

SYLLABUS OF THE EDUCATIONAL COMPONENT**MEDICAL CHEMISTRY**

(title of the educational component)

Speciality: 222 «Medicine» Volume: 3 credits ECTS (90 hours)
Educational and professional program: Medicine Training sessions: lectures, Practical
Component code in the educational program: MC 5 Classes
Higher education level: second (master's degree) Final control: Graded Credit
Form of education: full-time Prerequisites: Fundamentals of inorganic
Year of study: 1 chemistry acquired in secondary education
Semester(s): I (Autumn)
Type of educational component: mandatory
Academic year: 2024-2025

Department/Unit: Department of Medical and Bioorganic Chemistry, 4 Nauky Ave., Building A, 6th Floor

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Page of the educational component in the Distance Learning System of KhNMU (Moodle):
<https://distance.knu.edu.ua/course/view.php?id=520>

DESCRIPTION OF THE EDUCATIONAL COMPONENT

“Medical Chemistry” studies the chemical foundations of vital processes in the living organism, which follow fundamental chemical principles. Medical Chemistry examines the structure and reactivity of the most important biologically active molecules, the theory of chemical bonding in coordination compounds of biometals with bioligands, and the role of biogenic elements in the functioning of the organism. It focuses on chemical equilibrium and a physicochemical approach to studying life processes, particularly the molecular and submolecular mechanisms underlying the causes of various diseases and the specificity of hereditary traits.

PURPOSE OF THE COURSE: the learners' understanding of the functions of individual systems in the human organism, its interaction with the environment, the types of chemical equilibrium, and physicochemical approaches to studying vital processes, as well as their ability to apply various quantitative calculations for the analysis of specific processes; to enable students to use the laws of chemistry for the independent comprehension of the nature of biochemical processes both in the whole organism and in isolated organs and tissues.

LEARNING OUTCOMES:

- Ability to interpret the main types of chemical equilibrium to form a comprehensive physicochemical approach to the study of vital processes in the human body.
- Knowledge of the main types of chemical equilibrium, and the fundamental methods of quantitative and qualitative analysis.
- Ability to apply chemical methods of quantitative and qualitative analysis.
- Ability to classify chemical properties and transformations of bioinorganic substances in the organism and interpret general physicochemical regularities.
- Ability to establish relevant connections to achieve learning objectives.
- Responsibility for the timely acquisition of up-to-date knowledge.

CONTENT OF THE EDUCATIONAL COMPONENT**List of lecture topics (16 hours):**

1. Complex formation in biological systems. Fundamentals of chelatotherapy.
2. Colligative properties of biological liquids.

3. Protolytic equilibria in chemical and biological systems.
4. Fundamentals of titrimetric analysis.
5. Theoretical fundamentals of bioenergetics.
6. Kinetics of biochemical processes.
7. Micro heterogeneous systems. Colloidal solutions. Coarsely dispersed systems.
8. Physical-chemical properties of biopolymers solutions (HMWC).

List of topics of laboratory and practical classes (44 hours):

1. Fundamentals of laboratory technology. Overview of the biogenic elements. Complex formation in biological systems.
2. Values characterizing the quantitative composition of solutions. Preparation of solutions. Colligative properties of solutions.
3. Acid-base equilibrium in the organism. pH of biological liquids. Buffer solutions, classification and properties. Buffer systems of the human body.
4. Fundamentals of titrimetric analysis. Preparation and standardization of NaOH operating solution.
5. Gastric juice acidity determination. Tap water hardness determination
6. Chemical thermodynamics.
7. Kinetics of biochemical reactions and catalysis. Chemical equilibrium.
8. Oxidation-reduction reactions. Electrode potentials and mechanism of their origin. Role of electrochemical phenomena in biological processes. Potentiometry.
9. Preparation and properties of colloidal solutions. Coagulation of colloidal solutions. Colloidal protection.
10. Properties of biopolymer solutions. Isoelectric point of proteins. Summary of students' self-work (biogenic elements).
11. Graded test

