Ministry of Education and Science of Ukraine
Sumy National Agrarian University
Faculty of Veterinary Medicine
Department of Internal Medicine, Pharmacy and Biochemistry

Work program (syllabus) of the educational component

Bioinorganic and analytical chemistry

(mandatory)

Specialty	H6 Veterinary medicine
Educational program	**Veterinary medicine**
Level of higher education	Second Master's level of higher education

Sumy – 2025

Розробники: _____

(підпис) (прізвище, ініціали) (вчений ступінь та звання, посада)

_____ **Морозов Б.С., к.вет.н, старший викладач**

(підпис) (прізвище, ініціали) (вчений ступінь та звання, посада)

Розглянуто, схвалено та затверджено на засіданні кафедри внутрішніх хвороб, фармації та біохімії	протокол від 09.06.2025 р..№ 17
	Завідувач кафедри _____ (підпис) **Нечипоренко О.Л.** (прізвище, ініціали)

Погоджено:

Гарант освітньої програми _____ (підпис) Олександр **Чекан** (ПІБ)

Декан факультету, де реалізується освітня програма _____ (підпис) Людмила **Нагорна** (ПІБ)

Рецензія на робочу програму надана: _____ (підпис) _____ (ПІБ)

_____ (підпис) _____ (ПІБ)

Методист відділу якості освіти, ліцензування та акредитації _____ (підпис) (Надія Тарамік) (ПІБ)

Зареєстровано в електронній базі: дата: 02.07 2025 р.

Developers: _____
(signature) (last name, initials) (academic degree and title, position)

_____ **Morozov B.S.,** **doctor philosophy**
(signature) (last name, initials) (academic degree and title, position)

Reviewed, approved and ratified at a meeting of the Department of Internal Medicine, Pharmacy and Biochemistry	protocol dated 09.06.2025. No. 17
	Manager departments _____ (signature) **Nechiporenko O.L.** (last name, initials)

Agreed:

Guarantor of the educational program _____Halyna **RIABENKO**
(signature) (Full name)

Dean of the faculty where the educational program is implemented _____ Liudmyla **NAHORNA**
(signature) (Full name)

The work program review was provided by:_____
(signature) (Full name)
_____
(signature) (Full name)

Methodologist of the Department of Educational Quality, licensing and accreditation _____ (_____)
(signature) (Full name)

Registered in the electronic database: date: _____2025.

Information on reviewing the work program (syllabus):

Academic year in which changes are made	Number of the appendix to the work program with a description of the changes	Changes reviewed and approved		
		Date and number of the minutes of the department meeting	Head of the Department	Educational program guarantor

1. GENERAL INFORMATION ABOUT THE EDUCATIONAL COMPONENT

1.	Name OK	**OK 7.**Bioinorganic and analytical chemistry			
2.	Faculty/department	Veterinary Medicine/Internal Medicine, Pharmacy and Biochemistry			
3.	Status OK	Mandatory			
4.	Program/Specialty(s) that include OK for	Specialties H6 "Veterinary Medicine"			
5.	OK can be offered for	-			
6.	Semester and duration of study	1 course, 1 semester (1-15 weeks)			
7.	Number of ECTS credits	5			
8.	Total hours and their distribution 150	Contact work (classes)			Independent work
		Lectures	Practical/seminar	Laboratory	
		14		60	76
9.	Language of instruction	English			
10.	Teacher/Educational Component Coordinator	Teacher: PhD, Senior Lecturer Morozov Bogdan Stanislavovych			
11.1	Contact information	Workplace: room 25, veterinary medicine building E-mail: MorozovBS@meta.ua Tel. (066) 3130411 Consultation hours: every Wednesday from 12:00 to 13:00			
11.	General description of the educational component	**"Bioinorganic and Analytical Chemistry"** is an interdisciplinary academic discipline that combines the study of the chemistry of inorganic elements, which play a key role in biological processes, with the fundamentals of chemical analysis methods used to examine the composition of biological samples, pharmaceuticals, feed, water, and other objects of veterinary and agricultural significance. The course aims to develop knowledge about the involvement of metallic and non-metallic elements in enzymatic systems, metabolism, oxygen transport functions, mineral exchange, as well as modern qualitative and quantitative analysis methods (titrimetry, gravimetry, photometry, potentiometry, etc.). This discipline serves as a foundational basis for further study in biochemistry, pharmacology, toxicology, and clinical diagnostics.			

