

**MINISTRY OF HEALTH OF THE REPUBLIC OF BELARUS
EDUCATIONAL INSTITUTION
BELARUSIAN STATE MEDICAL UNIVERSITY**

**Контрольный
экземпляр**



APPROVED

by First Vice-Rector, Professor

I.N.Moroz

Reg. # UD-1.571/1920/edu.

TOXICOLOGICAL CHEMISTRY

**Curriculum of higher educational institution
in the educational discipline for the specialty:**

1-79 01 08 «Pharmacy»

Curriculum is based on the educational program «Toxicological chemistry», approved 03.01.2017, registration # УД-L.571/1617/уч.

COMPILERS:

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RECOMMENDED FOR APPROVAL:

by the Department of Pharmaceutical Chemistry of the Educational Institution «Belarusian State Medical University»
(protocol #6 of 18.11.2019);

by the Scientific Methodical Council of the Educational Institution «Belarusian State Medical University»
(protocol # 4 of 18.12.2019)

EXPLANATORY NOTE

«Toxicological chemistry» is the educational discipline containing systematized scientific knowledge and techniques in the field of toxicological chemistry, studying the adverse effects of chemical substances to the living organisms and the practice of diagnosis and treatment of toxins' and toxicants' exposures.

The curriculum of the discipline «Toxicological chemistry» includes the latest scientific data about the properties and methods of isolation, detection and quantification of toxic substances and their metabolites in biological material and environmental objects.

The aim of teaching and learning the discipline «Toxicological chemistry» is providing the students with the scientific knowledge about methods of isolation, detection and quantitative detection of toxic substances in biological objects.

The tasks of studying the discipline are to develop the students' academic competences, based on the ability to self-search educational and information resources, as well as acquire and understand the knowledge of:

- the classification of toxic substances;
- toxic substances isolation methods;
- the correlation between the chemical structure, properties and methods of toxic substances release;
- the factors affecting the isolation of toxic substances from biological objects;
- the methods and techniques of the detection and quantification of toxic substances in biological objects;
- the fundamentals of biochemical toxicology.

The successful teaching and learning of the discipline «Toxicological chemistry» are carried out on the basis of the knowledge and skills previously acquired by the students in the following disciplines:

Biological physics. Fundamentals of optics, thermodynamics; surface phenomena - adsorption, desorption; physical research methods.

General and inorganic chemistry. Basic chemical laws and regulations, properties of elements and their compounds.

Physical and colloid chemistry. Fundamentals of chemical kinetics, the theory of thermodynamics of phase equilibria, physical chemistry of surface phenomena, methods for calculating chemical equilibria.

Organic chemistry. Properties and methods of analysis of organic compounds, the nature of chemical bonds and electronic ideas about the structure of organic compounds.

Analytical chemistry. Chemical and physico-chemical methods of analysis; methods of masking, separation and concentration.

Biological chemistry. The main pathways of drug metabolism, the mechanism of transport of foreign compounds.

Pharmaceutical Botany. Diagnostic signs of plants; main physiological processes occurring in the plant body.

Pharmaceutical Chemistry. Properties and methods of drug analysis.

Pharmacology. Principles of action of drugs, pharmacodynamics, pharmacokinetics. Side effect of drugs. Drug addiction.

Organization and economics of pharmacy. The main provisions of decisions and orders in the field of public health and activities in the field of the circulation of medicines, the state system for monitoring the quality, effectiveness and safety of medicines, forms of control over the activities of pharmaceutical organizations.

As a result of studying the discipline «Toxicological chemistry» the student should

know:

- the organizational structure of the State Forensic Examination Committee of the Republic of Belarus, narcological dispensaries;
- legal basis for conducting forensic chemical examination;
- the issues of biochemical toxicology;
- the methods of isolating toxic substances and their metabolites from biological objects, their detection and quantification;

be able to:

- conduct analytical diagnosis of acute poisoning;
- identify narcotic and other toxic substances in biological fluids;
- interpret the results of chemical toxicological studies;
- document the conducting of forensic chemical examination and chemical toxicological analysis;
- use normative, reference and scientific literature to solve professional problems;

master:

- skills of isolating toxic substances from biological material;
- skills in using physical, chemical and instrumental methods of analysis to identify and quantify toxic substances;
- skills of using express methods of analysis for the analytical diagnosis of drug addiction, substance abuse, acute poisoning.

The structure of the curriculum in the educational discipline «Toxicological chemistry»: «General issues of toxicological chemistry», «Fundamentals of biochemical toxicology», «Analytical toxicology of the main groups of xenobiotics».

