



The syllabus for discipline «TOXICOLOGICAL AND FORENSIC CHEMISTRY»

1. General information	
Name of the faculty	pharmaceutical faculty
Educational program	22 Health, 226 Pharmacy, industrial pharmacy, Second (master's) educational level, full-time course
Навчальний рік	2021-2022
Course title, code	Toxicological and forensic chemistry, OK35,
Department (address, phone, e-mail)	Department of toxicological and analytical chemistry 79010, Lviv, Pekarska str., 69 +38 (032) 368437 kaf_toxchemistry@meduniv.lviv.ua
Head of department (e-mail)	Halkevych Irine, PhD, Associated professor, galkirin@meduniv.lviv.ua
Year of study	4 nd year
Semester	VII, VIII semester
Type of discipline	Compulsary
Викладачі	1. Bidnychenko Yuriy, PhD, Associated professor; bidnyuri@i.ua 2. Davydovych Sofia, PhD, Assistant professor, ihlitska.sophia@gmail.com
Erasmus yes/no	no
Author	associat. prof. Davydovych Sofiia e-mail: ihlitska.sophia@gmail.com
Total credits ECTS	6.0 credits
Total number of hours	180 h (Lectures – 30 / Practical classes – 70 / ISW – 80)
Language	English
Інформація про консультації	Consultations at the department take place in accordance with the approved schedule of consultations
2. Course description (abstract)	
<p>"Toxicological and Forensic Chemistry" is one of the specialty pharmaceutical disciplines, which studies the properties of poisonous and potent substances, their behavior in the body and corpse, develops methods of isolation, identification and determination of toxic substances and their metabolites in objects of biological origin.</p> <p>According to the syllabus, discipline "toxicological and forensic chemistry" is studied in the fourth year in the 7th and 8th semesters.</p>	

In teaching the theoretical course of toxicological chemistry, special attention is paid to the systematic approach to the study of toxicity of poisonous substances, which is based on taking into account the physicochemical properties of the poison, the ways of penetration to the organism, toxicokinetics, selective action, peculiarities of the victim's body, individual sensitivity, etc.), as well as methods of life-long and post-mortem laboratory diagnosis. This is of great importance for the correct interpretation of the results of the analysis and the prevention of poisoning.

The formation of students of chemical-expert thinking and the development of skills and skills from laboratory methods for determining xenobiotics and their metabolites in objects of biological origin are facilitated by laboratory classes. Important importance is attached to the solution of experimental problems, in the decision of which students learn to draw up a study plan for the isolation, detection and identification of poisons, to analyze and interpret the results and to draw up an act of forensic toxicological research.

3. Goals and objectives of the course

1. **The purpose of the course « Toxicological and Forensic Chemistry »** is to provide students with the necessary knowledge and, based on modern scientific ideas, to form the necessary theoretical knowledge in the field of forensic and toxicological chemistry. As well as the formation of students' chemical-expert thinking and development of skills and methods of methods of isolation of poisons from objects of biological origin, as well as the identification and determination of xenobiotics and their metabolites in carrying out chemical-toxicological or forensic toxicological studies.

2. **The main tasks of studying the discipline "Toxicological and Forensic Chemistry"** are: providing students with the basics of knowledge, skills and abilities to work in the field of chemical-toxicological, forensic-toxicological, sanitary-hygienic research (lifetime and post-mortem diagnostics of poisons, quality control of food raw materials, food and nutritional supplements, quality control of perfumery products household chemicals, environmental studies (water, air, soil, household items, etc.).

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 higher education).

According to the requirements of the Standard, the discipline "Toxicological and Forensic Chemistry" facilitates the acquisition of *competencies for* students :

common :

- ability to apply knowledge in practical situations ;
- knowledge and understanding of the subject area and understanding of the profession;
- ability to think abstractly, analyze and synthesize, to be able to learn and master modern knowledge;
- skills of using information and communication technologies;
- ability to evaluate and ensure the quality of work performed;
- ability to conduct research at the appropriate level;
- desire to preserve the environment;

with special (specialty, subject) :

- ability to organize, provide and carry out chemical-toxicological analysis and forensic toxicological study of objects of biological origin for the presence and content of poisonous substances of different nature and nature.
- ability to correctly select research objects for forensic toxicology studies.
- ability to properly draw up a plan for conducting chemical-toxicological and forensic

toxicological studies.

- ability to determine the list of equipment and reagents for specific forensic and chemical toxicological studies.
- ability to prepare reagents for the analysis of toxic substances by chemical and physico-chemical methods;
- ability to develop methods of analysis suitable for the selection of poisons from the objects of study and methods of qualitative and quantitative analysis of these poisons.
- ability to interpret and evaluate the results of forensic and chemical toxicological studies.

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

4. Course prerequisites

"Toxicological and Forensic Chemistry" as a discipline: based on the knowledge, skills and knowledge acquired by students in the study of previous disciplines, namely:

- *inorganic, physical and colloidal chemistry* (properties of elements and their compounds, basics of chemical kinetics, ionic equilibrium, methods of calculating chemical equilibrium at known starting concentrations and equilibrium constants, basics of extraction processes);

- *organic and bioorganic chemistry* (properties of organic compounds, nature of chemical bonds and electronic ideas about the structure of organic compounds, mechanisms of reactions of organic compounds in the body and outside the body, methods of analysis in organic chemistry),

- *analytical chemistry* (general issues of trace amounts analysis, modern chemical, physical and physico-chemical methods of analysis),

- *biological chemistry* (basic laws of drug metabolism, biochemical bases of individual variability of drug metabolism, cell membranes, their properties, xenobiotics transport),

- *pharmaceutical chemistry* (drug properties and methods of their analysis),

- *pharmacognosy* (poisonous medicinal plants, medicinal plants, containing alkaloids, glycosides, toxins of animal origin),

- *pharmacology* (principles of action of drugs, pharmacodynamics, pharmacokinetics, fundamentals of mathematical modeling of pharmacokinetic processes, side effects of drugs, drug poisoning, drug dependence and drug abuse),

- *medical and biological physics* (physical research methods, fundamentals of optics, quantum mechanics, thermodynamics basics, adsorption, desorption, biophysics of biological membranes and processes of transfer across membranes),

- *basics of higher mathematics, statistics and informatics* (statistical analysis of experimental data and modern mathematics of computer science and computer engineering),

- *organization and economics of pharmacy* (basic provisions of legislation), government regulations, public health orders and activities in the field of drug circulation, the structure and the functioning of the state system of quality control, effectiveness and safety of drugs, undue influence on the pharmaceutical companies).

