

DANYLO HALYTSKY LVIV NATIONAL MEDICAL UNIVERSITY
Department of Toxicological and Analytical Chemistry



APPROVED

The Acting First Vice-Rector for
scientific and pedagogical work
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CURRICULUM ON THE OPTIONAL DISCIPLINE
ECOTOXICOLOGY

for students of the fourth year of the Pharmacy Faculty
for the training of specialists of the 2nd (master degree) level of higher education
education sector 22 Public Healthcare
specialty 226 «Pharmacy, Industrial Pharmacy»

Discussed and approved

at the methodical meeting of the Department
of Toxicological and Analytical Chemistry,
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Head of the department

 Assoc. prof. I.Y. Halkevych


«Approved»

by profile methodical commission
in chemical and pharmaceutical disciplines
Protocol No. 3 from 21.06.2022

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INTRODUCTION

Curriculum of the optional discipline "**Ecotoxicology**" is made in accordance with the draft Standard of Higher Education of Ukraine for the training of specialists of *the second (master's) level*

education sector 22 " Public Healthcare"

specialty 226 " *Pharmacy, Industrial Pharmacy* "

educational program of *Master of Pharmacy*

The curriculum of the optional discipline "Ecotoxicology" ensures: compliance of the content of industry standards of higher education through the direct connection of the content of the discipline with the goals of higher education (skills and abilities of the specialist, defined in Educational and Professional Program 2022); compliance with the license and accreditation conditions and requirements; compliance with the "Standards and Recommendations for Quality Assurance in the European Higher Education Area"; possibility of using disciplinary competences as an information base for the formation of diagnostic tools; the uniqueness of the criteria for assessing academic achievement.

The developed curriculum defines: the amount of knowledge of the optional discipline "Ecotoxicology", which the student must master in accordance with the requirements of educational and qualification characteristics of the future specialist; algorithm of studying the educational material of the discipline taking into account the interdisciplinary of the bundles; necessary methodological support and methodology for assessing students' knowledge.

The curriculum of the optional discipline "Ecotoxicology" establishes the ideology of the content of education and organization of the educational process, defines the educational and methodological foundations of the department. This Program is the basis for the development of all teaching materials for the educational process, including for students' independent work.

Environmental Toxicology (Ecotoxicology) is a section on toxicology that studies the effects of toxic substances on ecosystems and their cycling in the biosphere, especially in food chains.

Environmental Toxicology studies the sources of toxicant input into natural biosystems, the toxic effects of the effects of chemicals on living organisms, as well as the persistence and functioning of biosystems at the organismal level under conditions of their toxic contamination.

One of the main biological objects in the study of ecotoxicology is man. From this point of view, ecotoxicology is designed to solve one of the most important problems of human ecology - the protection of human health from damage by harmful substances in the environment. In contrast to traditional, modern ecotoxicology studies toxic effects not only at the level of the organism, but also mainly at the population and biocenotic levels. Another feature of ecotoxicology is the study of toxic effects of the environment as an active ingredient that affects the manifestation of toxicity. Thus, a systematic approach to solving problems of protection of humans and biota in general from harmful substances. Goals and objectives of ecotoxicology: the study of types of ecotoxicity, their mechanisms and consequences.

STRUCTURE OF THE COURSE

Structure of the discipline	Number of credits (hours)			ISW (hours)	Year of study / semester	Type of control
	Total credits / hour	Classroom				
		Lectures (hours)	Practical classes (hours)			
Course title: Ecotoxicology	3,0 credit / 90 hours	10	20	50	Fourth year (7-8 term)	credit

The subject of study of the optional discipline "Ecotoxicology" is:

- the effects of harmful chemicals in the environment on living organisms and their populations that are part of the ecosystem;
- physico-chemical and toxic characteristics of the pressure of the main groups of ecotoxicants;
- assessment of the degree of danger of the impact of ecotoxicant on living organisms;
- the consequences, mechanisms of restoration of biological systems and their protection against the effects of toxic substances;
- methods of bioindication of pollution by heavy metals, pesticides, polycyclic hydrocarbons and oil;
- methods of bioindication of air, soil and water pollution;
- toxicometric parameters.

Interdisciplinary Relations:

The study sample subject:

- a) is based on knowledge of inorganic chemistry, organic chemistry, biological chemistry and integrates with pharmaceutical chemistry, toxicological chemistry and pharmacology;
- b) lays the foundations for the study of pharmaceutical chemistry, toxicological chemistry and pharmacotherapy and provides for the development of skills to apply the knowledge acquired to the study of special disciplines and in professional activity.

1. The purpose and objectives of the educational sample discipline

- 1.1. **The purpose of teaching the optional discipline "Ecotoxicology"** is to prepare students for the development of medical and biological and special disciplines, which on the basis of modern scientific ideas to form the necessary knowledge, skills and skills in the field of toxicological chemistry.
- 1.2. **The main tasks of studying the optional discipline "Ecotoxicology"** are:
 - formation of students' knowledge and skills, practical skills in toxicology, which is a general theoretical discipline in the system of preparation of the pharmacist;
 - to prepare students for mastering the specialty "pharmacy", discipline toxicological chemistry and obtaining basic toxicological knowledge necessary for understanding and mastering a number of biomedical and chemical sciences, studied the pharmaceutical department.
- 1.3. **Competencies and learning outcomes**, the formation of which contributes discipline (relationship with the normative content of training seekers of higher education, formulated in terms of learning outcomes in the Standard of Higher Education).

