

MINISTRY OF HEALTH OF UKRAINE
BOGOMOLETS NATIONAL MEDICAL UNIVERSITY

GUIDELINES
to the practical classes

Discipline of choice "Toxicological and forensic chemistry"

Field of knowledge 22 Health care

Specialty 226 "Pharmacy, industrial pharmacy"

Specialization 226.01 "Pharmacy"

Form of study Full-time

Department of medicinal chemistry and toxicology

Approved at the meeting of the department on "30" August 2024, protocol No. 14

Head of the Department of medicinal chemistry and toxicology

Doctor of Medicine, Professor

Nizhenkovska I.V.

Considered and approved:

on the meeting of cycle methodical commission of specialty 226 "Pharmacy, industrial pharmacy" dated August 30, 2024, protocol No. 1

Topic N 1. Engineering of safety during the working at the laboratory of chemical-toxicological analysis. Theoretical base of toxicological and forensic chemistry and chemical-toxicological analysis. External examination of the objects of investigation, preliminary tests of the objects of investigation, draw up of the forensic-toxicological investigation's plan.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the engineering of safety during the working at the laboratory of chemical-toxicological analysis, theoretical base of toxicological and forensic chemistry and chemical-toxicological analysis, external examination of the objects of investigation, preliminary tests of the objects of investigation, draw up of the forensic-toxicological investigation's plan; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, a set of laboratory dishes - devices for purity detection and isolation.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis).

Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.:

PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 4-16.

<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU.
<https://www.youtube.com/@useryj2fn5mz3x/>

Auxiliary

1. Caio H. P. Rodrigues, Livia S. Mariotto, Aline T. Bruni. Acute, chronic, and *postmortem* toxicity: a review focused on three different classes of new psychoactive substances. *Forensic Toxicology*. V. 41,187–212 (2023).
2. Marine Deville & Corinne Charlier. Cannabidiol in urine is not a proof of CBD consumption—lesson learned from urine sample analysis in routine caseworks. *Forensic Toxicology*. V. 41,213–220 (2023).
3. Kelly Francisco da Cunha, Karina Diniz Oliveira, Jose Luiz Costa. Green analytical toxicology method for determination of synthetic cathinones in oral fluid samples by microextraction by packed sorbent and liquid chromatography–tandem mass spectrometry. *Forensic Toxicology*. (2023).

Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298.

www.webofpharma.com Pharmacopoea USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets <http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevticheskoj-byologicheskoytoksykologicheskoy-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of

Ukraine <https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (**IJMTFM**).

<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan.

<http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain.

<http://www.tandfonline.com/page/termsand-conditions>

pubmed.ncbi.nlm.nih.gov www.cochrane.org

Questions for student self-preparation for the class:

1. Toxicological and forensic chemistry, its content, tasks, main sections of toxicological and forensic chemistry (forensic-toxicological and chemical-toxicological analysis), its connection with toxicology and other medical-biological, pharmaceutical, fundamental disciplines.
2. Forensic - toxicological and chemical-toxicological laboratories, their tasks, organization of work, legal bases of activity.
3. Peculiarities of chemical and toxicological analysis. General and targeted chemical and toxicological analysis.
4. Fields of use of methods of chemical and toxicological analysis.
5. Procedure and documentation of forensic toxicological (chemical-toxicological) examinations.
6. Preliminary tests (screening studies) in chemical-toxicological analysis and their role in drawing up a plan of chemical-toxicological analysis.
7. Definition of the terms "poisoning" and "poison".
8. General principles of classification of poisons: according to chemical structure, purpose of use (production purpose), degree of toxicity (hygienic), type of toxic action (toxicological), selective toxicity, according to the method of isolation from objects of biological origin.
9. Classification of poisoning by the cause of occurrence (accidental, intentional), by the conditions (place) of development (domestic, industrial, medical). Division of intentional poisoning into criminal and suicidal. Classification of poisoning according to the clinical principle (acute, chronic, subacute poisoning); by ways of penetration into the body; nosological classification.
10. Metabolism (biotransformation) of poisons in the human body. I and II phases of metabolism.
11. Lethal synthesis.
12. Objects of chemical and toxicological research, their characteristics, preservation methods.
13. Rules for selection, transportation, acceptance of biological material for forensic chemical examination. Sample storage procedure.
14. Peculiarities of the analysis of certain types of biological material depending on their nature, state, chemical properties of poisonous substances.
15. General principles of interpretation of forensic chemical research results.
16. General characteristics of the methods used to detect and quantify poisons in chemical-toxicological analysis (chemical, physico-chemical, biochemical, pharmacological). Their comparative characteristics (sensitivity, specificity).