5. Program learning outcomes		
List of learning outcomes		
Code of learning outcomes	Content of learning outcomes	Link to the code in the Competence Matrix
<i>Knowledge – Kn., Skill – Sk., Communication – C., Autonomy and responsibility – AR, Learning outcomes – LO.</i>		
General competencies		
Kn-1	Have specialized conceptual knowledge acquired in the learning process.	<i>LO-2. Ability to apply knowledge in practical situations</i>
Sk-1	Be able to solve complex problems and problems that arise in professional activity.	
C-1	Clear and unambiguous communication of their own conclusions, knowledge and explanations, which substantiate them to specialists and non-specialists.	
AR-1	Responsible for acceptance decisions in difficult conditions	
Kn-2	Have deep knowledge of structure professional activity.	<i>LO-6. Knowledge and understanding of the subject area and understanding of the profession</i>
Sk-2	Be able engage in professional activities that require updating and integration of knowledge.	
C-2	Ability to effectively shape communication strategy in professional activities.	
AR-2	Be responsible for professional development, the ability to further vocational training with a high level of autonomy.	
Kn-3	Know the methods of analysis, synthesis and further modern learning.	
Sk-3	Be able to analyze information, make informed decisions, be able to acquire modern knowledge.	<i>LO-4. Ability to abstract thinking, analyzing and synthesizing, being able to learn and be modern in learning.</i>
C-3	Establish appropriate links to achieve goals.	
AR-3	Be responsible for the timely acquisition of modern knowledge.	
Kn-4	Have deep knowledge in the field of information and communication technologies used in professional activity	<i>LO-9. Use of information and communication technologies</i>
Sk-4	Be able to use information and communication technologies in the professional field that requires updating and integration of knowledge	
C-4	To use information and communication technologies in professional activity	
AR-4	Be responsible for the development of professional knowledge and skills	
Kn-5	Know the methods of evaluating performance indicators	
Sk-5	Be able to provide quality work	<i>LO-11. Ability to evaluate and ensure the quality of work</i>
C-5	Establish links to ensure the quality of work	

AR-5	Be responsible for quality work	<i>performed</i>
Kn-6	Know the components of the health care system, plan and evaluate research	<i>LO-12. Ability to conduct research at an appropriate level;</i>
Sk-6	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	
C-6	Use information from scientific sources	
AR-6	Be responsible for the development and implementation of planned projects	
Kn-7	Know the problems of environmental conservation and how to conserve it	<i>LO-3. The desire to preserve the environment</i>
Sk-7	Be able to formulate requirements for yourself and others for environmental protection	
C-7	Make proposals to the relevant authorities and agencies on conservation and environmental protection measures	
AR-7	Be responsible for the implementation of environmental measures within its competence	
Special (specialized, subject) competences		
Kn-8	Know the current requirements for the organization and maintenance of chemical and toxicological analysis and forensic toxicological studies.	<i>LO-18. Ability to organize, provide and carry out chemical-toxicological analysis and forensic toxicological research in poisoning.</i>
Sk-8	Be able to choose chemical and physico-chemical methods of analysis for carrying out chemical-toxicological analysis and forensic toxicological research.	
C-8	To substantiate the correctness of the choice of the method of extraction of poisons from the objects of study and methods of qualitative and quantitative analysis of poisons in chemical-toxicological analysis and forensic toxicological research.	
AR-8	Be responsible for organizing, providing and conducting chemical-toxicological analysis and forensic toxicological research.	
Kn-9	Know the peculiarity of the distribution of poisons in the body and the accumulation of poisons in the organs and tissues of the body.	<i>LO-16. Ability to properly select research objects for forensic toxicology studies.</i>
Sk-9	Be able to select objects of study for analysis, based on knowledge of the distribution of poisons in organs, tissues and fluids of the body.	
C-9	To substantiate the correctness of the choice of objects of research for forensic toxicological analysis.	
AR-9	Be responsible for deciding on the choice of study sites for each particular study	
Kn-10	Know the basic requirements for drawing up a forensic toxicology plan. Know what actions, procedures, and documents are based on the research plan.	<i>LO-14. Ability to properly draw up a plan for conducting</i>

Sk-10	Be able to draw up a research plan based on guidance, review of research objects, previous (screening) research and supporting documents.	<i>chemical-toxicological and forensic toxicological studies.</i>
C-10	To substantiate the correctness of the plan of forensic toxicological examination.	
AR-10	To be responsible for drawing up the approval of the plan for carrying out chemical-toxicological and forensic toxicological investigations.	
Kn-11	Know the chemical and instrumental methods of analysis.	<i>LO-32 - Ability to test, biopharmaceutical research and drug control methods</i>
Sk-11	Be able to apply chemical and instrumental methods of analysis, to carry out biopharmaceutical research for drug control.	
C-11	It is grounded to evaluate the results of conducted chemical, physico-chemical and biopharmaceutical methods in quality control of medicines.	
AR-11	Be responsible for deciding on the evaluation of the results of chemical, physico-chemical and biopharmaceutical methods of drug control.	
Kn-12	Know the requirements of regulations for the placement of equipment and for the safe and high-quality correct maintenance of the equipment required for each specific analysis.	
Sk-12	Be able to prepare the necessary reagents and work with modern equipment of forensic and chemical-toxicological laboratories.	<i>LO-17 - Ability to determine the list of equipment and reagents for specific forensic and chemical toxicological studies.</i>
C-12	Ensure the work of the laboratory in accordance with the requirements of regulatory documents.	
AR-12	Responsible for the organization of forensic and chemical toxicological investigations in accordance with regulatory documents	
Kn-13	Know the chemical and modern instrumental methods of analysis, know the specificity and sensitivity of different methods of study.	
Sk-13	Be able to choose research methods for different groups of poisons and for different objects of study as well prepare reagents for analysis.	<i>LO-31 - Ability to prepare reagents for chemotoxicological analysis and forensic research.</i>
C-13	Argumentative choice of methods of analysis.	
AR-13	Be responsible for the results of chemical and toxicological analysis and forensic research.	
Kn-14	Know: - basics of selection of poisons from different objects of research; - chemical, physico-chemical, enzymatic and pharmacological methods for the detection of poisons: acids, alkalis and their salts; volatile poisons; metal poisons; medicinal substances; natural poisons; pesticides; fluorides,	<i>LO-18 - The ability to develop methods of analysis suitable for the selection of poisons from the objects of study and methods of</i>

	bromides, iodides; carbon monoxide. - methods of determining the listed poisons in the objects of study.	<i>qualitative and quantitative analysis of these poisons.</i>
Sk-14	To detect and determine poisons by methods: chemical, sedimentary, microcrystalloscopic, spectrophotometric (in UV and IR regions), chromatographic (GLC and TLC), enzymatic, pharmacological.	
C-14	To develop methods of chemical-toxicological analysis and forensic chemical research.	
AR-14	To be responsible for the validity of the developed methods of isolation of poisons from the objects of research and methods of qualitative and quantitative analysis.	
Kn-15	Know standard statistical analysis procedures	<i>LO-12 - The ability to interpret and evaluate the results of forensic and chemical toxicological studies.</i>
Sk-15	Be able to justify the size of the sample, apply methods of statistical analysis, provide the results of statistical data processing.	
C-15	It is reasonable to evaluate and interpret the research findings.	
AR-15	Be responsible for conducting research and producing accurate and reproducible results.	

6. The course format

The format of the course	Full-time course		
Type of classes	The total number of hours	The number of hours in 7 semester	The number of hours in 8 semester
Lectures	30	14	16
Practical classes	70	32	38
Self-study	60	44	36

