Ministry of Health of Ukraine Poltava State Medical University

Department of Chemistry and Pharmacy

«AGREED»
Guarantor of educational-professional program «Dentistry»
_____ Olga SHESHUKOVA
«28» серпня 2024

«APPROVED»
Chairman of the Academic Council of Medicine No. 1
_____ Mykola Ryabushko
Minutes from 28.08 2024 № 1

SYLLABUS

MEDICAL CHEMISTRY

Normative discipline

level of higher education	*the second (master's) level of higher education*
branch of knowledge	*22 «Health care»*
specialty	*221 «Dentistry»*
educational qualification	*Master of Dentistry*
professional qualification	*dentist*
educational and professional program	*221 «Dentistry»*
form of education	*daily*
course and semester of study of thediscipline	*1 course, I semester*

«APPROVED»
at a meeting of the department ofchemistry and pharmacy
Head of the Department
_____ Sergey KOVALYOV
Minutes № 1 of August 26 2024

Poltava 2024

DATA ON TEACHERS TEACHING THE COURSE

Surname, name, patronymic of the teacher (teachers), scientific degree, academic title	Ivashchenko Olena Dmytrivna, Candidate of Chemical Sciences, Associate Professor; Kopantseva Larysa Mykolayivna, senior teacher Stryzhak Diana Oleksandrivna, teacher
Teacher's profile (s)	https://med-chemistry.pdmu.edu.ua/
Contact phone	0993004111
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Page of the department on the PSMU website	https://med-chemistry.pdmu.edu.ua/

MAIN CHARACTERISTICS OF THE COURSE

The scope of the discipline

Number of credits / hours – 3/90, of which: lectures (hours) – 12; practical classes (hours) – 36; independent work (hours) – 42.

Type of control – PMK.

Course policy

The policy of the academic discipline is determined by the system of requirements set out in the regulations of the Department of Chemistry and Pharmacy.

1. At practical classes and lectures, students must wear gowns and caps. Robes must be clean and ironed. It is strictly forbidden to enter the department in outerwear.

2. The head of the group or a responsible person appointed by him (on duty) must accept before the beginning of the practical class, and after its completion, hand over the property of the study room in proper condition to the senior laboratory technician of the department, or the appointed last auxiliary worker.

3. Students are not allowed to enter the classroom after the bell until the break. It is not allowed to enter and leave the classroom during the educational process.

4. To work in a practical session, students must have a textbook, a summary of lectures, as well as mandatory educational and methodological aids, which are made in the form of workbooks.

5. Under the conditions of proper maintenance of the workbook of the academic discipline, they can be used during the exam.

When organizing the educational process in PSMU students, teachers and administration act in accordance with: educational and professional program «Dentistry», regulations on the organization of the educational process at Poltava State MedicalUniversity, regulations on academic integrity of higher education and staff of Poltava State Medical University, regulations on organization and methods of assessment of educational activities of higher education students in PSMU, regulations on the organization of independent work of students in PSMU, regulations on the completion of missed classes and unsatisfactory assessments of higher education students of PSMU. To get acquainted with the above Regulations, you can follow the link: https://www.pdmu.edu.ua/n-process/department-npr/normativni-dokumenti

Description of the discipline (abstract)

The discipline «Medical Chemistry» is a classical model of a chemical course adapted to the needs of medicine, namely, it contains separate sections of general, inorganic, analytical, physical and colloid chemistry.

Prerequisites and postrequisites of the discipline

Prerequisites knowledge, skills and abilities of the subjects of Chemistry and Biology, which are taught in general educational institutions, which are necessary for mastering this discipline.

Postrequisites disciplines that require knowledge, skills and abilities acquired after the study of this discipline: biological and bioorganic chemistry.

The purpose and objectives of the discipline:

1.1. The purpose of teaching the discipline «Medical Chemistry» is to form students' knowledge of the basic types of chemical equilibrium, the formation of a holistic physico-chemical approach to the study of life processes, as well as to apply chemical methods of quantitative and qualitative analysis, to classify chemical properties and transformation of bioinorganic substances in the process of vital activity of the organism.

1.2. The main tasks of studying the discipline «Medical Chemistry» are: the creation of a fundamental scientific base of future doctors in their understanding of the general physico-chemical laws that underlie the processes of human life.

Competences and learning outcomes, the formation of which is facilitated by the discipline (integral, general, special):

– integral competencies according to the educational and professional program, the formation of which is facilitated by the discipline:

Ability to solve complex problems and problems in the field of health care in the specialty «Dentistry» in a professional activity or in the learning process, which involves research and / or innovation and is characterized by uncertainty of conditions and requirements.

