WORKING CURRICULUM OF THE SELECTIVE COURSE

ECOTOXICOLOGY

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
Protocol No 1 from 31.08.2021.
Head of Toxicological and Analytical
Chemistry department
Assoc. Prof. I.J. Halkevych

Approved
the profile methodical commission
of Pharmaceutical Disciplines
Protocol No 1 from 31.08.2021.
Head of the methodical commission of
Pharmaceutical Disciplines
Assoc. prof. S.B. Bilous

Lviv – 2021
Working curriculum of the elective course Ecotoxicology for 4th year students of the Faculty of Pharmacy, studying in the specialty 226 "Pharmacy, Industrial Pharmacy" worked out associated professor Bidnychenko Yu.I. on the basis of the sample program of the discipline Ecotoxicology, approved by the State Institution "Central Methodical Cabinet for Higher Medical Education of the Ministry of Health of Ukraine" and the curriculum approved by the profile methodical commission (Protocol No 3 from 30.08.2019.)

Changes and additions to the curriculum for the academic discipline
for 2021-2022 academic year

<table>
<thead>
<tr>
<th>No</th>
<th>Contents of changes (additions)</th>
<th>Date and protocol No of the department meeting</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Updated bibliography</td>
<td>No 1 from 31.08.2021</td>
<td></td>
</tr>
</tbody>
</table>

Head of Toxicological and Analytical Chemistry department

Assoc. Prof. Halkevych I.J.
INTRODUCTION

The educational program of the elective discipline "Ecotoxicology" was elaborated by the lecturer of the department of toxicological and analytical chemistry Assoc. Prof. Bidnchenko Yu.I. and is based on the industry standard of higher education in accordance with the curriculum.

The work program of the elective 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 OKH); 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 elective 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 work curriculum of the elective 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 biocoenotic 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.
DESCRIPTION OF THE CURRICULUM
Elective discipline "Ecotoxicology" for students of the Faculty of Pharmacy, specialty 226 "Pharmacy", qualification - pharmacist

Types of educational activities according to the curriculum are: a) lectures, b) seminars and classes, c) independent work of students (VTS).

<table>
<thead>
<tr>
<th>Structure of the discipline</th>
<th>Number of credits, hours, of them</th>
<th></th>
<th></th>
<th>Year of study / semester</th>
<th>Types of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course title: Ecotoxicology</td>
<td>3,0 credit and / 90 year</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>IV course (7-8 semester)</td>
</tr>
</tbody>
</table>

Note: 1 ECTS credit - 30 hours; classroom load - 56, 0%; CPC - 44, 0%.

The subject of study of the elective 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 elective 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 elective 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 elective 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;

**common:**
- the ability to apply knowledge in practical situations;
- knowledge and understanding of the subject area and understanding of the profession;
- DA atnist to abstract thinking, analysis and synthesis, capacity to learn and to master modern ymi knowledge;
- Nav ychky use of information and communication technologies;
- the ability to evaluate and ensure the quality of the work performed;
- the ability to conduct research at an appropriate level;
- the desire to preserve the environment;

**with special (specialty, subject):**
- the ability to analyze data from educational and specialized literature when solving professional problems related to ecotoxicological studies;
- the ability to organize research to determine the ecotoxicological parameters of chemical safety;
- ability to analyze and interpret the results obtained during the study;
- ability to predict possible mechanisms of toxic action;
- the ability to use specialized software in eco-toxicological studies;
- the ability of documented eco-toxicological studies (maintenance workbook).

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

**Competence Matrix**

<table>
<thead>
<tr>
<th>No</th>
<th>Competence</th>
<th>Knowledge</th>
<th>Skill</th>
<th>Communication</th>
<th>Autonomy and responsibility-ness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