Total number of hours for the study of the discipline is 272 academic hours. Classroom hours according to the types of studies: lectures – 40 hours, laboratory studies (practical classes – 111 hours), student independent work (self-study) – 121 hours.

Current assessment is carried out according to the syllabus of the specialty in the form of a credit (8 semester) and examination (9 semester).

Form of higher education – full-time.

**ALLOCATION OF ACADEMIC TIME
ACCORDING TO SEMESTERS OF STUDY**

Code, name of the specialty	semester	Number of academic hours					Form of current assessment
		total	in-class	including		out-of-class self-studies	
				lectures	laboratory studies (practical classes and seminars)		
1-79 01 08 «Pharmacy»	8	120	76	22	54	44	credit
	9	152	75	18	57	77	exam
Всего часов		272	151	40	111	121	

THEMATIC PLAN

Section (topic) name	Number of class hours	
	lectures	practical
8 semester		
1. The general questions of toxicological chemistry	4	9
1.1. The goals and objectives of the discipline «Toxicological chemistry	1	3
1.2. Organization of medical forensics in the Republic of Belarus. Introduction to narcology and clinical toxicology	1	3
1.3. Classification of toxic substances	1	3
1.4. Chemical toxicology analysis methodology	1	-
2. Fundamentals of biochemical toxicology	4	3
2.1. The intake and distribution of toxic substances in the human body	1	1
2.2. Biotransformation of foreign compounds in the body. The main ways of biotransformation	2	1
2.3. Metabolites and toxicity. Isolation of foreign compounds and their metabolites from the human body	1	1
3. Analytical toxicology of the main groups of xenobiotics	32	99
3.1. Substances isolated from biological material by mineralization	6	21
3.2. «Flying» poisons	6	18
3.3. Substances defined directly in biological material	2	3
9 semester		
3.4. Modern physicochemical methods used in chemical toxicological analysis	6	9
3.5. Substances isolated from biological material by water extraction	1	3
3.6. Substances requiring private isolation methods	1	3
3.7. Substances isolated from biological material by polar solvents	9	42
3.8. Substances isolated from biological material by non-polar solvents (pesticides)	2	3
Total hours	40	111

CONTENT OF THE EDUCATIONAL MATERIAL

1. General issues of toxicological chemistry

1.1. The goals and objectives of the discipline «Toxicological chemistry»

Toxicology. Toxicological Chemistry: definition, tasks, connection with other academic disciplines. History of Toxicological Chemistry. The main sections of the discipline.

Rules and procedures in the laboratory, safety requirements.

1.2. Organization of medical forensics in the Republic of Belarus.

Introduction to narcology and clinical toxicology

Organization of medical forensics in the Republic of Belarus. The structure of the State Forensic Examination Committee of the Republic of Belarus. Decisions and orders governing the conduct of forensic chemical examinations in the Republic of Belarus. Rights and obligations of state medical forensic chemical experts. Rules for conducting a forensic chemical examination, chemical and toxicological research: grounds for conducting a forensic chemical examination, selection of objects for forensic chemical examinations, reception and storage of material evidence and supporting documents, procedure for the production of forensic-chemical examinations, premises and equipment for the production of forensic-chemical examinations, documentation in the production of forensic-chemical examinations.

Introduction to clinical toxicology. The prevalence of acute poisoning, the nature and causes. Classification of poisoning by reason and place of occurrence, by the methods of ingestion of poison into the body, by severity. Factors determining the development of acute poisoning. Clinical diagnosis of acute poisoning, types of diagnostic measures: methods of electroencephalography, electrocardiography, instrumental diagnosis of respiratory disorders.

The main methods of body detoxification in acute poisoning. Methods of enhancing the natural processes of detoxification: gastric lavage, bowel cleansing, forced diuresis, therapeutic hyperventilation, regulation of enzymatic activity, therapeutic hypo- and hyperthermia, hyperbaric oxygenation.

Methods of artificial detoxification: aseretic methods, dialysis and filtration of blood (lymph), sorption, physiotherapy.

Methods of antidote detoxification. Features of antidote therapy. The main groups of antidotes: chemical, biochemical antidotes, pharmacological antagonists, antitoxic serum.

Introduction to narcology. Terminology (addiction, substance abuse, narcotic substance, alcohol abuse, psychotropic substances, etc.). Physical dependence, mental dependence, tolerance. Epidemiology of alcoholism, drug addiction, substance abuse. Organization of institutions providing analytical diagnostics of drug addiction and substance abuse.