– general competencies according to the educational and professional program, the formation of which is facilitated by the discipline:

1. Ability to abstract thinking, analysis and synthesis.
2. Knowledge and understanding of the subject area and understanding ofprofessional activity.
3. Ability to apply knowledge in practice.
4. Ability to search, process and analyze information from various sources.
5. Ability to identify, pose and solve problems.

– special (professional, subject) competences according to the educational and professional program, the formation of which is facilitated by the discipline:

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

Program learning outcomes according to the educational and professional program, the formation of which is facilitated by the discipline:

1. Collect information about the general condition of the patient, assess thepsychomotor and physical development of the patient, the condition of the maxillofacial organs, based on the results of laboratory and instrumental studies to assess information about the diagnosis.
2. Prescribe and analyze additional (mandatory and optional) methods of examination (laboratory, radiological, functional and / or instrumental), patients with diseases of the organs and tissues of the oral cavity and maxillofacial region for differential diagnosis of diseases.
3. Assess the impact of the environment on the health of the population in a medical institution according to standard methods.
4. To organize the necessary level of individual safety (own and persons cared for) in case of typical dangerous situations in the individual field of activity.

Learning outcomes for the discipline*:*

Upon completion of the discipline, students must

know:

– The relationship between the biological role of biogenic s-, p-, d-elements and the form of their presence in the body.

– Principles of structure of complex compounds.

– Features of the structure of complex compounds as a basis for their use in chelation therapy.

– Characteristics of the quantitative composition of solutions.

– Quantitative content in the solution of acids and bases using acid-base titrationmethods.

– The mechanism of action of buffer systems and their role in maintaining acid-base balance in biosystems.

– Relationship between colligative properties and solution concentration.

– Thermal effects of chemical and biochemical processes.

– Thermodynamic functions to assess the direction of processes, to explain the energy conjugation in living systems.

– Dependence of reaction rate on concentration and temperature.

– 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.

– The mechanism of formation of electrode potentials.

– Features of the structure of the surface layer of adsorbed molecules of surfactants, principles of structure of biological membranes.

– Adsorption equations and limits of their use.

– Regularities of adsorption of substances from solutions on a solid surface.

– Physico-chemical bases of methods of adsorption therapy.

– Principles of methods for obtaining and purifying colloidal dispersed solutions.

– Physico-chemical 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.

– Analyze the quantitative content in the solution of acids and bases using acid-base titration methods.

– To 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.

– 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 explainthe 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 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 equilibrium and explain its condition from the standpoint of thermodynamics and kinetics.

– Explain the influence of external factors on chemical equilibrium.

– Analyze the conditions of precipitation and dissolution of sediments, 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.

– To draw conclusions about the surface activity of substances on the basis of their structure.

– To analyze the peculiarities of the structure of the surface layer of adsorbed moleculesof surfactants, to explain the principles of the structure of biological membranes.

– Analyze the adsorption equations and the limits of their use, 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 selective and ion exchange adsorption of electrolytes.

– Interpret 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 ofall body tissues.

– Draw conclusions about the charge of dissolved biopolymers based on their isoelectric point.

Thematic plan of lectures (by modules) with the indication of the basicquestions considered at lectures

№ s/n	**Name topics**	**Number of hours**
	MODULE 1. FUNDAMENTALS OF MEDICAL CHEMISTRY	
1	TOPIC: **Chemistry and dentistry. Complexation and precipitation processes inbiological fluids.** 1. Basic concepts and terminology. 2. The nature of the chemical bond. 3. Isomerism, classification, nomenclature of the COP. 4. Chemical properties of COP. 5. Biologically active complexes. Chelation therapy.	2
2	TOPIC: **Protolytic equilibria in chemical and biological systems.** 1. Solutions of electrolytes. Electrolytes in the human body. 2. Electrolytic dissociation The degree of dissociation and the dissociation constant of weak electrolytes. 3. Properties of solutions of strong electrolytes. Water-electrolyte balance inthe human body. 4. Dissociation of water. Ionic product of water. Hydrogen pH. 5. Hydrolysis of salts. Degree of hydrolysis.	2
3	TOPIC: **Fundamentals of bioenergy.** 1. The subject of chemical thermodynamics. Basic concepts of chemical thermodynamics. 2. The first law of thermodynamics. Enthalpy. 3. Spontaneous and non-spontaneous processes. The second law of thermodynamics. Entropy. 4. Application of the basic provisions of thermodynamics to living organisms.	2
4	TOPIC: **Electrode processes and their biological role in dentistry.** 1. Electrode potentials. Classification of electrodes. 2. Galvanic element. Redox systems. 3. Potentiometry.	2

5	TOPIC: **Physico-chemistry of surface phenomena.** 1. Characteristics of surface phenomena and their significance. 2. Sorption. Adsorption. Biological significance. 3. Chromatography. 4. The role of adsorption in biology and medicine.	2
6	TOPIC: **Colloidal solutions. Coarsely dispersed systems.** 1. The concept of dispersed systems. 2. Conditions and methods of obtaining colloidal solutions. 3. Methods of cleaning colloidal solutions. 4. Properties of colloidal solutions. 5. Structure of colloidal particles. 6. Stability and coagulation of dispersed systems.	2
	Total:	**12**