7. Topics and content of the course

Type of classes	Theme	Code of learning outcomes
L-1	Theoretical foundations of toxicological and forensic chemistry, toxicology, forensic toxicology, clinical toxicology and environmental toxicology. Toxicometry and its basic parameters. Biochemical and analytical toxicology. Classification of poisons.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-2	Classification of poison. The main factors that affect the development of intoxication. Assistance in poisoning. Methods of detoxification.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-3	The main patterns of behavior of toxic substances in the body. Biotransformation of poisons. Phases of metabolism. The phenomenon of lethal synthesis and lethal inclusion. Toxicokinetics and toxicodynamics. The distribution of tinder in the body.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-4	Forensic examination of poisoning, its tasks and main stages. Purpose, tasks, procedure for carrying out and drawing up a plan of chemical-	Kn-1 – Kn-15; Sk-1 – Sk-15;

	toxicological analysis and forensic toxicological research. Evidence. Objects of study. A group of toxic substances that are isolated from biological material by infusion of the investigated objects with water (mineral acids, alkalis and their salts). Toxicological characteristics, features of their separation from biological material and detection and quantification.	C-1 – C-15; AR-1 – AR-11.
L-5	A group of toxic substances that are isolated from biological material by steam distillation (volatiles). Toxicological characteristics and features of the release of volatile substances from the objects of study.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-6	A group of toxic substances that are isolated from biological material by mineralization (metals). Toxicological characteristics, isolation and methods of forensic toxicological analysis.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-7	Toxicological characteristics and studies of the poison group requiring special isolation methods (fluorides, iodide bromides) and poison groups not requiring isolation from the objects of study (carbon monoxide). Detoxification methods for poisoning by these groups of substances.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-8	A group of toxic substances that are isolated by polar solvents (drugs). Chemical structure and toxicological characteristics of medicinal substances, mechanisms of toxic action, behavior and distribution in the body, preservation in the bodies of corpses, methods of separation from the objects of study.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-9	Toxicological characteristics and features of chemical-toxicological analysis of medicinal substances of acidic and weakly basic character. Methods of qualitative and quantitative analysis of medicinal substances in extracts from acidic medium.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-10	Toxicological characteristics and features of chemical and toxicological analysis of medicinal substances of basic nature. Methods of qualitative and quantitative analysis of medicinal substances in extracts from alkaline medium. Instrumental methods used in forensic expertise in performing chemical-toxicological and forensic toxicological studies.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-11-12	Poisons of natural origin (poisons of plants, fungi, animals and insects). Classifications of natural poisons, toxicological characteristics, mechanisms of toxic action, distribution in the body, methods of isolation from the objects of study and chemical-toxicological analysis in the diagnosis of poisoning. Assistance in poisoning.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-13	Fundamentals of laboratory rapid diagnosis of acute poisoning. Express analysis of acute intoxication by different groups of drugs and poisons of natural origin. Clinical diagnosis of acute and chronic intoxication.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
L-14	A group of toxic substances that are isolated from biological material by organic solvents (pesticides). General characteristics of pesticides: application, classification, toxicity, mechanisms of toxic action, biotransformation. Toxicological characteristics and methods of	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

