

**MINISTRY OF THE HEALTH CARE OF THE UKRAINE**  
**ODESSA NATIONAL MEDICAL UNIVERSITY**  
DEPARTMENT HISTOLOGY, CYTOLOGY, EMBRYOLOGY AND  
PATHOLOGICAL MORFOLOGY WITH A COURSE IN FORENSIC MEDECINE

**I APPROVE**  
Vice-rector for scientific and pedagogical work  
Eduard BURJACHKIVSKY  
September 1, 2024



**THE WORKING PROGRAM OF THE SUBJECT**  
**“Toxicological and forensic chemistry”**

**Level of high education:** the second (master) level

**Field of knowledge:** 22 «Health care»

**Specialties:** 226 "Pharmacy, industrial pharmacy"

**Educational-professional program:** Pharmacy, industrial pharmacy

Odesa 2024

The working program is compiled on the basis of the educational and professional program «Medicine» for the training of specialists of the second (master's) level of higher education in the specialty 222 “Medicine” of the field knowledge 22 «Health care», approved by Scientific Council of the ONMedU protocol No.10 of June 24, 2024)

Developers:

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The program was approved at the meeting of the forensic medical department forensic medical.

Protocol No. 1 date August 26, 2024

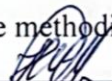
Head of the department  Varvara SYTNIKOVA

Agree with the guarantor of OPP

 Liana UNHURIAN

Approved by the subject cycle commission for pharmacy's disciplines

Protocol No. 1 date August 28, 2024

Head of the subject cycle methodical commission from pharmacy's disciplines of ONMedU  Natalia FIZOR

Reviewed and approved at the meeting of the department

Minute No 1 of “\_\_\_” \_\_\_\_\_ 20\_\_\_\_

Head of the department \_\_\_\_\_

(signature)

(First name, LAST NAME)

Reviewed and approved at the meeting of the department

Minute No 1 of “\_\_\_” \_\_\_\_\_ 20\_\_\_\_

Head of the department \_\_\_\_\_

(signature)

(First name, LAST NAME)

## 1. Description of the academic discipline:

Name of indicators	Field of knowledge, specialty, specialization, level of higher education	Characteristics of the academic discipline
The total number of: Credits: 3.0 Hours: 90 Content modules : 1	Branch of knowledge 22 "Health care"  Specialty 226 "Pharmacy, industrial pharmacy"  Level of higher education second (master's)	<i>Full-time education</i>
		<i>Mandatory discipline</i>
		<i>Year of training: 4</i>
		<i>Semesters VIII</i>
		<i>Lectures (20 hours)</i>
		<i>Seminars (0 hours)</i>
		<i>Practical (40 hours)</i>
		<i>Laboratory (0 hours)</i>
		<i>Independent work (30 hours) including individual tasks (0 hours)</i>
<i>Final control form – Differential offset</i>		

## 2. The purpose and tasks of the educational discipline

**Purpose:** Mastering the necessary knowledge by the applicant and, on the basis of modern scientific concepts, 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 the development of skills and abilities in the methods of isolating poisons from objects of biological origin, as well as the detection and determination of xenobiotics and their metabolites in chemical toxicological or forensic toxicological research.

### Tasks:

1. To provide knowledge of the subject, tasks and main sections of toxicological and forensic chemistry, its application, classification of poisons and poisoning;
2. To provide knowledge of the classification of toxic substances by methods of their isolation from objects of biological origin;
3. To provide knowledge of the main regulatory documents governing forensic toxicological and chemical toxicological analysis;
4. To teach students safety precautions and rules of work in a chemical and toxicological (forensic toxicological) laboratory (theoretical foundations of methods for the isolation of toxic substances from biological material, their detection, identification and quantification using chemical and physicochemical methods);
5. To provide knowledge of the ways of entering the body and excretion of poisons, their toxicokinetics, distribution in the body, storage in cadaveric material and the impact of these processes on the results of chemical and toxicological analysis.

**The process of studying the discipline is aimed at forming elements of the following competencies:**

### - Integral (IC):

The ability to solve typical and complex problems, including those of a research and innovation nature in the field of medicine. Ability to continue learning with a high degree of autonomy.

### General (GC):

- GC02. Knowledge and understanding of the subject area and understanding of professional activities
- GC03. Ability to communicate in the state language both orally and in writing
- GC05. Ability to evaluate and ensure the quality of work performed.
- GC06. Ability to work in a team.
- GC10. Ability to make decisions and act in compliance with the principle of inadmissibility of corruption and any manifestations of dishonesty.
- GC11. Ability to apply knowledge in practical situations.
- GC12. The desire to preserve the environment.
- GC13. Ability to show initiative and entrepreneurship.
- GC14. Ability to adapt and act in a new situation.
- GC15. Knowledge and understanding of the subject area and understanding of professional activities
- GC16. Ability to conduct experimental research at the appropriate level.

### **Special (SC)**

SC 09. Ability to provide first aid to patients and injured in extreme situations and in case of emergencies.

SC 10. Ability to monitor the effectiveness and safety of medicines in the population according to data on their clinical and pharmaceutical characteristics.

SC. Ability to identify drugs, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological studies for the diagnosis of acute poisoning, drug and alcohol intoxication.

SC 20. Ability to develop and evaluate methods of quality control of medicines of natural and synthetic origin, including active pharmaceutical ingredients, medicinal plant materials and excipients using physical, chemical, physicochemical, biological, microbiological, pharmacological and technological methods; to standardise medicines in accordance with current requirements

SC 24. Ability to use in professional activities the knowledge of regulatory and legal acts of Ukraine and recommendations of good pharmaceutical practices.

SC 25. Ability to demonstrate and apply in practice communication skills, fundamental principles of pharmaceutical ethics and deontology based on moral obligations and values, ethical standards of professional behaviour and responsibility in accordance with the Ethical Code of Pharmacists of Ukraine and WHO guidelines.

### **Programme learning outcomes for the discipline (PLO):**

PLO25. To comply with the norms of sanitary and hygienic regime and safety requirements in the performance of professional activities.

PLO26. To argue information for decision-making, to be responsible for them in standard and non-standard professional situations; to adhere to the principles of deontology and ethics in professional activities.

PLO32. Analyse information obtained from scientific research, summarise, systematise and use it in

professional activities.

PLO33. Determine the influence of factors that affect the processes of absorption, distribution, deposition, metabolism and excretion of drugs and are caused by the state, characteristics of the human body and physicochemical properties of drugs.

PLO34. Use data from clinical, laboratory and instrumental studies to monitor the efficacy and safety of medicines.

PLO43. To organise the necessary level of individual safety (own and persons under care) in case of typical dangerous situations in the individual field of activity.

**As a result of studying the academic discipline, the applicant of higher education must:**

**Know:** classification of poisons in forensic toxicological analysis and methods of their isolation from objects of biological origin, identification and quantification. Subject, objectives and main sections of the discipline "Toxicological and Forensic Chemistry", as well as areas of its application; basics of toxicology, toxicodynamics, toxicokinetics, toxicometry, types of toxic effects and determination of toxic doses, features of chemical and toxicological analysis, procedure and documentation of forensic toxicological (chemical and toxicological) examinations; general principles of interpretation of the results of forensic toxicological studies.

**Be able to:** perform preliminary tests (screening) of groups of toxic substances to detect them in blood, urine, saliva, hair and other objects; conduct TLC screening of drugs in biological fluids; have the skills to correctly draw up a plan for forensic toxicological analysis in the rapid diagnosis of acute poisoning; be able to isolate substances of these groups from objects of biological origin; be able to detect these substances using chemical, physicochemical and immunoenzyme methods; be able to predict the direction of metabolism of substances in order to take measures to prevent the negative impact of "lethal" synthesis on the victim's body; be able to predict the effect of poisons on the body in the somatogenic phase of poisoning and to propose effective methods of detoxification of the body; be able to predict the impact of combined poisoning on the victim's condition and on the course of chemical and toxicological research.

**Master the skills:**

:to conduct poison research using preliminary samples (screening tests).

To isolate poisons from internal organs of corpses, blood and urine.

Detection and identification of poisons isolated from research objects using chemical reactions (colour, precipitation, microcrystallographic), physicochemical methods (spectrophotometric, chromatographic, electrophoretic, fluorescent), physiological samples and enzyme-linked immunosorbent assays.

Quantitative determination of poisons isolated from the research objects.

### 3. Content of the subject

**Section 1.** Fundamentals of forensic and toxicological chemistry and chemical and toxicological analysis. Groups of toxic substances that are isolated from biological material by infusion of the objects under study with water (mineral acids, alkalis and their salts), distillation with water vapour (volatile substances) and mineralisation (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. Group of poisons requiring special methods of isolation (fluorides, bromides iodides). A group of poisons that do not require isolation but are studied directly in the object of study (carbon monoxide). Methods of detoxification in case of poisoning by these groups of substances.

#### **Topic 1: Fundamentals of toxicological and forensic chemistry, toxicology, forensic toxicology, clinical toxicology and environmental toxicology.**

Interrelation of toxicological and forensic chemistry with forensic toxicology and clinical toxicology. Toxicological and forensic chemistry, their content and tasks. The 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. Legislative acts and organisation of forensic medicine in Ukraine. The importance of toxicological and forensic chemistry in the training of a pharmacist and their place among other pharmaceutical disciplines. Ethics and deontology in toxicological and forensic chemistry. Toxicological chemistry is a science that studies and develops methods for the isolation of toxic substances from research objects, as well as develops methods for the qualitative and quantitative analysis of these poisons. Forensic chemistry is a science that deals with the chemical examination of material evidence. Forensic chemistry solves the problems and tasks of forensic toxicology. Forensic toxicology is a branch of forensic medicine that studies poisons and poisoning in terms of issues of interest to investigative and judicial authorities. Forensic toxicology studies the theoretical and practical issues of poisoning examination and is directly related to both clinical toxicology and toxicological chemistry. Forensic toxicology is aimed at fulfilling the tasks of justice and healthcare. It provides scientific justification for the methods of examination of fatal and non-fatal poisoning resulting from the use of poisons for the purpose of murder or suicide, or as a result of accidents. Clinical toxicology studies acute and chronic diseases caused by toxic chemicals in order to scientifically substantiate methods of diagnosis, prevention and therapy of poisoning. In this regard, the tasks in clinical toxicology are divided into diagnostic, therapeutic and preventive. Ecological toxicology studies the impact of pollutants (toxicants) on various biological systems at all levels of their organisation (from the individual to entire communities and ecosystems), as well as their functioning under conditions of pollution. The main tasks of ecotoxicology are to establish the fact of pollution, assess the risks of pollution, predict the consequences and develop effective measures to prevent any harmful effects in the present and in the future. The main branches of forensic and toxicological chemistry are biochemical toxicology and analytical toxicology. The subject of study is biochemical toxicology (mechanisms of toxic effects of substances on the body: kinetics of absorption, distribution, excretion, mechanisms of metabolic reactions, pathways and mechanisms of substance transport and elimination). The subject of study is analytical toxicology (methods and techniques for isolation, identification and quantification of toxic substances). Analytical and applied toxicology. Analytical diagnosis of acute poisoning. Analytical diagnosis of occupational diseases.