Thematic plan of seminars by modules and content modules indicating the main issues addressed in the seminar – *not provided by the working curriculum.*

Thematic plan of practical classes by modules and content modules with indication of the main issues considered in the practical lesson

№ s/n	**Name topics**	**Number of hours**
	MODULE 1. FUNDAMENTALS OF MEDICAL CHEMISTRY	
	CONTENT MODULE 1. *HOMOGENEOUS EQUILIBRIA IN BIOLOGICAL FLUIDS*	
1	TOPIC: **Safety in the laboratory. Biogenic s-, p-, d-elements and their role in medicine and dentistry.** 1. Biogenic elements: organogens; macronutrients; trace elements 2. Electronic structure of biogenic s-, p-, d-elements. Application in medicine. 3. Typical chemical properties of s-elements and their compounds (reactions without changing the degree of oxidation). 4. Typical chemical properties of d-elements and their compounds: reactions with a change in the degree of oxidation; complex formation. 5. Metals of life. 6. Biological role of biogenic s-, p-, d-elements. 7. The relationship between the content of biogenic p-elements in the human body and their content in the environment. 8. Endemic diseases, their connection with the features of biogeochemical provinces (areas with a natural deficiency or excess of certain chemical elements in the lithosphere). 9. Problems of pollution and cleaning of the biosphere from toxic chemical compounds of man-made origin. 10. The relationship between the location of s-elements in the periodic table and their content in the body. 11. Toxic effect of d-elements and their compounds. Application in dentistry.	2
2	TOPIC: **Ways to express the quantitative composition.** 1. The composition of solutions. 2. Classification of solutions. 3. Values that characterize the quantitative composition of solutions: – mass, volume and molar fractions; – molar concentration; – molar concentration of the equivalent (deci-, santi-, milli- and micromoles); – molar concentration; – title.	2

3	TOPIC: **Preparation of solutions with a given quantitative composition.** 1. Solutions in life. 2. Enthalpy and entropy dissolution factors and their connection with the dissolution mechanism. 3. Solubility of gases in liquids and its dependence on various factors. Laws of Henry and Dalton. 4. The effect of electrolytes on the solubility of gases (Sechenov's law). Solubility of gases in the blood. Bends. 5. Solubility of liquids and solids. Distribution of substances between two immiscible liquids. Nernst distribution law, its significance in the phenomenon of permeability of biological membranes. 6. Preparation of solutions of a given composition.	2
4	TOPIC: **Acid-base balance and pH of biological fluids.** 1. Electrolytes in the human body. Degree and constant of dissociation of weak electrolytes. Properties of solutions of strong electrolytes. 2. Types of protolytic reactions. Neutralization, hydrolysis and ionization reactions. 3. Hydrolysis of salts. 4. The degree of hydrolysis, its dependence on concentration and temperature. 5. The hydrolysis constant. 6. Water-electrolyte balance - a necessary condition for homeostasis. 7. Dissociation of water. Ionic product of water. 8. Hydrogen pH. 8. pH values for various fluids of the human body in normal and in pathology.	2
5	TOPIC: **Titrimetric analysis. Acid-base titration method.** 1. Basics of titrimetric analysis. 2. Classification of titration methods. 3. Application of the method in medical practice. 4. Method of acid-base titration. 5. Acid-base indicators.	2
6	TOPIC: **Properties of buffer solutions. The role of buffer solutions in biosystems.** 1. Classification of buffer solutions. 2. Mechanisms of action of buffer systems. 3. pH of buffer solutions (Henderson-Hasselbach equation). 4. Buffer blood systems: – bicarbonate (hydrogen carbonate) buffer; – phosphate buffer; – protein buffer systems. 5. The concept of acid-base status (KOS) of blood. 6. Buffer capacity and the factors on which it depends.	2
7	TOPIC: **Colligative properties of solutions.** 1. Colligative properties of dilute solutions of non-electrolytes: – the relative decrease in saturated vapor pressure of the solvent over thesolution. Raoul's law; – increasing the boiling point and lowering the freezing point of the solution,compared with the solvent. – the use of osmetry and cryometry in medical-biological and laboratory-diagnostic studies. – osmosis; osmotic pressure. Vant-Goff's law. Hemolysis and plasmolysis.	2