	analysis of pesticides of the 1st, 2nd, 3rd, and 4th generations. Biopesticides (microbiological, plant and pheromones). Toxicological characteristics, methods of isolation of organophosphorus pesticides (FOP) and other organophosphorus compounds (FOS) from biological material. Diagnosis of FOS poisoning and medical care.		
L-15	Methods of chemical-toxicological analysis of organophosphorus pesticides in extracts from biological material. Preliminary tests and analytical screening methods for the diagnosis of acute pesticide poisoning. Immunochemical methods of pesticide analysis.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.	
Type of classes	Theme	Content	Code of learning outcomes
P-1	<i>Fundamentals of Toxicological and Forensic Chemistry, Toxicology, Forensic Toxicology, Clinical Toxicology and Environmental Toxicology. Toxicometry and its basic parameters.</i>	The relationship between toxicology and forensic chemistry with forensic toxicology and clinical toxicology. Toxicological and forensic chemistry, their content and tasks. Main sections of toxicology and their tasks. The concept of environmental toxicology. Types and mechanisms of toxic action. Toxic doses. Stages of formation and development of toxicological and forensic chemistry. Legislation and organization of forensic examination in Ukraine. The importance of toxicological and forensic chemistry in the preparation of a pharmacist and their place among other pharmaceutical disciplines. <u>Toxicometry</u> , its objectives and basic parameters (Lim ac; DL ₅₀ ; DL ₁₀₀ ; MPC; DL ₅₀ / Lim ac).	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-2	<i>The concept of poison. Characteristics and examples of xenobiotics. Classification of poisons. Ways of poison penetration into the body and transport mechanisms. Distribution of poisons in the body. Characteristics of the poison. Factors affecting the toxicity of chemical compounds. Removal of poisons from the body.</i>	Definition of the terms "xenobiotic", "poison". The main factors that determine the toxicity of substances. General principles of classification of poisons. Forensic classification of poisons. Types of toxic action. Embryotoxic, gonadotoxic, teratogenic and mutagenic action of toxic substances. Toxic doses and concentrations of poisons. Ways of poisons penetration into the body. The concept of toxicodynamics and toxicokinetics of poisons. The main types of links between poisons and receptors that affect toxicity. Factors that	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		determine the distribution of toxic substances in the body. The relationship between the physical and chemical properties of poisons and their distribution in organs and excretion. The concept of cumulation and addiction to the poisons. Elimination of poisons is a natural detoxification of the body.	
P-3	<i>General characteristics of poisoning (intoxication). Classification of poison. Characteristics of the factors that determine the development of acute poisoning. Characteristics of toxicogenic and somatogenic phases of poisoning. Clinical and laboratory diagnosis of poisoning (specific symptoms). Methods of detoxification. Antidotes and antagonists.</i>	<p>Definition of the term "poisoning". Classification of poisoning by origin (etiopathogenetic), by conditions (place) of development, by clinical principle (acute, chronic, subacute poisoning), by pathways of penetration into the body, nosological classification. Forensic classification of poisoning.</p> <p>Phases of poisoning: toxicogenic (poisonous substance is in the body, metabolized and excreted) and somatogenic (poisonous substance is excreted from the body, the effects of poisoning are observed). Characteristics of the factors that determine the development of acute poisoning. Clinical symptoms and specific symptoms of poisoning. Methods of detoxification of the body in poisoning. Symptomatic and antidote therapy.</p>	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-4	<i>Basic patterns of behavior of toxic substances in the body. Metabolism (biotransformation) of xenobiotics. The first and second phases of metabolism. Fatal Synthesis and Fatal Inclusion.</i>	Ways of biotransformation of xenobiotics in the body. Metabolism and metabolites. The concept of "lethal synthesis" and "lethal inclusion". Microsomal and non-microsomal metabolism. Characterization of metabolism processes in cells of different organs and tissues. Participation and role in the enzymatic metabolism of oxyreductase, transferase, hydrolases, lyase, isomerase and ligase (synthetase). Mechanisms of reactions of the first phase of biotransformation (microsomal and non-microsomal oxidation, microsomal and non-microsomal recovery and hydrolysis). Mechanisms of phase II	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		biotransformation reactions. Attachment reactions (conjugation).	
P-5	<i>Forensic toxicological research and chemical-toxicological analysis. Forensic examination, its stages and tasks. Objects of study. Review of research objects, preliminary tests and preparation of forensic toxicological study plan.</i>	<p>The directions, goals and objectives of chemical-toxicological and forensic toxicological research. The main stages of chemical-toxicological analysis and forensic toxicological research. Analysis of physical evidence. Objects of forensic toxicological research, their characteristics, means of preservation. Rules for selection, referral and admission of objects for forensic toxicological examination and storage of samples.</p> <p>Review of research objects and preliminary tests (screening studies) in forensic toxicological analysis and their role in drawing up a plan of chemical toxicological analysis. Objects of the study and forensic toxicological investigation plan for unknown poison (not directed analysis) and suspected poisoning by specific poison (directed or targeted analysis).</p> <p>Procedure and documentation of forensic toxicological (chemical-toxicological) examinations and forensic examination in general. Drawing up a plan of chemical-toxicological analysis.</p>	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-6	<i>Toxicological characteristics and analysis of a group of toxic substances that are isolated from biological material by infusion of the investigated objects with water (mineral acids, alkalis and their salts). Isolation from biological material and detection and quantification of nitrates and nitrites.</i>	<p>A group of poisonous substances that are isolated by infusion with water (inorganic acids, alkalis, salts). General characteristics of the group. Physico-chemical properties. Application. Toxic effect of nitric (nitrate), sulfuric (sulfate), hydrochloric (chloride) acids, salts of nitric and nitric acids (nitrates, nitrites), caustic alkalis (sodium hydroxide, potassium, ammonium, calcium). Features of isolation of acids, alkalis, salts from objects of biological origin. Methods of purification and separation using the phenomena of dialysis, electro dialysis and osmosis. Methods of detection and quantification of acids, caustic alkalis, nitric and nitric</p>	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		acid salts. Storage of compounds of this group in biological material. Evaluation of analysis results.	
P-7	<i>A group of toxic substances that are isolated from biological material by steam distillation (volatiles). Toxicological characteristics and methods of isolation of volatile substances from the objects of study.</i>	General and toxicological characteristics of the group of toxic substances that are isolated from biological material by the method of distillation (volatile substances). Physico-chemical properties, structure and action on the body of volatile substances. Causes and frequency of poisoning by volatile substances. Features of combined poisoning. The value of the results of chemical-toxicological analysis for the diagnosis of poisonings by volatile substances. Means of detoxification of the body in case of poisoning by volatile substances. Methods of extracting volatile substances from biological, food and environmental objects: steam distillation, dry air distillation, inert gas distillation, carrier distillation.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-8	<i>Analysis of distillate for the presence of volatile substances by chemical methods.</i>	Chemical method of distillate analysis. Types of chemical reactions used in the analysis, evaluation of their sensitivity and specificity. Schematic diagram of the study of biological objects on volatile substances in direct and non-directional analysis by combination Influence of time and conditions of storage of research objects on the results of analysis.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-9	<i>Qualitative analysis of volatile substances in distillate by gas-liquid chromatography (GC).</i>	Theoretical bases of gas-liquid chromatography method. Chromatographs. Stationary liquid phases. Chromatographic columns. Types and characteristics of detectors. Factors affecting chromatographic separation. Influence of endogenous compounds on the sensitivity and specificity of the GC method in the analysis of volatile substances. Methods of qualitative analysis in GC. Methods of group and individual identification of	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		poisonous substances by the method of gas-liquid chromatography (GCM). Examination of alcohol intoxication.	
P-10	<i>Quantitative analysis of volatile substances in distillate by gas-liquid chromatography (GC).</i>	<p>Tasks of quantitative gas chromatographic method of analysis: determination of the content of one, several or all components of the mixture; determination of the content of micro-impurities in individual substances and different media; determination of the total composition of the mixture.</p> <p>Parameters of chromatographic peak for the quantitative determination of HRH: area of the peak (S), peak height (h), product of peak height at a retention and product of peak height detained in volume. Methods of processing quantitative parameters of chromatograms. Methods of quantitative determination in GC.</p>	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-11	<i>Toxicological characteristics and methods of metal separation. Investigation of mineral deposit on the presence of metals.</i>	Trace elements and macro elements. General characteristics, applications and toxicity of metal compounds. Ways of entering metals into the body. The types of bonds between metals and proteins, peptides and amino acids in the body. Distribution and accumulation of metals in the body. Removal of metals from the body. Characterization of mineralization methods. Characteristics of metals that may be contained in the minerals in the form of sediments. Washing and recrystallization of the precipitate. Separation of barium sulfate and lead sulfate precipitates. Qualitative reactions for detection lead and barium cations.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-12	<i>Investigation of the liquid part of mineralizate for the presence of metals. Detection and determination of manganese, chromium, silver, copper and zinc.</i>	Method of individual study of metals (method of separate research, "fractional" method, separate analysis of metals) in mineralization. Scheme of a separate study of metals in mineralization. Characteristics of reagents for masking interfering ions. Requirements for the sensitivity of reactions in the study of metals in	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		minerals. General characteristics of methods for quantitative determination of metals in mineralization. Detection and quantification in the mineralizate of manganese, chromium, silver, copper and zinc cations.	
P-13	<i>Investigation of the liquid part of the mineralizate for the presence and content of cadmium, antimony, bismuth, thallium and arsenic.</i>	Separate method for the mineralization of cadmium, thallium, bismuth, antimony and arsenic cations. Features and methods of quantitative determination of metals in objects of biological origin. Detection and quantification cadmium, bismuth, thallium, antimony, arsenic. Forensic evaluation of the results of forensic toxicological study taking into account the natural content of metals in the body.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-14	<i>Isolation of mercury from biological material. Detection and quantification of mercury.</i>	Toxicological characteristics of mercury compounds, mechanisms of toxic action, binding to cells of the body, distribution and accumulation in the body. Features of mercury isolation from biological material. The essence of the method of destruction. Detection of mercury. Methods for the quantitative determination of mercury in destructate. Antidotes used in mercury poisoning and their mechanisms of action. Methods of atomic absorption spectroscopy, diffraction-free X-ray fluorescence analysis and other physical methods for the study of metals in minerals and biological fluids.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-15	Toxicological characteristics and methods of analysis of poisonous substances that require special methods of isolation (fluorides, silicon fluorides, bromine, iodine).	Physico-chemical properties of fluorides, silicon fluorides, bromine, iodine. Poisoning by substances of this group. Methods of isolation of fluorine, bromine, iodine compounds. Methods for detection and quantification of fluorides, bromides, iodides. Features of detection of fluorine in organo-fluoro-compounds (freons). Evaluation of analysis results.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-16	Toxicological characteristics of carbon monoxide, features of its detection and	Physico-chemical properties of carbon monoxide (carbon (II) oxide, carbon monoxide (II), carbon monoxide). Acute	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15;