According to the requirements of the Standard, the optional discipline "Ecotoxicology" promotes the acquisition of students **competencies**:

Integral:

- to solve typical and complex specialized problems and practical problems in professional pharmaceutical activity with application of theoretical principles of toxicology bases, to reasonably substantiate the results of researches and to unambiguously communicate their conclusions and knowledge to professional and non-professional audience;

general

- GC 2. Ability to apply knowledge in practical situations.
- GC 3. Efforts to preserve the environment.
- GC 4. Ability to think abstractly, analyze and synthesize, learn and be modernly trained.

- GC 6. Knowledge and understanding of the subject area and understanding of professional activity.
- GC 7. Ability to adapt and act in a new situation.
- GC 11. Ability to evaluate and ensure the quality of performed works
- GC 12. Ability to conduct research at the appropriate level.

special (professional, subject):

- PC 1. The ability to carry out sanitary and educational work among the population for the purpose of prevention of common diseases, prevention of dangerous infectious, viral and parasitic diseases, as well as for the purpose of promoting timely detection and support of adherence to the treatment of these diseases according to their medical and biological characteristics and microbiological features .
- PC 6. The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and body tissues, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication.
- PC 19. Ability to organize and carry out quality control of medicinal products in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy, to determine sampling methods for medicinal product control and to carry out their standardization in accordance with current requirements, to prevent the distribution of falsified medicinal products.
- PC 20. Ability to develop methods of quality control of medicines, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological, pharmacotechnological and pharmaco-organoleptic control methods..

Detailing competencies according to the NQF descriptors in the form of the Competence Matrix.

Competence Matrix

No	Competence	Knowledge	Skill	Communication	Autonomy and responsibility-ness
1	2	3	4	5	6
Integral competence					
of usefulness to solve common and complex specialized tasks and practical problems in a professional pharmaceutical activities using the theoretical foundations provisions toxicology reasonably justify the results of research and clearly communicate their findings and knowledge to the professional and unprofessional audience.					
General competencies					
1	GC 2. Ability to apply knowledge in practical situations	Have specialized conceptual knowledge acquired in the learning process.	To be able to solve complex tasks and problems that arise in professional activity.	Clear and unambiguous presentation of one's own conclusions, knowledge and explanations, which justify them to	Be responsible for making decisions in difficult conditions

				specialists and non-specialists.	
2	GC 3. The desire to preserve the environment	To know the problems of environmental preservation and ways of its preservation	To be able to form requirements for oneself and others regarding the preservation of the environment	Make proposals to relevant bodies and institutions regarding measures to preserve and protect the environment	To be responsible for the implementation of environmental protection measures within the framework of one's competence
3	GC 4. Ability to abstract thinking, analysis and synthesis, ability to learn and be modernly educated.	Know methods of analysis, synthesis and further modern education.	Be able to analyze information, make informed decisions, be able to acquire modern knowledge.	Establish appropriate connections to achieve goals.	To be responsible for the timely acquisition of modern knowledge.
4	GC 6. Knowledge and understanding of the subject area and understanding of the profession 3ability to adapt and act in a new situation	Have deep knowledge of the structure of professional activity.	To be able to carry out professional activities that require updating and integration of knowledge.	The ability to effectively form a communication strategy in professional activities.	To be responsible for professional development, the ability to further professional training with a high level of autonomy.
5	GC 7. The ability to evaluate and ensure the quality of the work performed	Know the elements of industrial and social adaptation; factors of successful adaptation to a new environment	To be able to form an effective strategy of personal adaptation	Interact with a wide range of people (colleagues, management, specialists from other fields) when new situations arise with elements of unpredictability	Be responsible for making decisions
6	GC 11. Ability to conduct research at an appropriate level	Know the methods of evaluating performance quality indicators	to new conditions	Establish relationships to ensure quality performance of work	To be responsible for quality performance of works
7	GC 12. Ability to apply knowledge in practical situations	Know the components of the health care system, planning and evaluation of scientific research	Be able to ensure quality performance of work	Use information data from scientific sources	Be responsible for the development and implementation of planned projects
Special competences					
1.	PC 1. The ability to carry out sanitary and educational work among the population for the purpose of prevention of common diseases, prevention of dangerous infectious, viral and parasitic diseases, as well as for the purpose of	To know the causes and methods of prevention of dangerous infectious, viral and parasitic diseases, as well as methods of treatment of these diseases according to their medical and	Organize scientific and practical seminars for medical personnel and lectures for the public on prevention and treatment issues	Conduct preventive work and take anti-epidemic measures to prevent dangerous infectious, viral and parasitic diseases. Provide information on the sources of income and the	To be responsible for the quality and timeliness of prophylactic and anti-epidemic measures