1.3. Classification of toxic substances

General characteristics of toxic effects. The formation of a toxic effect as a factor in the interaction of poison, the body and the human environment. General and special classifications of toxic substances: chemical, hygienic, toxicological, for selective toxicity, pathomorphological, pathochemical, biological, for the purpose of

use. Chemical-toxicological significance of the classification of toxic substances by isolation methods.

1.4. Chemical toxicology analysis methodology

Chemical toxicological laboratories, their tasks.

Acquaintance with the data of the forensic medical examination, clinical data, preliminary diagnosis of poisoning. Features of chemical toxicological analysis. The choice of analysis methods in relation to the requirements of the study. Metrological characteristics of toxicant determination methods: specificity, correctness, linearity, reproducibility, range of application, convergence, repeatability, laboratory accuracy, detection limit, robustness, dimensionality of the result.

The choice of research objects and the method of isolation of toxic substances. General principles, rules for the selection and direction of research objects for analysis, conditions of transportation and storage. Methods of preserving biological objects. Initial processing of various research objects, depending on the method of analysis used. Features of the processing of blood samples and urine samples. Isolation methods and methods for the concentration of organic and inorganic toxic substances from various biological and environmental objects. The sequence of preliminary and confirmatory methods of identification, the need for quantitative analysis of toxicants. Assessment of the results of a forensic chemical study.

2. Fundamentals of Biochemical Toxicology

2.1. The intake and distribution of toxic substances in the human body

Ways of entry of toxic substances into the human body. Absorption of toxicants, the main types of transport of foreign compounds through the biological membranes of the human body. Mechanisms of damage to biological membranes. The distribution of toxic substances in the human body, factors affecting the distribution. The influence of various factors on the binding of foreign compounds. The interaction of toxic substances with receptors. Types of binding of toxic substances to serum proteins, with components of organs and tissues.

2.2. Biotransformation of foreign compounds in the body. The main ways of biotransformation

Phases of the metabolism of foreign compounds. The main ways of biotransformation of foreign compounds, the classification of metabolic transformations. Oxidation reactions with microsomal enzymes: hydroxylation of acyclic and aromatic compounds, epoxidation, N-hydroxylation, N-, S-oxidation, dealkylation, deamination, desulfurization, etc. Microsomal enzyme reduction reactions: reduction of nitro and azo compounds. Non-microsomal oxidation reactions: deamination, oxidation of alcohols, aldehydes, aromatization of acyclic compounds. Non-microsomal reduction reactions: reduction of aldehydes and ketones. Hydrolysis reactions involving microsomal and non-microsomal enzymes: hydrolysis of esters and amides. Other reactions of the first phase of metabolism: rupture of the heterocyclic ring, oxidative cleavage of arene compounds, oxidative cyclization, dehydroxylation of hydroxamic acids, dehalogenation, reduction of disulfides to thiols, etc. Synthesis reactions: formation of conjugates with glucuronic acid, sulfates, glutathione, acetyl, methyl thios conjugation with amino acids.

Decomposition of biological material after death.

2.3. Metabolites and toxicity. Isolation of foreign compounds and their metabolites from the human body

The formation of pharmacologically active metabolites. The concept of lethal synthesis, endogenous intoxication. Factors affecting the metabolism of foreign compounds: molecular genetic, intraspecific, age-related, organ-specific, neuroendocrinal, environmental factors. Induction of metabolizing enzymes, inhibition of metabolism.

Excretion of toxic compounds through the kidneys: glomerular filtration, passive and active tubular transport. The release of toxic substances through the gastrointestinal tract. Excretion of foreign compounds with bile. Other routes of elimination of toxic compounds (excretion through the respiratory tract, through the skin, etc.), including specific ones (hair, nails). The influence of physico-chemical properties of toxic substances and factors of the internal environment of the body on the speed and nature of their removal from the human body. Kinetics of the allocation of foreign compounds.

3. Analytical toxicology of the main groups of xenobiotics

3.1. Substances isolated from biological material by mineralization

Ecology of the environment and the prevalence of poisoning by compounds of heavy metals and arsenic. General characteristics of the group. The prevalence of poisoning by compounds of heavy metals, arsenic, antimony. The list of «metallic» poisons subject to mandatory forensic chemical investigation in cases of suspected poisoning by unidentified poison. Compounds of metallic poisons of toxicological significance. The stability of the chemical composition of the body. Essential and toxic trace elements. The concept of synergism and antagonism of trace elements in the human body. The role of chemical elements in the human body.