	determination in humans. Methods for detecting carboxyhemoglobin and carboxymyoglobin. Spectrophotometric determination of carboxyhemoglobin and carboxymyoglobin.	poisoning and classification of carbon monoxide poisoning. Detection of carboxyhemoglobin directly in the blood by chemical, spectroscopic and spectrophotometric methods. Quantitative determination of carbon monoxide in the blood by spectrophotometric and spectroscopic methods. Chemical, spectroscopic and UV spectrophotometric methods for the detection and determination of carbon (II) oxide in the blood. Methods of natural and artificial detoxification of the body in acute carbon monoxide poisoning.	AR-1 – AR-11.
P-17	Final (credit) employment of the content module 1.	Fundamentals of Toxicological and Forensic Chemistry. Groups of poisonous substances that are isolated from biological material by infusion of the studied objects with water (mineral acids, alkalis and their salts), distillation with water vapor (volatile substances) and mineralization (metals). Toxicodynamics, toxicokinetics and distribution of these poisons in body tissues. Methods of isolation of these groups of poisons from the objects of study and their methods of analysis. A group of poisons that require special isolation methods (fluorides, iodide bromides). A group of poisons that do not need to be isolated but are investigated directly in the object of study (carbon monoxide). Detoxification methods for poisoning by these groups of substances.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-18	Toxicological characteristics, mechanisms of toxic action and methods of extraction of medicinal substances of natural (alkaloids) and synthetic origin from biological material.	Physico-chemical properties, structure and action on the body of toxic and potent substances of organic nature. Modern general and individual selection methods, their characteristics and comparative evaluation. The influence of various factors on the efficiency of selection of test substances at different stages of this process. Characteristics of solvents commonly used for isolation.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		Separate (special) methods for the isolation of barbiturates, 1,4-benzodiazepine derivatives, phenothiazine derivatives. Methods for purification of extracts and separation of toxic substances from the concomitant endogenous impurities of protein and lipid character, dyes, etc. Methods of concentration of test substances from extracts: extraction with organic solvents, adsorption, evaporation and the like.	
P-19	<i>Investigation of chloroform extracts from acidic medium ("acidic" chloroform extracts) by chemical reactions.</i>	Toxicological characteristics and methods of analysis of medicinal substances and poisons of natural origin, extracted from acidic medium (substances of acidic, neutral and weakly basic nature). Medicinal substances (alkaloids and their synthetic analogues) and poisons of natural origin. Synthetic Medicinal Substances. Chemical-toxicological analysis of "acidic" chloroform extract (chloroform extract) for substances of acidic, neutral and slightly basic character. Chemical research methods. Types of reactions: colored (colored), sedimentary and microcrystalline reactions, features of their implementation. Sensitivity and specificity of reactions. The concept of false positive and false negative result.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-20	<i>Investigation of "acidic" chloroform extracts by physical and chemical methods.</i>	Chromatographic methods of investigation: chromatography in thin layers of sorbent (TLC), high-performance liquid (HPLC), gas-liquid chromatography (GC) and their use in forensic toxicological analysis. TLC-screening as a preliminary identification step in non-directional chemical-toxicological analysis. Group developers in TLC. Photometric methods: spectrophotometry in the visible, UV and IR regions of the spectrum, photoelectrocolorimetry, fluorimetry, chromatographic mass spectrometry. Pharmacological studies and their role in	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		<p>the identification of certain compounds.</p> <p>Comparative evaluation of methods of analysis, their sensitivity, specificity and the possibility of using in the presence of some impurities of endogenous origin.</p>	
P-21-22	<p>Investigation of chloroform extracts from alkaline medium ("alkaline" chloroform extracts) by means of color, sediment and microcrystalloscopic reactions.</p>	<p>Toxicological characteristics and methods of analysis of medicinal substances extracted from an alkaline medium (substances of basic and slightly basic nature). Medicinal substances (alkaloids and their synthetic analogues) and poisons of natural origin. Synthetic medicinal substances. Determination of group and individual accessory of medicinal substances by chemical reactions (sedimentary, color, microcrystalloscopic).</p>	<p>Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.</p>
P-23	<p>Investigation of "alkaline" chloroform extracts by chromatographic methods (TLC, GLC, HPLC), spectrophotometric (UV-, IR-spectrophotometry) and enzyme-linked immunosorbent assay methods. Quantitative determination of medicinal substances in extracts from biological material.</p>	<p>TLC-screening as a preliminary identification step in non-directional chemical-toxicological analysis. Identification by TLC, GLC and HPLC. Use of immunochemical methods (radioimmunoassay and enzyme immunoassay) for the detection and determination of toxic substances in biological fluids. Determination of group and individual alkaloids by pharmacological tests (atropine, strychnine, nicotine). Assessment of the specificity and sensitivity of these methods. Photometric methods: photoelectrocolorimetry (extraction photometry), UV spectrophotometry (direct, differential with the example of barbiturates). Influence of various factors related to the peculiarity of biological objects on the results of quantitative determination of medicinal substances isolated from biological material in the course of chemical-toxicological study. Requirements for the degree of purification of biological extracts to be quantified.</p>	<p>Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.</p>
P-24	<p>Poisons of natural origin (poisons of plants, fungi, algae, animals and insects).</p>	<p>General and toxicological characteristics, separation from biological material and methods of</p>	<p>Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15;</p>

		<p>chemical-toxicological analysis. Diagnosis of poisoning and detoxification of the body. Characteristics of poisons of natural origin. Plant poisons (phytotoxins). Animal poisons (zootoxins) - tetrodotoxin. Hat mushroom poisons and their classification. Mechanisms of toxic action and clinical symptoms of poisoning by the use of poisonous mushrooms (pale toadstool, red fly agaric, false foam, false wrinkles) and conditionally edible mushrooms (wrinkles, stitches, pigs, lupus, whey). Diagnosis, emergency care, antidote and symptomatic therapy for mushroom poisoning. Methods of isolation of venoms of hat mushrooms from objects of research and chemical-toxicological analysis. Poisons of natural origin that require special methods of isolation from the objects of study: mycotoxins, algotoxins and microbial toxins.</p>	AR-1 – AR-11.
P-25	Express analysis of acute barbiturate intoxication.	<p>Toxic effects, mechanism of toxic action and clinical picture of acute barbiturate poisoning. Toxicokinetics of barbiturates. Preliminary tests for laboratory express - diagnosis of acute barbiturate poisoning. Methods for isolation of barbituric acid derivatives and their metabolites from blood, urine and other biological objects. Methods for detection of barbiturates and their metabolites in rapid - diagnosis of acute poisoning by chemical reactions, method of chromatography in a thin layer of sorbent. Detection of barbiturates by absorption spectra in the UV region. Keto-enol and lactam-lactic tautomerism of barbiturates. Analysis of barbituric acid derivatives in biological fluids by gas-liquid chromatography (GC). Interpretation of the results of laboratory rapid diagnostics of poisoning with barbituric acid derivatives. First aid and antidote therapy for acute barbiturate</p>	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		poisoning.	
P-26	Express analysis of acute intoxication by 1,4-benzodiazepine derivatives.	Toxicological characteristics and mechanisms of toxic action of 1,4-benzodiazepine derivatives. Pharmacodynamics and pharmacokinetics. Directions of metabolism of 1,4-benzodiazepine derivatives. Preliminary tests for the detection of 1,4-benzodiazepine derivatives in blood and urine in acute poisoning. Methods for the separation of 1,4-benzodiazepine derivatives and their metabolites from blood and urine. Detection of 1,4-benzodiazepine derivatives and their metabolites by color reactions, thin-layer sorbent chromatography, UV spectrophotometry, fluorescence and GCM . Quantitative determination of 1,4-benzodiazepine derivatives. Interpretation of analysis results.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-27	<i>Express analysis of acute intoxication by phenothiazine derivatives.</i>	Toxicological characteristics and mechanisms of toxic action of phenothiazine derivatives. Pharmacodynamics and pharmacokinetics. Preliminary tests for the detection of phenothiazine derivatives in blood and urine in acute poisoning. Methods for extracting phenothiazine derivatives and their metabolites from blood and urine. Detection of phenothiazine derivatives and their metabolites by color reactions, thin-layer sorbent chromatography, and UV spectrophotometry. Quantitative determination of phenothiazine derivatives. Interpretation and evaluation of analysis results.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-28	Express analysis of acute opiate intoxication.	Toxic characteristics, mechanism of toxic action and clinical picture of acute opioid alkaloids and their synthetic analogues. Metabolism of opium alkaloids and opioids. Preliminary tests for the detection of opium alkaloids and their synthetic analogues in biological fluids. Isolation of opium alkaloids and	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

		opioids from blood and urine. Detection of opiates and their synthetic analogues by chemical reactions, thin-layer sorbent chromatography, UV spectrophotometry, enzyme immunoassay, GC and HPLC. Quantitative determination of opiates and opioids in extracts. Interpretation of results of rapid analysis of acute opiate intoxication.	
P-29	Express analysis of acute cannabinoids intoxication.	Characteristics and chemical composition of cannabinoids. Toxic effect of cannabinoids. Ways of entering cannabinoids in the body and their removal from the body. The main metabolic pathways of cannabinoids. Characteristics of study objects in cannabinoid poisoning. Investigation of saliva and skin of hands for the presence of cannabinoids. Preliminary tests for the detection of cannabinoids in biological fluids. Isolation of cannabinoids from study objects. Detection of cannabinoids by chemical methods, TLC and GC method.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-30	General characteristics of pesticides: classifications, toxicity, mechanisms of toxic action, biotransformation. Toxicological characteristics and methods of analysis of pesticides of the 1st, 2nd, 3rd and 4th generations. Biopesticides (microbiological, plant and pheromones). Toxicological characteristics and methods of isolation of pesticides from biological material.	Pesticides from the group of organochlorine compounds (HOS), carbamic acid derivatives, synthetic pyrethroids, phenol derivatives. Organic mercury pesticides. Pesticides from the group of derivatives of phosphoric acids. Methods of isolation of organophosphorus pesticides (OPP) from organs of a corpse, biological liquids, food. The choice of extractant depending on the condition, nature of the object of study and poison. The choice of method of purification of extracts containing OPP, depending on the nature and amount of co-extractive substances.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-31	Investigation of extracts of biological material on the pesticide content by enzymatic methods (chromatosensory method, enzyme-linked	Methods of analysis of OPP in extracts from biological material: cholinesterase test, enzyme immunoassay. The role of enzymatic methods in the rapid diagnosis of acute and chronic OPP intoxication. Evaluation of the results of	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.