12.	The purpose of education component	To provide students with fundamental knowledge about the role of inorganic elements in biological processes, the chemical properties of bioinorganic compounds, as well as basic skills in applying analytical chemistry methods for the detection and quantitative determination of substances in biological, pharmaceutical, and veterinary-sanitary samples.
13.	Study prerequisites OK, connection with other Educational components of the OP	1.Educational component based on knowledge of chemistry (terminology, basic laws and concepts, properties of ions depending on their finding in the periodic table of D.I. Mendeleev), physics (understanding basic laws of chemical processes reactions), foundations of higher mathematics (performing calculations), experimental techniques (knowledge of chemical glassware, concentrations). 2. Educational component is the basis for study components: "Organic Chemistry with Clinical Biochemistry", "Vetpharm of Medicinal and Poisonous plants", "Veterinary toxicology", "Clinical and laboratory diagnostics of animal diseases", "System of analysis of dangerous factors and control at critical points"
14.	Academic policy virtue	Maintaining academic integrity for higher education students involves: independent completion of educational tasks, assignments current and final monitoring of learning outcomes; reference to sources of information in the case of using ideas, statements, information; compliance with copyright legislation; provision reliable information about the results of one's own educational or scientific work activities. Violation academic virtue at studied OK "Bioinorganic and analytical chemistry" are considered: academic plagiarism, academic fraud (copying, deception, impersonation of someone else's work) work for one's own account), use of electronic devices during final knowledge control.By violation academic integrity, education seekers can be held accountable for the following academic responsibilities: **Academic plagiarism**– score 0, re-execution of the task. **Academic fraud**– cancellation of points received; re-scoring passing the assessment, re-doing the task that was not completed independently work; **Use of electronic devices during the final exam knowledge control** – suspension from work, score 0, re-passing the final control
15.	Keywords	Quantitative analysis, qualitative analysis, titrimetry, gravimetry, spectrophotometry, electrochemical methods, chromatography (GC, HPLC, TLC), mass spectrometry, atomic absorption analysis (AAS), ion chromatography, fluorimetry, trace element analysis, calorimetry, potentiometry, metalloproteins, coordination compounds, metals in biology, ligand interaction, biometals, enzymes with metals, hemoglobin / chlorophyll / cytochrome, zinc-containing enzymes, copper-containing proteins, selenoproteins, vital trace elements https://cdn.snau.edu.ua/moodle/course/view.php?id=846

2. LEARNING OUTCOMES BY EDUCATIONAL COMPONENT AND THEIR RELATIONSHIP WITH PROGRAM LEARNING OUTCOMES

Learning outcomes for OK: After studying the educational component, the student is expected to be capable..."	Program results training, to achieve which directed OK (specify number according to the numbering, given in the OP)1					How is RND assessed?
	PRN 2	PRN 4	PRN 9	PRN 15	PRN 17	
DRN 1. Understand the chemical nature of processes in the animal body, which determines their subordination to basic chemical laws	+	+		+		Multiple choice tests and for compliance; solution situational tasks; exam
DRN 2. Establish relationships the course of chemical and biological processes that occur in the animal body normally and pathologically	+	+		+	+	Multiple choice tests and for compliance; solving situational problems tasks; exam
DRN 3. Analyze performance processes, right using instruments, laboratory glassware, reagents, materials, following safety regulations	+	+	+			Multiple choice tests and for compliance; protocols laboratory work; exam
DRL 4. Apply optimal methods and tools for conducting research, collecting and data processing	+	+		+	+	Presentation with a report; exam
DRN 5. Know the measures aimed at To protect the environment when using chemicals and their waste	+		+			Oral interview; exam; solving situational problems tasks