	promoting timely detection and support of adherence to the treatment of these diseases according to their medico-biological characteristics and microbiological features.	biological characteristics and microbiological features. Know particularly dangerous ecotoxins, their entry into ecosystems and their impact on the human body.		mechanism of action of ecotoxins to prevent their negative impact on the population and the ecosystem.	
2	PC 6. The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication.	Know the peculiarity of the distribution of ecotoxins in organs, tissues and body fluids.	infectious, viral and parasitic diseases; diseases arising as a result of the effect of ecotoxins on human and animal bodies.	To substantiate the correctness of the choice of research objects for conducting toxicological and ecotoxicological studies	Be responsible for drawing up a plan for conducting toxicological and eco-toxicological studies.
3	PC 19. The ability to organize and carry out quality control of medicinal products in accordance with the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy, to determine sampling methods for the control of medicinal products and to carry out their standardization in accordance with current requirements, to prevent the distribution of falsified medicinal products.	Know the requirements of the current State Pharmacopoeia of Ukraine and proper practices in pharmacy for quality control of medicinal products and their standardization and environmental regulation. Carry out determination of xenobiotics in food products, water, soil and air. Know chemical and modern instrumental methods of analysis.	To be able to choose research objects for analysis, guided by knowledge about the distribution of ecotoxins in organs, tissues and body fluids.	To justify the chosen methods of xenobiotic research in various research objects.	To be responsible for the chosen methods of research of xenobiotics, depending on the object of research.
4	PC 20. The ability to develop methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, micro-biological, pharmaco-	Know the modern requirements for the organization and provision of environmental safety control of medicinal products. Know the specificity and sensitivity of various research methods. Know the standard procedures of statistical analysis.	Be able to choose appropriate methods of analysis for the detection and quantification of xenobiotics	Objectively evaluate the obtained results	Be responsible for conducting analysis and obtaining reliable and reproducible results.

technological and pharmaco-organolep-technical methods of control.				
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Learning outcomes:

Integrative end programmatic learning outcomes facilitated by the optional course in ecotoxicology:

PLO 1. To carry out professional activities in social interaction based on humanistic and ethical principles; to identify future professional activity as socially significant for human health.

PLO 2. Apply knowledge from general and specialized disciplines in professional activity.

PLO 3. To comply with the norms of the sanitary and hygienic regime and the requirements of safety equipment when carrying out professional activities.

PLO 4. Demonstrate the ability to independently search, analyze and synthesize information from various sources and use these results to solve typical and complex specialized tasks of professional activity.

PLO 5. To position one's professional activity and personal qualities on the pharmaceutical labor market; formulate the goals of one's own activity taking into account public and industrial interests.

PLO 6. Argue information for decision-making, bear responsibility for them in standard and non-standard professional situations; adhere to the principles of deontology and ethics in professional activity.

PLO 7. Perform professional activities using creative methods and approaches.

PLO 8. Carry out professional communication in the state language, use oral communication skills in a foreign language, analyzing specialized texts and translating foreign language information sources.

PLO 9. To carry out professional activities using information technologies, "Information databases", navigation systems, Internet resources, software and other information and communication technologies.

PLO 10. Adhere to the norms of communication in professional interaction with colleagues, management, consumers, work effectively in a team.

PLO 11. Use methods of evaluating indicators of the quality of activity; identify reserves for increasing labor efficiency.

PLO 12. Analyze information obtained as a result of scientific research, summarize, systematize and use it in professional activities.

PLO 13. To carry out sanitary and educational work in professional activities in the event of outbreaks of infectious, viral and parasitic diseases.

PLO 14. Determine the advantages and disadvantages of drugs of various pharmacological groups, taking into account their chemical, physicochemical, biopharmaceutical, pharmacokinetic and pharmacodynamic features. Recommend to consumers over-the-counter medicines and other products of the pharmacy assortment with the provision of advisory assistance and pharmaceutical care.

PLO 15. Provide pre-medical assistance to patients in emergency situations and victims in extreme situations.

PLO 16. Determine the influence of factors that affect the processes of absorption, distribution, deposition, metabolism and excretion of a medicinal product and are determined by the condition, features of the human body and the physicochemical properties of medicinal products.

PLO 17. To use the data of clinical, laboratory and instrumental studies to monitor the effectiveness and safety of the use of medicinal products.

PLO 18. Choose biological objects of analysis, determine xenobiotics and their metabolites in biological environments and evaluate the results obtained taking into account their distribution in the body.

PLO 19. Predict and determine the influence of environmental factors on the quality of medicines and consumer characteristics of other products of the pharmacy assortment during their storage.

PLO 24. Plan and implement professional activities on the basis of normative legal acts of Ukraine and recommendations of proper pharmaceutical practices.

PLO 25. Contribute to the preservation of health, in particular the prevention of diseases, the rational prescription and use of medicinal products. To faithfully fulfill one's professional duties, to comply with the legislation on the promotion and advertising of medicinal products. Possess psychological communication skills to achieve trust and mutual understanding with colleagues, doctors, patients, consumers.

PLO 27. To justify the technology and organize the production of medicinal products at pharmaceutical enterprises and draw up technological documentation for the production of medicinal products at pharmaceutical enterprises.

PLO 28. Organize and carry out rational procurement of medicinal plant raw materials. Develop and implement measures for the protection, reproduction and rational use of wild species of medicinal plants.

PLO 29. To ensure competitive positions and effective development of pharmaceutical organizations based on the conducted research work on all elements of the marketing complex.

PLO 30. Ensure quality control of medicines and document its results. To carry out quality risk management at all stages of the life cycle of medicinal products.

PLO 31. Carry out all types of quality control of medicinal products; draw up quality certificates of a series of medicinal products and a certificate of analysis, taking into account the requirements of current regulatory documents, the State Pharmacopoeia of Ukraine and the results of quality control. Develop specifications and quality control methods in accordance with the requirements of the current State Pharmacopoeia of Ukraine.

PLO 32. Determine the main organoleptic, physical, chemical, physicochemical and pharmacotechnological indicators of medicinal products, justify and choose methods of their standardization, carry out statistical processing of the results in accordance with the requirements of the current State Pharmacopoeia of Ukraine.