	immunosorbent assay (ELISA), cholinesterase test).	the analysis.	
P-32	Investigation of extracts from biological material on the content of OPP by chemical reactions.	Chemical methods of analysis of OPP in extracts from biological material. Detection of organophosphorus by phosphorus. Detection of phosphorylating activity. Detection of thio- and dithiophosphoric acid derivatives. Detection by functional groups and by hydrolysis products. Evaluation of the results of the analysis.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-33	Investigation of extracts from biological material on OPP content by chromatographic methods.	Characterization of chromatographic methods of analysis of OPP in extracts from biological material. Detection and identification by TLC, GLC and HPLC. Evaluation of the results of the analysis.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-34	Quantitative determination of organophosphorus pesticides in the objects of study.	Methods for quantitative determination of OPP (photocolorimetric, photometric for phosphorus, planimetric, enzymatic, GC method). Characterization of the main methods for determining OPP in extracts from biological material and their comparative evaluation.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
P-35	<i>Final (credit study) of the content module 2.</i>	A group of toxic substances that are isolated from biological material by polar solvents. Medicinal substances and natural poisons (plants, fungi, animals, insects and algae). A group of toxic substances released from the objects of study by non-polar organic solvents (toxic chemicals). Toxicodynamics, toxicokinetics and distribution of these poisons in the body. Methods of isolation of these poisons from the objects of study and methods of their analysis Express analysis of acute intoxication with these poisons. Methods of detoxification in poisoning.	Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-11.
ISW-1	Fundamentals of Toxicological and Forensic Chemistry. Forensic examination of poisoning and forensic toxicology. Classification of poisons.		Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15;
ISW-2	Fundamentals of biochemical toxicology (mechanisms of toxic action of substances on the body: kinetics of absorption, distribution, excretion, mechanisms of metabolic reactions, pathways and mechanisms of substance transport and elimination). Classification of		AR-1 – AR-11.

	poison.
ISW-3	Toxicological characteristics and methods of analysis, poisonous substances released from the objects of study by instillation of water and purification of water extracts by dialysis.
ISW-4	Forensic toxicological study of a group of toxic substances that are isolated from biological material by steam distillation (volatile substances).
ISW-5	Forensic toxicological study of cyanides, alkyl halides and aliphatic monohydric alcohols.
ISW-6	Forensic toxicological study of aldehydes and ketones.
ISW-7	Forensic toxicological study of aromatic hydrocarbons, monatomic phenols, phenol-formaldehyde resins and aromatic amines. Detoxification methods for poisoning with these substances.
ISW-8	Forensic toxicological study of carboxylic acids, ethers, esters and cellosols. Detoxification methods for poisoning with these substances.
ISW-9	Forensic toxicological study of petroleum products and adhesive components. Detoxification methods for poisoning with these substances.
ISW-10	Forensic toxicological study of components of perfumery and cosmetics. Detoxification methods for poisoning with these substances.
ISW-11	Forensic toxicological study characteristics of phosgene.
ISW-12	Investigation of volatile poisons by gas-liquid chromatography (GC).
ISW-13	A group of poisons isolated from biological objects by mineralization (metal poisons).
ISW-14	The study of the mineralization of the presence and content of metal poisons.
ISW-15	A group of poisons that require special (special) methods from objects of study when conducting forensic toxicological analysis.
ISW-16	A group of poisons that are tested directly in biological material without their pre-release (carbon monoxide, carbon monoxide).
ISW-17	General and toxicological characteristics, mechanisms of pharmacological and toxic action of medicinal substances. Classical methods of extraction of medicinal substances from biological material during forensic toxicological examination.
ISW-18	Forensic toxicological study of medicinal substances and natural poisons of indole, pyridine and piperidine derivatives.
ISW-19	Forensic toxicological study of imidazolin (clonidine) derivatives,
ISW-20	Forensic toxicological study of poisons of natural origin: phytotoxins, zootoxins, algotoxins (algae toxins) and microbial toxins. Diagnosis of poisoning and detoxification of the body.
ISW-21	Forensic toxicological study of fungal poisons and derivatives of lysergic acid.
ISW-22	Forensic toxicological study of phenylalkylamine derivatives. Express diagnostics of acute intoxication with amphetamines.
ISW-23	Forensic toxicological study of opium alkaloids and synthetic opioids.
ISW-24	Forensic toxicological study of cannabinoids.

ISW-25	Forensic toxicological study of tricyclic antidepressants.
ISW-26	Forensic toxicological study of chlorine-containing pesticides.
ISW-27	Forensic toxicological study of pesticide derivatives of urea.
ISW-28	Forensic toxicological study of pesticides derived from sim-triazine.
ISW-29	Forensic toxicological study of pesticides derived from phenol.
ISW-30	Forensic toxicological study of pesticides of carbamic acid derivatives, as well as thio- and dithiocarbamic acid derivatives.
ISW-31	Forensic toxicological study of pesticides of chloracetanilide derivatives.
ISW-32	Forensic toxicological study of synthetic pyrethroids - pesticides of cyclopropanecarboxylic acid derivatives.
ISW-33	Toxicological characteristics and methods of chemical-toxicological analysis of pesticides - organic compounds of tin and mercury. Biopesticides (microbiological, plant and pheromones).

Learning methods

Explanatory-illustrative, problematic presentation, partially-exploratory.

Studying Toxicological and Forensic Chemistry students use textbooks, lecture notes, methodological guidelines, chemical computer software, molecular models, laboratory devices and glassware necessary for performing experiments.

Methods for organization and accomplishment of studies are:

- a) lectures
- b) practical classes
- c) students' independent study.

The topics of the lecture course cover the problematic issues of the appropriate sections of toxicological and forensic chemistry.

Practical classes are organized as laboratory classes. These classes include: laboratory studies on detection of specific classes of toxic compounds according to their functional groups, performing specific reactions. Students are recommended to write short-term protocols of laboratory studies, indicating the purpose of the study and the conclusions.

The structure of practical classes includes:

- Discussion and explanation of the most complicated issues of the topic;
- Written test;
- Practical (laboratory) work.
- Filling in a practical lesson protocol.
- Summary of the lesson.

The student's self-study material, which is provided in the subject of the practical lesson at the same time as the classroom work, is evaluated during the ongoing control of the topic in the relevant practical lesson.

Assessment of topics that are presented for self-study and not included in the topics of classroom training, are controlled during the final (credit) classes and exam.

