistry, general laws of chemical reactions, the doctrine of solutions, general information about chemical elements and their compounds, knowledge of physicochemical bases of different types of equilibria in biological systems in solving specific

and skills that must be mastered by a doctor. The knowledge that students receive from the discipline "Medical Chemistry" is basic for the block of disciplines that provide scientific and professional training.	specific problems in medicine to modern needs.

4. Competencies and learning outcomes

Learning outcomes for the course: On completion of study of discipline "Medical Chemistry " students **must**

***know*:**

• basic provisions of thermodynamics, kinetics and catalysis, necessary to understand the peculiarities of biochemical reactions;

• basics of modern doctrine of solutions, which are necessary for a correct understanding of biochemical processes;

• basic provisions of electrochemistry, physicochemistry of surface phenomena and dispersed systems, necessary for understanding the structures and properties of biological membranes, as well as research methods of medical practice: dialysis, electrophoresis, electroosmosis, etc .;

be able:

• to interpret the main types of chemical equilibrium for the formation of a holistic physico-chemical approach to the study of life processes of the organism;

• to apply chemical methods of quantitative and qualitative analysis;

• to classify the chemical properties and transformation of bioinorganic substances in the process of life of the organism;

• to interpret the general physical and chemical laws that underlie the processes of human life;

• to prepare solutions with a given quantitative composition.

According to the requirements of the Standard of Higher Education, the discipline "Medical Chemistry " provides students with the following competencies:

integrated:

Ability to interpret the general chemical patterns that underlie the processes of human life.

general:

- ability to abstract thinking, analysis and synthesis;
- ability to learn and master modern knowledge;
- ability to apply knowledge in practical situations;
- knowledge and understanding of the subject area and understanding of professional activity;
- ability to make informed decisions;
- skills of using information and communication technologies;
- definiteness and perseverance in terms of tasks and responsibilities.

Special (professional, substantive):

- ability to determine the necessary list of laboratory and instrumental research and evaluate their results;
- ability to determine the nature of nutrition in the treatment of diseases;
- to determine the tactics of emergency medical care on the basis of a diagnosis of emergency;
- ability to determine the principles and nature of disease treatment;
- ability to assess the impact of the environment, socio-economic and biological determinants on the health of the individual, family, population.

Matrix of competencies

№	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
1	2	3	4	5	6
Integrated competence					
Ability to solve typical and complex specialized problems and practical problems in a professional health care activity, or in a learning process that involves research and / or innovation and is characterized by the complexity and uncertainty of conditions and requirements.					
General competencies					
1	Ability to apply knowledge in practical situations	To have specialized conceptual knowledge acquired in the learning process.	To 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.	To be responsible for making decisio in difficult conditions.
2	Knowledge and understanding of the subject area and understanding of the profession	To have deep knowledge of the structure of professional activity.	To be able to carry out professional activities that require updating and integration of knowledge.	Ability to effectively form a communication strategy in professional activities	To be responsible for professional development, ability to further professional trainir with a high level o autonomy.
3	Ability to exercise self-regulation, lead a healthy lifestyle, ability to adapt and act in a new situation.	To know ways to self-regulate, lead a healthy life.	To be able to apply the means of self-regulation, be able to lead a healthy lifestyle and adapt to new situations (circumstances) of life and activity.	To establish appropriate connections to achieve results.	To be responsible for a healthy lifestyle and timely use of self-regulation method
4	Ability to choose a communication strategy; ability to work in a team; interpersonal skills	To know the tactics and strategies of communication, laws and ways of communicative behavior	To be able to choose ways and strategies of communication to ensure effective teamwork	To use communication strategies and interpersonal skills	To be responsible for the choice and tactics of communication.
5	Ability to communicate in the native language both orally and in writing; ability to communicate in another language	To have a perfect knowledge of the native language and basic knowledge of a foreign language	To be able to apply knowledge of the native language, both orally and in writing, be able to communicate in a foreign language.	To use the native language in professional and business communication and in the preparation of documents. Use a foreign language in a professional activities.	To be responsible for fluency in the native language, fo the development o professional knowledge.