	2. Colligative properties of dilute electrolyte solutions: – Isotonic coefficient. – hypo-, hyper- and isotonic solutions in medical practice. – The role of osmosis in biological systems. 3. Properties of semipermeable membranes. 4. Oncotic blood plasma pressure.	
	***CONTENT MODULE 2** HETEROGENEOUS EQUILIBRIA IN BIOLOGICAL FLUIDS*	
8	TOPIC: **Thermodynamic regularities of biochemical processes.** 1. Basic concepts of chemical thermodynamics: system, system parameters, system state functions, processes, heat, work, internal energy,enthalpy. 2. The first law of thermodynamics, its biological significance. 3. Thermochemistry. Thermal effect of a chemical reaction. Hess's law and its consequences. 4. The second law of thermodynamics, its biological significance. 5. Entropy, factors influencing its value. The role of the entropy factor for the characterization of the system and processes. 6. Gibbs energy, its significance for thermodynamic calculations. Influence of entropy and enthalpy factors on the possibility of spontaneous process. 7. Features of energy metabolism in living organisms as open systems. Macroergic compounds. 8. Energy conjugations in living systems: exergonic and endergonic processes in the body.	2
9	TOPIC: **Kinetic regularities of biochemical processes.** 1. Basic concepts of chemical kinetics: real and average rate of chemical reaction, simple and complex reactions; homogeneous and heterogeneous reactions; molecularity and order of reaction. 2. Kinetics of complex reactions: parallel, sequential, conjugate, reversible, chain. The concept of antioxidants. Free radical reactions in aliving organism. 3. Dependence of the reaction rate on: a) the nature of the reactants; b) the concentration of reagents (the law of active masses; the physical content of the reaction rate constant); c) temperature (the essence of the theory of active collisions, the role of activation energy, the Arrhenius equation, the Vant-Goff rule). The concept of the theory of transition state (activated complex). 4. Chemical kinetics as a basis for studying the rates and mechanisms of biochemical processes. Features of kinetics of biochemical processes. 5. Catalysis and catalysts. Types of catalysts. The mechanism of action of the catalyst. 6. Homogeneous, heterogeneous and microheterogeneous catalysis. Acid- base catalysis. Autocatalysis. Promoters and catalytic poisons. 7. Enzymes as biological catalysts. Representation of the kinetics of enzymatic reactions. Features of enzyme action: selectivity, efficiency, dependence of enzymatic action on temperature and reaction of environment. Dependence of the rate of enzymatic processes on the concentration of enzyme and substrate.	2
10	TOPIC: **Complexation in heterogeneous systems.** 1. Complexation reactions. A. Werner's coordination theory and modern ideas about the structure of complex compounds. 2. Classification of complex compounds by the charge of the internal sphereand by the nature of ligands. Dentancy. 3. Intracomplex compounds (chelates). 4. Iron-, Cobalt-, Copper- and zinc-containing biocomplex compounds. The concept of metal-ligand homeostasis. Violation of homeostasis. 5. Complexones and their use in medicine as antidotes for heavy metal poisoning (chelation therapy) and as antioxidants in the storage of drugs.	2

11	TOPIC: **Precipitation and dissolution reactions.** 1. Chemical equilibrium. Chemical equilibrium constant and methods of its expression. 2. Displacement of chemical equilibrium with changes in temperature, pressure, concentration of substances. The principle of Le Chatelier. 3. Precipitation and dissolution reactions. The product of solubility. Conditions for precipitation and dissolution of sediments. 4. The role of heterogeneous equilibrium with the participation of salts in the general homeostasis of the organism. Chemical basis of mineralization of boneand dental tissues.	2
12	TOPIC: **Determination of electrode potentials.** 1. Electrode potentials and the mechanism of their occurrence. 2. Nernst's equation. Normal (standard) electrode potential. 3. Normal hydrogen electrode. 4. Measurement of electrode potentials. Determination electrodes and comparison electrodes. Silver chloride electrode. Ion-selective electrodes. Glass electrode. 5. Galvanic cells. 6. Diffusion potential. Membrane potential. The potential for peace. Action potential. 7. Redox potential as a measure of oxidative and reducing capacity of systems. Peters equation. Normal redox potential. 8. Prediction of the direction of redox reactions by the values of redox potentials. The value of redox potentials in the mechanism of biological oxidation processes. 9. Potentiometry. Potentiometric titration.	2
13	TOPIC: **Adsorption processes and ion exchange in biosystems. Chromatography.** 1. Surface phenomena and surface tension. Significance in biology andmedicine. 2. Classification of substances in relation to changes in surface tension of water, their characteristics. Surface tension isotherm. Duclos-Traube rule. 3. Orientation of surfactant molecules in the surface layer. Representation ofthe structure of biological membranes. 4. Gibbs, Langmuir and Freundlich adsorption equations, adsorption isotherms. Their analysis. 5. Adsorption of electrolytes: selective (selective) and ion exchange. Panetta-Faience rule. Ionites. 6. Physico-chemical bases of adsorption therapy (hemosorption, plasmasorption, lymphosorption, enterosorption, application therapy). 7. What is chromatography? Application of chromatography in biology and medicine. 8. Classification of chromatographic methods of analysis by the physical stateof the phases. 9. Classification of chromatographic methods of analysis by technique. 10. Classification of chromatographic methods of analysis by distribution mechanism.	2
14	*TOPIC: Preparation, purification and properties of colloidal solutions.* 1. Classification of dispersed systems by degree of dispersion. 2. Colloidal state. Lyophilic and lyophobic colloidal systems. 3. The structure of colloidal particles. 4. Double electric layer. Electrokinetic potential of a colloidal particle. 5. Methods of obtaining colloidal solutions. 6. Methods of purification of colloidal solutions: – dialysis; – electrodialysis;	2