#### **Topic 2. The concept of poison. Characteristics and examples of xenobiotics. Classification of poisons. Ways of penetration of poisons into the body and transport mechanisms. Distribution of poisons in the body. Characteristics of the action of poisons. Factors affecting the toxicity of chemical compounds. Removal of poisons from the body.**

Definition of the terms "xenobiotic" and "poison". The main factors that determine the toxicity of substances. General principles of classification of poisons: chemical structure, purpose of use, degree of toxicity (hygienic), type of toxic effect (toxicological), selective toxicity,

pathophysiological (by type of hypoxia), Pokrovsky pathochemical (by mechanism of interaction with enzyme systems), by the degree of carcinogenic activity (strong, medium and weak carcinogens), biological (by the nature of the biological consequences of poisoning - allergens, teratogens, mutagens, carcinogens), by the methods of isolation from objects of biological origin (chemical and toxicological). Forensic classification of poisons. Types of toxic effects. Embryotoxic, gonadotoxic, teratogenic and mutagenic effects of toxic substances. Toxic doses and concentrations of poisons. Characteristics of xenobiotics (individual medicines, food additives, alcoholic beverages, preservatives, cosmetics, pesticides, detergents, poisonous gases, alkalis, acids, "heavy metals", plant and animal poisons, disinfectants, plant protection products, pesticides, mineral fertilisers, household chemicals for various purposes, technical fluids, organic solvents, industrial waste, etc.) Ways of poisons entering the body (oral, parenteral, inhalation, percutaneous, through body cavities). The concept of toxicodynamics and toxicokinetics of poisons. Transport of poisons and their metabolites across cell membranes. Theory of nonionic diffusion. The concept of membranotoxins. Diseases and mechanisms of membrane damage. Theory of toxicity receptors. The main types of connections between poisons and receptors that affect toxicity. Factors that determine the distribution of toxic substances in the body (spatial, concentration and time). The relationship between the physical and chemical properties of poisons and their distribution in organs and excretion from the body. The concept of cumulation and addiction to poisons. Combined action of toxic substances. Selective toxicity. Adaptation to poisons. Elimination of poisons - natural detoxification of the body. Removal of poisons from the body (excretion). Excretion through the lungs. Renal excretion. Liver excretion (hepatocyte uptake, biliary excretion). Excretion through the intestine. Other routes of excretion.

**Topic 3. General characteristics of poisoning (intoxication). Classification of poisoning. Characteristics of 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 of the body Antidotes and antagonists.**

Definition of the term "poisoning" ("intoxication"). Classification of poisoning by the cause of occurrence (etiopathogenetic), by conditions (place) of development, by clinical principle (acute, chronic, subacute poisoning), by ways of penetration into the body, nosological classification. Forensic classification of poisoning. Phases of poisoning: toxicogenic (the poisonous substance is in the body, metabolised and excreted) and somatogenic (the poisonous substance is excreted from the body, the effects of poisoning are observed). Toxicokinetic features of oral, parenteral, inhalation and percutaneous poisoning. Characteristics of factors that determine the development of acute poisoning (I. Basic factors related to poisons; II. Additional factors related to a specific "toxic situation"; III. The main factors that characterise the victim; IV. Additional factors affecting the victim). Clinical symptoms and specific symptoms of poisoning (discolouration of urine and skin; impaired perception of taste, smell, colour; hearing and visual impairment, alopecia, etc.) Methods of detoxification of the body in case of poisoning (removal of unabsorbed poison, active detoxification therapy, stimulation of natural body cleansing processes, artificial physical and chemical detoxification). Symptomatic and antidote therapy.

**Topic 4. Basic laws of behaviour of toxic substances in the body. Metabolism (biotransformation) of xenobiotics. The first and second phases of metabolism. Lethal synthesis.**

Ways of biotransformation of xenobiotics in the body. Metabolism and metabolites. The concepts of "lethal synthesis" and "lethal incorporation". Microsomal and non-microsomal metabolism. Characteristics of metabolic processes in cells of various organs and tissues (liver, lungs, kidneys, placenta, blood, intestines). Patterns and mechanisms of reactions of the first phase of biotransformation. Mechanisms of reactions of the second phase of biotransformation. Coupling reactions (conjugation).

**Topic 5. Forensic toxicological research and chemical toxicological analysis. Forensic medical examination, its stages and tasks. Objects of research. Overview of research objects,**

### **preliminary tests and preparation of a forensic toxicological research plan.**

Directions, goals and objectives of chemical toxicological and forensic toxicological research. The main stages of chemical toxicological analysis and forensic toxicological research. Use of chemical toxicological analysis in theoretical toxicology, clinical toxicology, preventive toxicology and forensic toxicology. Forensic medical examination of poisoning, its tasks and stages. Forensic toxicological research as the main stage of forensic examination of poisoning. An indicative list of forensic issues to be resolved by an expert in case of suspected poisoning: 1) whether death occurred as a result of poisoning or for other reasons; 2) what poison caused the poisoning; 3) what dose and concentration of poison caused the poisoning; 4) how and in what form the poison entered the body; 5) what were the clinical symptoms of poisoning; 6) how long after poisoning death occurred; 7) whether the deceased suffered from any diseases and whether they contributed to intoxication; Forensic medical examination of poisoning consists of the following main stages a) acquaintance of the forensic expert with the materials collected during the investigation of the incident, which are relevant for the forensic determination of poisoning; b) participation of the forensic physician in various investigative actions, primarily in the examination of the scene with the seizure of material evidence and in the interrogation of victims, witnesses and medical workers; c) studying and assessing the clinical picture of poisoning based on the materials of the inpatient's card (medical history), other medical documents and eyewitness testimony; d) forensic examination of the corpse (in case of fatal poisoning) or forensic examination of the victim (in case of non-fatal poisoning); e) forensic toxicological examination and other additional laboratory tests. Forensic toxicological examination of internal organs, tissues and body fluids is the most important stage of forensic examination. Its purpose is to identify the poison, determine its quantitative content and distribution in the body. Analysis of material evidence. Objects of forensic toxicological research, their characteristics, and preservation methods. Rules for the selection, referral and acceptance of objects for forensic toxicological examination and sample storage. Examination of research objects and preliminary tests (screening studies) in forensic toxicological analysis and their role in the preparation of a chemical toxicological analysis plan. Objects of study and plan of forensic toxicological analysis for an unknown poison (non-directed or non-targeted analysis) and in case of suspected poisoning with a specific poison (directed or targeted analysis). The procedure for performing and documenting forensic toxicological (chemical toxicological) examinations and forensic medical examinations in general. Drawing up a plan for chemical and toxicological analysis. General principles of interpretation of the results of forensic toxicological research.

### **Topic 6: Toxicological characterisation and analysis of a group of toxic substances isolated from biological material by infusion of the objects under study with water (mineral acids, alkalis and their salts). Isolation from biological material and detection and quantification of nitrates and nitrites.**

A group of toxic substances that are isolated by infusion with water (inorganic acids, alkalis, salts). General characteristics of the group. Physical and chemical properties. Application. Toxic effect of nitric (nitrate), sulfuric (sulphuric), hydrochloric (chloride) acids, salts of nitric and nitrite acids (nitrates, nitrites), caustic alkalis (sodium, potassium, ammonium, calcium hydroxides). Features of the separation of acids, alkalis, salts from objects of biological origin. Methods of purification and separation using the phenomena of dialysis, electro dialysis and osmosis. Methods for the detection and quantification of acids, caustic alkalis, salts of nitrate and nitrite acids. Storage of compounds of this group in biological material. Evaluation of analysis results.

### **Topic 7. A group of toxic substances that are isolated from biological material by steam distillation (volatile substances). Toxicological characteristics and methods for the isolation of volatile substances from research objects.**

General and toxicological characteristics of the group of toxic substances isolated from biological material by distillation (volatile substances): hydrocyanic acid and cyanides, alkyl halides (chloroform, 1,2-dichloroethane, tetrachloromethane, chloral hydrate, trichloroethylene), aliphatic single-atom alcohols (methyl, ethyl, including "fusel oils: propyl, isopropyl, butyl, isobutyl, amyl



and isoamyl alcohols), polyhydric alcohols (ethylene glycol), aldehydes (formaldehyde, acetaldehyde, polyacetaldehyde (metaldehyde or dry alcohol), ketones (acetone), aromatic hydrocarbons (benzene, toluene, xylene), monoatomic phenols (phenol, cresol), aromatic amines (aniline and its derivatives), carboxylic acids (acetic or acetate), ethers (diethyl), esters (ethyl acetate, butyl acetate tricresyl phosphate), cellulose (ethyl cellulose), organometallic compounds (tetraethyl lead), phenol-formaldehyde resins, petroleum products (petrol, kerosene, diesel, fuel oil, gas oils), adhesive components (aromatic and chlorinated hydrocarbons, alcohols, acetone, gasoline, dibutyl phthalate, dioctyl phthalate, etc.), components of perfumes and cosmetics (alcohols, benzyl benzoate, diethyl phthalate, propylene glycol, oil refining products, etc.). Physical and chemical properties, structure and effects of volatile substances on the body. Causes and frequency of poisoning by volatile substances. Features of combined poisoning. Substance abuse. Directions and products of transformation of alkyl halides, aromatic amines, aromatic hydrocarbons and other volatile substances. General and toxicological characteristics of phosgene, a product of oxidation of chloroform and trichloroethylene. The significance of the results of chemical and toxicological analysis for the diagnosis of volatile substance poisoning. Means of detoxification of the body in case of poisoning with volatile substances. Methods for the isolation of volatile substances from objects of biological origin, food and environmental objects: distillation with water vapour, dry-air distillation, distillation with inert gases, distillation with carrier. Theoretical justification of the methods, selection of the method and distillation conditions depending on the object and physical and chemical properties of the substance under study. Substances distilled from an acidic medium and substances distilled from an alkaline medium.