**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**

<p>| 1  | Ability to apply knowledge in practical situations | Have specialized conceptual knowledge acquired in the learning process. | Be able to solve complex problems and problems that arise in professional activity. | Clear and unambiguous report their findings, knowledge and explanations that they are grounded in to specialists and | Responsible for decision-making under difficult circumstances |</p>
<table>
<thead>
<tr>
<th></th>
<th>Knowledge and understanding of the subject area and understanding of the profession</th>
<th>Have deep knowledge of the structure of professional activity.</th>
<th>Be able to perform professional activities that require updating and integration of knowledge.</th>
<th>Ability to effectively shape communication strategy in professional activities.</th>
<th>Carry liability - range for professional development, the ability to further professional training with a high level of autonomy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Ability to think abstractly, analyze and synthesize, to be able to learn and to be modernly taught.</td>
<td>Know the methods of analysis, synthesis and further modern learning.</td>
<td>Be able to analyze information, make informed decisions, and be able to acquire modern knowledge.</td>
<td>Establish appropriate links to achieve goals.</td>
<td>Carry liability - range for the timely acquisition of modern knowledge.</td>
</tr>
<tr>
<td>3</td>
<td>Use of information and communication technologies</td>
<td>Have a thorough knowledge of information and communication technologies used in professional activities</td>
<td>Able to use ICT professional field that requires updating and integration of knowledge</td>
<td>To use information and communication technologies in professional activity</td>
<td>Carry liability - range for the development of professional knowledge and skills</td>
</tr>
<tr>
<td>4</td>
<td>Ability to evaluate and ensure the quality of work performed</td>
<td>Know the methods of evaluating performance indicators</td>
<td>Be able to provide quality work</td>
<td>Establish links to ensure the quality of work</td>
<td>Carry liability - range for quality work</td>
</tr>
<tr>
<td>5</td>
<td>Given that research is at an appropriate level</td>
<td>Know the components of the health care system, plan and evaluate research</td>
<td>Search for scientific sources of information; to choose the methods of scientific research, to use the methods of mathematical analysis and modeling, theoretical and experimental research in pharmacy</td>
<td>Use information from scientific sources</td>
<td>Carry liability - range development and implementation of planned projects</td>
</tr>
<tr>
<td>6</td>
<td>The desire to preserve the environment</td>
<td>Know the problems of environmental conservation and how to conserve it</td>
<td>Be able to formulate requirements for yourself and others for environmental protection</td>
<td>Make proposals to the relevant authorities and agencies on conservation and environmental protection measures</td>
<td>Carry liability - a range of measures for the implementation of environmental conservation within their competence</td>
</tr>
</tbody>
</table>

**Special competences**

1. **On the usefulness**
   - Know the current
   - To be able to
   - To justify the
   - Carry liability -
<table>
<thead>
<tr>
<th>#</th>
<th>Learning outcomes:</th>
</tr>
</thead>
</table>
| 2 | **Learning outcomes:**  
Integrative end programmatic learning outcomes facilitated by the elective course in ecotoxicology:  

**general:**  
– apply knowledge of general and professional disciplines in professional activity;  
– use the results of independent search of scientific and professional information using modern computer tools, network technologies, databases and knowledge;  
– to reason information for decision-making, to be responsible for them in standard and non-standard professional situations; adhere to the principles of deontology and ethics in professional activity;  
– to use methods of estimating quality of activity indicators; identify reserves for improving labor efficiency;  
– to analyze the information obtained as a result of scientific researches, to generalize, systematize and use it in professional activity  
– independently apply the methods and means of cognition, training and self-control to acquire new knowledge and skills.  

**special:**  
– carrying out scientific researches both as a part of a group and independently, while realizing special means and methods of obtaining new knowledge;  

From usefulness to predict possible mechanisms eco toxic effects  
Know eco toxicological tech properties of xenobiotics  
Be able to use toxicological models to calculate ecotoxicological parameters  
Grounded evaluate the results of toxicologist IR them and ecotoxicological research  
Carry liability - range for the decision on the evaluation of the results of research on the ecological safety of medicines  

On the usefulness specialized software for toxicological studies.  
Know the mathematical model for calculating toxicological and eco toxicological options  
Be able to use special software to calculate eco-safety parameters of medicines  
Grounded evaluate the results of toxicologic governmental and ecotoxicological payments  
Carry liability - range for the decision on the evaluation results of ecological safety of medicines  

To analyze and interpret the results obtained during the study  
Know standard statistical analysis procedures  
Be able to justify the size of the sample, apply methods of statistical analysis, to provide the results of statistical data processing.  
It is reasonable to evaluate the results obtained.  
Carry liability - range for analysis and obtain reliable and reproducible results.
the ability to organize research to determine the various types of toxicity and safety of the substances under study;
ability to predict the main mechanisms of toxic action of substances on the basis of their chemical structure;
the ability to anticipate possible mechanisms eco toxic effects of the substance;
ability to determine the main indicators of eco-safety of medicines by their toxicological parameters.

