

EUROPEAN MEDICAL UNIVERSITY

“APPROVED”

Vice-rector of EMU,
MD, PhD, DrMedSc, Professor

_____Herman TITOV

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SYLLABUS OF THE EDUCATIONAL DISCIPLINE " MEDICAL CHEMISTRY

Cycle of Higher Education:	second cycle of higher education (Master's degree)
Field of Study:	22 «Healthcare»
Specialty	221 Dentistry
Educational qualification	Master of Dentistry
Professional qualification	doctor
Educational program	EPP «Dentistry» 2023
Department	Department of Fundamental Disciplines
Contact information	dp1funddis@dmtnm.edu.ua 10 Titova St.; Dnipro
Compilers of the syllabus	Ph.D., Docent Irina PISMENETSKA

Dnipro - 2024

1. Status and structure of the discipline

Discipline status	Mandatory
Discipline code in EPP/place of discipline in EPP	EC 5, professional training discipline
Course/semester	1 course (1 semester)
Course volume (total number of hours/ number of ECTS credits)	90 hours / 3 ECTS credits
Number of Chapter :	1
Number of content sections	1
Distribution by types of training and hours of study	Lectures 18 hours Practical classes 38 hours Independent work 34 hours
Language of instruction	English
Form of education	Full-time
Type of final control	Exam

2. Prerequisites and Postrequisites of educational discipline

Prerequisites: Medical chemistry as an educational discipline is based on the knowledge gained by students in medical biology, lays the foundations for students to study biological and bioorganic chemistry, physiology, histology, microbiology, pathophysiology, hygienic disciplines, as well as clinical diagnosis of the most common diseases. observation of the course of the disease, control over the effectiveness of the use of medicines and measures aimed at preventing the occurrence and development of pathological processes.

Postrequisites: disciplines, the study of which requires knowledge, abilities and skills acquired after completing the study of this discipline: biological and bioorganic chemistry.

3. Characteristic of the educational discipline

Purpose and definition of the educational discipline:

The goal of teaching the academic discipline "Medical Chemistry" is to create a holistic view of the main theoretical and methodological aspects of medical chemistry, as one of the foundations of the education of a future dentist.

Medicinal chemistry is an academic discipline that provides concepts of inorganic, analytical, physical and colloidal chemistry.

General competences (GC): GC 1-3

GC 1	Ability to think abstractly, analyses and synthesize.
GC 2	Ability to learn and master modern knowledge.
GC 3	Ability to apply knowledge in practical situations.

Special (professional, subject) competencies (SC): SC 2, SC 13

SC 2	Ability to determine the necessary list of laboratory and instrumental studies and evaluate their results.
SC 13	The ability to assess the impact of the environment on the health of the population (individual, family, populational).

Program results of learning (PRL): PRL 2

PRL 2	Understanding and knowledge of fundamental and clinical biomedical sciences at a level sufficient to solve professional problems in the field of healthcare.
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.4. Content of the discipline**Lectures (L)**

№	THEMES	hours
1	Introduction to medicinal chemistry. Structure of atoms and characteristics of bonds. Theoretical foundations of bioenergetics.	2
2	Kinetic laws of chemical processes	2
3	Colligative properties of biological fluids.	2
4	Biogenic elements in medicine. Complexation in biological systems. Fundamentals of chelation therapy	2
5	Acid-base equilibrium in biological systems.	2
6	Electrode processes, their biological role and application in medicine	2
7	Physico-chemistry of surface phenomena. Adsorption processes and ion exchange in biosystems. Chromatography. Fundamentals of adsorption therapy.	2
8	Colloidal solutions. Coarsely dispersed systems	2
9	Physicochemical properties of biopolymer solutions.	2
In total		18

Practical lessons plan (PL)