#### **Topic 8: Analysis of distillate for volatile substances using chemical methods.**

Chemical method of analysis of distillates. Types of chemical reactions used in the analysis, assessment of their sensitivity and specificity. Schematic diagram of the study of biological objects for volatile substances in directed and non-directed analysis using a combination Influence of time and storage conditions of the study objects on the analysis results.

#### **Topic 9: Qualitative analysis of volatile substances in a distillate by gas-liquid chromatography (GLC).**

Theoretical foundations of the method of gas-liquid chromatography. Chromatographs. Solid carriers in chromatography. Immobile liquid phases (ILP). Chromatographic columns. Types and characteristics of detectors. Processes that take place in chromatographic separation. Factors affecting chromatographic separation. Influence of endogenous compounds on the sensitivity and specificity of the GC method for the analysis of volatile substances. Retention parameters. Methods of qualitative analysis in GC. Methods of group and individual identification of toxic substances using the method of gas-liquid chromatography (GLC). Examination of alcohol intoxication.

#### **Topic 10. Quantitative analysis of volatile substances in a distillate by gas-liquid chromatography (GLC).**

The tasks of the quantitative gas chromatographic method of analysis are: a) determination of the content of one, several or all components of a mixture; b) determination of the content of trace elements in individual substances and various media; c) determination of the total composition of a mixture. Chromatographic peak parameters for quantitative determination in GC: peak area (S), peak height (h), product of peak height and retention time (R ht), and product of peak height and retained volume (R hV). Methods of processing quantitative parameters of chromatograms. Methods of quantitative determination in GC.

**Topic 11: Toxicological characteristics and methods of metal extraction.** Examination of mineralisation precipitate for the presence of metals. General characteristics, application and toxicity of metal compounds: barium, lead (plumbum), manganese (manganese), chromium, silver (argentum), copper (copper), zinc, cadmium, bismuth, thallium, stibium, arsenic and mercury (mercury). Ways metals enter the body. Types of bonds formed when poison metals interact with proteins, peptides and amino acids in the body. Distribution and accumulation of metals in the body. Excretion of metals from the body. Trace elements and macroelements. Theoretical justification of the need for mineralisation of objects of biological origin in their study for metals.

Characteristics of mineralisation methods. Choice of mineralisation method depending on the nature of the object of study and the metal under investigation. Denitration of mineralisate and its preparation for study. Characterisation of metals that may be contained in the mineralisation in the form of precipitates. Detection of barium and lead cations in the mineralisation. Separation of the precipitate from the liquid part of the mineralisation. Washing and recrystallisation of the precipitate. Solubility of lead and barium salts. Separation of barium sulphate and lead sulphate precipitates. Selection of conditions for complete separation of lead sulphate from barium sulphate. Conversion of barium sulphate into soluble compounds. Detection reactions for lead and barium cations.

**Topic 12: Examination of the liquid part of a mineralisation for the presence of metals. Detection and determination of manganese, chromium, silver, copper and zinc.**

The method of individual study of metals (method of separate study, "fractional" method, separate analysis of metals) in mineralisate. Theoretical provisions. Selection of research objects. Scheme of separate study of metals in mineralisate (according to O.M. Krylova). Characteristics of reagents for masking interfering ions in the separate study of metals. Characteristics of reagents used for the isolation and analysis of metals. Requirements for the sensitivity of reactions in the study of metals in minerals. General characteristics of methods for the quantitative determination of metals in minerals. Detection and quantification of manganese (manganese), chromium, silver (argentum), copper (copper) and zinc cations in minerals.

**Topic 13. Investigation of the liquid part of the mineralisation for the presence and content of cadmium, thallium, bismuth, stibium and arsenic.**

A method of individual determination of cadmium, thallium, bismuth, stibium and arsenic cations in mineralisate. The systematic course of analysis of metals in mineralisate. Features and methods of quantitative determination of metals in objects of biological origin. Possible errors in the analysis. Forensic assessment of the results of forensic toxicological research, taking into account the natural content of metals in the body.

**Topic 14: Isolation of mercury (mercury) from biological material and its study in destructate.** Toxicological characteristics of mercury compounds, mechanisms of toxic action, binding to body cells, distribution and accumulation in the body. Peculiarities of mercury release from research objects of biological origin. The essence of the destruction method. Detection of mercury in the destructant. Methods of quantitative determination of mercury in the destructant. Antidotes used in mercury poisoning and mechanisms of their action. Methods of atomic absorption spectroscopy, diffractionless X-ray fluorescence analysis and other physical methods in the study of metals in minerals and biological fluids.

**Topic 15: Toxicological characteristics and methods of analysis of toxic substances requiring special methods of isolation (fluorides, silicon fluorides, bromine, iodine).** Group of toxic substances requiring special methods of isolation. Physical and chemical properties of fluorides, silicon fluorides, bromine, iodine. Poisoning by substances of this group. Methods of isolation of fluorine, bromine, iodine compounds. Methods of detection and quantification of fluorides, bromides, iodides. Features of the detection of fluorine in organofluorine compounds (freons). Evaluation of analysis results.

**Topic 16. Toxicological characteristics of carbon monoxide, features of its detection and determination in the human body. Methods of detection of carboxyhaemoglobin and carboxymyoglobin. Spectrophotometric determination of carboxyhaemoglobin and carboxymyoglobin.**

A group of poisonous substances that can be detected directly in biological material without being isolated. Physicochemical properties of carbon monoxide (carbon (II) oxide, carbon monoxide, carbon monoxide). Acute poisoning and classification of carbon monoxide poisoning by severity. Detection of carboxyhaemoglobin 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 detection and determination of carbon monoxide in blood; Methods

of natural and artificial detoxification of the body in acute carbon monoxide poisoning.

**Division 2.** 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 that are isolated from research objects by non-polar organic solvents (pesticides). 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. Rapid analysis of acute intoxication with these poisons. Methods of detoxification in case of poisoning.

**Topic 17: Toxicological characteristics, mechanisms of toxic action and methods of isolation of drugs of natural (alkaloids) and synthetic origin from biological material.**

General characteristics of the group. Physicochemical properties, structure and effects on the body of poisonous and potent organic substances. Drug addiction and drug dependence. Diagnosis of narcotic conditions. Doping agents. Doping control. Methods of natural and artificial detoxification of the body in acute poisoning. Basic physicochemical constants (pH, pKa, partition coefficient, etc.). Extraction of substances with organic solvents from aqueous media, its importance for the isolation of the specified group of compounds, the dependence of its effectiveness on various factors. Modern general and individual extraction methods, their characteristics and comparative evaluation. Influence of various factors on the efficiency of the isolation of the studied substances at different stages of this process (nature, condition and preliminary preparation of the object, nature of the solvent, pH of the solution, nature of the acid and electrolyte, degree of ionisation, methods of protein precipitation, nature of the extractant, etc.) Characteristics of the solvents most commonly used for isolation. Separate (special) methods for the isolation of barbiturates (method of P. Valov, V.I. Popova), 1,4-benzodiazepine derivatives (method of B.M. Izotov), phenothiazine derivatives (method of E.M. Salomatin). Methods of purification of extracts and separation of toxic substances from concomitant endogenous impurities of protein and lipid nature, colouring substances, etc. (TLC, gel chromatography, extraction, electrophoresis, extraction, freeze-drying, dialysis and electro-dialysis). Methods of concentration of the substances under study from the extracts: extraction with organic solvents, adsorption, evaporation, etc.

**Topic 18: Investigation of chloroform extracts from acidic environments ("acidic" chloroform extracts) by chemical reactions.**

Toxicological characteristics and methods of analysis of medicinal substances and poisons of natural origin extracted from acidic environment (substances of acidic, neutral and weakly basic nature). Medicinal substances (alkaloids and their synthetic analogues) and poisons of natural origin: Indole derivatives (strychnine and brucine - alkaloids of chilli seeds; reserpine - alkaloid of plants of the Rauwolfia genus; physostigmine - alkaloid of beans of the physostigma plant; ergonine and ergotamine - alkaloids of ergot; Xanthine derivatives (caffeine - alkaloid of coffee tree, tea, holly, guarana, cola; theobromine - alkaloid of cocoa, cola, holly; theophylline - alkaloid of cocoa, camellia, holly). Medicinal substances of synthetic origin: derivatives of barbituric acid (barbital, phenobarbital, benzonal, barbamy, sodium ethamine); derivatives of salicylic acid (sodium salicylate, acetylsalicylic acid, methyl salicylate, phenyl salicylate, salicylamide, oxaphenamide, sodium para-aminosalicylate, bepasc); pyrazolone derivatives (analgin, antipyrine, amidopyrine, butadiene). Application in medicine: indole, xanthine, pyrazolone, barbituric and salicylic acid derivatives. Physicochemical properties and chemical structure, causes of poisoning, mechanisms of toxic action, basic patterns of behaviour in the body (routes of entry, metabolism, distribution, excretion). Chemical and toxicological analysis of "sour" chloroform extract (chloroform extract) for substances of acidic, neutral and weakly basic nature. Chemical methods of research. Types of reactions: colour (dye), precipitation and microcrystallographic reactions, features of their performance. Sensitivity and specificity of reactions. The concept of false positive and false negative results. Schematic diagram of identification and quantification of substances isolated by polar solvents.

**Topic 19: Study of "acidic" chloroform extracts by physicochemical methods.** Physicochemical methods of analysis and their use for the detection and quantification of medicinal

substances. Chromatographic methods of research: thin sorbent layer chromatography (TLC), high-performance liquid chromatography (HPLC), gas-liquid chromatography (GLC) and their use in forensic toxicological analysis. TLC screening as a preliminary stage of identification in non-directed chemical toxicological analysis. Group detectors in TLC. Photometric methods: spectrophotometry in the visible, UV and IR spectral regions, photoelectrocolourimetry, fluorimetry, chromatography-mass spectrometry. Pharmacological studies and their role in the identification of certain compounds. 25 Comparative assessment of analytical methods, their sensitivity, specificity and the possibility of using them in the presence of some endogenous impurities.