	– compensatory dialysis; – vividialism; – ultrafiltration; – hemodialysis and the device «artificial kidney». 7. Molecular kinetic properties of colloidal systems (Brownian motion,diffusion, osmotic pressure). 8. Optical properties of colloidal systems. 9. Electrophoresis, its application in research and clinical and laboratory practice. Helmholtz-Smolukhovsky equation.	
15	TOPIC: **Coagulation of colloidal solutions.** 1. Stability of dispersed systems. Stability factors. 2. Coagulation of hydrophobic colloids. The mechanism of coagulating action of electrolytes. 3. Coagulation threshold, its definition. Schulze-Hardy rule. 4. Colloidal protection. 5. Aerosols: classification, production methods and properties. Application in clinical and sanitary practice. 6. Toxic effects of some aerosols. Powders. 7. Suspensions, production methods and properties. Pastes, their medical use. 8. Emulsions: types, production methods and properties. Application in clinical practice. 9. Emulsifiers. Biological role of emulsification. 10. Semi-colloidal soaps, detergents. Micelle formation in solutions of semi-olloids.	2
16	TOPIC: **Physico-chemistry of biopolymer solutions.** 1. Macromolecular compounds (IUD) – the basis of living organisms. 2. Comparative characteristics of Navy solutions, true and colloidal solutions. 3. The mechanism of swelling of polymers, and dependence on various factors. The role of swelling in the physiology of organisms. 4. Ionic state of biopolymers in aqueous solutions. Isoelectric state of protein. 5. Isoelectric point of protein, methods of its determination. 6. Jeweling of solutions of the Navy, properties of jewels. 7. Abnormal viscosity of IUD solutions. Blood viscosity. 8. Donnan's membrane equilibrium.	2
17	Calculation and situational problems. Control of practical skills from module 1 «Fundamentals of medical chemistry».	2
18	*Final control of mastering the module «Fundamentals of Medical Chemistry».*	2
	Total:	**36**

Individual work

№ s/n	**Topic**	**Quantity hours**
1	Preparation for practical classes theoretical training and development of practical skills.	17
2	Preparation for laboratory work.	16
3	Writing an educational medical history.	–
4	Preparation of test work, essay, preparation for current control activities.	–
5	Preparation for the final modular control.	5
6	Preparation for the exam.	–
7	Elaboration of topics that are not included in the classroom lesson plan (list).	–

MODULE 1. *FUNDAMENTALS OF MEDICAL CHEMISTRY*		
Content module 1*. Homogeneous equilibria in biological fluids*		
1	TOPIC: **Composition and properties of solutions.** 1. Methods of expressing the content of substances in solution. 2. Concepts saturated, unsaturated, supersaturated solutions. 3. Methods of quantitative analysis of the composition of solutions.	1
2	TOPIC: **The value of buffer solutions in biosystems.** 1. Buffer systems – conjugate acid-base pairs. Classification of buffer solutions. 2. Buffer systems of living organisms: functions, mechanism of action and significance. 3. Buffer capacity as a quantitative characteristic of the effectiveness of thebuffer action.	1
Content module 2. *Heterogeneous equilibria in biological fluids*		
3	TOPIC: **Preparation, purification and properties of colloidal solutions.** 1. The organism as a complex set of dispersed systems. 2. Ion exchangers and their applications. 3. Application of electrophoresis in research and clinical and laboratory practice. Electrophoregrams.	1
4	TOPIC: **Properties of biopolymer solutions.** 1. Globular and fibrillar structure of proteins. 2. The role of swelling in the physiology of the organism. 3. The effect of pH, temperature and electrolytes on the rate of dredging. Thixotropy. Syneresis.	1
	Total:	**42**

Individual tasks *are not provided by the working curriculum.*

The list of theoretical questions for preparation of students for the final modularcontrol

CONTENT MODULE 1.

HOMOGENEOUS EQUILIBRIA IN BIOLOGICAL FLUIDS:

1. Electronic structure of nutrients. Typical chemical properties of elements and their compounds (reactions without changing the degree of oxidation, with changing the degree of oxidation, complexation). The relationship between the location of s-, p-, d- elements in the periodic table and their content in the body.