№	THEMES	hours
1	Basics of bioenergy. Thermodynamic and kinetic patterns of biological processes.	2
2	Biochemical reactions. Orientation of processes. Chemical equilibrium.	2
3	Catalysis. Kinetics of chemical reactions.	2
4	Imagination about the kinetics of enzymatic reactions. Constanta Michaelis.	2
5	Properties of solutions: ways of expressing the quantitative composition of solutions.	2
6	Colligative properties of solutions. Theory of strong and weak electrolytes.	2
7	Thermal effects of chemical reactions in solutions. Orientation of processes	2
8	Control work No. 1. Basics of bioenergy. Kinetics of biochemical reactions. Properties of solutions.	2
9	Acid-base balance and pH of biological fluids.	2

10	Protolytic theory of acids and bases. Hydrogen index of biological fluids.	2
11	Buffer systems, classification and mechanism of action, biological role.	2
12	Physical chemistry of surface phenomena. Lyophobic and lyophilic dispersion systems	2
13	Basics of titrimetric analysis. Chemical equilibrium. Solubility product	2
14	Complex formation in heterogeneous systems. Precipitation and dissolution reactions.	2
15	Biogenic s-p-d-elements, biological role.	2
16	Electrode potentials and the mechanism of their occurrence. The Nernst equation. Determination of electrode potentials and redox potential	2
17	Absorption processes and ion exchange in biosystems. Chromatography. Solving calculation and situational problems	2
18	Coagulation of colloidal solutions, preparation, purification, physico-chemistry of polymer solutions. Basics of adsorption therapy.	2
19	Properties of biopolymer solutions. Isoelectric point of protein. Stability factors of protein molecules.	2
In total		38

Independent work topics (IW)

№	THEMES	hours
1	Theoretical foundations of bioenergetics	4
2	Physicochemical foundations of kinetics of chemical reactions	5
3	Bioinorganic chemistry and medicine. Chemistry of biogenic elements	5
4	Properties of biopolymer solutions. Isoelectric point of protein. Buffer solutions. Their importance in biology and medicine.	5
5	Electrode processes and electrochemical research methods in physiology and medicine	5
6	Physicochemistry of dispersed systems.	5
7	Physicochemical properties of surface phenomena. Sorption of biologically active substances at the phase interface. Chromatography.	5
In total		34

5. Credit structure of “MEDICAL CHEMISTRY” discipline.

Discipline	Credit ECTS	Number of hours				
		In total	Aud	Lectures	Seminary	independent
«MEDICAL CHEMISTRY»	3	90	67	18	38	34

The topics of the lecture course in the 1st year reveal the problematic issues of the relevant sections of "Medical Chemistry".

Practical skills: not provided

The applicant's independent work involves preparation for practical classes and final class, mastering topics for independent work, preparation of abstract reports, presentations, tables.

Control of mastering the topics of practical classes and independent work is carried out in practical classes and the final class and exam in the discipline.

Individual work includes researching scientific literature, preparing reviews on the given topics for presentation, performing scientific and practical research, participation in specialized scientific and practical conferences, competitions, scientific work.

Methodical recommendations for practical classes, independent work, lecture materials are available on the website of the department.

The way to get materials: EMU site/Student/Department of fundamental disciplines/Educational and methodological support of the department/"Medical Chemistry"/ or follow the link Department of fundamental disciplines/Discipline "Medical Chemistry". Materials are accessed from the student's Office 365-based corporate account.

6. Forms and methods of monitoring learning success

Current control in practical classes	Methods: individual oral survey, structured written works, test tasks with the choice of correct answers.
Control of mastering the thematic section of the discipline in intermediate control classes	Methods: oral or written survey, electronic testing, <i>methods of self-control and self-assessment</i> .
Final semester control	According to the regulation on control measures in EMU (regulation of EMU)
Final control of the discipline - <i>exam</i>	Methods: by exam cards in the form of an oral exam, monitoring of acquiring of practical skills (According to the Regulation on control measures in EMU (Regulation of EMU).
Tools for diagnosing learning success	Theoretical questions, tests, clinically oriented situational tasks, practical tasks, demonstration of practical skills.