6	Skills in the use of information and communication technologies	To have deep knowledge in the field of information and communication technologies used in professional activities	To be able to use information and communication technologies in the professional field, which requires updating and integration of knowledge.	To use information and communication technologies in professional activities.	To be responsible for the development of professional knowledge and skills.
7	Ability to abstract thinking, analysis and synthesis, the ability to learn and be modernly trained.	To know the methods of analysis, synthesis and further modern learning.	To be able to analyze information, make informed decisions, be able to acquire modern knowledge.	To establish appropriate connections to achieve goals.	To be responsible for the timely acquisition of modern knowledge.
8	Ability to evaluate and ensure the quality of work performed.	To know the methods of evaluating performance indicators.	To be able to ensure quality work.	To establish connections to ensure quality work.	To be responsible for the quality of work.
9	Determination and perseverance are persistent in the tasks and responsibilities.	To know the responsibilities and ways to perform the tasks.	To be able to set goals and objectives to be persistent and conscientious in the performance of duties.	To establish interpersonal relationships to effectively perform tasks and responsibilities.	To be responsible for the quality of the tasks.
10	The ability to act socially in accordance with public consciousness.	To know your social and community rights and responsibilities.	To form one's civic consciousness, to be able to act according to it	Ability to convey one's public and social position.	To be responsible for your civic position and activities.
11	The desire to preserve the environment.	To know the problems of environmental protection and ways to preserve it.	To be able to form requirements for themselves and others to preserve the environment.	To make proposals to the relevant authorities and institutions on measures to preserve and protect the environment.	To be responsible for the implementation of environmental protection measures within its competence.

Special competencies					
1	Ability to evaluate results laboratory and instrumental research.	To have specialized knowledge about the person, his organs and systems, know the standard methods of laboratory and instrumental research (according to list 4).	To be able to analyze the results of laboratory and instrumental studies and on their basis to assess information about the diagnosis of the patient (according to list 4).	It is reasonable to assign and evaluate the results of laboratory and instrumental research (according to list 4).	To be responsible for deciding on the evaluation of laboratory and instrumental research results.

2.	Ability to determine the principles and nature of disease treatment.	To have specialized knowledge of algorithms and standard schemes for the treatment of diseases (list 2).	To be able to determine the principles and nature of treatment of the disease (according to list 2).	To form and communicate to the patient and specialists their own conclusions about the principles and nature of treatment (according to list 2).	To be responsible for deciding on the principles and nature of treatment of the disease (according to list 2).
3.	Ability to diagnose emergencies.	To have specialized knowledge about the person, his organs and systems, standard methods of human examination (at home, on the street, in a health care facility) in the absence of information.	To be able, in the absence of information, using standard techniques, to by making an informed decision to assess the human condition and make a diagnosis (according to list 3).	Under any circumstances, in compliance with the relevant ethical and legal norms to make an informed decision to assess the human condition, diagnosis and organization of the necessary medical measures depending on the human condition; fill in the relevant medical documents.	To be responsible for the timeliness and effectiveness of medical measures to diagnose emergencies.
4.	Ability to determine therapeutic nutrition in the treatment of diseases.	To have specialized knowledge about man, his organs and systems; knowledge of algorithms and standard schemes of medical nutrition in the treatment of diseases (according to list 2).	To be able to determine, on the basis of a preliminary clinical diagnosis, the nature of therapeutic nutrition in the treatment of diseases (according to list 2).	To form and convey to the patient, specialists conclusions on therapeutic nutrition in the treatment of the disease (according to list 2).	To be responsible for the validity of the definition of therapeutic nutrition in the treatment of the disease (according to list 2).
5.	Ability to assess the impact of the environment on the health of the population (individual, family, population).	To know the methods of assessing the health of the population (individual, family, population); environmental factors that negatively affect the health of the population; methods of statistical analysis and laboratory research (according to list 4), assessment of the health of certain contingents, assessment of environmental factors and methods of determining the relationship between them; measures to prevent the negative impact of environmental factors on public health. Know the principles of risk groups, risk areas, time and risk factors.	To be able to assess the health of the population, assess the state of the environment and the negative factors influencing the health of the population. To have methods of statistical and laboratory (according to list 4) analysis of the state of health of different groups of the population.	To draw conclusions about the state of health of the population, based on data on communication with environmental factors and make proposals to the relevant authorities and institutions for preventive measures. Interact with specialists of sanitary and hygienic profile and heads of enterprises, institutions and relevant departments on nature protection, environment.	To be responsible for timely conclusions about the state of health of the population on the basis of data on the negative impact of environmental factors; for timely submission of proposals for appropriate preventive measures.