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 elective 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.

**Theme 2. Toxic substances in different environments.** Principle classification of toxic substances.


**Theme 3. Characteristics of pollutants and parameters of toxicity assessment.**


**Theme 4. Ecotoxicokinetics.**


**Theme 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.

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


**Theme 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

**Theme 8. Food contamination.**

**Theme 9. Anthropogenic pollution of the environment.**

**Theme 10. Modern concepts of chemical carcinogenesis.**

**Theme 11. The effects of water pollution and x ecosystems.**

**Theme 12. Population environmental toxicology.**

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

**3. Structure of the educational sample discipline**
<table>
<thead>
<tr>
<th>Topic</th>
<th>Number of hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lectures</td>
</tr>
<tr>
<td><strong>Topic 1.</strong> Ecotoxicology as a science. The current state of the environment.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Topic 2.</strong> Toxic substances in different fields. Principles of classification of toxic substances.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Topic 3.</strong> Characterization of pollutants and parameters of toxicity assessment.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Topic 4.</strong> Ecotoxicokinetics.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Topic 5.</strong> Ecotoxicodynamics.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Topic 6.</strong> Mechanism of action of xenobiotics in the body. Patterns of formation of toxicity of poisons.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Topic 7.</strong> Major toxicants in agricultural products.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Topic 8.</strong> Food contamination.</td>
<td>2</td>
</tr>
<tr>
<td><strong>Theme 9.</strong> Anthropogenic pollution of the environment.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Topic 10.</strong> Modern concepts of chemical carcinogenesis.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Topic 11.</strong> Consequences of pollution of aquatic ecosystems.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Topic 12.</strong> Population environmental toxicology.</td>
<td>1</td>
</tr>
<tr>
<td><strong>Topic 13.</strong> Ecotoxicants and humans.</td>
<td>1</td>
</tr>
</tbody>
</table>

Human protection from hazardous substances in domestic and industrial conditions. **Final lesson** of the practical course.

Enrollment of student's independent work. **Score off.**

**Total** 20 30 40

### 4. Thematic plan of lectures

<table>
<thead>
<tr>
<th>No.</th>
<th>Topic of the lecture</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ecotoxicology as a science. The current state of the environment. Toxic substances in different environments.</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Ecotoxicokinetics.</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>Ecotoxicodynamics.</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>Mechanism of action of xenobiotics in the body. Patterns of formation of toxicity of poisons.</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>The main toxicants in agricultural products.</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>Food contamination.</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>Anthropogenic pollution of the environment. Modern concepts of chemical carcinogenesis.</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>Consequences of pollution of aquatic ecosystems. Biomonitoring.</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Population environmental toxicology. Ecotoxicants and humans.</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total** 20

### 5. A thematic plan of practical lessons

<table>
<thead>
<tr>
<th>No.</th>
<th>Topic</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ecotoxicology as a science. The current state of the environment.</td>
<td>2</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>No</th>
<th>Topic</th>
<th>Hours</th>
<th>Kind of control</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>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, &quot;dirty dozen&quot;. The concept of persistence. There are three main groups of pollution: point (local), chronic (regional), global.</td>
<td>2</td>
<td>Current control over practical classes</td>
</tr>
<tr>
<td>3.</td>
<td>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 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.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Xenobiotic profile of the environment. Migration and stability of chemicals in the environment. Factors affecting bioaccumulation. Ecological magnetization. Biomagnification.</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Bioaccumulation. Abiotic transformation of pollutants in the atmosphere, water and soil. Biotransformation of ecotoxicants in the body. Ecotoxicological effects on populations and ecosystems.</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
### 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.


### 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.


<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>40</td>
</tr>
</tbody>
</table>

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

#### 8. 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. Zoototoxins 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.
25. Biological control methods.
27. Ecological-analytical monitoring of environmental pollution: common problems.
29. Metabolic processes that occur with toxicants in living systems.
30. Toxicants and their biogeochemical features.
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.
37. Identification and classification of environmental toxicants.
38. Bioindication and biotesting.
39. Toxicants in our food.
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.

9. Learning methods

In the course of studying elective 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:
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

10. Control methods

Ongoing 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 elective 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 on the 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.

11. 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.

11.1 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 elective 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.