**Topic 20-21. Investigation of chloroform extracts from alkaline environments ("alkaline" chloroform extracts) using colour, precipitation and microcrystallographic reactions.**

Toxicological characteristics and methods of analysis of medicinal substances extracted from alkaline environment (basic and weakly basic substances). Medicinal substances (alkaloids and their synthetic analogues) and poisons of natural origin: pyridine and piperidine derivatives (anabazine, nicotine, arecoline, konium, lobeline, pachycarpine); tropane derivatives (belladonna and dope alkaloids, atropine, scopolamine, cocaine); quinoline derivatives (quinine alkaloids, quinine, quinidine; quinazole, quiniphone); isoquinoline derivatives (opiates): tetrahydroisoquinoline derivatives (narcotine, narcine); benzyloisoquinoline derivatives (papaverine); phenanthreneisoquinoline derivatives (morphine, codeine, thebaine); semisynthetic opioids (ethylmorphine, heroin, hydrocodone, oxycodone, levorphanol, etc.) Phenylalkylamine derivatives (acyclic alkaloids - ephedrine, pseudoephedrine and their oxidation products - ephedrone and norephedrone; amphetamines - phenamine (amphetamine), methamphetamine, MDMA (ecstasy), etc.) Medicinal substances of synthetic origin: 1,4- benzodiazepine derivatives (chlordiazepoxide, diazepam, oxazepam, mesapam, phenazepam, nitrazepam, clonazepam); phenothiazine derivatives (aminazine, diprazine, emozine, levomepromazine, thioridazine); p-aminobenzoic acid derivatives (novocaine, novocainamide); isonicotinic acid derivatives (isoniazid, iproniazid, phtivazide); butyrophenone derivatives (haloperidol, droperidol, benperidol); 1. Imidazoline derivatives (clofelin); tricyclic antidepressants (imipramine, amitriptyline, trimipramine); synthetic opioids (tramadol, methadone, fentanyl, promedol, phencyclidine, ketamine, dextromethorphan, pentazocine, etc.) phenylalkylamine derivatives (amphetamines - phenamine (amphetamine), methamphetamine, MDMA (ecstasy), etc.); lysergic acid derivatives (LSD, Lysergic acid diethylamide/ - lysergic acid diethylamide). Application in medicine, causes of poisoning. Physicochemical properties, chemical structure (classification by heterocycle structure), basic patterns of behaviour in the body (routes of entry, distribution, excretion, metabolism), toxic effects. Chemical and toxicological analysis of "alkaline" chloroform extract (chloroform extract) for basic medicinal substances. Determination of group and individual belonging of medicinal substances by means of chemical reactions (precipitating, colour, microcrystalloscopic). Chemical and toxicological assessment of the results obtained. Diagnostics of narcotic conditions. Doping agents. Doping control. Drug addiction and substance abuse and their prevention.

**Topic 22. Investigation of "alkaline" chloroform extracts by chromatographic methods (TLC, GC, HPLC), spectrophotometric (UV, IR spectrophotometry) and enzyme-linked immunosorbent assay methods. Quantitative determination of medicinal substances in extracts from biological material.**

TLC screening as a preliminary stage of identification in non-directed chemotoxicological analysis. Group manifestations in TLC screening. Establishment of group and individual suitability of medicinal substances extracted from biological fluids by means of TLC screening. Theoretical basis of chromatographic methods and their application in chemical toxicological studies. Identification by TLC, GC and HPLC methods. Physical bases of spectrophotometric methods and peculiarities of their application in chemical and toxicological studies. The use of immunochemical methods (radioimmunoassay and enzyme-linked immunosorbent assay) for the detection and determination of toxic substances in biological fluids. Determination of the group and individual belonging of

alkaloids using pharmacological samples (atropine, strychnine, nicotine). Evaluation of the specificity and sensitivity of these methods. Methods for the quantitative determination of drugs isolated from biological material. Photometric: photoelectrocolourimetry (extraction photometry), UV spectrophotometry (direct, differential on the example of barbiturates). Extraction-photometric determination of medicinal substances in extracts. Chromatographic methods for the quantitative determination of poisons: HPLC, GC, TLC (densitometry, planimetry). Comparative assessment of methods by sensitivity. Influence of various factors related to the peculiarities of biological objects on the results of quantitative determination of drugs isolated from biological material during chemical toxicological research. Requirements for the degree of purification of biological extracts subject to quantitative analysis. Selection of optimal conditions for the extraction-photometric determination of basic drugs by reaction with acid dyes (for example, sulfophthalein dyes) (selection of the most sensitive dye, light filter, thickness of the absorbing layer, destruction of the ionic association and re-extraction of the dye into the aqueous layer) and use of the developed methodology for the quantitative analysis of drugs in biological fluids.

**Topic 23: Poisons of natural origin (poisons of plants, fungi, algae, animals and insects). General and toxicological characteristics, isolation from biological material and methods of chemical and toxicological analysis. Diagnosis of poisoning and detoxification of the body.**

Characteristics of poisons of natural origin. Plant poisons (phytotoxins) - ricin, dithylin, nicotine, strychnine, scopolamine, etc. Animal poisons (zootoxins) - tetrodotoxin. Poisons of cap fungi and their classification. Mechanisms of toxic action and clinical symptoms of poisoning when eating poisonous mushrooms (pale toadstool, red fly agaric, false mushrooms, false morels) and conditionally edible mushrooms (morels, strokes, porkies, woolly mushrooms, raw mushrooms). Diagnostics, emergency care, antidote and symptomatic therapy for mushroom poisoning. Methods of isolation from the objects of study and chemical and toxicological analysis of poisons of cap fungi. Poisons of natural origin that require special methods of isolation from research objects: toxins of lower fungi or fungal poisons (mycotoxins), algal toxins (algotoxins) and microbial toxins.

**Topic 24. Rapid analysis of acute intoxication with barbiturates.**

Features of the rapid analysis of biological fluids in acute poisoning: focus of the analysis, peculiarities of the isolation of drugs from biological fluids, requirements for sensitivity and specificity of analytical methods used in the analysis. Toxic effects, mechanism of toxic action and clinical picture of acute barbiturate poisoning. Toxicokinetics (routes of entry into the body, distribution in the body, metabolic pathways, routes of excretion) of barbiturates of different spectra of action. Preliminary samples for laboratory rapid diagnostics of acute barbiturate poisoning. Methods for the isolation of barbituric acid derivatives and their metabolites from blood, urine and other biological samples. Methods of detection of barbiturates and their metabolites in the rapid diagnosis of acute poisoning using chemical reactions, thin sorbent chromatography. Detection of barbiturates by UV absorption spectra. Keto-enol and lactamlactam tautomerism of barbiturates. Analysis of barbituric acid derivatives in biological fluids by gas-liquid chromatography (GLC). Quantitative determination of barbiturates isolated from blood and urine (photocolourimetric, spectrophotometric and gas chromatographic methods). Interpretation of the results of laboratory rapid diagnostics of poisoning with barbituric acid derivatives. First aid and antidote therapy for acute barbiturate poisoning.

**Topic 25. Rapid analysis of acute intoxication with 1,4-benzodiazepine derivatives.**

Toxicological characteristics and mechanisms of toxic action of 1,4-benzodiazepine derivatives (nitrazepam, clonazepam, diazepam, mesapam, chlordiazepoxide, oxazepam, lorazepam, phenazepam, etc.) 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 isolation of 1,4-benzodiazepine derivatives (nitrazepam, clonazepam, diazepam, mesapam, chlordiazepoxide, oxazepam, lorazepam, phenazepam) and their metabolites from blood and urine. Detection of 1,4-benzodiazepine derivatives and their metabolites using colour reactions, thin layer sorbent chromatography, UV

spectrophotometry, fluorescence and GC method. Possibilities of using the reaction on the blocked aromatic amino group of 1,4-benzodiazepine derivatives with their preliminary hydrolytic cleavage to benzophenones. Quantitative determination of 1,4- benzodiazepine derivatives. Interpretation of the analysis results.

**Topic 26. Rapid analysis of acute intoxication with phenothiazine derivatives.**

Toxicological characteristics and mechanisms of toxic action of phenothiazine derivatives (aminazine, diprazine, fluoroacetylene, teaserzine, etaperazine, etc.) Pharmacodynamics and pharmacokinetics. Areas of metabolism of phenothiazine derivatives. Preliminary tests for the detection of phenothiazine derivatives in blood and urine in acute poisoning. Methods for the isolation of phenothiazine derivatives and their metabolites from blood and urine. Detection of phenothiazine derivatives and their metabolites by colour reactions, thin layer chromatography and UV spectrophotometry. Quantitative determination of phenothiazine derivatives. Interpretation and evaluation of analysis results.

**Topic 27. Rapid analysis of acute opiate intoxication.**

Toxic characteristics, mechanism of toxic action and clinical picture of acute poisoning with opium alkaloids and their synthetic analogues (morphine, codeine, thebaine, papaverine, narcotin, ethylmorphine, heroin). Metabolism of opium alkaloids and opioids. Preliminary tests for the detection of opium alkaloids and their synthetic analogues in biological fluids. Separation of opium alkaloids and opioids from blood and urine. Detection of opiates and their synthetic analogues using chemical reactions, thin sorbent layer chromatography, UV spectrophotometry, enzyme-linked immunosorbent assay, gas-liquid chromatography and high-performance liquid chromatography. Quantitative determination of opiates and opioids in the extracts. Conclusions and interpretation of the results of rapid analysis of acute opiate intoxication.

**Topic 28. Rapid analysis of acute cannabinoid intoxication.**

Characteristics and chemical composition of cannabinoids (marijuana, hashish and hashish oil). Toxic effects of cannabinoids. Ways of cannabinoids entering the body and their excretion from the body. The main pathways of cannabinoid metabolism. Characteristics of research objects in cannabinoid poisoning. Examination of saliva and hand skin for the presence of cannabinoids. Preliminary tests for the detection of cannabinoids in body fluids. Isolation of cannabinoids from research objects. Detection of cannabinoids using chemical methods, thin-sorbent chromatography and gas-liquid chromatography.