5. Organization of course training			
The volume of the course			
Type of lesson		***Total amount of hours 90***	
Lectures		10	
Practical classes		40	
Independent work		40	
Course signs			
Semester: The1st.	Specialty 221 "Dentistry"	Course (year of study) The1st	Normative discipline

Course thematics

The syllabus is structured into 2 modules:

Module 1 "Fundamentals of Medical Chemistry"

Submodule 1. Chemistry of nutrients. Complexation in biological fluids.

Specific goals:

• *To interpret the relationship between the biological role of biogenic s-, p-, d-elements and the form of their presence in the body.*

• *To explain the principles of structure of complex compounds.*

• *To interpret the peculiarities of the structure of complex compounds as the basis of their use in chelation therapy.*

Topic. Biogenic s-, p-elements; biological role, application in medicine, dentistry.

Basic safety rules when working in a chemical laboratory.

General information about nutrients. Qualitative and quantitative content of nutrients in the human body. Macronutrients, trace elements and impurity elements. Organogens. The concept of the teachings of V.I. 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 on CO_3^{2-}, SO_4^{2-}, NO_2^-, $S_2O_3^{2-}$ ions

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

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 on ions MnO^{4-}, Fe^{3+}, Cu^{2+}, Ag^+.

Topic. 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.

Submodule 2. Acid-base equilibria in biological fluids.

Specific goals:

- *To be able to characterize the quantitative composition of solutions.*
- *To be able to prepare solutions with a given quantitative composition.*
- *To analyze the quantitative content in the solution of acids and bases using the methods of cysto-basic titration.*
- *To make conclusions about the acidity of biological fluids based on the hydrogen index*
- *To explain the mechanism of action of buffer systems and their role in maintaining acid-base balance in biosystems.*
- *To analyze the relationship between the colligative properties of the concentration of solutions.*

Topic. Values that characterize the quantitative composition of solutions.

The composition of the solutions. Classification of solutions.

Values that characterize the quantitative composition of solutions:

mass, volume and mole fractions;

molar concentration;

molar concentration of equivalent (deci-, santi-, milli- and micromoles);

molar concentration;

caption.

Topic. Preparation of 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 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.

Values that characterize the quantitative composition of solutions. Preparation of solutions with a given quantitative composition.

Neutralization method: definition, classification, working solutions, starting materials, the principle of selection of acid-base indicators, titration curves, equivalent point, titration jump. Application in medicine, pharmacy and sanitary analysis

Acidimetry: definitions, working solutions, starting materials, the principle of selection of acid-base indicators, titration curves, equivalent point, titration jump. Application in medicine, pharmacy and sanitary analysis

Topic. Acid-base balance in the body.

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.

Topic. Hydrogen index of biological fluids.

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.

Topic. Fundamentals of titrimetric analysis.

Fundamentals of titrimetric analysis. Acid-base indicators.

Methods of titrimetric analysis:

a) methods of neutralization (acid-base titration): - alkalimetry; - acidimetry.

b) redox titration (oxidimetry): method of permanganatometry; - method of iodometry.

c) the method of complexometry.

d) deposition method. Argentometric titration - direct titration (Moore and Faience methods) and reverse titration (Folgard method).

Topic. Buffer systems, their biological role.

Buffer solutions, their classification. Henderson-Hasselbach equation. The mechanism of buffer action. Buffer systems of the human body (phosphate, bicarbonate, protein, hemoglobin-oxyhemoglobin) and the mechanism of their action.

Buffer capacity: definition, dependence on various factors. Determination of buffer capacity by acid and alkali. Buffer blood capacity. The concept of acid-base state of the blood. Alkaline blood reserve. Violation of the alkaline-alkaline balance in the body.

Topic. Colligative properties of solutions.

Colligative properties of dilute solutions of non-electrolytes. The relative decrease in the pressure of saturated solvent vapor 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.

Submodule 3. Thermodynamic and kinetic laws of processes and electrokinetic phenomena in biological systems.