Learning outcomes for the optional discipline "Ecotoxicology":

Know:

- subject, tasks and main sections of ecotoxicology, its field of application;
- theoretical foundations of ecotoxicology - physical and chemical properties of toxicants, classification of ecotoxicants, basic mechanisms of their toxic effects on nature;
- mechanisms of adaptation of the organism to changes in the environment;
- conditions and factors affecting the atmosphere, hydrosphere and lithosphere;
- main characteristics of changes in the material composition of the environment due to human activity;
- basic principles of evaluation of the negative impact of toxicants on living organisms (environmental diagnostics);
- basic principles for preventing the negative impact of toxicants on living organisms (environmental prevention);
- basic principles of environmental improvement (ecosalvation);
- have an idea of the specific negative effects of toxicants on the flora and fauna and the method of analysis of individual toxins and edges on the biota;
- methods for toxicological studies of biological systems and their biomonitoring;

- basics of mathematical processing of results of ecotoxicological researches;
- basic literature and reference books on ecotoxicology.

Be able:

- analyze data from educational and specialized literature in solving professional problems related to ecotoxicological studies;
- predict the main mechanisms of ecotoxic activity of substances based on their chemical structure;
- anticipate possible types of eco-toxicity of substances based on their chemical structure;
- to evaluate the quality of water, air and soil for various needs;
- perform appropriate calculations, final calculations using statistical processing of analysis results;
- use specialized software in eco-toxicological studies;
- work independently with educational and reference books on eco toxicology;
- apply theoretical basics of ecological toxicology and acquired experimental skills in the study of specialized disciplines.

2. Information volume of the educational sample discipline – 3 credits and ECTS / 90 hours are allocated for the study of optional discipline._

Topic 1. Ecotoxicology as a science. The current state of the environment.

Prerequisites for the occurrence of environmental toxicology. History of formation of ecotoxicology as a science. Combining the concepts of "ecology" and "toxicology". Communication with other sciences. Characteristics of the subject, tasks and objects of ecological toxicology. Special types of toxicology. Scientific and practical problems of modern ecotoxicology.

Ecological crisis and its relation to the state of natural ecosystems. Environmental pollution. The main types of pollutants in their home environment and their sources. Atmospheric pollution. Types of pollution of the aquatic environment. Priority scientific areas. Practical results of research. The main classes of toxic substances. Xenobiotics, super ecotoxicants, "dirty dozen". The concept of persistence. There are three main groups of pollution: point (local), chronic (regional), global.

Topic 2. Toxic substances in different environments. Classification principles of toxic substances.

Formation of environmental pollution by toxic substances under the influence of economic activity. Practical classification of poisonous substances. Industrial poisonous substances. Pesticides. Effect of pesticides on living organisms and soil system. Selective exposure classification of toxic substances.

Principles of substance toxicity assessment in ecosystems. Levels of biological effects and systems of toxicological characteristics. Threshold concept of a harmful substance. Stock ratio. Accumulation of harmful substances. Accumulation factor. Combined effect of poisons. Adaptation and compensation during exposure to harmful substances. Addictive. Manifestations of poison action Sensitization. Addictively, synergism and antagonism during the joint impact of harmful environmental factors.

Topic 3. Characteristics of pollutants and parameters of toxicity assessment.

Experimental determination of toxicometric parameters. Hygienic regulation and standardization of xenobiotics. Assessment of the degree of ecotoxicity. Environmental Impact Assessment (EIA). Scientific, legislative and regulatory framework of the EIA. Basic principles of hygienic regulation of chemicals. Ecological and hygienic regulation of the state of ecosystems. Environmental certification of food products. Parameters of ecosystems that n and are required for registration under environmental regulation. The sequence of environmental rationing. The main criteria for determining the allowable environmental load. Methods for determining load limit values.

Topic 4. Ecotoxicokinetics.

Eco-pollutants in the environment. Persistence of xenobiotics in the environment. Transformation of toxic substances in the environment. The concept of "ecotoxicokinetics". Acute and chronic ecotoxicity. Xenobiotic profile of the environment. Migration and stability of chemicals in the environment. Factors affecting bioaccumulation. Ecological magnetization. Biomagnification.

Topic 5. Ecotoxicodynamics.

The concept of "ecotoxicodynamics". Direct and indirect effect of xenobiotic profile of the environment on biotic or abiotic components of the habitat population. Consequences of indirect effects of toxicants on the environment. Bioaccumulation. Abiotic transformation of pollutants in the atmosphere, water and soil. Biotransformation of ecotoxicants in the body. Ecotoxicological effects on populations and ecosystems.

Topic 6. Mechanism of action of xenobiotics in the body. Patterns of forming toxic at Art and poisons.

The concept of mechanism of toxic action. Toxic receptors. Primary action receptors. Occupation theory of A. Clark. Basics of the modern theory of toxicity receptors. Characteristics called communication toxin receptor (ionic, covalent, hydrogen, Van der Waals forces). The effect of toxicants on the structural elements of cells.

Relation toxicity to the structure and physicochemical properties of poisons. Formation is the toxicity of a substance, depending on the molecular weight, size and spatial structure of the toxicant molecules. The main regularities of the effect of isomerism on the toxicity of substances. Factors affecting the toxicity of substances.

Topic 7. The main toxicants in agricultural products.