Methodological support. The list and content of educational and methodological support for the study of the discipline "Toxicological and Forensic Chemistry" 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 current and final control of students' knowledge and skills, complex control work, post-certification monitoring of acquired knowledge and skills in the discipline.

8. Verification of learning outcomes

Current control

Types of control: current (routine) and final. **Form of final control in accordance with the curriculum:** a credit (7 semester); exam (8 semester).

Control of knowledge and level of students' mastering theoretical material, independent work and the level of acquired skills and practical skills is carried out in practical classes by oral questioning of students; by means of test, graphic and written control; solving situational problems; by evaluating the practical experimental work performed, by assessing the student's ability to correctly interpret the research results obtained, and by evaluating the laboratory protocols drawn up.

At each practical session, the student answers standard questions from the material of the current topic of the lesson, the questions of the lecture course and independent work that relate to the current lesson. The student demonstrates knowledge and skills of practical skills in accordance with the topic of the practical lesson.

It is recommended to apply objective (standardized) kind of control to check theoretical and practical knowledge of students.

The standardized control of the theoretical part includes 13 tasks. Ten of them are the first level test questions. Another three are referred to the tasks of the second level and required a written response (reaction schemes, structure formulas etc.) on the topic of the practical lesson, 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.

Criteria of assessment of current educational activity:

"Excellent" mark receives a student who correctly, clearly, logically and completely

answered the standardized questions of the current topic, including the questions of the lecture course and independent work, gave at least 90% of correct answers to standardized tests, responded to written tasks without any mistake, performed practical work and filled in the protocol.

"Good" mark gets a student who answered the standardized questions of the current topic, lecture course and independent work, gave at least 70% of correct answers to standardized tests, responded to written tasks with some insignificant mistakes, performed practical work and filled in the protocol.

"Satisfactory" mark receives a student who gave with additional questions incomplete answer, could not independently build a clear, logical answer; gave at least 50% of correct answers to standardized tests, responded to written tasks with a lot of mistakes, made mistakes while demonstrating practical skills but performed practical work and made the protocol.

"Unsatisfactory" mark receives a student who can not answer on question on the current topic with additional questions, can not construct a logical answer, did not understand the content of the material; gave less than 50% of correct answers to standardized tests, responded to written tasks with gross mistakes or did not give answer, didn't perform practical work and didn't make the protocol.

The total score for the current achievement is the arithmetic mean (CA) of the sum of the scores for the test control and the answers to the questions.

Only those students who completed all types of works provided by syllabus and during study scored points not less than the minimum (3,0), and don't have any undone lectures and practical classes are allowed to put the exam. The standardized form of the exam includes control of theoretical and practical knowledge.

Code of learning outcomes	Type of classes	Verification of learning outcomes	Enrollment criteria
Kn-1 – Kn-15; Sk-1 – Sk-15; C-1 – C-15; AR-1 – AR-15.	P-1–P-35 ISW-1–ISW-33	Current control: <ul style="list-style-type: none"> • oral control over the topic of the lesson, standardized questions, knowledge of which is necessary to understand the current topic, questions of the lecture course that relate to the current lesson; • written test control, • solving situational problems, • conducting laboratory tests, • interpretation and evaluation of laboratory test results, • report on the performed laboratory work. 	Assessment according to established criteria (see above) with 4-point (national) scale. To enroll in the discipline, it is necessary to confirm the achievement of each learning outcome.
Kn-1 – Kn-15; Sk-1 – Sk-15;	ISW-1–ISW-33	<ul style="list-style-type: none"> • Oral control in the form of a survey in accordance with 	Enrolled / not enrolled

C-1 – C-15; AR-1 – AR-15.		the subject of independent work. • Test control on the subject of independent work.	
The Final control			
General evaluation system	The final control is carried out upon completion of the study of the discipline Toxicological and Forensic Chemistry in the form of a credit (7 semester) and the exam (8 semester). 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. Participation in the work during the semester - 100% on a 200-point scale		
Grades	4-point (national) scale, a multi-scale (200-point) scale, ECTS success scale		
Conditions of admission to the final control	Students who have completed all types of work required by the curriculum, have completed all training sessions, and have earned points above the 120 points when studying the course.		
Form of final control	The form of final control of the success of studies in the study of "Toxicological and Forensic Chemistry" in the 7th semester is a semester credit , and in the 8th semester there is a semester exam .	Evaluation criteria	
A semester credit	Each class assesses students' knowledge on a 4-point (national) scale. This takes into account all types of work provided by the discipline program. The assessment of toxicological and forensic chemistry in the 7th semester is based on the results of the current educational activity and is expressed on a two-point scale "enrolled" or "not enrolled". The student receives a grade on each topic to further convert the grades into scores on a multi-scale (200-point) scale.	<i>The maximum number of points - 200.</i> <i>The minimum number of points - 120</i>	
An exam	The semester exam is a form of final control of the student's acquisition of theoretical and practical material in toxicological and forensic chemistry. A student is considered to be admitted to the semester examination in a discipline, if he has attended all the academic curriculum provided by the discipline, completed all types of work stipulated by the curriculum of this discipline, and in his study during the semester he scored less than the minimum score "Satisfactory" (72 points).	<i>The maximum number of points – 80.</i> <i>The minimum number of points - 50</i>	
<p style="text-align: center;">Examination Regulations</p> <p>The form of final control is standardized and includes control of theoretical and practical training. <i>The final control</i> is a written answer to 5 questions that are in each exam ticket. It takes 2 hours to take the exam. Each written answer question is rated:</p> <p style="padding-left: 40px;">5 points - "<i>excellent</i>"</p> <p style="padding-left: 40px;">4 points – "<i>good</i>"</p>			

3 points - *"satisfactory"*

0 points - *"unsatisfactory"*

"Excellent" - the student logically, competently, thoroughly, deeply and in detail presented material on all tasks, correctly wrote formulas of substances and chemisms of reactions, showed the schemes of metabolism of substances, substantiated the correct choice of methods of forensic toxicological analysis, correctly solved situational problems.

"Good" - the student logically, competently essentially provides incomplete answers to all theoretical questions, with minor errors in chemical formulas, chemisms of reactions and in calculations and conclusions.

"Satisfactory" - the student answers the theoretical questions without detail, admits inaccuracies and incorrect formulations in the answers, violates the logic of the material, makes mistakes in the chemical formulas of calculations and in the chemisms of reactions and in situational problems.

"Unsatisfactory" - the student makes significant mistakes, does not cover the essence of the question posed, does not answer the tasks.

The score for the written answer to each question in the exam ticket, where there are 5 questions, is converted according to the scale below:

Rating	Scores	The maximum number of points	The minimum number of points
<i>"Excellent"</i>	16	80 (16 x 5)	
<i>"Good"</i>	13		
<i>"Satisfactorily"</i>	10		50 (10 x 5)
<i>"Unsatisfactory"</i>	0		

The maximum number of points that a student can get for current educational activity during study is 200 points.

The minimum number of points that a student must get to pass the test on the discipline is 120 points.

The toxicological chemistry exam score is the sum of the scores for the answer to each of the 5 questions after converting them from a 4-point to a 200-point scale. The maximum score for the exam is **80**. The minimum score is **50**.