Specific goals:

- *To interpret chemical and biochemical processes from the standpoint of their thermal effects.*
- *To be able to use thermodynamic functions to assess the direction of processes, to explain the energy conjugation in living systems.*
- *To analyze the dependence of the reaction rate on the concentration, temperature, activation energy.*
- *To analyze the features of catalysts and explain the mechanism of homogeneous and heterogeneous catalysis. Explain the dependence of the rate of enzymatic processes on the concentration of enzyme and substrate*
- *To analyze chemical equilibrium and explain its condition from the standpoint of thermodynamics and kinetics.*
- *To analyze the conditions of precipitation and the formation of sediments and their role in the overall homeostasis of the organism.*
- *To explain the mechanism of formation of electrode potentials and analyze the principles of the method of potentiometry. Be able to predict the direction of redox reactions.*

Topic. Thermal effects of chemical reactions. Orientation 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. Kinetics of biochemical reactions.

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. Kinetic equations of first, second and zero order reactions. The half-life is a quantitative characteristic of the change in the concentration of radionuclides, pesticides, etc. in the environment. The concept of the reaction mechanism. Molecularity of the reaction.

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

Activation energy. Theory of active collisions. Arrhenius equation. The concept of the theory of transition state (activated complex).

Representation of the kinetics of complex reactions: parallel, sequential, conjugate, reversible, competing, chain. The concept of antioxidants. Free radical reactions in a living organism. Photochemical reactions, photosynthesis.

Topic. Kinetics of biochemical reactions.

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

Representation of the kinetics of enzymatic reactions. Enzymes as biological catalysts. Features of enzyme action: selectivity, efficiency, dependence of enzymatic action on temperature and reaction of environment. The concept of the mechanism of action of enzymes. Dependence of the rate of enzymatic processes on the concentration of enzyme and substrate. Activation and inhibition of enzymes. Influence of ecological factors on the kinetics of enzymatic reactions.

Topic. Chemical equilibrium. The product of solubility.

Chemical equilibrium. Chemical equilibrium constant and methods of its expression. Displacement of chemical equilibrium with changes in temperature, pressure, concentration of substances. Le Chatelier principle. Deposition and dissolution reactions. The product of solubility. Conditions for precipitation and dissolution of sediments. The role of heterogeneous equilibrium with the participation of salts in the general homeostasis of the organism.

Topic. Electrode potentials.

The role of electrochemical phenomena in biological processes. Electrode potentials and the mechanism of their occurrence. Nernst's equation. Normal (standard) electrode potential. Normal hydrogen electrode. Measurement of electrode potentials. Determination electrodes and comparison electrodes. Silver chloride electrode. Ion-selective electrodes. Glass electrode. Galvanic cells. Potentiometry. Potentiometric determination of pH, ion activity. Potentiometric titration.

Topic. Determination of redox potential.

The role of redox reactions in life processes. Redox potential as a measure of oxidative and reducing capacity of systems. Peters equation. Normal redox potential.

Forecasting the direction of redox reactions by the values of redox potentials. The equivalent of oxidant and reducing agent. The value of redox potentials in the mechanism of biological oxidation processes.

Submodule 4. Physico-chemistry of surface phenomena. Lyophobic and lyophilic dispersed systems

Specific goals:

- *To draw conclusions about the surface activity of substances based on their structure. Explain the principle of structure of biological membranes.*
- *To analyze the equations of adsorption and the limits of their use, distinguish between monomolecular and polymolecular adsorption. To explain the physicochemical basis of adsorption therapy.*
- *To distinguish between selective and ion exchange adsorption of electrolytes.*
- *To interpret methods of chromatographic analysis and their role in biomedical research.*
- *To analyze the principles of methods for obtaining and purifying colloidal dispersed systems.*
- *To explain the physicochemical basis of hemodialysis.*
- *To interpret the physicochemical properties of proteins - structural components of body tissues.*
- *To draw conclusions about the charge of dissolved biopolymers based on their isoelectric point.*

Topic. Sorption of biologically active substances. Ion exchange.

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.

Adsorption of electrolytes: 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.

Topic. Chromatography.

Chromatography. Classification of chromatographic methods:

By physical state of phases: gas chromatography; liquid chromatography.

By technique: adsorption chromatography; distribution chromatography; ion exchange chromatography; sediment chromatography; gel filtration.

By distribution mechanism: paper chromatography; thin layer chromatography; column chromatography; capillary chromatography.

Application of chromatography in biology and medicine.

Topic. Obtaining purification and properties 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. Electrokinetic potential of the colloidal particle. Methods of obtaining and purifying colloidal solutions. Dialysis, electrodialysis, ultrafiltration, compensatory dialysis, vividialysis. Hemodialysis and "artificial kidney" device. 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-laboratory practice. Electrophoregrams.