List of topics of independent work of the student (30 hours)

1. Macroelements, microelements and impurity elements. Organogens. Application in medicine. Complexones and their use in medicine as antidotes for heavy metal poisoning (chelation therapy) and as antioxidants in the storage of drugs. Drawing up the formula of complex compounds and equations of complex formation reactions for understanding the role of natural complex compounds in the life of organisms. Method of molecular orbitals. Cytochromes (cytochrome P450).
2. The role of solutions in the life activity of the organism. Solubility of gases in liquids. Dependence of gas solubility on pressure (Henry Dalton's law), nature of gas and solvent, temperature. Influence of electrolytes on gas solubility (Sechenov's law). Solubility of gases in the blood. Decompression sickness and mountain disease. One-sided and two-sided diffusion. The role of osmosis in biological systems.
3. Electrolytes and non-electrolytes. Characteristics of electrolytes' properties: electrolyte strength, solubility, concentration of hydrogen and hydroxyl ions. pH values for various biological fluids in norm and pathology. The role of hydrolysis in biochemical processes. Factors influencing the shift of hydrolysis equilibrium.
4. Acid-base theories: 1. Arrhenius theory; Bronsted-Lowry theory; Lewis theory. Preparation of buffer solutions. Buffer solutions of an organism. Buffer capacity, factors that affect it. The concept of acid-base state of the blood.
5. Classification and principles of titrimetric methods of analysis (permanganatometry, iodometry and others). Indicators. Methods of titrimetric determination.
6. Acidity of gastric juice and its types. Features of determination of gastric juice acidity by acid-base titration. Water hardness and its types.

7. Energy characteristic of biochemical processes. Thermochemical calculations to estimate calorificity of food and compile rational and therapeutic diets. Macroergic compounds. Energetical coupling in living systems: exergonic and endergonic processes in the body. ATP – energetical currency of the human body.
8. Main regularities of chemical reactions of different types. The concept of the reaction mechanism. Chain reactions. Photochemical reactions. Activation energy. Theory of active collisions. Arrhenius equation. The concept of the theory of transition state (activated complex).
9. Electrode potentials and the mechanism of their origin. Nernst's equation. Types of electrodes. Indicating electrodes and reference electrodes. The role of redox reactions in life processes. Redox potential as a measure of oxidative and reducing capacity of systems. The essence of the potentiometry.
10. Surface phenomena and their significance in biology and medicine. Surfactants and surfactants. Physico-chemical bases of adsorption therapy (hemisorption, plasma sorption, lymphosorption, enterosorption, application therapy). The role of adsorption and ion exchange in the vital processes of plants and organisms. Adsorbents and their application as medicinal products. Classification of chromatographic methods. Application of chromatography in biology and medicine.
11. Methods of obtaining of lyophobic sols, their structure and properties. The concept of kinetic (sedimentation) and aggregative stability of dispersed systems. Methods of obtaining and purification of colloidal solutions. Dialysis, electro dialysis, ultrafiltration, compensatory dialysis, dialysis - medical aspects. Hemodialysis and "artificial kidney" apparatus. Clearance as an operating characteristic of a hemodialyzer. Physiotherapy as a treatment method. Significance of colloidal protection for medicine.
12. Comparative characteristics of biopolymer solutions, true and colloidal solutions. Neutrality principle. Donnan equilibrium in the human body. The role of swelling in the physiology of the human body. Coacervation and its role in biological systems. Review of scientific literature in "Biogenic role of elements".
13. Work with lecture notes, with the electronic learning management system MOODLE. Preparation for Graded Test.

The IWS is aimed at deepening and consolidating the theoretical knowledge gained during classroom training and contributing to the formation of professional competencies. The results of the IWS are subject to control and are included in the final control of knowledge.

Consultations: *offline/online, according to the schedule of the department or by pre-registration, indicating the method of registration.*

Teaching methods: lecture, performing exercises and practical work, solving situational tasks, testing (oral and written), structured written assignments, structured assessment of practical skills.