2. Solutions of complex compounds. Modern ideas about the structure of complex compounds. Classification of complex compounds (by the nature of ligands and the charge of the internal sphere).

3. Intracomplex compounds. Polynuclear complexes. Complex compounds in biological systems.

4. Solutions in life. Enthalpy and entropy dissolution factors and their connection with the dissolution mechanism.

5. Solubility of gases in liquids and its dependence on various factors. Henry Dalton's law. Influence of electrolytes on gas solubility(Sechenov's law). Solubility of gases in the blood.

6. Solubility of solids and liquids. Distribution of substances between two immiscible liquids. Nernst distribution law, its significance in the phenomenon of permeability of biological membranes.

7. Equilibrium in electrolyte solutions.

8. Dissociation of water. Ionic product of water. pH of biological fluids.

9. Types of protolytic reactions. Neutralization, hydrolysis and ionizationreactions.

10. Hydrolysis of salts. Degree of hydrolysis, its dependence on concentration and temperature. Hydrolysis constant.

11. Basics of titrimetric analysis. Acid-base titration method. Acid-baseindicators.

12. Buffer systems and their classification, pH of buffer solutions.

13. The mechanism of action of buffer systems.

14. Buffer capacity and factors on which it depends. Blood buffer systems.

15. Colligative properties of dilute solutions: relative decrease in the pressure of saturated solvent vapor over the solution; LawRaoul; lowering the freezing temperature; increase in boiling point. Cryometry and ebuliometry.

16. Colligative property of dilute solutions - osmosis. Osmotic pressure. Vant-Goff's law. Plasmolysis and hemolysis.

17. Colligative properties of dilute electrolyte solutions. Isotonic coefficient. Hypo-, hyper- and isotonic solutions in medical practice. The role of osmosis in biological systems.

CONTENT MODULE 2.

HETEROGENEOUS EQUILIBRIA IN BIOLOGICAL FLUIDS

18. ATP as an energy source for biochemical reactions. Macroergic compounds.

19. The first law of thermodynamics. Enthalpy. Standard heat of formation and combustion of substances.

20. Hess's law.

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

22. The reaction rate. Dependence of reaction rate on concentration. The law of active masses for the reaction rate. Speed constant.

23. The idea of the kinetics of complex reactions: parallel, sequential, conjugate, reversible, competing, chain.

24. The order of the reaction. Kinetic equations of first, second and zero orderreactions. Half-life.

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

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

27. Features of catalysts. Homogeneous, heterogeneous and micro-heterogeneous catalysis. Acid-base catalysis. Autocatalysis.

28. Enzymes as biological catalysts. Features of enzyme action: selectivity, efficiency, dependence of enzymatic action on temperature, reaction of environment, concentration of enzyme and substrate. The mechanism of action of enzymes.

29. 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.

30. Deposition and dissolution reactions. The product of solubility.

31. Electrode potentials and the mechanism of their occurrence. Nernst's equation. Normal (standard) electrode potential.

32. Normal hydrogen electrode.

33. Measurement of electrode potentials. Determination electrodes and comparison electrodes. Silver chloride electrode. Ion-selective electrodes. Glass electrode.

34. Redox potential as a measure of oxidative and reducing capacity of systems. Peters equation. Normal redox potential.

35. Forecasting the direction of redox reactions by the values of redox potentials.

36. Potentiometric determination of ion activity. Potentiometric titration.

37. Diffusion potential. Membrane potential. Biological role of diffusion and membrane potentials. Damage potential. The potential for peace. Action potential.

38. Surface phenomena and their significance in biology and medicine. Surfactants and surfactants. Surface activity. Duclos' rule - Traube.

39. Adsorption at the interface between liquid - gas and liquid - liquid. Gibbs equation. Orientation of surfactant molecules in the surface layer. Representation of the structure of biological membranes.

40. Adsorption at the interface of solid - gas. Langmuir's equation.

41. Adsorption from solution on the surface of a solid. Freundlich equation.

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

43. Adsorption of electrolytes: specific (optional) and ion exchange. Panetta - Faience rule.

44. Natural and synthetic ion exchangers.

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

46. Classification of dispersed systems by degree of dispersion. Methods of obtaining and purifying colloidal solutions. Dialysis, electrodialysis, ultrafiltration, compensatory dialysis, vividialysis. Hemodialysis and the device «artificial kidney».

47. The structure of colloidal particles.

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

49. Electrokinetic potential of a colloidal particle. Helmholtz equation – Smolukhovsky. Electrophoresis, its application in research and dental practice.

50. Kinetic (sedimentation) and aggregative stability of dispersed systems. Stability factors. Coagulation. The mechanism of coagulating action of electrolytes.