Topic. Coagulation of colloidal solutions.

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 drinking water and wastewater treatment. Colloidal protection. Disperse systems with gaseous dispersion medium. Classification of aerosols, production methods and properties. The use of aerosols in clinical practice. Adverse effects of industrial aerosols on human health. 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. 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 pH, temperature and electrolytes on swelling. The role of swelling in the physiology of the organism. Jeweling of IUD solutions. The mechanism of dragging. Influence of pH, temperature and electrolytes on the rate of dredging. 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. Calculation and situational tasks. Control of practical skills from Module 1 "Fundamentals of Medical Chemistry"

THEMATIC PLAN OF LECTURES
The 1st semester

№	Topic	Hours
1	Acid - basic balance in biosystems	2
2	Colligative properties of biological fluids	2
3	Physico - chemistry of surface phenomena.	2
4	Chromatography. Microheterogeneous dispersed systems.	2
5	Physico-chemical properties of biopolymer solutions	2
	Total:	**10**

THEMATIC PLAN OF PRACTICAL CLASSES
The 1st semester

№	Topic	Hours
	Module 1 "Fundamentals of Medical Chemistry"	
	Submodule 1. Chemistry of biogenic elements. Complex formation in biological fluids.	
1	Biogenic p-elements: biological role, applications in medicine, dentistry.	2
2	Biogenic *d*- elements: biological role, applications in medicine, dentistry.	2
	Submodule 2. Acid-base equilibria in biological fluids.	
3	Methods of expressing the quantitative composition of solutions.	2
4	Preparation of solutions with a given quantitative composition.	2
5	Acid-base equilibrium, pH value in vital liquids.	2
6	Titrimetric analysis. Acid-base titration method.	2
7	Properties of buffer solutions.	2
8	The role of buffer solutions in biosystems. Determination of buffer capacity.	2
9	Colligative properties of solutions.	2

	Submodule 3. Thermodynamic and kinetic laws of processes and electrokinetic phenomena in biological systems.	
10	Thermodynamic basics of biochemical processes.	2
11	Kinetics of biochemical reactions.	2
12	Chemical equilibrium. Shift of chemical equilibrium.	2
13	Reactions of precipitation and dissolution.	2
14	Measurement of electrode potentials.	2
	Submodule 4. Physico-chemistry of surface phenomena. Lyophobic and lyophilic dispersed systems	
15	Adsorption processes and ionic exchange in biosystems. Chromatography.	2
16	Obtaining, purification and properties of colloidal solutions.	2
17	Coagulation of colloidal solutions.	2
18	Methodical biopolymers.	2
19	Calculation and situational tasks. Control of practical skills.	2
20	Diff.credit	2
	Total	**40**

THEMATIC PLAN OF INDEPENDENT WORK OF STUDENTS (IWS)
The 1st semester

№	TOPIC	Hours	Type of control
1	**Preparation for practical classes** - theoretical preparation and working off the practical skills.	18	Current control in practical classes
2	**Elaboration of topics that are not included in the lesson plan:**		
2.1.	Methods of expressing the concentration of solutions.	4	Final modular control
2.2.	Determination of osmotic concentration and isotonicity of solutions by cryometry.	4	-"-
2.3.	Obtaining and characterization of complex and intracomplex compounds (CC). Complexometry.	4	-"-
2.4.	Determination of acidity of gastric juice.	4	-"-
3.	**Preparation for the final modular control**	6	***Final modular control***
	Total	**40**	

6. Course evaluation system	
General course evaluation system	**Current control** is performed based on the control of theoretical knowledge, skills and abilities in practical classes. Independent study students are assessed in practical classes, and is an integral part of the final grade of the student. Current control is performed during the training sessions and aims at checking the assimilation of students learning the material. Forms of current control are: a) test tasks with a choice of one correct answer, with the definition of the correct sequence of actions, with determination of the conformity, defining the specific portion of the photo or diagram ("detection"); b) individual oral questioning, interview;

c) the solution of typical situational tasks;
d) control of practical skills;
e) the typical problems of genetics and medical genetics.
Grades on the national scale ("excellent" - 5, "good" - 4, "satisfactory" - 3, "unsatisfactory" - 2), received by students, are displayed in the journals of attendance and academic group performance.