Substances used in crop production. Chemicals for plant protection: pesticides, growth regulators, mineral fertilizers. Contamination with substances and compounds used in animal husbandry: antibacterial, hormonal preparations, nitrogen-containing feed additives. Effect of toxic substances on ontogeny, immune status of the body and the like.

Topic 8. Food contamination.

Food contamination by microorganisms and their metabolites: bacterial toxicosis and toxic infections. Mycotoxins and mycotoxicosis. Sanitary criteria for the safety of food raw materials and foodstuffs. Sanitary and hygienic evaluation of drinking water.

Topic 9. Anthropogenic pollution of the environment.

Air pollution by producing organisms, bacterial preparations and their components.

Heavy metals. Dioxins and their derivatives. Hydrocarbon pollution. Polycyclic aromatic hydrocarbons. Biphenyls. Polycyclic aromatic and chlorine-containing hydrocarbons. Contamination with substances and compounds used in everyday life: phthalates, formaldehyde, chlorine, surfactants.

Pharmaceutical pollution. Pharmaceutical ecology. The problem of garbage collection and recycling. The main pollutants formed from solid household waste.

Topic 10. Modern concepts of chemical carcinogenesis.

Mutagen Mr. A and carcinogenic effect chemicals. Classification of carcinogens. Polycyclic aromatic hydrocarbons. Nitrosamines. Aromatic amine. Heterocyclic amines. Nitro compounds. Aflatoxin B1. Arsenic. TCDD. Tobacco pyrolysis products. Benzpiren. Asbestos. Sources and ways of receiving radionuclides into the body. External and internal irradiation. Biological effects of ionizing radiation on the human body. Units and doses of human exposure. Technological ways of reducing radionuclide content in food.

Topic 11. The effects of water pollution and x ecosystems.

The problem of "clean water". Features of the aquatic environment as habitat. Water quality regulation. Water quality and types of water use. The main indicators of water quality. Water classification by integrated quality indicators. Biological indication of reservoirs. The concept of saprobity. Water capability system. Poly - meso- and oligosaprobic zones. The concept of toxicity. Classification of polluted waters. Natural and anthropogenic eutrophication of reservoirs.

Cultural eutrophication. Influence of metal and acid pollution on components of aquatic ecosystems. Thermal pollution. Biological self-purification of reservoirs. Mineralization work of hydrobionts. Hydrobiont accumulation of harmful substances. Hydrobiont transit of contamination from water to soil.

Topic 12. Population environmental toxicology.

Environmental diagnostics, bio-indication and environmental monitoring. Basic criteria of ecological and hygienic regulation. Sources of pollutants to the environment. Toxicological characteristics of pollutants. Xenobiotic profile of the environment. Estimation methods, limit values. Environmental regulations. Regulations. Environmental monitoring. Classification of environmental monitoring. Forms of migration of pollutants between natural environments. Soil-environmental monitoring. Criteria for assessing the environmental cleanliness of the site Regulations.

Topic 13. Ecotoxicants and humans. Human protection from hazardous substances in domestic and industrial conditions.

Impact of pollution on the human body. State of the environment and the incidence rate. The resistance of the body. Isolated, combined, complex or combined effect of factors on a person. Chemical pollution and human health. The risk of exposure to the polluted atmosphere: mass action, diversity of pollutants, direct access to the internal environment of the body, the difficulty of protection against antibiotics. Classification of pollutants by human effects. Sensitivity of the organism at different stages of ontogeny.

Rules of conduct in industrial emergencies. First aid in the defeat of various substances. The effect of antidotes. Ecological catastrophes.

3. Structure of the educational sample discipline

Topic	Number of hours			
	Lectures	Practice	ISW	Ind. work
Topic 1. Ecotoxicology as a science. The current state of the environment.	1	2	3	-
Topic 2. Toxic substances in different fields. Principles of classification of toxic substances.	1	2	3	-
Topic 3. Characterization of pollutants and parameters of toxicity assessment.	1	2	4	-
Topic 4. Ecotoxicokinetics.	1	2	4	-
Topic 5. Ecotoxicodynamics.	1	2	4	-
Topic 6. Mechanism of action of xenobiotics in the body. Patterns of formation of toxicity of poisons.	1	4	4	-
Topic 7. Major toxicants in agricultural products.	1	2	4	-
Topic 8. Food contamination.	1	2	4	-
Theme 9. Anthropogenic pollution of the environment.	1	2	4	-
Topic 10. Modern concepts of chemical carcinogenesis.	1	2	4	-
Topic 11. Consequences of pollution of aquatic ecosystems.	1	2	4	-
Topic 12. Population environmental toxicology.	1	2	4	-
Topic 13. Ecotoxicants and humans.	1	2	2	-
Topic 14. Human protection from hazardous substances in domestic and industrial conditions. Final lesson of the practical course. Enrollment of student's independent work.		2	2	-
Total	20	30	50	

4. Thematic plan of lectures

No	Topic of the lecture	Hours
1.	Ecotoxicology as a science. The current state of the environment. Toxic substances in different environments.	2
2.	Principles of classification of toxic substances. Characteristics of pollutants and toxicity assessment parameters.	2
3.	The main toxicants in agricultural products. Food contamination.	2
4.	Anthropogenic pollution of the natural environment. Biomonitoring. Modern ideas about chemical carcinogenesis.	2
5.	Population ecological toxicology. Ecotoxicants and man.	2
Total		10