3. CONTENT OF THE EDUCATIONAL COMPONENT (CURRICULAR PROGRAM) DISCIPLINES)

Topic. List of issues to be addressed within the topic	Distribution in within general time budget			Recommended reading2
	Auditor for work		Itself-stable work	
	Luk e	Lab . from.		
Topic 1. Introduction. Safety rules and regulations laboratory work Rules for working in the laboratory, with reagents. Rules of technique Safety. Providing first aid. Familiarization with laboratory glassware and other equipment. The simplest operations with substances	2	2	2	1,3,7,9

[1] ~~Must comply with the Matrix of e~~nsuring program learning outcomes by the relevant components of the educational program, indicated for mandatory educational components of OP I and II levels, for all (mandatory and selective OK) OP III [2] Specific source from the main or additionally recommended literature

Topic 2. Basic concepts and laws of chemistry. Basic concepts of atomic-molecular theory: molecule, atom, chemical element, simple and complex substance, relatively – atomic and molecular mass, mole, molar mass. Law of conservation mass and energy. Law of equivalents. Avogadro's law. Law constancy of the composition of chemical compounds. Chemistry in veterinary medicine.			6	2,6,8,12
Topic3. The structure of the atom and the periodic law of D.I. Mendeleev. Chemical bonding. Characteristics of an element by place in the periodic table. Periodic law. Structure of the atom: nucleus and electrons. Characteristics of an electron. Valence electrons. Composition of the nucleus. Nucleon, neutron and proton number. Energy level. Atomic formulas: electronic, graphic. Atomic diagrams. Atomic states: normal and excited. Energy and length chemical bond. Chemical bond length. Types of chemical communication. Typical tasks and examples of their solutions.			8	15,4,7
Topic 4. Classification and nomenclature of inorganic compounds Oxides. Chemical properties and methods of obtaining oxides. Peroxides. Bases. Chemical properties and methods Preparation of bases. Acids. Chemical properties and methods Preparation of acids. Salts. Chemical properties and methods Production of salts. Use and role in veterinary medicine.			8	1,8,12,4
Topic 5. Fundamentals of thermochemistry Thermochemistry. Thermodynamic process. Exothermic and endothermic processes. Heat effect of reaction. Standard thermal effect. Heat of combustion and formation. Standard conditions. System: definition, classification, functions (enthalpy, entropy, Internal energy, Gibbs energy), heat capacity, parameters (pressure, mass, temperature, volume). The first, second and third laws of thermodynamics. Regularities of chemical reaction. Hess's law and its consequences. Lavoisier's and Laplace's law.			8	1,6,11,15
Topic 6. Chemical reaction rate, influencing factors on her. Basic concepts of chemical kinetics. Rate chemical reaction, factors influencing it. Law of active masses – the basic law of chemical kinetics. Rate constant chemical reaction. The concept of activation energy, the influence temperature on the reaction rate. Van't Hoff's rule. The concept of catalysis and its nature. Enzymes as catalysts of chemical processes.			6	13,7,9
Topic 7. Irreversible and reversible reactions. Chemical equilibrium. Equilibrium constant. Shift of chemical equilibrium. Influence external factors on chemical equilibrium. Le- principles Chatelier.			6	21.3, 17.9
Topic 8. General concepts about redox processes. Oxidation state of an element in compounds. Typical oxidizing agents and Reducing agents. Changing the redox properties of elements			2	22.18