Final control

The final control is the form of a differentiated credit at the end of the 1st semester and an exam at the end of the 2nd semester upon completion of the course of medical biology.
The semester exam is a form of final control of mastering by the student of theoretical and practical material on academic discipline. The final control (exam) is carried out at the last control lesson.

Students are admitted to the FC who have attended all the classes provided by the curriculum in the discipline and while studying the module scored the number of points not less than the minimum (**72 points**). A student who, for good or bad reasons, has missed classes, is allowed to rework academic debt for a certain period of time.

Evaluation of current educational activities. During the assessment of mastering each topic for the current educational activity of the student scores are set on a 4-point (national) assessment scale. This takes into account all types of work provided by the discipline program. The student must receive a score on each topic. Scores on the traditional scale are converted into points. The final assessment of the current academic activity is the arithmetic mean (the sum of scores for each lesson is divided by the number of lessons per semester) and translated into points according to **Table 2.**

Table 2. Conversion of the average score for the current activity into a multi-point scale (for disciplines completed by diff.credit, exam)

4-point scale	120-point scale	4-point scale	120-point scale	4-point scale	120-point scale	4-point scale	120-point scale
5	120	4,45	107	3,91	94	3,37	81
4,95	119	4,41	106	3,87	93	3,33	80
4,91	118	4,37	105	3,83	92	3,29	79
4,87	117	4,33	104	3,79	91	3,25	78
4,83	116	4,29	103	3,74	90	3,2	77
4,79	115	4,25	102	3,7	89	3,16	76
4,75	114	4,2	101	3,66	88	3,12	75
4,7	113	4,16	100	3,62	87	3,08	74
4,66	112	4,12	99	3,58	86	3,04	73
4,62	111	4,08	98	3,54	85	3	**72**
4,58	110	4,04	97	3,49	84	<3	Not enough
4,54	109	3,99	96	3,45	83		
4,5	108	3,95	95	3,41	82		

The maximum number *of points that a student can collect for current educational activity during semester in order to be admitted to the exam is* ***120 points.***

The minimum number *of points that a student can collect for current educational activity during semester in order to be admitted to the exam is* ***72 points.***

Calculating of the number of points is based on obtained marks of student according to traditional scale while learning subject

	during the semester, by calculating the arithmetic mean (AM) that is rounded to two signs after comma. ***Evaluation of independent work of students.*** Independent work of students, which is provided by the topic of the lesson together with the classroom work, is evaluated during the current control of the topic in the relevant lesson. Assimilation of topics that are submitted only for independent work is checked during the final module control. ***Evaluation of final control.*** **The maximum number** of points that a student can score during the exam is **80 points.** The final control is considered credited if the student scored at least 60% of the maximum amount of points (for a 200-point scale - at least **50 points**). ***Determining the number of points that a student scored in the discipline:*** the number of points that a student scored in the discipline is defined as the sum of points for the current academic activity (Table1) and for the final control (diff.credit, exam) (Table 3). **Table 3. Scale of assessment of differentiated (exam) credit:**

Traditional scale	Points
«5»	**70-80**
«4»	**60-69**
«3»	**50-59**

Requirements for written work	The final written work is performed in the form of a test.
Practical classes	Classroom work

The 1st semester

Module 1. «ACID-BASE EQUILIBRIUM AND FORMATION OF COMPLEXES IN BIOLOGICAL LIQUIDS»

Topics 1-18:
Classroom work - score from 2 to 5 for each topic.

Topic 19: Classroom work - score from 2 to 5 Written test consists of 5 calculation tasks, evaluated by 1 point for each task.

Topic 20: Differentiated credit (semester control) Semester control at the end of the 1st semester is provided in the form of Differentiated credit. (Table 2) Provides a final grade on a 120-point scale as the sum of grades for the current control of knowledge (oral examination, written survey, Practical work, abstracts), the results of 2 modules.

STRUCTURE EXAMINATION CARD

1. Theoretical question
2. Theoretical question
3. Practical work

Example of CARDS
TO THE DIFFERENTIATED CREDIT

Card № 1

1. Complex compounds in biological systems and their application in medicine.
2. Features of the temperature coefficient of the reaction rate for biochemical processes.
3. The task. A solution containing in 500 ml of water 18 g of solute has an osmotic pressure at 0 ° C of 0.0456 MPa. Calculate the molar mass of the solute.