5. A thematic plan of practical lessons

No	Topic	Hours
1.	Ecotoxicology as a science. The current state of the environment.	2
2.	Toxic substances in different environments. Principles of classification of toxic substances.	2
3.	Characteristics of pollutants and parameters of toxicity assessment.	2
4.	Ecotoxicokinetics.	2
5.	Ecotoxicodynamics.	2
6.	Mechanism of action of xenobiotics in the body.	2
7.	Patterns of formation of toxicity of poisons.	2
8.	The main toxicants in agricultural products.	2
9.	Food contamination.	2
10.	Anthropogenic pollution of the environment.	2
11.	Modern concepts of chemical carcinogenesis.	2
12.	Consequences of pollution of aquatic ecosystems.	2
13.	Population environmental toxicology.	2
14.	Ecotoxicants and humans. Final lesson.	2
15.	Human protection from hazardous substances in domestic and industrial conditions. Score.	2
Total		30

6. Thematic plan of students' independent work

No	Topic	Hours	Kind of control
1.	Ecological crisis and its relation to the state of natural ecosystems. Environmental pollution. The main types of pollutants in their home environment and their sources. Atmospheric pollution. Types of pollution of the aquatic environment. Priority scientific areas. Practical results of research. The main classes of toxic substances. Xenobiotics, super ecotoxicants, "dirty dozen". The concept of persistence. There are three main groups of pollution: point (local), chronic (regional), global.	3	Current control over practical classes

2.	Principles of substance toxicity assessment in ecosystems. Levels of biological effects and systems of toxicological characteristics. Threshold concept of a harmful substance. Stock ratio. Accumulation of harmful substances. Accumulation factor. Combined effect of poisons. Adaptation and compensation during exposure to harmful substances. Addictive. Manifestations of poison action Sensitization. Additivity, synergism and antagonism during the joint impact of harmful environmental factors.	3	
3.	Basic principles of hygienic regulation of chemicals. Ecological and hygienic regulation of the state of ecosystems. Environmental certification of food products. Parameters of ecosystems that n and are required for registration under environmental regulation. The sequence of environmental rationing. The main criteria for determining the allowable environmental load. Methods for determining load limit values.	4	
4.	Xenobiotic profile of the environment. Migration and stability of chemicals in the environment. Factors affecting bioaccumulation. Ecological magnetization. Biomagnification.	4	
5.	Bioaccumulation. Abiotic transformation of pollutants in the atmosphere, water and soil. Biotransformation of ecotoxicants in the body. Ecotoxicological effects on populations and ecosystems.	4	
6.	Relationship of toxicity to the structure and physicochemical properties of poisons. Formation is the toxicity of a substance, depending on the molecular weight, size and spatial structure of the toxicant molecules. The main regularities of the effect of isomerism on the toxicity of substances. Factors affecting the toxicity of substances.	4	
7.	Contamination with substances and compounds used in animal husbandry: antibacterial, hormonal preparations, nitrogen-containing feed additives. Effect of toxic substances on ontogeny, immune status of the body and the like.	4	
8.	Mycotoxins and mycotoxicosis. Sanitary criteria for the safety of food raw materials and foodstuffs. Sanitary and hygienic evaluation of drinking water.	4	
9.	Pharmaceutical pollution. Pharmaceutical ecology. The problem of garbage collection and recycling. The main pollutants formed from solid household waste.	4	
10.	Sources and ways of receiving radionuclides into the body. External and internal irradiation. Biological effects of ionizing radiation on the human body. Units and doses of human exposure. Technological ways of reducing radionuclide content in food.	4	
11.	Classification of polluted waters. Natural and anthropogenic eutrophication of reservoirs. Cultural eutrophication. Influence of metal and acid pollution on components of aquatic ecosystems. Thermal pollution. Biological self-purification of reservoirs. Mineralization work of hydrobionts. Hydrobiont accumulation of harmful substances. Hydrobiont transit of contamination from water to soil.	4	
12.	Xenobiotic profile of the environment. Estimation methods, limit values. Environmental regulations. Regulations. Forms of migration of pollutants between natural environments. Soil-environmental	4	

	monitoring. Criteria for assessing the environmental cleanliness of the site Regulations.		
13.	Environmental monitoring. Classification of environmental monitoring. Biomonitoring.	4	
	Total	40	