depending on the structure of their atoms. Rules for composing equations redox reactions. Classification of redox reactions reduction reactions.				
Topic 9. **Classification**redox reactions (intermolecular, intramolecular and disproportionation). The influence of the environment on the nature course of the reaction. Redox processes in living organism			2	23,2,8,16
Topic 10. General ideas about solutions Solution and its components (solute, solvent). Disperse phase. Classification of solutions by degree dispersion, state of aggregation (liquid, solid and gaseous) and content of the reactant diluted, concentrated, saturated,supersaturated, unsaturated). Concentration of solutions (mass, molar, equivalent, molal). Mass fraction solute. Normality. Titer. Value of solutions for veterinary medicine.			6	17,20,6
Topic 11. Physical properties of nonelectrolyte solutions. The concept of electrolyte and non-electrolyte solutions and their properties. Osmotic pressure (Van't Hoff's law). Pressure saturated solvent vapor above the solution (Raoult's first law). Boiling and crystallization temperatures of solutions (II law Raoult). Osmotic pressure of solutions. Vapor pressure of the solvent above the solution. Boiling and crystallization temperatures of solutions.			4	11,15,17
Topic 12. Electrolyte solutions. Electrolytic mechanism dissociation. Quantitative characteristics of the dissociation process: degree and constant of electrolytic dissociation. Strong and Weak electrolytes. Dissociation constants of weak electrolytesof electrolytes, its relationship with the degree of dissociation. Reactions in electrolyte solutions. Ionic reaction equations. Water as a weak electrolyte. Ionic product of water. Hydrogen and hydroxyl indices. Methods of measuring pH. General information about indicators. Characteristics of the solution medium using pH. The essence of salt hydrolysis. Types of salt hydrolysis. Constant and degree of salt hydrolysis. Properties of electrolyte solutions. Theory of electrolytic dissociation. Ionic product of water. Hydrogen index. Hydrolysis of salts. Degree and constant of dissociation. Hydrolysis of salts.			2	22,7,13
Topic 13. Buffer solutions. Buffer system, buffer capacity, buffer values solutions. Types of buffer systems. Buffer action. Value buffer solutions for the animal body.			6	10,12,16
Topic 14. Coordination compounds Complex (coordination) compounds. Classification. Nomenclature. Inner, Outer sphere Complexing agent. Ligands. Werner's theory. Coordination number. Coordination bonds. Coordination capacity. Instability constant. Dissociation of complex compounds. Significance of coordination compounds for medicine (veterinary science).			6	21,23,19

Dialysis. Ultrafiltration. Structure of a colloidal particle. Potential-determining ions. Counterions. Coagulation. Threshold coagulation. Granule. Micelle. **Topic 16**General characteristics and basic concepts **qualitative and quantitative analysis. Classification of chemical quantitative analysis methods.** Theoretical and experimental foundations of quantitative and qualitative chemical analysis. The concept of the reliability of the results of chemical analysis, systematic and random errors of analysis methods. Qualitative reactions to cations and anions.			4	
Topic 17. Acid-base titration method (method **neutralization).**Indicators their choice. Requirements for standard solutions. Preparation of standard and working solutions. Determining the concentration of acid and alkali solutions.			2	12,14,18,21
Topic 18. Complexometric titration method. Complexometric titration method. Theoretical foundations Complexonometry. Characteristics of the method. Complexones. General properties of complexones and complexonates. Method indicators. Determination of water hardness.			2	23,18,9
Topic 19. Redoxometry (redox titration). Permanganatometry. General characteristics of the method. Standard and working solutions. Preparation and determination concentrations of oxalic acid and permanganate solutions Potassium. Determination of Iron (II) in Mohr's salt solution.			4	1,5,7,18
Topic 20. Theoretical foundations of gravimetry (weight analysis) Features of the gravimetric method of analysis. Moisture research products depending on the type, conditions and storage times. Weighing, dry matter.			4	23,22,17
Topic 21. Physico-chemical (instrumental) methods of analysis Physico-chemical (instrumental) methods in control productions: a) optical analysis methods; b) electrochemical analysis methods; c) chromatographic analysis methods. Biological methods of analysis. Electrochemical methods of analysis, their classification. Spectral (optical) methods of analysis. Chromatography.			4	2,6,9,11,20
Total	**14**	**60**	**76**	