The diff.credit is evaluated from 50 to 80 points

Amount: minimum 72 + 50 = 122, maximum 120 + 80 = 200

THE LIST OF THEORETICAL QUESTIONS FOR PREPARATION OF STUDENTS FOR THE FINAL CONTROL (DIFF.CREDIT)

1. Biogenic elements: their electronic structure; typical chemical properties of elements and their compounds - acid-base, redox, complexation. The relationship between the location of s-, p-, d-elements in the periodic table and their content in the human body. Macro-, micro- and impurity elements in the human body. Application in medicine. Toxic effect of compounds.
2. Complex compounds: Werner's theory, the nature of the chemical bond, classification, intracomplex compounds. Complex compounds in biological systems. Complexones and their application in medicine.
3. Solutions and their role in life. Methods of expressing the concentration of solutions.
4. Solubility of gases in liquids and its dependence on various factors. Henry Dalton's law. Solubility of gases in the blood.
5. Solubility of solids and liquids, its dependence on various factors. Distribution of substances between two immiscible liquids. Nernst distribution law and its significance in the phenomenon of permeability of biological membranes.
6. Solutions of electrolytes. Ostwald's law of breeding. Properties of strong electrolyte solutions, activity and activity coefficient. Ionic strength of the solution. Water-electrolyte balance is a necessary condition for homeostasis.
7. Dissociation of water. Ionic product of water. Hydrogen pH of solutions of strong and weak electrolytes. pH of biological fluids in normal and pathology.
8. Theories of acids and bases. Types of protolytic reactions. Hydrolysis of salts, degree of hydrolysis, its dependence on concentration and temperature, hydrolysis constant. The role of hydrolysis in biochemical processes.
9. Methods of titrimetric analysis. Acid-base titration method: alkali and acidimetry, their characteristics. Acid-base indicators.
10. Buffer systems, their classification, mechanism of action, basic equation, Henderson-Hasselbach equation.
11. Buffer capacity, its practical definition. Buffer capacity of blood, Buffer systems of the human body, their mechanism of action. Acid-base balance and alkaline blood reserve.
12. Colligative properties of solutions. Decrease in freezing point and increase in boiling point of solutions. Raoul's law. Cryometry and ebuliometry, their application in medical and biological research.
13. Osmosis, semipermeable membranes, osmotic pressure. Vant-Goff's law and its equations for non-electrolytes and electrolytes. Isotonic coefficient. Hypo- hyper- and isotonic solutions. Plasmolysis, hemolysis, turgor.
14. The role of osmosis in biological systems. Osmotic pressure of blood plasma. Haller's equation. Oncotic pressure. Application of osmometry in medical and biological research.
15. The first law of thermodynamics. Internal energy. Enthalpy. Heat of isobaric and isochoric processes.
16. Thermochemistry. Hess's law. Thermochemical transformations. Standard heat of formation and combustion of substances.
17. The second law of thermodynamics. Entropy. Gibbs energy.
18. Macroergic compounds. ATP as a universal source of energy for biochemical reactions. Characteristics of macroergic connections.
19. The rate of chemical reactions. The law of active masses for the rate of chemical reactions. Reaction rate constant.
20. Reactions are simple and complex (sequential, parallel, conjugate, reversible, chain).