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

13. 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: $x = CA \times \frac{120}{5}$

The conversion of the average estimate for the current activity into a multicolor scale is made according to the table:
Recalculation of the average analytical chemistry score for the current activity into a multi-scale scale

<table>
<thead>
<tr>
<th>4-point scale</th>
<th>5</th>
<th>4.97</th>
<th>4.95</th>
<th>4.92</th>
<th>4.9</th>
<th>4.87</th>
<th>4.85</th>
<th>4.82</th>
<th>4.8</th>
<th>4.77</th>
<th>4.75</th>
<th>4.72</th>
<th>4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-point scale</td>
<td>200</td>
<td>199</td>
<td>198</td>
<td>197</td>
<td>196</td>
<td>195</td>
<td>194</td>
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<td>192</td>
<td>191</td>
<td>190</td>
<td>189</td>
<td>188</td>
</tr>
<tr>
<td>4-point scale</td>
<td>4.67</td>
<td>4.65</td>
<td>4.62</td>
<td>4.6</td>
<td>4.57</td>
<td>4.52</td>
<td>4.47</td>
<td>4.45</td>
<td>4.42</td>
<td>4.4</td>
<td>4.37</td>
<td>4.35</td>
<td>4.32</td>
</tr>
<tr>
<td>200-point scale</td>
<td>187</td>
<td>186</td>
<td>185</td>
<td>184</td>
<td>183</td>
<td>181</td>
<td>180</td>
<td>178</td>
<td>177</td>
<td>176</td>
<td>175</td>
<td>174</td>
<td>173</td>
</tr>
<tr>
<td>200-point scale</td>
<td>172</td>
<td>171</td>
<td>170</td>
<td>169</td>
<td>168</td>
<td>167</td>
<td>166</td>
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<td>164</td>
<td>163</td>
<td>162</td>
<td>161</td>
<td>160</td>
</tr>
<tr>
<td>4-point scale</td>
<td>3.97</td>
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<td>3.92</td>
<td>3.89</td>
<td>3.87</td>
<td>3.84</td>
<td>3.82</td>
<td>3.79</td>
<td>3.77</td>
<td>3.74</td>
<td>3.72</td>
<td>3.7</td>
<td>3.67</td>
</tr>
<tr>
<td>200-point scale</td>
<td>159</td>
<td>158</td>
<td>157</td>
<td>156</td>
<td>155</td>
<td>154</td>
<td>153</td>
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<td>151</td>
<td>150</td>
<td>149</td>
<td>148</td>
<td>147</td>
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<tr>
<td>4-point scale</td>
<td>3.65</td>
<td>3.62</td>
<td>3.57</td>
<td>3.55</td>
<td>3.52</td>
<td>3.5</td>
<td>3.47</td>
<td>3.45</td>
<td>3.42</td>
<td>3.4</td>
<td>3.37</td>
<td>3.35</td>
<td>3.32</td>
</tr>
<tr>
<td>200-point scale</td>
<td>146</td>
<td>145</td>
<td>143</td>
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<td>141</td>
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<td>139</td>
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<td>137</td>
<td>136</td>
<td>135</td>
<td>134</td>
<td>133</td>
</tr>
<tr>
<td>4-point scale</td>
<td>3.3</td>
<td>3.27</td>
<td>3.25</td>
<td>3.22</td>
<td>3.2</td>
<td>3.17</td>
<td>3.15</td>
<td>3.12</td>
<td>3.1</td>
<td>3.07</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>200-point scale</td>
<td>132</td>
<td>131</td>
<td>130</td>
<td>129</td>
<td>128</td>
<td>127</td>
<td>126</td>
<td>125</td>
<td>124</td>
<td>123</td>
<td>Not enough</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 elective 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:

<table>
<thead>
<tr>
<th>Score from discipline</th>
<th>Score on a 4-point scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>170 to 200 points</td>
<td>5</td>
</tr>
<tr>
<td>From 140 to 169 points</td>
<td>4</td>
</tr>
<tr>
<td>From 139 points to the minimum number of points a student must score</td>
<td>3</td>
</tr>
<tr>
<td>Below is the minimum number of points a student must score</td>
<td>2</td>
</tr>
</tbody>
</table>

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).

14. Methodological support
The list and content of educational and methodological support for the study of the elective 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 elective discipline.
RECOMMENDED TEXTBOOKS

Basic


Optional