Calculating the number of points made on the basis of the student's scores on the traditional 4-point scale during the study of the discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The received value is converted into points by multi-point rate as follows:

$$x = \frac{CA \times 120}{5}$$

The average score for the current activity is converted into a multi-scale scale using the table below:

Recalculation of the average score on "toxicological and forensic chemistry" for the current activity into a multi-scale scale:

4-point rate	5	4.95	4.91	4.87	4.83	4.79	4.75	4.7	4.66	4.62	4.58	4.54	4.5
200-point rate	120	119	118	117	116	115	114	113	112	111	110	109	108
4-point rate	4.45	4.41	4.37	4.33	4.29	4.25	4.2	4.16	4.12	4.08	4.04	3.99	3.95
200-point rate	107	106	105	104	103	102	101	100	99	98	97	96	95
4-point rate	3.91	3.87	3.83	3.79	3.74	3.7	3.66	3.62	3.58	3.54	3.49	3.45	3.41
200-point rate	94	93	92	91	90	89	88	87	86	85	84	83	82
4-point rate	3.37	3.33	3.29	3.25	3.2	3.16	3.12	3.08	3.04	3	Less than 3		
200-point rate	81	80	79	78	77	76	75	74	73	72	Not enough		

The **maximum number of points** that a student can earn for his / her current academic activity upon obtaining a semester credit **in the 7th semester** is - 120 points. The minimum number of points that a student must earn for his / her current academic activity in the 7th semester (to receive a semester credit) is 72 points (60% of 120 - maximum points).

The **maximum number of points** that a student can earn for his / her current educational activity for the **8th semester** with admission to the semester exam is 120 points.

The minimum number of points, which student can get for current activity and 8th semester for admission to the compilation of semester exam - is 72 points.

Final assessment of the discipline "toxicological and forensic chemistry".

Initially, traditional estimates of current control over the entire course (two semesters) are summarized and calculated the arithmetic mean, to the second decimal place. The calculated arithmetic mean is converted to points on the scale above. And then to these points are added the points obtained for the final control (for the exam). **The sum of these points (for current achievement and for final control) is the final estimate for the course of toxicology and forensic chemistry.**

The points obtained by students in the final assessment of the discipline are converted into the traditional 4-point scale by the absolute criteria, which are given in the table below:

Score from discipline	Score on 4-point rate
From 170 to 200 points	5
From 140 to 169 points	4
From 139 to the minimum number of points which student must get	3
Below the minimum number of points which student must get	2

To determine the ECTS score, a ranking is made by the number of points earned by the student in the final assessment of the discipline.

Ranking with assignments of grades "A", "B", "C", "D", "E" is made for students of this course, who study in one specialty and have successfully completed the study of the discipline.

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).

Conversion of rating point to ECTS success scale :

ECTS grade	Statistics	Calculations
A	Top 10%	200 - 110 = 90 points 90 b. \times 10% = 9 b.
B	Next 25%	90 b. \times 25% = 23 b.
C	Next 30%	90 b. \times 30% = 27 b.
D	Next 25%	90 b. \times 25% = 23 b.
E	Last 10%	90 b. \times 10% = 9 b.
F _x	Resubmission	The gap between "folded - not folded" and the minimum tolerance score
F	Compulsory re-training	Less than the minimum tolerance score

Students who have received grades F_x and F ("unsatisfactory") are not included in the list of students who are ranked. Students with an F_x score automatically receive an "E" grade upon transfer. Upon receipt of the F_o rating, it is necessary to undergo a second course of study.

Mark written by ECTS can't be converted into traditional scale because the ECTS scale and 4-point scale are independent (do not coincide).

9. Course policies

Attendance policies outline student requirements for participation, whether in a physical classroom or digital learning experience. These policies will generally outline how often a student must attend a course and the consequences of not fulfilling that obligation.

Students are expected to attend all classes and course activities for which they are registered. Any class meeting missed, regardless of cause, reduces the opportunity of learning and may adversely affect a student's achievement in the course. Students are required to attend at least 90% of the class meetings in order to receive credit for the course. An accurate record of attendance will

be kept for each course. If a student misses one- third or more of a class session, the student will be counted absent. Three tardies will count as one absence. Leaving early is the same as being tardy.

If a student misses a class, it is THEIR responsibility to make up the material missed.

Academic Dishonesty. Adherence to academic integrity by students involves:

1. Independent performance of educational tasks, tasks of current and final control of learning outcomes (for persons with special educational needs this requirement is applied taking into account their individual needs and opportunities);

2. References to sources of information in the case of the use of ideas, developments, statements, information; Compliance with copyright and related rights legislation;

3. Providing reliable information about the results of their own (scientific, creative) activities, used research methods and sources of information.

Violations of academic integrity are: academic plagiarism, self-plagiarism, fabrication, falsification, write-off, deception, bribery, biased evaluation.

For violation of academic integrity, students may be involved in re-assessment.

Personal technology policies focus on the permitted use of technology within the classroom.

Per university policy and classroom etiquette; mobile phones, iPods, etc. must be silenced during all classroom and lab lectures. Those not heeding this rule will be asked to leave the classroom/lab immediately so as to not disrupt the learning environment. Please arrive on time for all class meetings. Students who habitually disturb the class by talking, arriving late, etc., and have been warned may suffer a reduction in their final class grade.

10. Recommended Literature

Compulsory course literature

1. Bidnychenko Y. Toxicological chemistry: Handbook for students. – Lviv, 2009. – 175 p.
2. Bidnychenko Y. Toxicological chemistry: Practical recommendations. – Lviv, 2009. – 43 p.
3. Bondar V.S. Toxicological chemistry. Schemes and tables: Handbook for students of higher school / V.S. Bondar, S.A. Karpushina – Kharkiv: NUPh:Golden Pages, 2009. – 120 p.
4. Fundamentals of Analytical Toxicology / R.J. Flanagan, A.A. Taylor, I.D. Watson, R. Whelpton. - John Wiley & Sons, 2008 p. - 544 p.
5. Hodgson E. A Textbook of Modern Toxicology, 4th Edition – John Wiley & Sons, 2004. – 672 p.

Auxiliary literature

1. Karpushyna S.A. Collection of Multiple Choice Questions on Toxicological Chemistry with answers and explanations: for self-training foreign students in specialty 8.12020101 «Pharmacy». – Kh.: NUPh Publishing, 2017. – 92 p.
2. Cazes J., Scott R.P.W. Chromatography Theory. - Avon, Connecticut: CRC Press, 2002. - 496 p.
3. Clark's isolation and identification of drugs. – London: The Pharmaceutical Press, 1986. – 1224 p.
4. Handbook of Toxicology. 2 ed. / Edited by Derelanko M.J., Hollinger M.A. - N.W.: CRC Press LLC, 2002 – 1380 p.
5. Lars Hagel, Günter Jagschies, Gail K. Sofer. Handbook of Process Chromatography, Second Edition: Development, Manufacturing, Validation and Economics. - Academic Press, 2007. – 384 p.
6. Poisoning and Drug Overdose. Fifth Edition / Edited by Kent R. Olson. - San Francisco: The McGraw-Hill Companies, 2007. – 1132 p.
7. Randall C. Baselt. Disposition of Toxic Drugs and Chemicals in Man. – California, Foster

City; Chemical Toxicology Institute, 2000. – 920 p.

8. Robert I. Grob, Eugene f. Barry. Modern practice of gas chromatography. Fourth edition. New Jersey: John Wiley & Sons, 2004. – P. 1048.
9. Scott R.P.W. Liquid Chromatography column theory. - New York: John Wiley & Sons, 2002. - 212 p.
10. Lappas N.T., Lappas C.M. Forensic Toxicology: Principles and Concepts. - Academic Press, 2016. — 362 p.

11. Equipment, logistics and software of the discipline / course

Textbooks, computers

12. Additional information

The time and place (specialized, classroom, laboratory, studio, etc.) of the discipline is determined in accordance with the approved schedule. All compulsory and auxiliary literature are available as an e-books.

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