7. There are no individual tasks *for full-time students*.

Tasks for independent work

1. Toxicological and ecotoxicological characteristics of mercury.
2. Toxicological and ecotoxicological characteristics of lead.
3. Toxicological and ecotoxicological characteristics of cadmium.
4. Toxicological and ecotoxicological characteristics of metals (tin, arsenic, zinc, copper, iron).
5. Toxicological and ecotoxicological characteristics of sulfur oxides.
6. Toxicological and ecotoxicological characteristics of harmful gases (nitrogen and carbon oxides).
7. Toxicological and ecotoxicological characteristics of chlorine hydrocarbons (freons).
8. Toxicological and ecotoxicological characteristics of organic solvents (gasoline, toluene, etc.).
9. Toxicological and ecotoxicological characteristics of dioxins and dioxin-like substances.
10. Toxicological and ecotoxicological characteristics of pesticides (insecticides).
11. Toxicological and ecotoxicological characteristics of pesticides (herbicides).
12. Toxicological and ecotoxicological characteristics of polycyclic aromatic hydrocarbons (benzpyrene and its derivatives, others).
13. Toxicological and ecotoxicological characteristics of petroleum and petroleum products.
14. Toxicological and ecotoxicological characteristics of mineral fertilizers.
15. Toxicological characteristics of mycotoxins (toxic metabolites of molds).
16. Toxicological and ecotoxicological characteristics of nitrates, nitrites and nitro compounds.
17. Toxicological characteristics of surfactants.
18. Zootoxins and their toxicological characteristics.
19. Mushroom toxins, their toxicological characteristics.
20. Phytotoxins, their toxicological characteristics.
21. Metabolism of xenobiotics in the environment.
22. Poisons and their effects: the accumulation and combined action of poisons.
23. Behavior of chemicals in the environment.
24. Sanitary-hygienic assessment of water by the organoleptic method.
25. Biological control methods.
26. Environmental rationing.
27. Ecological-analytical monitoring of environmental pollution: common problems.
28. Methods for sampling ecotoxicants.
29. Metabolic processes that occur with toxicants in living systems.
30. Toxicants and their biogeochemical features.
31. Criteria and concepts for substance toxicity assessment.
32. Aquatic toxicology: sources of toxicant input into the aquatic environment and major components of water pollution.
33. Toxic substances into hydrobiont tissues and detoxification pathways.
34. Effect of xenobiotics on aquatic organisms and populations.
35. Influence of environmental factors and body properties on the degree of toxic effect.
36. Basic laws of dynamics of toxic action.
37. Identification and classification of environmental toxicants.
38. Bioindication and biotesting.

39. Toxicants in our food.
40. Environmental terrorism: essence, problems, ways of elimination.
41. Ecotoxicological issues of the food industry.
42. Ecotoxicological problems of the pharmaceutical industry.
43. Problems of household ecotoxicology.
44. Ecotoxicological problem of environmental pollution by motor vehicle emissions.
45. Ecotoxicological problem of sewage and sewage.
46. Ecotoxicological problems of waste disposal.
47. Social Toxicants: Distribution and Distribution in the Region.

8. Teaching methods

In the course of studying optional discipline "Ecotoxicology" the following teaching methods of students are applied:

by sources of knowledge:

- verbal - lecture, explanation, instructing;
- visual - demonstration, illustration;
- practical - practical work, situational tasks.

by the nature of the logic of cognition:

- analytical,
- synthetic,
- analytical and synthetic,
- inductive, deductive.

by level of independent mental activity:

- problematic,
- partial search,
- research.

by the main stages of the process:

- the formation of knowledge,
- developing skills,
- applying knowledge,
- generalization,
- fixing,
- audit

on a systematic approach:

- stimulation and motivation,
- control and self-control

9. Control methods

Current control is carried out at each practical session according to the specific objectives of the topic. All practical classes use objective control of independent work, theoretical training and mastering practical skills.

The following means of diagnostics of the level of preparation of students are applied: testing, solving of situational problems, carrying out of laboratory researches, interpretation and evaluation of their results, control of practical skills.

At each practical session the student answers the test tasks (by topic of the practical lesson, standardized questions, knowledge of which is necessary for understanding the current topic, questions of the lecture course and independent work, related to the current lesson; demonstrates knowledge and skills of practical skills in accordance with the topic of the practical lesson).

The form of final control in the study of optional discipline "Ecotoxicology" is **the credit**. Final control is allowed for students who have completed all types of work required by

the curriculum, have completed all training sessions, and have earned points above the minimum level when studying the module.

Methods and means of standardized assessment in the preparation of final control

Setting off the score

The form of final control is standardized, including control of theoretical and practical training.

Final control consists of writing the second answer format tests (blank). The student is responsible for 40 tests with each format th theme module and evaluated 2 point and for every correct answer.

The credit score is determined by the sum of points for the answers to the test tasks.

The maximum score is 80. The minimum score is 50.

10. Current control is carried out during the training sessions and is aimed at checking students' mastering of educational material. Forms of assessment of current educational activities are standardized and include control of theoretical and practical training.

10.1 Evaluation of current learning activities. At each practical session, the student answers 10 tests, 5 questions on the topic of the practical lesson, knowledge of which is necessary for understanding the current topic, the questions of the lecture course and independent work related to the current lesson.

Evaluation criteria

I. Current control. Each class assesses students' knowledge on a 4-point (national) scale. This takes into account all types of work provided by the program of optional discipline. The student receives a grade on each topic to further convert the grades into scores on a multi-scale (200-point) scale.

Excellent ("5"). The student correctly answered 100-90% of the tests of format A. Correctly, clearly, logically and completely answers to standardized questions of the current topic, including questions of the lecture course and independent work. Closely binds theory to practice and correctly demonstrates the implementation (knowledge) of practical skills. Freely reads the results of analyzes, solves situational problems of increased complexity, is able to generalize material, has methods of chemical analysis. The laboratory work is done in full and the student freely and correctly explains the research and gives them an assessment.

Good ("4"). The student correctly answered 70-89% of A-format tests, correctly and essentially answers the standardized questions of the current topic, lecture course and independent work. Demonstrates the implementation (knowledge) of practical skills. Correctly uses theoretical knowledge to solve practical problems. Able to solve light and medium complexity situational problems. Possesses the necessary practical skills and techniques of their implementation in the amount that exceeds the required minimum. Laboratory work is done with minor errors, but the student correctly explains the research and gives them an assessment.