4. TEACHING AND LEARNING METHODS

DRN	**Teaching methods**(work that will be carried out by the teacher during classroom lessons, consultations)	**Number of hours**	**Teaching methods**(what types of learning activities should the student perform independently)	Number of hours
DRN 1. Understandthe chemical nature of physiological processes in the animal body involving organic substances, which determines their subordination to basic chemical laws	*Explanatory and reproductive*methods: lecture, story-explanation, conversation, aimed at identifying the value-oriented content of the educational material (in the context of professional tasks) Using the platformMOODLE, PADLET, ZOOM during blended learning.	20	working with textbooks, manuals, Internet materials; illustration, demonstration, performing experiments, exercises, didactic tasks, independent work, etc.	20
DRN 2. Establish the relationships between the chemical and biological processes that occur in the animal body normally and pathologically.	*Partial search methods*: problem-dialogical, modeling, case method, etc. *Inductive methods*-related to predicting observations and experiments based on experience data Using the platformMOODLE, Google Meet, ZOOM during blended learning.	20	independent search for educational information, performance of laboratory work of partial search content, complex didactic tasks and tasks.	20
DRN 3. Be able to use laboratory equipment and chemical reagents in compliance with the rules for their safe storage and use when conducting specialized research	*Visual methods*– demonstration of experiments *Practical methods*–work with reagents, laboratory glassware and instruments in compliance with safety regulations.	18	Preparation for laboratory work, execution and preparation of a report on the results of laboratory work	18
DRN 4. Formulate conclusions, recommendations, advice on the maintenance, feeding and treatment of animals or establish a diagnosis based on the results of laboratory tests	*Deductive methods* – related to the formulationgeneral provisions, formulas, laws and their application to specific tasks.*Inductive methods*-related to predicting observations and experiments based on experience data	18	Reading literature on the topic, preparing for a laboratory session, performing and writing a report on the results of laboratory work	16

5. EVALUATION BY EDUCATIONAL COMPONENT

5.1. Diagnostic assessment (indicated as needed)

5.2. Summative assessment

5.2.1. To assess the expected learning outcomes, there are

No.	Summative assessment methods	Points / Weight in the overall score	Date of compilation
1.	Preparation of a comprehensive written control	*(3*x15) points /45%	7, 10, 14 weeks
2.	Laboratory work report	*25 points / 25%*	until 14-15 weeks
3.	Final control: exam	*30 points / 30%*	Exam week

5.2.2. Evaluation criteria

Component[1]	**Unsatisfactorily**	**Satisfactorily**	**Good**	**Perfectly**[2]
Preparation of a comprehensive written thematic control (3 papers)	*<5 points*	*5-8 points*	*9-12 points*	*13-15 points*
	A shortened condition of the problem has been drawn up, reaction equations and formulas are missing	A shortened problem statement was drawn up, calculations were performed only using the ready-made formula	The necessary formulas of substances and reaction equations are given, the solutions to the problems contain errors.	The tasks are completed in full, the presentation is logical and rational, the conclusions and generalizations are well-reasoned.
Laboratory work report	*<5 points*	*6-15 points*	*16-22 points*	*23-25 points*
	the main content of the material is not presented, conclusions and generalizations are lacking	There are gaps in the presentation of the material, the presentation is not systematized, the conclusions and generalizations are poorly argued, and there are errors in them.	There are minor shortcomings in the presentation of the material, the presentation is not sufficiently systematized, and there are some inaccuracies in the conclusions and generalizations.	the material is presented in full, the presentation is logical, the conclusions and generalizations are well-reasoned
Final control: exam	<14 points	15-20	21-26	27-30
	Ticket issues not resolved	No more than two tasks are revealed	No more than three tasks revealed	Three tasks are revealed and a practical solution is proposed.