7. Evaluation criteria

Knowledge assessment is carried out according to regulation on control measures in EMU ([regulation of EMU](#)).

Current control	According to the four-point system of traditional grades: 5 "Excellent", 4 "Good", 3 "Satisfactory", 2 "Unsatisfactory"
Control of practical skills	According to the four-point system of traditional grades
Exam	Based on a 200-point scale (the sum of points for the current academic activity of the student, the result of passing the exam and for successful completion of an individual task, if any) Credited: 120 to 200 points Not credited: less than 120 points (see Rating scale)
Final control for the discipline	The final control of students' academic performance is carried out after completing the study of the discipline and is implemented in the form of an exam.

Discipline assessment:	The score on the discipline is determined based on the results of assessment of current activities and is expressed using a four point scale : ("Excellent", "Good", "Satisfactory", "Unsatisfactory"), multi-point scale and ECTS. The assessment in the discipline consists of an assessment of the current academic performance and the result of passing the exam (in points), which is set when evaluating theoretical knowledge and practical skills in accordance with the list defined by the discipline program. The number of points that the applicant scored for current academic.
	performance in the discipline is defined as the arithmetic mean of the number of points that the applicant received during the study of the discipline (practical, seminar, laboratory classes, etc.). The resulting value of the average traditional rating is converted to points according to the scale of conversion of traditional ratings to rating points. The maximum number of points is 200.

Matching grades on a 200-point scale, a 4-point (traditional) scale, and ECTS scale

On a 200-point scale	Rating on a 4-point scale
180–200	Excellent
140–179	Good
120–139	Satisfactory
0–119	Unsatisfactory

On a 200-point scale	ECTS evaluation
192–200	A
172–191	B
148–171	C
128–147	D
120–127	E
0–119	F

Discipline/course policy

The student has the right to receive high-quality educational services, access to up-to-date scientific and educational information, qualified advice during the study of the discipline and mastering practical skills. The policy of the department in the provision of Educational Services is student-centered, based on the regulatory documents of the Ministry of Education and the Ministry of Health of Ukraine, the Charter of the EMU and the procedure for providing educational services regulated by the regulation on the organization of the educational process in the EMU and the principles of academic integrity.

Compliance with the EMU schedule, safety precautions in the classroom.

Requirements for preparing for practical classes.

Students should arrive at classes on time, without being late. A student who is more than 10 minutes late for classes is not allowed in and must work it out in accordance with the established procedure. During practical classes, the student must wear a work uniform (medical gown, cap). Students who do not have a work uniform are not allowed to attend classes. The student must follow the safety rules during practical classes and while staying in the Department's premises. When discussing theoretical issues, students should demonstrate tolerance, politeness and respect for their colleagues and the teacher; when performing practical tasks, the workplace should be kept in order and cleaned after completing practical work.

Use of mobile phones and other electronic devices. The use of mobile phones and other electronic devices in the classroom is not allowed, only during Distance Learning, provided that it is technically necessary.

Academic integrity. When studying the discipline, the student should be guided by the following regulations: on academic integrity of EMU (regulation of EMU). In case of violation of the regulations of academic integrity during the current and final controls, the student receives a grade of "2" and must work it out to the teacher in accordance with the established procedure. Regulation on control measures in EMU (Regulation of EMU).

Skipping classes. Missed classes should be worked out in accordance with the procedure established in the regulations on control measures in the EMU (regulation of EMU) during the time determined by the work schedule (Department of fundamental disciplines) to the teacher on duty. To work out a missed lesson the student must pass a test and answer in writing or verbally the question on the topic of the lesson.

Procedure for admission to the final control in the discipline is given in the regulations on control measures and regulations on the organization of the educational process in the EMU (regulation of EMU) and regulations on control measures in the EMU (regulation of EMU). Students who do not have missed not worked out practical classes and lectures and have received an average traditional grade of at least "3" are allowed to participate in the final control.