Satisfactory ("3"). The student correctly answered 50-69% of tests of format A. Incomplete, with the help of additional questions, answers standardized questions of the current topic, lecture course and independent work. Can not independently build a clear, logical answer. The student makes mistakes while answering and demonstrating practical skills. The student solves only the easiest problems, possesses only the obligatory minimum of methods of research. The laboratory work is made with mistakes, the student cannot fully explain the conducted research.

Unsatisfactory ("2"). The student answered less than 50% of A-format tests. Does not know the material of the current topic, can not construct a logical answer, does not answer additional questions, does not understand the content of the material. He makes significant, gross

mistakes when answering and demonstrating practical skills. Laboratory work is not completed or the student cannot explain the research.

At each practical session, the student's knowledge is assessed by a four-point system ("5", "4", "3", "2") according to the criteria for evaluating the student's current activity.

Independent work of the student is evaluated during the current control of the topic in the relevant classroom. Assessment of topics presented for self-study and not included in the topics of classroom training, is controlled during the final control work and examination.

11. A form of final control of the success of training in the study of the optional discipline "Ecotoxicology" is credit.

12. Scheme of calculation and distribution of points that students receive:

The maximum number of points that a student can earn for his / her current educational activity for admission to the exam is 200 points.

The minimum number of points, which student can get for current activities for admission to the assembly offset is 120 marks.

The calculation of the number of points is made on the basis of the student's scores on a 4-point scale, by calculating the arithmetic mean (CA), rounded to two decimal places. The resulting value is converted to scores on a multicolour scale as follows: $x = CA \times 120/5$

The conversion of the average estimate for the current activity into a multicolor scale is made according to the table:

Recalculation of the average score for the current activity into a multi-scale scale

4-point scale	5	4.97	4.95	4.92	4.9	4.87	4.85	4.82	4.8	4.77	4.75	4.72	4.7
200-point scale	200	199	198	197	196	195	194	193	192	191	190	189	188
4-point scale	4.67	4.65	4.62	4.6	4.57	4.52	4.47	4.45	4.42	4.4	4.37	4.35	4.32
200-point scale	187	186	185	184	183	181	180	178	177	176	175	174	173
4-point scale	4.3	4.27	4.24	4.22	4.19	4.17	4.14	4.12	4.09	4.07	4.04	4.02	3.99
200-point scale	172	171	170	169	168	167	166	165	164	163	162	161	160
4-point scale	3.97	3.94	3.92	3.89	3.87	3.84	3.82	3.79	3.77	3.74	3.72	3.7	3.67
200-point scale	159	158	157	156	155	154	153	152	151	150	149	148	147
4-point scale	3.65	3.62	3.57	3.55	3.52	3.5	3.47	3.45	3.42	3.4	3.37	3.35	3.32

200-point scale	146	145	143	142	141	140	139	138	137	136	135	134	133
4-point scale	3.3	3.27	3.25	3.22	3.2	3.17	3.15	3.12	3.1	3.07	Less than 3		
200-point scale	132	131	130	129	128	127	126	125	124	123	Not enough		

Students individual work is evaluated during the current control of the topic in the relevant classroom. Assessment of topics presented for self-study and not included in the topics of classroom training, is controlled during the final control work and examination.

The maximum number of points that can be scored by a student when passing the test is 80.

The minimum number of credits in the course of crediting - not less than 50.

Ranking with assignment of grades "A", "B", "C", "D", "E" is made for the students of this course, who study in one specialty and have successfully completed the study of optional discipline. Students who have received FX, F ("2") grades are not included in the ranking student list. Students with an FX score automatically receive an "E" grade upon transfer.

Discipline points for students who have successfully completed the program are converted to the traditional 4-point scale by the absolute criteria given in the table below:

Score from discipline	Score on a 4-point scale
170 to 200 points	5
From 140 to 169 points	4
From 139 points to the minimum number of points a student must score	3
Below is the minimum number of points a student must score	2

The ECTS score is not converted to the traditional scale because the ECTS scale and the four-point scale are independent.

The objectivity of the evaluation of students' educational activity is verified by statistical methods (the correlation coefficient between the ECTS grade and the national scale grade).

13. Methodological support

The list and content of educational and methodological support for the study of the optional discipline "Ecotoxicology" includes:

- synopsis or extended lesson plan;
- thematic plans of lectures, practical classes, independent work of students;
- tasks for laboratory work and independent work of students;
- questions, tasks, tasks for the current and final control of students' knowledge and skills, complex control work, post-certification monitoring of acquired knowledge and skills in the optional discipline.

14. Recommended Literature

Basic

1. Newman M. C. Fundamentals of Ecotoxicology. The Science of Pollution. – CRC Press, 2020. – 708 p.

2. Landis W., Sofield R., Yu Ming-Ho Introduction to Environmental Toxicology: Molecular Substructures to Ecological Landscapes. – CRC Press, 2017. – 490 p.

Auxiliary

1. Jorgenson S.E. Modeling in Ecotoxicology. – Amsterdam, Oxford, New York, Tokyo: Elsevier, 1990. – 353 p.
2. Medicines: rational use of medicines. Geneva: World Health Organization; 2010 (WHO factsheet No. 338).
3. European Environment Agency. Pharmaceuticals in the environment: results of an EEA Workshop. Copenhagen: EEA; 2010 (EEA Technical Report No 1/2010).
4. Fent K., Weston A., Caminada D. Ecotoxicology of human pharmaceuticals // Aquatic Toxicology. – 2005. – 76. – P. 122-159.

15. Information resources:

- libraries
- internet resource

- lecture material