**Topic 29. General characteristics of pesticides: classification, toxicity, mechanisms of toxic action, biotransformation. Toxicological characteristics and methods of analysis of 1st, 2nd, 3rd and 4th generation pesticides. Toxicological characteristics and methods for the isolation of organophosphorus pesticides (OPP) and other organophosphorus compounds (OPC) from biological material.**

General understanding of pesticides. Classification of pesticides by area of application, toxicity, form of use. Chemical classification. Application in the economy. Negative aspects of pesticide use for the environment and humans. The problem of residual amounts of pesticides. Means of preventing pesticide poisoning. Pesticides from the group of organochlorine compounds (OCS), carboxylic acid derivatives, synthetic pyrethroids, phenol derivatives. Chemical structure and physicochemical properties of hexachlorocyclohexane, heptachlor, carbaryl, permethrin, decamethrin, cypermethrin, effects on the body, characteristics of poisoning. Basic patterns of behaviour in the body and corpse. Objects of chemical and toxicological analysis. Methods of isolation from objects of biological origin. Chemical, physicochemical and enzymatic methods of analysis. Methods of quantitative determination. Evaluation of analysis results. Organometallic pesticides (ethylmercury phosphate, ethylmercury chloride). Physical and chemical properties. Application and toxicity. Ways of penetration into the body, distribution, biotransformation and excretion. Methods of isolation from biological objects. Methods of detection and determination by native form and by mercury (II). Evaluation of analysis results. Pesticides from the group of phosphoric acid derivatives (PADs). Structure, physical and chemical properties of chlorophos, dichlorophos, metaphos, carbophos, phosphamide. Causes and frequency of FOS poisoning, stages

of FOS poisoning. Ways of penetration into the body. Biotransformation of FOS in the body of humans and animals, characteristics of the toxic properties of their metabolites. The main regularities of the behaviour of FOS in the body during life and after death. Objects of chemical and toxicological analysis for FOS. Methods for the isolation of PFAS from cadaver organs, biological fluids, food. Choice of extractant depending on the condition, nature of the object of study and poison. Selection of a method for purification of extracts containing PFAS, depending on the nature and amount of co-extractive substances. Methods and ways of providing assistance in case of poisoning with pesticides of different groups. Antidote therapy in case of FOS poisoning.

**Topic 30. Examination of extracts from biological material for pesticide content by enzymatic methods (chromatoenzyme method, enzyme-linked immunosorbent assay (ELISA), cholinesterase test).**

Methods for the analysis of FOS in extracts from biological material: cholinesterase test, chromatoenzyme and enzyme-linked immunosorbent assay. The role of enzyme methods in the rapid diagnosis of acute and chronic FOS intoxication. Evaluation of the analysis results.

**Topic 31. Investigation of extracts from biological material for the content of POPs by chemical reactions.**

Chemical methods for the analysis of POPs in extracts from biological material. Detection of organophosphates by phosphorus. Determination of phosphorylation activity. Detection of thio- and dithiophosphoric acid derivatives. Detection by functional active groups and hydrolysis products. Evaluation of the analysis results.

**Topic 32. Analysis of extracts from biological material for the content of PFCs by chromatographic methods.**

Characterisation of chromatographic methods for the analysis of FOS in extracts from biological material. Detection and identification by TLC, GC and HPLC. Evaluation of the analysis results.

**Topic 33. Quantitative determination of organophosphorus pesticides in the objects of study.**

Methods of quantitative determination of FFA (photocolourimetric, phosphorus photometric, planimetric, enzymatic, GC method). Characteristics of the main methods for determining FP in extracts from biological material and their comparative

#### 4. Structure of the discipline

Topic.	Number of hours		
	Total	Including.	
		L.	Pr.
<p><b>Unit 1.</b> Fundamentals of forensic and toxicological chemistry and chemical and toxicological analysis. Groups of toxic substances that are isolated from biological material by infusion of the objects under study with water (mineral acids, alkalis and their salts), distillation with water vapour (volatile substances) and mineralisation (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. Group of poisons requiring special</p>			

<p>methods of isolation (fluorides, bromides iodides). A group of poisons that do not require isolation but are studied directly in the object of study (carbon monoxide). Detoxification methods for poisoning with these groups of substances. 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 that are isolated from research objects by non-polar organic solvents (pesticides). Toxicodynamics, toxicokinetics and distribution of these poisons in the body. Methods of isolation of these poisons from research objects and methods of their analysis Rapid analysis of acute intoxication with these poisons. Methods of detoxification in case of poisoning.</p>				
<p>Topic 1: Introduction to the discipline "Toxicological and Forensic Chemistry". Fundamentals of toxicological and forensic chemistry, toxicology, forensic toxicology, clinical toxicology. General characteristics of poisoning (intoxication). Classification of poisoning. Characteristics of factors that determine the development of acute poisoning. Clinical and laboratory diagnosis of poisoning (specific symptoms). Methods of detoxification of the body. Familiarity with safety precautions and work procedures in the laboratory. External examination and preliminary testing of research objects and preparation of a forensic toxicology research plan.</p>	8.0	2.0	4.0	2.0
<p>Topic 2. Toxicological characterisation and analysis of a group of toxic substances isolated from biological material by infusion of the objects under study with water (mineral acids, alkalis and their salts). Isolation from biological material and detection and quantification of nitrates and nitrites. A group of toxic substances that are isolated from biological material by distillation with water vapour (volatile substances). Toxicological characteristics and methods for the isolation of volatile substances from the objects of study. Analysis of the distillate for volatile substances using chemical methods. Detection of volatile poisons by gas-liquid chromatography (familiarisation with the structure and procedure of chromatography, types of detectors). Checking the column resolution and detector sensitivity. Qualitative analysis of volatile substances in a distillate by gas-liquid chromatography. Quantitative analysis of volatile substances in the distillate by gas-liquid chromatography. Performing a practical task to detect an unknown "volatile" poison Detection and quantification of ethyl alcohol in biological fluids by GC. Construction of calibration graphs for the determination of ethanol in biological fluids by GC.</p>	22.0	4	10.0	8.0
<p>Topic 3. A group of substances that are isolated from biological material by its mineralisation. Its characteristics. Toxicokinetics and mechanisms of toxic action. Modern general and personal methods of mineralisation. Denitration</p>	14.0	2.0	6,0	6.0



of mineralisate. Features of the destruction of biological material in its study for mercury compounds. Mastering the method of mineralisation of biological material with a mixture of nitric and sulfuric acids and denitration of mineralisate. Examination of the mineralised precipitate and barium and lead cations. Determination of manganese, chromium, silver, copper, zinc cations in model mineralisates. Quantitative determination of manganese by photoelectrocolourimetry. Detection of bismuth, thallium, antimony, arsenic compounds in model minerals. Separation of mercury from biological material and its study in a destructant. Performing a practical task to identify an unknown "metal" poison.				
Topic 4. Toxicological characterisation and study of a group of poisons that require special methods of isolation (fluorides, iodide bromides) and a group of poisons that do not require isolation from the objects of study (carbon monoxide). Methods of detoxification in case of poisoning by these groups of substances. Toxicological characteristics and methods of analysis of toxic substances that require special methods of isolation (fluorides, silicon fluorides, bromine, iodine). Toxicological characteristics of carbon monoxide, peculiarities of its detection and determination in the human body. Methods of detection of carboxyhaemoglobin and carboxymyoglobin. Spectrophotometric determination of carboxyhaemoglobin and carboxymyoglobin.	10.0	2.0	6.0	2.0
Topic 5. Group of toxic substances that are isolated by polar solvents (medicinal substances). Chemical structure and toxicological characteristics of medicinal substances, mechanisms of toxic action, behaviour and distribution in the body, preservation in cadaveric organs, methods of isolation from research objects. Toxicological characteristics and peculiarities of chemical and toxicological analysis of drugs of acidic and weakly basic nature. Methods of qualitative and quantitative analysis of medicinal substances in extracts from acidic environments. Scheme of analysis of extracts. TLC screening of acidic and weakly basic substances and its importance for chemical and toxicological analysis. Toxicological characteristics and features of chemical and toxicological analysis of basic drugs. Methods of qualitative and quantitative analysis of medicinal substances in extracts from alkaline environments. Instrumental methods used in forensic examination in the performance of chemical and toxicological research. TLC screening of basic substances.	20.0	6.0	10.0	4.0
Topic 6. A group of toxic substances that are isolated from	8.0	2.0	4.0	2.0

biological material by organic solvents (pesticides). General characteristics of pesticides: use, classification, toxicity, mechanisms of toxic action, biotransformation. Toxicological characteristics and methods of analysis of pesticides (FOS, COC, ROS, carboxylic acid derivatives and pyrethroids).				
Topic 7. Methods of diagnosis and detoxification of the body in acute poisoning. Rapid diagnosis of acute poisoning. Interaction of drugs in the body (synergism). The use of enzyme-linked immunosorbent assay in chemical and toxicological studies. Antidote prophylaxis and therapy of poisoning. .	8.0	2.0	0	6.0
Differential credit	2.0			
Hours in <b>total</b> :	90.0	20.0	40.0	30.0

## 5. Topics of lectures / seminars / practical / laboratory classes

### 5.1. Topics of lecture classes

№ s/n	Name of the topic	Quantity hours
1.	Theoretical foundations of toxicological and forensic chemistry, toxicology, forensic toxicology, clinical toxicology. Definition of the concepts of "poison" and "poisoning". Classification of poisons and poisoning. Toxicokinetics. Distribution of toxic substances in the body. The main tasks of toxicological and forensic chemistry and areas of application of chemical and toxicological analysis. Objects of forensic toxicological analysis and their characteristics. Material evidence.	2.0
2.	Metabolism of toxic substances, its directions and dependence on the state of the body. Excretion of toxic substances from the body. A group of toxic substances that are isolated from biological material by infusing the objects under study with water (mineral acids, alkalis and their salts). Toxicological characteristics, peculiarities of their isolation from biological material. <u>detection and quantification</u>	2.0
3.	A group of substances that are isolated from biological material by steam distillation (volatile poisons). Toxicological characteristics of the group and methods for the isolation of volatile poisons from research objects, their detection and quantification. GC method in the analysis of volatile poisons	2.0
4.	A group of substances that are isolated from biological material by mineralisation. Its characteristics. Toxicokinetics and mechanisms of toxic action. Modern general and personal methods of mineralisation. Denitration of mineralisate. Features of the destruction of biological	2.0

5.	Toxicological characterisation and study of a group of poisons that require special methods of isolation (fluorides, iodide bromides) and a group of poisons that do not require isolation from the objects of study (carbon monoxide). Methods of detoxification in case of poisoning by these groups	2.0
6.	A group of toxic substances that are isolated by polar solvents (medicinal substances). Chemical structure and toxicological characteristics of medicinal substances, mechanisms of toxic action, behaviour and distribution in the body, retention in cadaver organs, methods of isolation from research objects.	2.0
7.	Toxicological characteristics and peculiarities of chemical and toxicological analysis of medicinal substances of acidic and weakly basic nature. Methods of qualitative and quantitative analysis of medicinal substances in extracts from acidic environments. Scheme of analysis of extracts. TLC screening of acidic and weakly basic substances and its	2.0
8.	Toxicological characteristics and peculiarities of chemical and toxicological analysis of basic drugs. Methods of qualitative and quantitative analysis of medicinal substances in extracts from alkaline environments. Instrumental methods used in forensic examination in the performance of chemical and toxicological research. TLC screening of basic substances.	2.0
9.	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 analysis of pesticides (FOS, COC, ROS, carbamic acid derivatives and pyrethroids).	2.0
10.	Methods of diagnosis and detoxification of the body in acute poisoning. Rapid diagnosis of acute poisoning. Interaction of drugs in the body (synergism). The use of enzyme-linked immunosorbent assay in chemical and toxicological studies. Antidote prophylaxis and therapy of poisoning.	2,0
	Total hours	20,0

## 5.2. Topics of seminar sessions

Seminar classes are not provided.