Methods of mineralization, removal of oxidizing agents. Objects of investigation in cases of suspected poisoning by «metallic» poisons. Sampling, preparation of samples for analysis. Classification of methods for isolating compounds of «metallic» poisons from biological objects and environmental objects. Justification of the need for mineralization. General and particular mineralization methods: wet and dry mineralization methods, destructive methods for mercury isolation. The choice of method and conditions for the isolation of «metal» poisons. Methods for carrying out the mineralization of biological material with sulfuric and nitric acids, sulfuric, nitric and perchloric acids, methods for fusing the test object with sodium carbonate and sodium nitrate, simple burning. Private methods for the isolation of mercury. Preparation of mineralization for research. Denitration methods: thermal method, denitration using reducing agents (using formaldehyde, urea, sodium sulfite).

Methods for the detection and quantification of «metallic» poisons. Qualitative analysis of «metallic» poisons. Fractional method of mineralizate analysis. The sequence of reactions for the detection of lead, barium, manganese, chromium, silver, copper, antimony, arsenic, bismuth, zinc, cadmium, thallium. Mercury detection. Preliminary and confirmatory reactions of identification of «metallic» poisons. Ways

to eliminate the interfering effect of foreign substances in the analysis of the mineralizate: the introduction of complexing agents, selective extraction, the use of redox reactions. The use of organic reagents in the analysis of minerals. Characterization of reagents, conditions for the detection reactions of «metallic» poisons.

Quantitative analysis of «metallic» poisons. Characterization of instrumental methods used in the analysis of minerals. Modern methods for the separation and determination of metal ions (thin layer chromatography, ion exchange chromatography, gas chromatography, polarography, electrophoresis). The use of spectrometric methods of determination in the analysis of «metallic» poisons: atomic emission, atomic absorption, X-ray fluorescence, molecular emission, molecular absorption spectrometry. Interpretation of the results of chemical toxicological analysis, taking into account the natural content of compounds of “metallic” poisons in the human body.

Organic mercury compounds and their toxicity. Isolation of ethyl mercuric chloride from objects of animal and vegetable origin, biological fluids. Qualitative and quantitative methods for the analysis of organic mercury compounds. Using modern methods for the analysis of organic mercury compounds.

3.2. «Flying» poisons

A group of substances isolated by distillation. Scheme of chemical and toxicological studies of «flying» poisons. The prevalence of poisoning by «flying» poisons. The list of «flying» poisons subject to mandatory forensic chemical investigation in cases of suspected poisoning by unidentified poison.

Classification of «flying» poisons according to acid-base properties. The choice of the object of study for volatile toxicants. The scheme of the study of the distillate by the chemical method. Isolation of volatile toxicants by steam distillation. Methods for the separation of azeotropic mixtures. Steam distillation apparatus. Conditions for isolating «flying» poisons by steam distillation. Features of isolation of hydrocyanic, acetic acids, ethylene glycol, methanol, tetraethyl lead. Methods of concentration, purification and isolation of «volatile» toxicants.

Chemical method for the analysis of distillate. Toxicological significance, qualitative detection and quantification of «flying» poisons. The sequence of reactions for the detection of hydrocyanic acid, formaldehyde, methanol, acetone, ethanol, alkyl halides, phenol, cresols. Detection reactions of “volatile” toxicants having negative forensic chemical significance.

Particular issues of chemical-toxicological analysis of certain groups of volatile toxicants (hydrocyanic acid, aldehydes and ketones (formaldehyde, acetone), alkyl halides (chloroform, chloral hydrate, carbon tetrachloride, 1,2-dichloroethane), monohydric phenols (phenol, cresols), acetic acid, monohydric aliphatic alcohols, dihydric alcohols (ethylene glycol)): properties and toxicological significance, the prevalence of poisoning, symptoms of poisoning, toxicokinetics, objects of study, features of sample preparation, identification and quantifying volatile toxicants.

Analysis methods used in chemical-toxicological analysis of “flying” poisons and forensic chemical examination (qualitative-quantitative).

Gas chromatographic definition of «flying» poisons. Examination of alcohol intoxication. Gas chromatographic analysis of «volatile» toxicants. General characteristics of gas chromatography. Chromatographic columns, adsorbents, stationary liquid phases, mobile phases, detectors. Sample preparation in gas chromatographic analysis of volatile toxicants: analysis of the equilibrium vapor-gas phase, solid-phase microextraction, dynamic gas extraction. Qualitative gas chromatographic analysis of «flying» poisons. Features of gas chromatographic determination of «volatile» toxicants. Interpretation of research results by gas chromatography.