Additional individual points. Points are awarded subject to the mandatory participation of the head, head teacher and teacher. These points are encouraging and are added once to the total score of the current academic performance and the result of passing the comprehensive exam. Their total number for one student should not exceed 10, and the final amount of points for an academic discipline should not exceed 200 points.

Individual tasks include:

- 1) writing essays and creating multimedia presentations with reports at meetings of the student scientific group of the department – 3 points;
- 2) participation in the creation of tables, graphological structure, posters on the topics of practical classes – 2 points;
- 3) participation in the student competition in the discipline at the First Stage – 1 point;
- 4) participation/prize-winner of the All-Ukrainian student competition in the discipline - 7/10 points;

- 5) author or co-author of abstracts/article – 2/5 points;
- 6) author or co-author of an oral/information stand report at a scientific conference – 6/3 points;
- 7) author of a student scientific paper accepted for participation or awarded by a diploma of I-III degree in the All – Ukrainian competition of student scientific papers at Stage II - 8 (participation) or 10 (diploma) points.

Resolving conflict issues. If there are misunderstandings and complaints against the teacher due to quality of educational services provided, knowledge assessment, and other conflict situations, the student must first report his/her claims to the teacher. If the conflict issue is not resolved, the student has the right to submit an appeal to the head of the department in accordance with the regulations on consideration of applications from applicants for higher education in EMU (regulation of EMU), Regulations on consideration of applications, complaints, and proposals of students in EMU (regulation of EMU), Regulations on meeting the requirements of the organization of the educational process (regulation of EMU), Regulation on the appeal of the results of the final control of knowledge of applicants for higher education in EMU (regulation of EMU), Regulations on safe educational environment in EMU (regulation of EMU).

Policy in the context of distance learning. The procedure for distance learning is regulated by regulation of EMU. The main training platforms for conducting training sessions are Microsoft Teams, Zoom. The procedure for conducting practical classes and lectures, working out and consultations during Distance Learning is published on the Department's Web page Department of fundamental disciplines .

Feedback from the teacher is provided directly during the lesson and/or consultation, and is also possible via email (in case of force majeure) during working hours.

1. Training resources

Educational and methodological support of the discipline is published on the website of the Department (Department of fundamental disciplines). Consultations are held according to the consultation schedule.

2. Schedule and distribution of groups by teacher are published on the Department's Web page (Department of fundamental disciplines).

3. Questions for intermediate and final control of the discipline are published on the Department's Web page (Department of fundamental disciplines).

Questions for the exam

Theoretical questions

1. Electronic structure of biogenic elements. Typical chemical properties of elements and their compounds (reactions without a change in the degree of oxidation, with a change in the degree of oxidation, complex formation). The relationship between the location of S-, p-, and 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 the ligands and charge of the inner sphere).
3. Constants of instability and stability of complex ions. Basics of complexonometry.
4. Internal complex compounds. Polynuclear complexes. Complex compounds in biological systems. Understanding the structure of hemoglobin.