## 5.3. Topics of practical classes

№ s/n	Topic of the workshop	Quantity hours
1.	Introduction to the discipline "Toxicological and Forensic Chemistry". Fundamentals of toxicological and forensic chemistry, toxicology, forensic toxicology, clinical toxicology. General characteristics of poisoning (intoxication). Classification of poisoning. Characteristics of factors that determine the development of acute poisoning. Clinical and laboratory	2.0
2.	Familiarity with safety precautions and work procedures in the laboratory. External examination and preliminary testing of research objects and preparation of a forensic toxicology research plan.	2.0
3.	Toxicological characterisation and analysis of a group of toxic substances isolated from biological material by infusion of the objects under study with water (mineral acids, alkalis and their salts). Isolation of nitrates and nitrites from biological material, detection and quantification.	2.0
4.	A group of toxic substances that are isolated from biological material by steam distillation (volatile substances). Toxicological characteristics and methods for the isolation of volatile substances from the objects of study. Analysis of the distillate for volatile substances using chemical methods.	2.0
5.	Detection of volatile poisons by gas-liquid chromatography (familiarisation with the structure and operation of the chromatography, types of detectors). Check the column resolution and detector sensitivity.	2.0
6.	Qualitative analysis of volatile substances in the distillate by gas-liquid chromatography. Quantitative analysis of volatile substances in the distillate by gas-liquid chromatography. Performing a practical task to identify an unknown "volatile" poison.	2.0
7.	Detection and quantification of ethanol in biological fluids by GC. Construction of calibration graphs for the determination of ethanol in biological fluids by GC.	2.0
8.	Mastering the method of mineralisation of biological material with a mixture of nitric and sulphuric acids and denitration of the mineralisate. Examination of the precipitate from the mineralisation and the cations of barium and lead.	2.0

9.	Determination of manganese, chromium, silver, copper, zinc cations in model mineralisates. Quantitative determination of manganese by photoelectrocolourimetry. Detection of bismuth, thallium, antimony, arsenic compounds in model minerals.	2.0
10.	Isolation of mercury from biological material and its study in a destructant. Performing a practical task to identify an unknown "metal" poison.	2.0
11.	Toxicological characteristics and methods of analysis of toxic substances requiring special methods of isolation (fluorides, silicon fluorides, bromine, iodine).	2.0
12.	Toxicological characteristics of carbon monoxide, peculiarities of its detection and determination in the human body. Methods of detection of carboxyhaemoglobin and carboxymyoglobin. Spectrophotometric determination of carboxyhaemoglobin and carboxymyoglobin.	2.0
13.	Toxicological characteristics, mechanisms of toxic action and methods of isolation of drugs of natural (alkaloids) and synthetic origin from biological material.	2.0
14.	Practical task (non-directed research). Isolation of toxic substances from biological material using polar solvents. Investigation of extracts from biological material for substances of acidic, neutral and weakly basic nature <u>by chemical methods</u> .	2.0
15.	Study of extracts from biological material for substances of acidic, neutral and weakly basic nature by chemical methods. Investigation of extracts from biological material for acidic, neutral and weakly basic substances by <u>chemical methods</u>	2.0
16.	Examination of extracts from biological material for substances of basic nature by chemical methods (colour, precipitation and microcrystallographic reactions). Testing of extracts from biological material for basic substances by physical and chemical methods. TLC	2.0
17.	Rapid analysis of biological fluids (blood, urine) in acute poisoning with barbituric acid, phenothiazine, 1,4-benzodiazepine derivatives (preliminary tests, TLC screening, UV spectrophotometry). Rapid analysis of acute intoxication with opiates and cannabinoids. Enzyme- linked immunosorbent assay for the determination of opiates in biological fluids. <u>A written test on the topic</u>	2.0
18.	Toxicological characteristics and methods for the isolation of organophosphorus pesticides (OPP) and organochlorine pesticides (OCP) from biological material.	2.0
19.	Detection of phosphorus-containing pesticides in extracts from biological material by chemical, physicochemical and enzymatic methods. Analysis of biological material for organometallic pesticides. Practical task. Isolation, detection and quantification of POPs in extracts from biological material. <u>Quantitative determination of POPs by enzymatic method.</u>	2.0

20.	Differential credit	2.0
	Together	40

#### 5.4 Topics for laboratory sessions

Laboratory classes are not provided.

#### 6. Independent work

№ s/n	The topic of the CDS	Number of hours
1.	The main stages of development of toxicological and forensic chemistry. Classification of poisoning by cause, by conditions (place) of development, by clinical principle (acute, chronic, subacute poisoning), by ways of penetration into the body; nosological classification. Basic laws of behaviour and distribution of toxic substances in the body and excretion.	1.0
2.	Rules for forensic toxicological examination of material evidence.	1.0
3.	Areas of application of chemical and toxicological analysis methods.	1.0
4.	Toxicological characterisation and methods of analysis of fusel oils, aromatic hydrocarbons, acetaldehyde, metaldehyde, esters, ethers, cellosols, phenol formaldehyde resins, components of oil refining products, adhesives and perfumes by chemical reactions and gas-liquid chromatography.	1.0
5.	Causes and frequency of poisoning by volatile substances. Features of combined poisoning. Methods of isolation of volatile substances from objects of biological origin, food and environmental objects. Factors influencing the process of isolation of volatile substances from objects of study by distillation. The significance of the results of chemical and toxicological analysis for the diagnosis of volatile substance poisoning. Means of detoxification of the body in case of volatile substances poisoning. General and toxicological characteristics of phosgene - a product of oxidation of chloroform and trichloroethylene (under the influence of light and oxygen). Rapid method of phosgene detection.	2.0
6.	Toxicokinetic constants in chemical toxicological analysis.	1.0
7.	HPLC and chromatography-mass spectrometry in chemical and toxicological analysis.	1.0

8.	Quantitative determination of poisons in toxicological chemistry.	1.0
9.	Toxicological characteristics of metals: use, properties, toxic effects, clinical picture of acute poisoning, metabolism, distribution in the body and excretion. Macroelements and trace elements. Methods for the extraction of metals from objects of biological origin. Preparation of minerals for analysis. Masking of ions in the analysis of "metal" poisons.	1.0
10.	Methods of absorption spectrophotometry in the visible, ultraviolet and infrared spectral regions; atomic absorption spectroscopy, X-ray fluorescence analysis. Application of these methods in chemical and toxicological analysis.	1.0
11.	<p>General and toxicological characteristics, mechanisms of pharmacological and toxic effects of drugs. Classical methods of isolation of drugs from biological material in forensic toxicological examination. Separate (special) methods for the isolation of barbiturates (P. Valov method), 1,4-benzodiazepine derivatives (B.M. Izotov method), phenothiazine derivatives (E.M. Salomatin method).</p> <p>Influence of various factors on the efficiency of the isolation of the substances under study at different stages of this process (nature, condition and preliminary preparation of the object, nature of the solvent, pH of the solution, nature of the acid and electrolyte, degree of ionisation, methods of protein precipitation, etc.)</p> <p>Methods of purification and separation of toxic substances from associated endogenous impurities (proteins, fats, lipids, colouring agents, etc.): various types of chromatography, electrophoresis, extraction, dialysis and</p>	2.0
12.	Toxicological characteristics of medicinal substances extracted from an acidic environment. Methods of analysis in the "acidic" chloroform extract of indole derivatives (strychnine and brucine - alkaloids of chilli seeds; reserpine - alkaloid of plants of the genus Rauwolfia; physostigmine - alkaloid of physostigma beans; ergonine and ergotamine - alkaloids of ergot; psilocin and psilocybin - alkaloids of hallucinogenic mushrooms).	2.0
13.	Toxicological characterisation of medicinal substances extracted from alkaline medium. Investigation of pyridine and piperidine derivatives, imidazoline derivatives, phenylalkylamine, tricyclic antidepressants, synthetic opioids in alkaline chloroform extracts using chemical reactions, chromatographic methods, spectrophotometric and enzyme-linked	1.0
14.	Toxicological characteristics and methods of chemical and toxicological analysis of poisons of natural origin: phytotoxins (ricin, dithylin, nicotine, atropine, scopolamine, etc.), zootoxins (tetrodotoxin), cap fungi, lower fungi or fungal poisons (mycotoxins), algal toxins (algotoxins) and microbial toxins. Diagnosis of poisoning and detoxification of the body.	2.0
15.	Drug addiction and drug dependence.	1.0