51. Coagulation threshold. Ruler Schultze - Hardy. Coagulation processes in thetreatment of drinking water and wastewater. Colloidal protection.

52. Aerosols, suspensions, emulsions. Methods of production, properties, application. Toxic effects of some aerosols. Types of emulsions. Emulsifiers. Biologicalrole of emulsification.

53. 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.

54. 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 organism.

55. Jeweling solutions of the Navy. Thixotropy. Syneresis. Salting of biopolymers from solutions.

56. Abnormal viscosity of IUD solutions. Blood viscosity.

57. Membrane equilibrium of Donnan.

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

List of practical skills for the final modular control

1. Follow safety rules and provide first aid in case of accidents in a chemicallaboratory.
2. Use chemical utensils and know its purpose.
3. Working with dimensional chemical utensils.
4. Compose electronic formulas of atoms and ions in the ground and excited states.
5. Draw up molecular and structural formulas of substances.
6. Determine the degree of oxidation of the atom of the element.
7. Carry out chemical reactions of qualitative determination of macro- and microelements in solutions.

8. Calculate the amount of solvent and solute to prepare a solution with a given concentration.

9. Be able to move from one way of expressing the content of a substance in solution to another.

10. Prepare solutions of a certain concentration.
11. Determine the hydrogen index of the environment with indicators and a pHmeter.
12. Prepare buffer solutions with a given pH value.
13. Calculate the pH of the buffer system.
14. Determine the buffer capacity of buffer solutions by acid and alkali.
15. Prepare isotonic solutions.
16. Calculate the rate of a chemical reaction.
17. Determine the conditions of formation and dissolution of sediments.
18. Measure the electrochemical characteristics of solutions.
19. Calculate and evaluate the quantitative characteristics of sorbents.
20. Separate the mixture.
21. Prepare colloidal solutions.
22. Determine the sign of the charge of the particles of the dispersed phase.
23. Determine the isoelectric point of Navy solutions.
24. Reproduce the methods of the experiment and explain the results.
25. Make out the results of laboratory work in the form of a protocol.

Teaching methods: verbal (lecture, explanation, story, conversation, instruction); visual (observation, illustration, demonstration); practical (various types of exercises, practice); brainstorming; analysis of specific situations (case method); problematic presentation; partial search, research, heuristic methods.

Assessment forms and methods

Control methods: oral control; written control; test control; programmable control; practical examination; self-control; self-esteem

Types of control: preliminary (outgoing); current; final modular control.

The form of final control of study success: final modular control (PMK).

System of current and final control

When evaluating the mastery of each topic of the module, the applicant is given a grade on a 4-point (traditional) scale using the following evaluation criteria for the discipline. At the same time, all types of works provided for by methodical instructions for studying topics are taken into account.

Standardized generalized criteria for assessing the knowledge of students of higher education at PDMU can be found at the following link: https://www.pdmu.edu.ua/storage/department-npr/docs_links/0nrGNrEzksWWytpXV8j05INcg9wbyVjkYx9FrbEY.pdf

Evaluation of current learning activities: the teacher must evaluate the performance of each student in each class on a four-point (traditional) scale. The assessment of academic performance is integrated (all types of work of the applicant are evaluated both during preparation for the class and during the class) according to the criteria that are communicated to the applicants at the beginning of the study of the relevant discipline.

Conversion of a grade on a traditional 4-point scale into a multi-point scale (maximum 120 points) – conversion of the total grade of current performance for the module - is carried out only after the current lesson preceding the final module control.

A unified table of correspondence between points for current performance, points for the PMC, exam, and the traditional 4-point grade is available here: https://www.pdmu.edu.ua/storage/department-npr/docs_links/0nrGNrEzksWWytpXV8j05INcg9wbyVjkYx9FrbEY.pdf

Current control is carried out by a scientific and pedagogical (pedagogical) employee systematically, during practical classes provided for by the working curriculum in the disciplines.

The teacher must evaluate the performance of each student at each lesson on a four-point (traditional) scale, taking into account standardized, generalized criteria for assessing the knowledge of higher education students.

Assessment of performance is integrated (all types of work of the higher education applicant are evaluated, both in preparation for the class and during the class) according to the criteria that are communicated to higher education applicants at the beginning of the study of the relevant discipline.

The grade is assigned by the teacher in the "Journal of attendance and progress of the applicant" and synchronously in the "Electronic Journal of PSMU" at the end of the lesson or after checking individual control tasks, but no later than 2 calendar days after the lesson (in accordance with the «Regulations on the electronic journal of progress»).

The presence of a grade of «2» for the current performance does not deprive the applicant of the right to be admitted to the final module control with the permissible minimum number of points for the current performance. The applicant is obliged to retake the grade «2» if the average score of current academic performance per module does not reach the minimum (3.0 points) for admission to the PMC. Applicants who have a grade point average of less than 3.0 have the right to retake the current «2», but no later than the beginning of the new semester.