Ethyl alcohol, its properties and toxicological significance. The prevalence of poisoning with ethanol and its surrogates. The mechanism of action of ethanol on the human body. Acute alcohol intoxication. Objects of research and rules for sampling from living individuals and cadaveric material in the study on the content of ethanol. Preliminary qualitative tests for ethanol in the study of exhaled air. Typical ethanol identification reactions. Biochemical methods for the determination of ethanol. Gas chromatographic detection and quantification of ethanol in biological fluids. Expert assessment of ethyl alcohol content in a chemical-toxicological study of various internal organs, blood, urine, saliva, etc.

3.3. Substances defined directly in biological material

Carbon monoxide (II), its properties and toxicological significance. Classification of carbon monoxide poisoning by severity. The clinical picture of carbon monoxide poisoning and first aid. Ways of entry and distribution of carbon monoxide (II) in the blood, the mechanism of toxic action.

Methods for the detection of carbon monoxide (II): spectrophotometric, microdiffusion, chemical express methods. Methods for the quantitative determination of carbon monoxide (II): spectrophotometric, gas chromatographic. Forensic evaluation of the results of a quantitative determination of carboxyhemoglobin in the blood.

3.4. Modern physicochemical methods used in chemical toxicological analysis

Chromatographic methods (thin-layer, gas-liquid, high-performance liquid chromatography), their advantages and disadvantages.

Spectrometric methods for the detection and quantification of drugs. Spectrophotometry in the UV and visible regions of the spectrum. Classification of organic compounds by electronic absorption spectra. Direct and differential spectrophotometry (for example, derivatives of barbituric acid), extraction photometry. Molecular emission analysis.

Prospects for the use of gas and high performance liquid chromatography methods for conducting chemical-toxicological analysis for medicinal substances in forensic chemical analysis and chemical-toxicological analysis for the purpose of diagnosing and treating poisoning. Gas and liquid chromatography with mass spectrometric detection.

The possibilities of physicochemical methods of quantitative determination and their limitations when used in chemical toxicological analysis. Metrological characteristics of methods for determining toxicants.

Biological material. Sampling for research. Methods of isolating the purification and concentration of toxic substances from biological material. Objects of chemical toxicological analysis (CTA). Selection and storage of biological media. Paperwork.

Sampling and preparation of samples of biological material, the main stages of isolating medicinal substances from biological material in general and directed analysis. Qualitative and quantitative factors affecting the isolation of drugs from internal organs (solid-liquid extraction). Methods for concentrating drugs: liquid-liquid extraction, solid-phase extraction.

Preparation of samples of biological material, the main stages of isolating medicinal substances from biological material in general and directed analysis. Modern methods of isolating (isolating) medicinal and narcotic substances from tissues, organs, biological fluids. Their characteristics and comparative assessment. Factors determining the effectiveness of isolation at all stages. Selection of optimal extraction conditions.

Chemical-toxicological analysis of substances by the method of immunochemistry (THEM). Preliminary tests for the presence of toxic substances in biological fluids. Basic requirements for methods for the quantitative determination of drugs in biological fluids.

Protein-binding assays. Immunochemical methods of analysis: radioreceptor, enzyme immunoassay methods, polarization fluoroimmunoassay. Prospects for the development of protein-binding and immunochemical methods of analysis in relation to the main areas of chemical-toxicological analysis.

3.5. Substances isolated from biological material by water extraction

General characteristics of the group, properties and toxicological significance of sulfuric, nitric, hydrochloric acids, ammonia, sodium, potassium hydroxides, nitrates and nitrites.

Features of the chemical-toxicological analysis of mineral acids (sulfuric, nitric, hydrochloric), alkalis (sodium, potassium hydroxides), ammonia, nitrates and nitrites: objects of research, preparation of biological samples for research, isolation, dialysis, preliminary samples for the presence of the analyzed compounds, quantitative definition, persistence in cadaveric material.

3.6. Substances requiring private isolation methods

General characteristics of the group, properties and toxicological significance of fluorine compounds (fluorides and silicofluorides), hydrogen sulfide, chlorine, bromine, iodine, bromides, iodides.

Features of the chemical-toxicological analysis of fluorides, silicofluorides, hydrogen sulfide, chlorine, bromine, iodine, bromides, iodides: isolation, identification, quantitative determination.