16.	Toxicological significance of chlorine-containing pesticides: Organochlorine pesticides and derivatives of chlorine-containing carboxylic acids. General and toxicological characteristics, mechanism of toxic action, biotransformation, distribution in the body and excretion of organochlorine pesticides. Methods of isolation from research objects and methods of chemical and toxicological analysis of chlorine-containing pesticides.	1.0
17.	Toxicological characteristics and methods of chemical and toxicological analysis of urea derivatives, sym-triazine and non-sim-triazine pesticides. Methods of isolation from research objects and methods of chemical and toxicological analysis. Diagnosis of acute poisoning and medical care.	1.0
18.	Toxicological characteristics and methods of chemical and toxicological analysis of pesticides of phenol derivatives, carboxylic acid derivatives, and thio- and dithiocarboxylic acid derivatives. Methods of isolation from research objects and methods of chemical toxicological analysis. Diagnosis of acute poisoning and medical care.	1.0
19.	Toxicological characteristics and methods of chemical and toxicological analysis of pesticides derived from chloroacetanilide and synthetic pyrethroids - pesticides derived from cyclopropanecarboxylic acid. Methods of isolation from research objects and methods of chemical and toxicological analysis. Diagnosis of acute poisoning and medical care.	1.0
20.	Pharmacological tests. Enzymatic methods in chemical and toxicological analysis. Examination of extracts from biological material for the content of pesticides by enzymatic methods (chromatoenzyme method, enzyme-linked immunosorbent assay (ELISA), cholinesterase test).	1.0
21.	Chemical warfare agents. Classification of chemical warfare agents according to their general effect on the body and the consequences of their action (sarin, mustard gas, phosgene, hydrocyanic acid and cyanides).	1.0
22.	Chemical warfare agents. Classification of toxic agents according to the speed of development of the damaging effect.	1.0
23.	Chemical warfare agents. Classification of chemical warfare agents in accordance with the continuation of damage to territory and troops after contamination.	1.0
24.	The problem of residual amounts of pesticides and methods of prevention in case of poisoning. Organometallic pesticides.	1.0
25.	Organisation of specialised care for acute poisoning.	1.0
26.	The use of extraction and photometric methods in chemical and toxicological analysis.	1.0
	Total hours	30.0



## 7. Teaching methods

**Lectures:** story, explanation, conversation.

**Practical classes:** conversation, solving situational problems, developing skills in inspecting research objects, demonstrating and practicing skills in performing chemical reactions, developing skills in working with electrical appliances.

**Independent work:** independent work with the textbook, independent work with the bank of test tasks.

## 8. Forms of control and assessment methods

(including criteria for evaluating learning outcomes)

**Current control:** oral control, testing, assessment of practical skills, solving situational clinical problems, assessment of activity in the classroom.

**Final control:** oral differential test, testing.

### About the evaluation of the current educational activity in a practical session

When assessing the mastery of each topic, a student of higher education is given grades on a 4-point (traditional) scale ("2", "3", "4", "5").

#### 1. Evaluation of theoretical knowledge on the subject of the lesson:

- methods: survey, solving a situational clinical problem, tests
- the maximum score is 5, the minimum score is 3, the unsatisfactory score is 2.

#### 2. Assessment of practical skills on the topic of the lesson:

- methods: assessment of the correctness of the performance of practical skills
- the maximum score is 5, the minimum score is 3, the unsatisfactory score is 2.

The grade for one practical session is the arithmetic average of all components and can only have a whole value (5, 4, 3, 2), which is rounded according to the statistical method.

### Current assessment criteria for practical training:

Rating	Evaluation criteria
«5»	The student is fluent in the material, takes an active part in discussing and solving a situational clinical problem, confidently demonstrates practical skills during the examination of the victim or corpse and interpretation of clinical, laboratory and instrumental studies, expresses the opinion on the topic, demonstrates clinical thinking
«4»	The student is well versed in the material, participates in the discussion and solution of situational clinical problems, demonstrates practical skills during the examination of the victim or corpse and interpretation of clinical, laboratory and instrumental studies with some errors, expresses the opinion on the topic, demonstrates clinical thinking.
«3»	The student does not know enough material, insecurely participates in the discussion and solution of a situational clinical problem, demonstrates practical skills during the examination of the victim or corpse and interpretation of clinical, laboratory and instrumental studies with significant mistakes
«2»	The student does not know the material, does not participate in the discussion and solution of the situational clinical problem, does not demonstrate practical skills during the examination of the victim or corpse and the interpretation of clinical, laboratory and instrumental data.

The student is admitted to the differential test provided that the requirements of the curriculum are met and if he received at least 3.00 points for the current academic activity.

**Evaluation of the independent work of a student of higher education.** The independent work of a student of higher education, which is provided by the topic of the lesson along with the classroom work, is evaluated during the current control of the topic in the corresponding lesson.

The mastery of topics that are assigned only to independent work is checked during the final control.

**Evaluation of learning results during the final control (differential offset)**

The content of the assessed activity	Amount
Answer to theoretical questions.	1
Answer to theoretical questions.	1
Solving a calculation problem.	1

Ticket number 7

1. Phenazepam, its chemical structure, use in medical practice, toxicological significance and methods of analysis.
2. Specify the methods of analysis of distillate and body fluids for the presence of chloroform.
3. Determination of arsenic in mineralisate from biological material. Features of the analysis results evaluation

**Criteria for assessment the learning results of students in the differential test:**

"5"	It is assigned to an applicant who has systematically worked during the semester, demonstrated during the exam a comprehensive and deep knowledge of the programme material, is able to successfully complete the tasks provided for by the programme, has mastered the content of the main and additional literature, has realised the interconnection of individual sections of the discipline, their importance for the future profession, has shown creativity in understanding and using the educational and programme material, has shown the ability to independently update and replenish knowledge; the level of competence is high (creative);
"4"	It is assigned to an applicant who has demonstrated full knowledge of the curriculum material, successfully completes the tasks provided by the programme, has mastered the basic literature recommended by the programme, has shown a sufficient level of knowledge of the discipline and is capable of their independent updating and renewal in the course of further study and professional activity; the level of competence is sufficient (constructive-variative)
"3"	It is assigned to an applicant who has demonstrated knowledge of the basic educational and programme material to the extent necessary for further study and subsequent work in the profession, copes with the tasks provided for by the programme, made some mistakes in the answers to the exam and in the performance of exam tasks, but has the necessary knowledge to overcome the mistakes made under the guidance of a scientific and pedagogical worker; level of competence - average (reproductive)
"2"	It is assigned to an applicant who has not shown sufficient knowledge of the basic educational and programme material, has made fundamental mistakes in performing the tasks provided for by the programme, cannot use the knowledge in further studies without the help of the teacher, has not been able to master the skills of independent work; the level of competence is low (receptive and productive)

**9. Distribution of points received by students of higher education**

The obtained average score for the academic discipline for applicants who have successfully

mastered the work program of the academic discipline is converted from a traditional four-point scale to points on a 200-point scale, as shown in the table:

**Conversion table of a traditional assessment into a multi-point scale**

<b>National assessment for discipline</b>	<b>The sum of points for the discipline</b>
Excellent ("5")	185 - 200
Good ("4")	151 - 184
Satisfactory ("3")	120-150
Unsatisfactory ("2")	Below 120

Multi-point scale (200-point scale) characterizes the actual success of each applicant in mastering the educational component. The conversion of the traditional grade (average score for the academic discipline) into a 200-point grade is performed by the information and technical department of the University.

According to the obtained points on a 200-point scale, the achievements of the applicants are evaluated according to the ECTS rating scale. Further ranking according to the ECTS rating scale allows you to evaluate the achievements of students from the educational component who are studying in the same course of the same specialty, according to the points they received.

The ECTS scale is a relative-comparative rating, which establishes the applicant's belonging to the group of better or worse among the reference group of fellow students (faculty, specialty). An "A" grade on the ECTS scale cannot be equal to an "excellent" grade, a "B" grade to a "good" grade, etc. When converting from a multi-point scale, the limits of grades "A", "B", "C", "D", "E" according to the ECTS scale do not coincide with the limits of grades "5", "4", "3" according to the traditional scale. Acquirers who have received grades of "FX" and "F" ("2") are not included in the list of ranked acquirers. The grade "FX" is awarded to students who have obtained the minimum number of points for the current learning activity, but who have not passed the final examination. A grade of "F" is given to students who have attended all classes in the discipline, but have not achieved a grade point average (3.00) for the current academic activity and are not admitted to the final examination.

Applicants who study in one course (one specialty), based on the number of points scored in the discipline, are ranked on the ECTS scale as follows:

**Conversion of the traditional grade from the discipline and the sum of points on the ECTS scale**

<b>Evaluation on the ECTS scale</b>	<b>Statistical indicator</b>
A	Top 10% achievers
B	The next 25% of earners
C	The next 30% of earners
D	The next 25% of earners
E	The next 10% of earners

**10. Methodological support:**

- Working program of the discipline
- The syllabus of the discipline
- Textbooks:
- Multimedia presentations
- Situational clinical tasks
- Methodical development of practical classes
- Electronic bank of test tasks by divisions of the discipline

## 11. List of questions for the differentiated test

1. The subject, tasks and sections of toxicological chemistry, its relationship with toxicology and biomedical and pharmaceutical disciplines.
2. Stages of development of toxicological chemistry.
3. Features of chemical and toxicological analysis. General and targeted chemical and toxicological analysis.
4. Procedure for conducting forensic toxicological (chemical toxicological) examinations and maintaining the necessary documentation.
5. The concepts of "poisoning" and "poison". Classification of poisoning and poisons.
6. Ways of penetration of poisons into the body. Transport mechanisms of absorption depending on the physical and chemical properties of toxic substances.
7. Influence of the nature, concentration and ways of absorption of poisons on the dynamics of growth of their concentration in the blood and distribution in organs.
8. Metabolism of poisons (first and second phases of biotransformation). Lethal synthesis.
9. Dependence of poison metabolism on species, age, sex sensitivity, presence of other xenobiotics and other factors.
10. The main toxicokinetic constants and their use for the interpretation of chemical toxicological analysis results.
11. Decay of biological material and basic reactions of secondary metabolism.  
Influence of metabolic processes on the results of chemical and toxicological studies.
12. Objects of chemical and toxicological research, their characteristics, methods of preservation.  
Rules for the selection, referral, and acceptance of objects for forensic chemical examination.  
The procedure for storing samples.
13. Peculiarities of analysis of individual objects depending on their nature, condition, chemical properties of toxic substances.
14. Methods of detoxification of the body in case of acute substance poisoning.
15. Features of forensic chemical examination of a corpse in case of death after resuscitation and intensive care.
16. General principles of interpreting the results of forensic chemical research.
17. Drug addiction and drug dependence.
18. General characteristics of methods used for the detection and quantification of poisons in chemical and toxicological analysis (chemical, physicochemical, biochemical, pharmacological methods), their comparative assessment (sensitivity, specificity).
19. Basic requirements for chemical and toxicological analysis methods.
20. Application of chromatographic methods in chemical and toxicological analysis (thin-sorbent chromatography, GC - gas-liquid chromatography).
21. Preliminary tests of biological material and their significance for the preparation of a chemical toxicology study plan.
22. CTSS - screening of extracts from biological material.
23. Methods of absorption spectroscopy in the visible, UV and IR spectral regions and their use in chemical and toxicological analysis.