The final module control is carried out after studying the module program in the discipline and is held at the last lesson of the module.

Higher education applicants who have scored the required minimum number of points during the current control (grade point average of 3.0 and above), have no unexcused absences from lectures, practical classes, have mastered the topics presented for independent work within the module and have fulfilled all the requirements for each discipline provided by the working curriculum for the discipline are allowed to participate in the PMC.

The hours provided for in the work curriculum are used for the PMC.

The result of the PMK is evaluated in points and is not converted to the traditional 4-point grade. The maximum number of points for a PMK is 80 points. The minimum number of points of the PMK, at which the control is considered passed, is 50 points. The maximum number of points per module is 200 points (including up to 120 points for current performance).

Applicants who, while studying in a particular discipline, the form of control of which is the final module control, have an average grade point average of 4.5 to 5.0 are exempt from passing the PMK and automatically receive a final grade accordingly.

In case of violation of the rules of academic integrity by a higher education applicant (clause 2.2.5. of the Internal Regulations), the results of the assessment obtained during the preparation of the PMK are assigned a grade of "unsatisfactory" for the answer.

An applicant who has received a score of less than 122 points based on the results of the PMK is obliged to retake the PMK according to the schedule no more than 2 times.

The academic staff puts the received points for the module in the "Statement of final module control" and the individual curriculum of the applicant.

Information about students who have not been enrolled in the PMC, with an accurate indication of the reason for non-enrollment, is also entered in the «Statement of final module control» and individual curricula of students.

The final control is carried out by means of the PMC, which consists of:

1 question (theoretical question) – from 0 to 31 points;

2 questions (practical skills) – from 0 to 30.5 points;

1 task – 5 points;

2 task – 5 points;

3 tasks – 5 points;

1 test – 0.5 points; 7 tests in total.

The final module control is considered to be credited if the applicant has scored at least 50 points. The maximum amount of points for the final control is 80.

Methodological support:

1. Methodological development of lectures.
2. Methodical instructions for independent work of applicants, according to the topics of the plan of practical classes.
3. Thematic plans of lectures and practical classes.
4. PDF presentations of lectures.
5. List of recommended literature.
6. Materials for control of knowledge, skills and abilities of applicants:
   – tests of different levels of difficulty;
   – situational tasks.
7. Multimedia presentations.
8. E-learning testing.

Recommended Books

Basic (available in the library of PSMU)Basic

1. Ivashchenko O.D., Nikozyat Yu.B., Ishcheykina L.K., Kopantseva L.M. Medicinal chemistry. Module 1. Acid-base balance and complex formation in biological systems for students of higher education of medical faculties of higher education institutions of the Ministry of Health of Ukraine: Study guide. Poltava: PUET, 2021. 107 p.

2. Ivashchenko O.D., Nikozyat Yu.B., Kopantseva L.M. Medicinal chemistry. Module P. Equilibria in biological systems at the boundary of phase separation for applicants of medical faculties of higher education institutions of the Ministry of Health of Ukraine. Study guide. Poltava, PDMU, 2022. 160 p.

3. Medicinal chemistry: a textbook for universities / V.O. Kalibabchuk, I.S. Chekman, V.I. Galinska and others; under the editorship Prof. V.O. Kalibabchuk. K.: VSV «Medicine!, 2013. 336 p.

4. Kharchenko S. V. Medical chemistry. Poltava: Poltava Writer, 2014. 212 p.

5. Medicinal chemistry: Methodological guidelines for students of medical faculties of higher educational institutions of the Ministry of Health of Ukraine / Kharchenko S.V., Ishcheykina L.K., Zuber V.Yu. etc. Poltava, 2017. 200 p.

Auxiliary:

1. Muzichenko V. P. Medical chemistry. Medicine. Kyiv. 2010. 496 p.

2. Poretsky A. V., Bannikova-Bezrodna O.V., Filippova L.V. Medical Chemistry: Textbook. K.: VCB «Medicine», 2012. 384 p.

3.Mironovich L.M. Medical Chemistry: A Textbook. Kyiv: Karavella, 2008. 159 p.

4.Moroz A.S. Medical chemistry: a textbook / D.D. Lucevich, L. P. Yavorska. Vinnytsia: New book, 2006. 776 p.

5.Workbook on the subject «Medical Chemistry» for students of the Faculty ofDentistry / Ivashchenko O.D., Nikozyat Y.B., Kharchenko S.V., Tsuber V.Y., Ishcheikina L.K., Kopantseva L.M. Podpala V.V. Poltava: RVV PUET, 2019.79 p.

Information resources

https://med-chemistry.pdmu.edu.ua/
https://www.pdmu.edu.ua/
(Web page Poltava State Medical University).

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