Photochemical reactions and their role in life.
21. The reaction procedure. Reactions of zero, 1st and 2nd order. Half-life.
22. Dependence of reaction rate on temperature. Temperature coefficient. Vant-Goff's rule. Features of the temperature coefficient of the reaction rate for biochemical processes.
23. Arrhenius equation. Activation energy. The concept of the theory of active collisions and the theory of transition state.
24. Homogeneous and heterogeneous catalysis. Features of the catalyst. The mechanism of catalysis and its role in metabolic processes.
25. Enzymes as catalysts for biochemical reactions. Dependence of enzymatic action on the concentration of enzyme and substrate, temperature and reaction of the medium.
26. Chemical equilibrium. Thermodynamic equilibrium conditions. Forecasting the direction of spontaneous processes. Exergonic and endergonic processes that occur in the body. Heterogeneous balances in the oral cavity.
27. Chemical equilibrium constant. Ways of its expression. The principle of Le Chatelier. Predicting the shift of chemical equilibrium.
28. Reaction and dissolution reactions. The product of solubility. Conditions for precipitation and dissolution of sediments. The role of heterogeneous equilibrium with the participation of salts in the general homeostasis of the organism
29. Electrode potentials and the mechanism of their occurrence. Nernst's equation. Normal (standard) electrode potential. Determination electrodes.
30. Redox electrode potentials (redox potentials). The mechanism of their occurrence, biological significance. Peters equation.
31. Redox reactions in the body. Predicting their direction by standard Gibbs energy values and by values of redox potentials.
32. Potentiometric titration, its use in medical and biological research.
33. Diffusion and membrane potentials, their role in the genesis of biological potentials.
34. Surface activity. Duclos-Traube rule. Gibbs equation. Orientation of molecules in the surface layer and structure of biological membranes.
35. Adsorption from solutions on the surface of a solid. Equations of Langmuir, Freundlich. Physico-chemical bases of adsorption therapy.
36. Adsorption of electrolytes (selective and ion exchange). Panetta-Faience rule. Ion exchange resins and their use in medicine.
37. Classification of chromatographic methods of research 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.
38. Disperse systems and their classification. Methods of obtaining and purifying colloidal solutions. Dialysis, electrodialysis, ultrafiltration. "Artificial kidney".
39. Molecular kinetic properties of colloidal systems (Brownian motion, diffusion, osmotic pressure). Optical properties of colloidal systems. Ultramicroscopy.
40. The structure of colloidal particles (micelles). Electrokinetic potential. Electrophoresis, its use in medicine and biomedical research.
41. Kinetic and aggregative stability of lyozoles. Stability factors. The mechanism of coagulating action of electrolytes. Coagulation threshold, its definition. Schultze-Hardy rule. Coagulation processes during drinking water and wastewater treatment. Colloidal protection, its biological role
42. Coarse systems (aerosols, suspensions, emulsions) - production, properties, medical application. Semi-colloids.
43. 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.
44. Isoelectric point of protein and methods of its determination.
45. Jeweling solutions of the Navy. Properties of gems. Gems in the human body.

Types of tasks

1. Calculation of Gibbs energy. 2. Thermochemical calculations. 3. Calculation of the rate of a chemical reaction. 4. Calculation of the equilibrium constant and determining the direction of equilibrium shift. 5. Calculations for the product of solubility. 6. Calculation of electrode and redox potentials. 7. Calculations for the value of Rf. 8. The structure of the micelle. Coagulation threshold. 9. Calculation of pH of electrolyte solutions. 10. Calculation of pH of buffer systems.	
Circumstance of admission to the final control	1. Semester control at the end of the 1st semester is provided in the form of a differential credit. (Table 2) Provides a final score on a 120-point scale as the sum of scores for the current control of knowledge (oral examination, written survey, tests, abstracts), the results of 2 content modules. 2. Students are allowed to take the differentiated credit, exam only if there is no debt for the implementation of the curriculum.

7. Course policy

The organization of the educational process is carried out with the use of the European Credit Transfer System (ECTS) to assess student performance. The points gained in the current survey, independent work and points of the final control are credited. This must take into account the student's presence in class and his activity during practical work. Inadmissible: absences and late classes; use of a mobile phone, tablet or other mobile devices during the lesson (except for the cases provided by the curriculum and methodical recommendations of the teacher); copying and plagiarism; untimely performance of the task, the presence of unsatisfactory grades for 50% or more of the submitted theoretical and practical material.

8. RECOMMENDED LITERATURE

1.Basic:	**Additional:**
1. Catch Up Chemistry: For the Life and Medical Sciences. Mitch Fry; 2005 by Scion Publishing. 2. Clinical Chemistry: Concepts and Applications. Shauna C. Anderson, Susan Cockayne; 2002 by McGraw-Hill Medical. 3. Principles of Thermodynamics. Myron Kaufman; 2002 by CRC. 4. Physical Chemistry of Surfaces, 6thEdition, 1997 by Wiley-Interscience. 5. Principles of Colloid and Surface Chemistry. Paul C. Hiemenz, Raj Rajagopalan; 1997 by CRC.	1. Kalibabchuk V.A., Halinska V.I., Hryshchenko V.I., Hozhdzynskyi S.M., Ovsiannikova T.A., Samarskyi V.A. Medical Chemistry. - K. : Medicine. - 2010.

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