[1]Specify the summative assessment component

[2]Indicate the distribution of points and the criteria that determine the level of assessment

5.3.Formative assessment:

To assess current progress in learning and understand areas for further improvement,

No.	**Elements of formative assessment**	**Date**
1	Interactive testing to check the mastery of lecture material	10 minutes at the beginning of the lab session
2	Checking individual homework, discussion with the teacher and self-correction of the work done by students	Within a week after execution
3	Survey and oral comments from the teacher on its results	weekly
4	Verification of the results of experiments for laboratory work with feedback	Within a week after execution

6. LEARNING RESOURCES (LITERATURE)

6.1 Main sources

5.3.1. Textbooks and manuals

1. Veterinary clinical biochemistry: textbook / V.I. Levchenko et al. ed. V.I. Levchenko and V.V. Vlizla. 2nd ed., revised and supplemented. Bila Tserkva, 2019. 416
2. Organic Chemistry / Snitynskyi V.V., Fedevich E.V., Solovodzinska I.E., Shkumbatyuk R.S., Vishchur O.I. — Lviv: SPOLOM, 2016. — 300 p.
3. Organic chemistry. Practical course: a teaching aid for agricultural students of III-IV levels of accreditation in the specialties "Veterinary medicine", "Zooengineering", "Agronomy" / O. I. Kononsky. - K.: Higher school, 2002. - 248 p.
4. Biochemistry. Workshop/ L.I. Ostapchenko, I.V. Kompanets, O.V. Skopenko and others. – Kyiv: Publishing and Printing Center *Kyiv University*, 2018.- p.296
5. Biochemistry short course. Part 1. / Z.M. Skorobagatova, M.A. Stashkevych, A.G. Matvienko. – Biokompozit, 2021. – 148 p.
6. **Analytical Chemistry: A Toolkit for Scientists and Laboratory Technicians**, 2nd Edition (2024) Authors: Bryan M. Ham, Aihui MaHam, Wiley Focus: a comprehensive guide for laboratories - methods, techniques, safety, instrumental approaches.
7. **Basics of Analytical Chemistry and Chemical Equilibria: A Quantitative Approach**, 2nd Edition (2023) Author: Brian M. Tissue, Wiley Focus: fundamental principles, calculations, chemical equilibrium for analysts.
8. **Bioinorganic Chemistry: A Short Course, 3rd Edition** Author: Rosette M. Roat-Malone, Wiley Publishing, January 2020Description: A compact, modern introduction to bioinorganic chemistry - metal-ligand interactions in biology, enzymatic mechanisms, physicochemical approach

5.3.2. Methodological support

9. **Morozov B.S.**Bioinorganic and analytical chemistry. Methodological guidelines for conducting laboratory and practical classes. Methodological guidelines for students of the Faculty of Veterinary Medicine of the full-time form of Sumy. 2023. – 33 p.
10. **Morozov B.S.**Bioorganic and analytical chemistry "Methodological instructions for conducting laboratory work". Methodological instructions for students of the Faculty of Veterinary Medicine of the full-time form of Sumy. 2023. – 25 p.

5.4. Additional sources

11. Kravchenko M.Y., Ivchenko V.D. Organic chemistry: methodological instructions for performing laboratory work for 1st year students of specialties 211 “Veterinary medicine”, 212 “Veterinary hygiene, sanitation and expertise” of the educational degree “master”. – Sumy, 2021. – 36 p.
12. Kravchenko M.Y., Ivchenko V.D. Organic Chemistry. Methodological instructions for independent study of the module "Theoretical foundations of organic chemistry" by 1st year students of specialties 211 "Veterinary medicine" and 212 "Veterinary hygiene, sanitation and expertise" of the educational degree "master" - Sumy: SNAU, 2021. - 37 p.
13. Kravchenko M.Y., Ivchenko V.D. Organic chemistry. Part 1. Hydrocarbons: lecture notes for 1st year students of specialties 211 “Veterinary medicine”, 212 “Veterinary hygiene, sanitation and expertise” of the educational degree “master”. – Sumy, 2021. – 51 p.

6.2.Software

Software (to support distance learning (Moodle), Zoom, Google Meet, etc.)