5. Solutions in vital activities. Enthalpy and entropy factors of dissolution and their connection with the mechanism of dissolution.
6. Solubility of gases in liquids and its dependence on various factors. Henry Dalton's law. Effect of electrolytes on the solubility of gases. Solubility of gases in blood.
7. Solubility of solids and liquids. Distribution of substances between two immiscible liquids. Nernst distribution law, its importance in the phenomenon of permeability of biological membranes.
8. Equilibrium in electrolyte solutions. Ostwald dilution law.
9. Dissociation of water. Ionic product of water. pH of biological fluids.
10. Solubility product. Conditions of sediment formation and dissolution.
11. Types of protolytic reactions. Reactions of neutralization, hydrolysis and ionization.
12. Hydrolysis of salts. The degree of hydrolysis, its dependence on concentration and temperature. Hydrolysis constant.
13. Basics of titrimetric analysis. Methods of acid-base titration. Acid-base indicators and principles of their selection.
14. Buffer systems and their classification, pH of buffer solutions.
15. Mechanism of action of buffer systems.
16. Buffer capacity and factors on which it depends. Blood buffer systems.
17. Colligative properties of dilute solutions: decrease in freezing point, increase in boiling point. Raoult's laws. Cryometry and ebulliometry.
18. The colligative property of dilute solutions is osmosis. Osmotic pressure. Van't Hoff's law. Plasmolysis and hemolysis.
19. Colligative properties of dilute solutions of electrolytes. Isotonic coefficient. GIPO, hyper- and isotonic solutions in medical practice. The role of osmosis in biological systems.
20. Macroergic compounds. ATP as a universal source of energy for biochemical reactions. Characteristics of macroergic connections.
21. The first law of thermodynamics. Internal energy. Enthalpy. Heat of isobaric and isochoric processes. Standard heats of formation and combustion of substances.
22. Thermochemistry. Hess's law. Thermochemical transformations.
23. Thermochemical calculations and their use for energy characteristics of biochemical processes.
24. The second law of thermodynamics. Entropy. Gibbs energy.
25. Chemical equilibrium. Thermodynamic equilibrium conditions. Forecasting the direction of arbitrary processes. Exergonic and endergonic processes occurring in the body.
26. Law of active masses. Chemical equilibrium constant. Ways of its expression. Le Chatelier's principle. Prediction of chemical equilibrium mixing.
27. Speed of chemical reactions. The law of active masses for the rate of chemical reactions. Reaction rate constant.
28. Simple and complex reactions (sequential, parallel, conjugate, reversible, chain). Photochemical reactions and their role in life.
29. Order of reaction. Reactions of the 1st and 2nd order. Zero-order reactions. semi-formation.
30. Dependence of the reaction rate on temperature. Temperature coefficient. Van't Hoff's rule. Features of the temperature coefficient of the reaction rate for biochemical processes.
31. Arrhenius equation. Activation energy. The concept of the theory of active collisions and the theory of the transition state.
32. Homogeneous and heterogeneous catalysis. Features of the catalyst. Mechanism of catalysis and its role in metabolic processes.

33. Enzymes as catalysts of biochemical reactions. Dependence of the enzymatic action on the concentration of the enzyme and substrate, temperature and reaction of the medium.
34. Electrode potentials and the mechanism of their occurrence. Perist's equation. Normal (standard) electrode potential.
35. Normal hydrogen electrode.
36. Measurement of electrode potentials. Determination electrodes. Comparison electrodes.
37. Redox electrode potentials. Mechanism of their occurrence, biological significance. Peters equation.
38. Redox reactions in the body. Prediction of their direction by standard values of Gibbs energy and values of redox potentials.
39. Redox titration (oxidimetry). Permanganatometry method.
40. Method of iodometry.
41. Potentiometric titration, its use in medical and biological research.
42. Diffusion and membrane potentials, their role in the genesis of biological potentials. Ion-selective electrodes, their use for measuring the concentration of ions (glass electrode), K^+ , Ca^{2+} , Na^+ in biological solutions.
43. Features of solutions of the Navy. The mechanism of IUD swelling and dissolution. Dependence of IUD swelling and dissolution on various factors. The role of swelling in the physiology of organisms.
44. Protein isoelectric point and methods of its determination.
45. Teasing of solutions of the Navy. Properties of dredges.
46. Abnormal viscosity of solutions of the Navy. Viscosity of blood and other biological fluids. Osmotic pressure of biopolymer solutions. Haller's equation. Oncotic pressure of plasma and blood serum.
47. Membrane equilibrium of Donnan.
48. Surface activity. Duclos-Traube rule. Gibbs equation. Orientation of molecules in the surface layer and structure of biological membranes.
49. Langmuir equation.
50. Adsorption from solutions on the surface of a solid body. Freundlich equation.
51. Physico-chemical basis of adsorption therapy.
52. Adsorption of electrolytes (selective and ion exchange). Paneth-Fayance rule.
53. Ionites and their use in medicine.
54. Classification of chromatographic methods of research based on the mechanism of distribution of substances, the aggregate state of phases and the technique of execution. Use of chromatography in medical and biological research.
55. Disperse systems and their classification. Methods of obtaining and cleaning colloidal solutions. Dialysis, electrodialysis, ultrafiltration. "Artificial kidney".
56. Molecular-kinetic properties of colloidal systems (Brownian motion, diffusion, osmotic pressure). Optical properties of colloidal systems. Ultramicroscopy.
57. Structure of colloidal particles.
58. Electrokinetic potential of colloidal particles. Electrophoresis, its use in medicine and medical-biological research. The Helmholtz-Smoluchovsky equation.
59. Kinetic and aggregative stability of lyosols. Stability factors. Mechanism of coagulating effect of electrolytes.
60. Coagulation threshold, its definition. Schulze-Hardy rule. Coagulation processes in drinking water and wastewater treatment. Colloid protection, its biological role.