3.7. Substances isolated from biological material by polar solvents

Classification and toxicological significance of substances isolated by polar solvents.

Physico-chemical properties and condition of acidic and basic drugs in solutions. Chemical-toxicological significance of the classification of drugs according to acid-base properties. Features of the determination of drugs in biological objects.

General methods for isolating drugs with polar solvents. Private methods for isolating medicinal substances: methods for isolating derivatives of barbituric acid, phenothiazine derivatives, substances of a basic and weakly basic nature. Features of the isolation of morphine, xanthine derivatives, phenothiazine derivatives. Scheme of a toxicological study of biological material for the presence of 1,4-benzodiazepine derivatives: the main stages of the analysis for acid hydrolysis products and for native compounds and metabolites.

Preliminary methods for the detection of drugs. Forensic chemical significance of reactions with general alkaloid precipitation reagents. Sensitivity of general alkaloid precipitating reagents. Confirmatory methods for the analysis of drugs: microcrystalloscopic reactions, staining reactions, physico-chemical methods of analysis, pharmacological tests.

The use of instrumental methods in the analysis of medicinal substances: possibilities of use, methods of determination, metrological characteristics. The influence of various factors on the results of the analysis (the presence of endogenous compounds in biological objects, the processes of putrefactive decomposition of tissues and organs, metabolic transformations of drugs). Calculation of the dose of a toxic drug substance introduced into the human body according to the results of determining the substance in the blood.

TLC screening of acidic, weakly basic and basic drugs in general and private solvent systems: chromatographic conditions, standards, developers, mobility factors. Interpretation of the results of TLC-screening of drugs.

Particular issues of chemical-toxicological analysis of certain groups of drugs of acidic, weakly basic, basic, neutral nature, ampholytic drugs. Toxicological significance, metabolism, isolation, detection, quantification of derivatives of barbituric acid (barbital, phenobarbital, butobarbital, cyclobarbital, ethaminal sodium, barbamil), xanthine derivatives (caffeine, theobromine, theophylline), pyrazolone derivatives (antipyrine, amilodip) derivatives of 1,4-benzodiazepine (chlordiazepoxide, diazepam, nitrazepam, oxazepam), phenothiazine derivatives (chlorpromazine, diprazine, levomepromazine, thioridazine), pyridine and piperidine derivatives (pachycarpine, anabazine, nicotine, promedol), derivatives of p-aminobenzoic acid (novocaine, novocainamide), derivatives of tropane (atropine, scopolamine, cocaine), phenanthrene isoquinoline derivatives (morphine, codeine, dionine, heroin), indole derivatives (strychnine), quinoline derivatives and isoquinoline (quinine), phenylalkylamines (ephedrine, pseudoephedrine, norephedrine, amphetamine, methamphetamine), cannabinoids (cannabidiol, cannabinal, tetrahydrocannabinol, tetrahydrocannabinol acid).

3.8. Substances isolated from biological material by non-polar solvents (pesticides)

General idea of pesticides, their importance for the national economy. Prevalence and causes of pesticide poisoning. Classifications of pesticides by chemical structure, use, toxicity, lethal dose.

Preparation of biological objects for the analysis of pesticides. Rules for selection, direction of objects for analysis. Scheme of a systematic analysis of biological fluids into the main groups of pesticides. Schemes for isolating certain

groups of pesticides from biological tissues. Methods of analysis of pesticides isolated from biological material or environmental objects: chemical, biochemical methods of analysis, elemental analysis, TLC-screening, gas-liquid chromatography.

Particular issues of chemical-toxicological analysis of individual groups of pesticides. Toxicological significance, metabolism, isolation features, identification, quantification of organophosphorus compounds (karbafos, metaphos, chlorophos, dichlorfos, phthalophos, fosalon, methyl nitrophos, etc.), organochlorine compounds (hexachlorocyclohexane, heptachlor, aldrin, etc.), carbamic acid derivatives (Sevin), synthetic pyrethroids (permethrin, zirconmethrin, deltamethrin, cygalotrin, etc.), polychlorinated biphenyls.