The use of extraction-photometric methods in chemical and toxicological analysis.

24. Microcrystalloscopy and its use in chemical and toxicological analysis.

25. Colour reactions and their application in chemical and toxicological analysis.

26. Pharmacological tests and their importance for chemical and toxicological analysis.

Application of enzyme methods in chemical and toxicological analysis.

27. Classification of poisons in toxicological chemistry.

28. Methods of isolation of volatile poisons from biological objects (water vapour distillation and dry-air distillation). Theoretical justification of the methods.

29. Preparation of biological material for steam distillation. Selection of methods and conditions of distillation depending on the object and physicochemical properties of the venom under study.

30. Methods of purification and concentration of volatile poisons in distillates.

Chemical methods for the study of "volatile poisons" in distillates, their sensitivity and specificity.

31. The use of gas-liquid chromatography for the analysis of volatile poisons. Types of detectors used in the analysis of volatile poisons by gas-liquid chromatography.

32. The use of gas-liquid chromatography for the analysis of alcohols. The value of the relative ethanol ratio in urine and blood for the diagnosis of alcoholic coma. Group and individual identification of "volatile" poisons by gas-liquid chromatography.

33. Schematic diagram of the study of biological objects for "volatile" poisons in general and targeted analysis using a combination of methods.

34. Some representatives of the group of "volatile" poisons: hydrocyanic acid, aliphatic monoatomic alcohols (C-C5), ethylene glycol, alkyl halides (chloroform, chloral hydrate, 1,2-dichloroethane, carbon tetrachloride); formaldehyde, acetaldehyde, phenol, cresols, acetone, acetate acid. Know the answers to the questions according to the scheme of studying groups and individual compounds in toxicological chemistry (see below).

35. Individual representatives of the group of substances that are isolated by polar solvents:

- Salicylic acid derivatives,
- Derivatives of barbituric acid (barbital, phenobarbital, benzonal, barbamy, sodium ethamine);
- Alkaloids:
  - purine (caffeine, theophylline, theobromine);
  - indole (strychnine, brucine, reserpine);
  - pyridine (nicotine, anabasine, pachycarpine);
  - tropane (atropine, scopolamine, cocaine);
  - quinoline (quinine, quinidine);
  - phenanthrene-isoquinoline (morphine, codeine), opium alkaloids and synthetic analogues and substitutes for morphine (papaverine, narcotine, narcine, ethylmorphine, heroin, promethol),
  - acyclic alkaloids (ephedrine).
- Synthetic medicinal substances of a basic nature:
  - pyrazolone derivatives (analgin, antipyrine),
  - 4-aminobenzoic acid derivatives (novocaine, novocainamide),
  - isonicotinic acid hydrazide derivatives (isoniazid, phthoviazid),
  - Phenothiazine derivatives (aminazine, diprazine, emozine, levomepromazine,

thioridazine),

- 1,4-benzodiazepine derivatives (chlordiazepoxide, diazepam, oxazepam, mesepam, phenazepam, nitrazepam, clonazepam),
- imidazoline derivatives (clofelin).

- General characteristics of some other groups of substances of significant chemical and toxicological interest:

- anticholinesterase substances,
- antidepressants,
- anticonvulsants.

(Know the answers to the questions according to the scheme of studying groups and individual compounds in toxicological chemistry.)

36. Modern general and personal methods of isolation with polar solvents (acidified alcohol, acidified water, V.P. Kramarenko, Valov, V.I. Popova). The influence of various factors on the efficiency of isolation of the studied substances at different stages of this process.

37. Methods of purification of extracts from biological material from associated impurities. Choice of method depending on the state, type of object of study and method of isolation of poison from biological material. Methods of concentrating toxic substances in extracts from biological material.

38. Chemical (colour, precipitation) reactions and physicochemical methods (LCMS, GC, HPLC, spectrophotometry in the visible, UV and IR spectral regions, microcrystallography, fluorometry, chromatography-mass spectrometry) for the study of substances isolated by polar solvents. Pharmacological tests (comparative characteristics of methods).

39. Methods of isolation, detection and quantification of toxic substances (medicinal poisons) from biological fluids in the diagnosis of acute poisoning.

40. Use of enzyme-linked immunosorbent assay for the diagnosis of acute opiate poisoning (heterogeneous enzyme-linked immunosorbent assay).

41. The role of CTCS screening in the diagnosis of acute poisoning with "medicinal poisons". Significance of the results of quantitative determination of "medicinal poisons" in biological fluids for assessing the severity of the victim's condition and choosing methods of therapy.

Pesticides. Definition, application, classification.

Negative aspects of pesticide use for humans and the environment. The problem of pesticide residues. Ways to prevent pesticide poisoning.

42. Some representatives of pesticides. Derivatives of phosphoric acids: chlorophos, dichlorophos, carbophos, metaphos. Derivatives of organochlorine compounds: hexachloroethane, heptachlor. Carbamic acid derivatives: carbaryl. Pyrethroids: permethrin, decamethrin, cypermethrin. Organometallic pesticides: ethylmercury chloride, ethylmercury phosphate. Know the answers to the questions according to the scheme of studying groups and individual compounds in toxicological chemistry.

43. Methods of isolation of PFOs from cadaver organs, biological fluids and foodstuffs. Choice of solvent for isolation depending on the condition, nature of the object and poison. Methods of cleaning hoods.

44. Chemical, enzymatic and chromatographic (GC, HPLC) methods of FOGI analysis. The

role of enzymatic and chromatographic methods in the diagnosis of acute and chronic FOGI poisoning. Evaluation of analysis results.

45. Methods for the isolation of ethylmercury chloride and ethylmercury phosphate from biological objects. Methods, their detection and determination by native substances and by mercury (II). Evaluation of analysis results.

46. A group of substances that are isolated from biological material by mineralisation ("metal poisons"): compounds of barium, lead, manganese, chromium, silver, copper, bismuth, antimony, zinc, arsenic, thallium and mercury. Know the answers to the questions according to the scheme of studying groups and individual compounds in toxicological chemistry.

47. Characteristics of general and specific mineralisation methods used in the analysis of biological material for "metal poisons". Choice of mineralisation method depending on the nature of the poison.

48. Methods of denitration of mineralisation.

49. The fractional method of analysis (method of separate detection) of "metal poisons", its theoretical justification and scheme.

50. Characteristics of reagents used in the fractional method of analysis for ion masking, isolation, detection and quantification of "metal poisons".

51. The results of quantitative determination of "metal poisons" and their significance for the forensic chemical evaluation of the research results. Differences in the study of biological material when analysed for inorganic and organometallic compounds.

52. A group of substances that are isolated from biological material by infusion with water. Inorganic acids: nitric, sulphuric, hydrochloric. Salts of nitric and nitric acids (nitrates, nitrites). caustic alkalis: sodium, potassium, calcium, ammonium hydroxides. Features of isolation and separation. Detection and quantification. Evaluation of analysis results.

53. A group of substances that are determined directly in biological material or require special isolation methods. Carbon monoxide (II), fluorides, bromine, iodine, organic fluorine compounds (CFCs).

54. Determination of carboxyhaemoglobin in the blood by chemical, spectroscopic and spectrophotometric methods. Evaluation of the analysis results.

55. Features of isolation from biological material, detection and determination of fluorine, bromine, iodine compounds

### **LIST OF PRACTICAL SKILLS TO BE CONTROLLED DURING THE DIFFERENTIAL ACCOUNT "Toxicological and Forensic Chemistry"**

- Use the provisions of the current legislation on the legal regulation of pharmaceutical activities.
- Demonstrate the ability to conduct :
  - research of poisons using preliminary samples (screening tests), isolation of poisons from internal organs of corpses, blood and urine, detection and identification of poisons isolated from research objects using chemical reactions (colour, sedimentation, microcrystalloscopic),
  - physical and chemical methods (spectrophotometric, chromatographic, electrophoretic, fluorescent),
  - physiological samples and enzyme-linked immunosorbent assays, quantification of poisons

isolated from the research objects; and - conducting poison research using preliminary samples (screening tests),

- release of poisons from the internal organs of corpses, blood and urine.
- detection and identification of poisons isolated from the objects of study using chemical reactions (colour, precipitation, microcrystallographic), physicochemical methods (spectrophotometric, chromatographic, electrophoretic, fluorescent), physiological samples and enzyme-linked immunosorbent assays.
- Quantification of poisons isolated from the research objects.

## 12 .Recommended reading

### Main:

1. Nizhenkovska I.V., Velchynska O.V., Kucher M.M. Toxicological chemistry.
2. Velchynska O.V., Nizhenkovska I.V., Toxicological chemistry. Toxic substances and their biotransformation. - K.: ADEF-Ukraine, 2015. - 320 p.

### Further reading

1. Galkevych I.I., Kucher M.M., Turkevych O.D. Toxicological chemistry. Methodical instructions for laboratory classes and tests. - Lviv: LNMU, 2006. - 128 p.
2. Zavalnyuk A.H., Kryvda G.F., Yukhymets I.O. Poisons and poisoning: forensic medical aspect. - Odesa: Astroprint, 2009. - 256 c.
3. General characteristics of toxic substances, diagnosis and treatment of acute poisoning. / Panasenko O.I., Kaplaushenko A.G., Samura B.A. et al: Karat, 2011. - 432 p.
4. Order No. 6 of the Ministry of Health "Rules for conducting forensic toxicological examinations" with its annexes, 1995.
5. Kucher M.M., Galkevych I.I. Gas-liquid chromatography in the analysis of drugs and poisons. Volume 1: Theoretical basis of the method. - Lviv: LNMU, 2011. - 236 c.
6. Turkevych M., Vladzimirska O., Lesyk R. Pharmaceutical Chemistry. - Vinnytsia, 2003. - 464 p.

## 13. Electronic information resources

1. University websites and electronic resources of the Internet.
2. <https://zakon.rada.gov.ua/laws/show/4651-17#Text>
3. <https://zakon.rada.gov.ua/laws/show/4038-12#Text>
4. <https://zakon.rada.gov.ua/laws/show/z0248-95#Text>
5. <https://zakon.rada.gov.ua/laws/show/2341-14#Text>