61. Coarsely dispersed systems (aerosols, suspensions, emulsions). Preparation and properties. Medical application. Semicolloids.

Practical questions

1. Observe the rules of safety and provide first aid in case of accidents.
2. Know the purpose of chemical dishes.
3. Write the electronic formulas of atoms and ions in the ground and excited states.
4. Know the molecular and structural formulas of substances.
5. Determine the degree of oxidation of an atom of an element.
6. Know how to determine trace and trace elements in solutions.
7. Calculate the amount of solvent and solute to prepare a solution with a given concentration.
8. Be able to switch from one way of expressing the content of a substance in a solution to another.
9. Know how to prepare solutions of a certain concentration.
10. Have knowledge of determining the hydrogen indicator of the environment with indicators and a pH meter.
11. Know how to prepare buffer solutions with a given pH value and calculate the pH of the buffer system and the buffer capacity of buffer solutions for acid and alkali.
12. Have knowledge of preparation of isotonic solutions.
13. Calculate the rate of a chemical reaction.
14. Determine the conditions of formation and dissolution of sediments.
15. Know how to measure electrochemical characteristics of solutions.
16. Calculate and evaluate quantitative characteristics of sorbents.
17. Know how to separate mixtures and prepare colloidal solutions.
18. Determine the charge sign of particles of the dispersed phase and the isoelectric point of the solution.
19. To know the methods of conducting an experiment and to explain the results.
20. Form the results of practical work in the form of a protocol.

8. Literature

Basic:

1. Medical chemistry: textbook / V.O. Kalibabchuk, V.I. Halynska, L.I. Hryshchenko et al. 7th edition. 2020. 224 p.
2. V.Y. Tsuber, A.A. Kotvytska, K.V. Tykhonovych. Medical Chemistry. Medicine. 2022. 392 p.
3. Zuzana Országhová, Ingrid Žitňanová et al. Textbook on Medical Chemistry. Comenius University in Bratislava. Bratislava. 2018. 302 p.
4. S.V. Eltsov, N. A. Vodolazkaya. Practical Medical Chemistry: Manual. – 2-nd ed. Kharkiv: V. N. Karazin Kharkiv National University. 2018. 195 p.
5. J.R. Burdge. Chemistry. – 5-th ed. New York: McGraw-Hill, 2019. 1205p.

Additional:

1. O. M. Korsun, N. A. Vodolazkaya. Medical Chemistry. V. N. Karazin Kharkiv National University. Kharkiv, 2021, 23p.
2. T. V. Dychenko, G. O. Yanovska. Medical Chemistry. Sumy State University. 2020. Sumy. 172 p.

Information resources:

1. <https://www.labxchange.org/library/pathway/lx-pathway:9bc13661-ec63-4406-b6e8-1264115336cf>
2. Labster www.labster.com
3. PraxiLabs www.praxilabs.com
4. Virtual Classroom Materials on Organic chemistry
<https://www.scienceprofonline.com/chemistry.html>

Responsible for the course

Ph.D., Docent

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