EDUCATIONAL DISCIPLINE CURRICULAR CHART

Section, topic #	Section (topic) name	number of hours		Self-studies	Equipment	Form of control
		Lectures	practical (laboratory or seminars)			
8 semester						
1.	General issues of toxicological chemistry	4	9	4		
1.1.	The goals and objectives of the discipline «Toxicological chemistry»	1	3	1	-	interviews, assessment based on role-playing, tests, abstracts, computer tests
1.2.	Organization of medical forensics in the Republic of Belarus. Introduction to narcology and clinical toxicology	1	3	1	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
1.3.	Classification of toxic substances	1			-	interviews assessment based on role-playing, tests, role-playing based evaluator, computer tests
1.4.	Chemical toxicology analysis methodology	1	3	2	-	interviews, colloquiums, tests, control questioning, written accounts of laboratory work, computer tests
2.	Fundamentals of biochemical toxicology	4	3	3		
2.1.	The intake and distribution of toxic substances in the human body	1	3	1	-	interviews, assessment based on role-playing, tests, abstracts, role-playing based evaluation, computer tests

2.2.	Biotransformation of foreign compounds in the body. The main ways of biotransformation	2	1	1-5	interviews, assessment based on role-playing, tests, role-playing based evaluation, written accounts of laboratory work, computer tests
2.3.	Metabolites and toxicity. Isolation of foreign compounds and their metabolites from the human body	1	1	-	interviews, colloquium, tests, control questioning, computer tests
3.	Analytical toxicology of the main groups of xenobiotics	32	37		
3.1.	Substances isolated from biological material by mineralization	7	15	-	interviews, assessment based on role-playing, tests, computer tests
	Ecology of the environment and the prevalence of poisoning by compounds of heavy metals and arsenic. General characteristics of the group	1	2	-	interviews, assessment based on role-playing, tests, abstracts, computer tests
	Methods of mineralization, removal of oxidizing agents	2	2	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, role-playing based evaluation, computer tests
	Methods for the detection and quantification of «metallic» poisons	2	2	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
	Mineralize analysis by the systemic method	2	1	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
	Mineralize analysis by fractional method	-	3	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests

Determination of mercury in biological material	-	3	3	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Final lesson on the topic «Metal Poisons»	-	3	2	-	interviews, colloquiums, tests, control questioning, computer tests
3.2. «Flying» poisons	5	18	19		
A group of substances isolated by distillation. Scheme of chemical and toxicological studies of «flying» poisons	1	3	3	1-5	interviews, assessment based on role-playing, tests, abstracts, role-playing based evaluation, computer tests
Chemical method for the analysis of distillate. Qualitative detection and quantification of «flying» poisons	2	6	6	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Gas chromatographic definition of «flying» poisons Examination of alcohol intoxication. Quantification of aliphatic alcohols	2	6	4	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Final lesson on the theme «Flying Poisons»	-	3	6	-	interviews, colloquiums, tests, control questioning, computer tests
3.3. Substances defined directly in biological material	2	3	3	1-5	interviews, oral credits, tests, written accounts of laboratory work, final tests, credit, computer tests
9 semester					
3.4 Modern physicochemical methods used in chemical toxicological analysis	6	9	8	-	interviews, assessment based on role-playing, tests, abstracts, computer tests
Gas chromatography with mass spectrometric detection	2	3	3	1-5	interviews, assessment based on role-playing, tests, abstracts, computer tests

High Performance Liquid Chromatography	2	-	3	-	interviews, assessment based on role-playing, tests, role-playing based evaluation, computer tests
Biological material. Sampling for research. Methods of isolating the purification and concentration of toxic substances from biological material	1	3	1	-	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Chemical-toxicological analysis of substances by the method of immunochemistry (IHC)	1	3	1	-	interviews, colloquiums, tests, control questioning, computer tests
3.5. Substances isolated from biological material by water extraction				1-5	interviews, assessment based on role-playing, tests, abstracts, computer tests
3.6. Substances requiring private isolation methods	1	3	4	1-5	interviews, assessment based on role-playing, tests, abstracts, computer tests
3.7. Substances isolated from biological material by polar solvents Alkaloids. General characteristics	9	42	65		interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
	2	3	4	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Characterization, toxicological significance, detection and quantification of substances extracted with organic solvents from an acidic medium	2	-	1	-	interviews, assessment based on role-playing, tests, abstracts, computer tests
General and private methods of isolating substances extracted with organic solvents from acidic medium	-	3	3	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Quantitative determination of barbiturates by the method of differentiated spectrophotometry	-	3	3	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests

Final lesson on the topic «Detection and quantification of substances extracted with organic solvents from an acidic environment»	-	3	3	1-5	interviews, assessment based on role-playing, tests, computer tests
Characterization, chemical-toxicological analysis of substances of a weakly basic nature	-	6	10	1-5	interviews, assessment based on role-playing, tests, computer tests
Characterization, chemical-toxicological analysis of substances extracted with organic solvents from an alkaline medium	1	-	4	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
General and private methods of isolating substances extracted with organic solvents from an alkaline medium	1	3	5	1-5	interviews, assessment based on role-playing, tests, computer tests
The procedure for performing acidic, alkaline hydrolysis using the example of isolation of 1,4-benzodiazepine derivatives	1	3	3	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Chemical-toxicological analysis of potent and psychotropic substances	-	3	3	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Chemical toxicological analysis of narcotic substances	1	6	10	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
TLC - screening of drugs		3	6	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests
Methods for the quantitative determination of drugs	1	3	7	1-5	interviews, assessment based on role-playing, tests, written accounts of laboratory work, computer tests

Final lesson on the topic «Detection and quantification of substances extracted with organic solvents from an alkaline medium»	-	3	3	-	interviews, colloquiums, tests, control questioning, computer tests
3.8. Substances isolated from biological material by non-polar solvents (pesticides)	2	3	2	1-5	interviews, colloquiums, tests, control questioning, abstracts, written accounts of laboratory work final tests, examination, computer tests
	40	111	121		

INFORMATION AND INSTRUCTIONAL UNIT

LITERATURE

Basic (relevant):

1. Toxicological chemistry : lecture course / S.A.Karpushina, V.S.Bondar, I.O.Zhuravel. – 2 ed. – Kharkiv : NUPh : Golden Pages, 2011. – 208 p.

Additional:

2. Chernykh V.P., Shemchuk L.A. Organic chemistry. Basic lecture course: The study guide for students of higher schools / Edited by V.P.Chernykh. – 4 ed., rev. and enl. – Kharkiv: NUPh, Original, 2011. – 440 p.

LIST OF AVAILABLE DIAGNOSTIC TOOLS

The following forms are used for competences assessment:

1. Oral form:
 - interviews;
 - colloquiums;
 - assessment based on role-playing.
2. Written form:
 - tests;
 - control questioning;
 - abstracts;
 - final tests;
 - written accounts of laboratory work.
3. Oral-written form:
 - credit;
 - examination;
 - role-playing based evaluation.
4. Technical form:
 - computer tests.

LIST OF EQUIPMENT IN THE LABORATORY

1. Gas chromatograph «Color 800», with PID, PID. 1999 issue.
2. Spectrophotometer SF-26, 1978.
3. Muffle furnace, 1977.
4. Equipment for TLC.
5. Laboratory glassware and reagents for analytical chemistry methods.

LIST OF PRACTICAL SKILLS

- skills of isolating toxic substances from biological material;
- skills in using physical, chemical and instrumental methods of analysis to identify and quantify toxic substances;
- skills of using express methods of analysis for the analytical diagnosis of drug addiction, substance abuse, acute poisoning.

LIST OF LECTURES

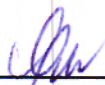
1. The general questions of toxicological chemistry.
2. Fundamentals of Biochemical Toxicology.
3. Analytical toxicology of the main groups of xenobiotics.
4. Substances isolated from biological material by mineralization.
5. «Flying» poisons.
6. Substances defined directly in biological material.
7. Modern physicochemical methods used in chemical toxicological analysis.
8. Substances isolated from biological material by water extraction.
9. Substances isolated from biological material by polar solvents.
10. Substances isolated from biological material by non-polar solvents (pesticides).

LIST OF LABORATORY STUDIES

1. The goals and objectives of the discipline «Toxicological chemistry».
2. Organization of medical forensics in the Republic of Belarus.
3. Introduction to narcology and clinical toxicology.
4. Classification of toxic substances.
5. Chemical toxicology analysis methodology.
6. Fundamentals of Biochemical Toxicology.
7. Substances isolated from biological material by mineralization.
8. «Flying» poisons.
9. Substances defined directly in biological material.
10. Modern physicochemical methods used in chemical toxicological analysis.
11. Substances isolated from biological material by water extraction.
12. Substances isolated from biological material by polar solvents.
13. Substances isolated from biological material by non-polar solvents (pesticides).

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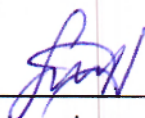
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Curriculum content, composition and accompanying documents comply with established requirements.

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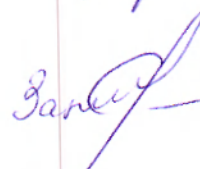
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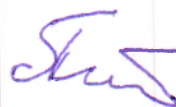
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