EVALUATION

Current Learning Activities (CLA). The assessment of the success of students of education is carried out in accordance with the Instructions for the assessment of the educational activity of students of higher education at KhNMU (https://knmu.edu.ua/doc_block_type/instrukczyi-navchalnogo-proczesu/). The grade for a class or module is from 2 to 5 points. Submission of tasks late for disrespectful reasons entails a decrease in the score according to the percentage of time delay from the time of completion of the task. Tasks are checked within 24 hours. Scores are submitted to the electronic journal. Unsatisfactory grades are worked out in accordance with the Regulation on the procedure for students of KhNMU to study classes (chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://knmu.edu.ua/wp-content/uploads/2021/05/pol_por-vidprac-zaniat.pdf).

At the end of the study of the discipline, the grade for the current learning activity (CLA) is calculated; it is equal to the average score (arithmetic average) for all classes during two semesters. This average score is converted into a multi-point score (from 70 to 120 points).

Individual tasks (IT) are evaluated up to 10 points.

Final control. Graded credit (GC) from 50 to 80 points.

Grade in the discipline (GD). GD=CLA+GC+IT

Appealing the results of the final control is carried out in accordance with the procedure established in KhNMU (https://knmu.edu.ua/wp-content/uploads/2021/05/polog_apel_kontrol.pdf).

POLICIES OF THE EDUCATIONAL COMPONENT

Recommendations for working on the course: Students are encouraged to actively participate in all forms of class activities, dedicate 1–2 hours daily to independent work and preparation for classes, ask questions during sessions, attend consultations, submit assignments on time, and complete all forms of assessment.

Attending classes. Attendance at lectures and practical classes is mandatory. The required attire for in-person sessions is a white medical coat. When visiting clinical base departments, students must wear a surgical suit, cap, medical mask, and changeable footwear. Students arriving more than 5 minutes late may be denied entry to the class. Missed classes must be made up in accordance with the *Regulations on the Procedure for Making Up Classes by Students at KhNMU* (https://knmu.edu.ua/wp-content/uploads/2021/05/pol_por-vidprac-zaniat.pdf).

Academic integrity. KhNMU stands on the positions of zero tolerance to manifestations of academic dishonesty. Any violations of the principles of academic integrity entail responsibility in accordance with the procedure established by KhNMU (https://knmu.edu.ua/wp-content/uploads/2021/05/polog_ad-1.pdf).

Use of electronic gadgets and artificial intelligence tools. Use of electronic devices and AI tools is permitted only with the teacher's approval.

Policy on persons with special educational needs. Students with special educational needs should contact the teacher to develop an individualized educational trajectory.

Teacher Response Time: 24 hours.

Technical requirements for the course:

- access to a computer, laptop, tablet or smartphone
- Corporate Google account with your own photo
- skills in working with Google Workspace (Google Meet, Docs, Sheets, Slides, Forms) and Moodle
- actively engage in all forms of in-class work, dedicate 1-2 hours daily to independent study and preparation for classes, ask questions during lessons, attend consultations, submit assignments on time, and complete all forms of assessment.

Technical support: ASM (ev.shevtsov@knmu.edu.ua), Google (tehotdelknmu@gmail.com), Moodle (al.korol@knmu.edu.ua)

RECOMMENDED SOURCES

1. Medical Chemistry: textbook – V.Y. Tsuber, A.A. Kotvytska, K.V. Tykhonovych. – Medicine, Poltava, 2022. – 392 p.
2. Medical chemistry: textbook / V.O. Kalibabchuk, V.I. Halynska, L.I. Hryshchenko et al.; edited by V.O. Kalibabchuk. – 5th edition, corrected. – Kyiv : AUS Medicine Publishing, 2017. – 224 p.
3. Educational-methodical complex for first-year students' and self-work in Medical Chemistry / compiled by G.O.Syrova, V.M.Petiunina, V.O.Makarov et al. – Kharkiv: KhNMU, 2019. – 162 p.

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