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 2. Toxicological characteristic of the group of substances isolated from biological material by water extraction of objects which investigated (mineral acids, alkalies and their salts). Peculiarities of isolation from biological material, identification and quantitative determination of sulfuric and nitric acids, nitrates and nitrites.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of the group of substances isolated from biological material by water extraction of objects which investigated (mineral acids, alkalies and their salts), peculiarities of isolation from biological material, identification and quantitative determination of sulfuric and nitric acids, nitrates and nitrites; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 320-330.

<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU.
<https://www.youtube.com/@useryj2fn5mz3x/>

Auxiliary

1. Caio H. P. Rodrigues, Livia S. Mariotto, Aline T. Bruni. Acute, chronic, and postmortem toxicity: a review focused on three different classes of new psychoactive substances. *Forensic Toxicology*. V. 41, 187–212 (2023).

"Toxicology Overview". *American Chemical Society*. Retrieved 10 May 2020.
Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London, 2020: I-1298.

www.webofpharma.com Pharmacopoeia USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets <http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevticheskoj-byologicheskoy-toksikologicheskoy-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine <https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).
<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan.
<http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain.

<http://www.tandfonline.com/page/termsand-conditions>
pubmed.ncbi.nlm.nih.gov www.cochrane.org

Questions for student self-preparation for the class:

1. Mineral acids: sulfuric (sulphate) acid. Detection, isolation and metabolism.
2. Mineral acids: nitric (nitric) acid. Detection, isolation and metabolism.
3. Mineral acids: hydrochloric (chloric) acid. Detection, isolation and metabolism.
4. Alkalis: sodium hydroxide (caustic soda). Detection, isolation and metabolism.
5. Alkalis: potassium hydroxide. Detection, isolation and metabolism.
6. Alkalis and ammonia (ammonia): ammonium hydroxide, ammonia (ammonia).

Detection, isolation and metabolism.

7. Salts of alkali metals: nitrites. Detection, isolation and metabolism.

8. Salts of alkali metals: nitrates. Detection, isolation and metabolism.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 3. A group of poisonous substances isolated from biological material by steam distillation ("volatile" poisons): hydrocyanic acid and cyanides, alkyl halides, aliphatic alcohols, aldehydes, ketones, phenols, carboxylic acids, alkyl halides, phenols, aniline. Quantitative analysis of volatile substances. *Control work № 1.*

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of the group of substances isolated from biological material by steam distillation («volatile» poisons): hydrocyanic acid and cyanides, halogenated aliphatic hydrocarbons, aliphatic alcohols, aldehydes, ketones (acetone), phenols, carbonic acids (acetic acid), peculiarities of isolation from biological material, identification and quantitative determination; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (writing control work - auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 48-81.
<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>
Auxiliary

1. "Isocyanic acid". National Institute of Standards and Technology (U.S. Department of Commerce). Retrieved 2023-04-20.

2. Scott, Kevin A.; Cox, Philip B.; Njardarson, Jon T. (2022-05-26). "Phenols in Pharmaceuticals: Analysis of a Recurring Motif". *Journal of Medicinal Chemistry*. **65** (10): 7044–7072. doi:10.1021/acs.jmedchem.2c00223. ISSN 0022-2623. PMID 35533692. S2CID 248667453.

Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoea USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevticheskoj-byologicheskoy-y-toksykologicheskoy-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

Questions for student self-preparation for the class:

1. A group of substances that are isolated by distillation ("volatile" poisons). General characteristics of the group. Physico-chemical properties, structure and effect on the body. The cause and frequency of poisoning. Features of combined poisoning. The significance of the results of chemical and toxicological analysis for the diagnosis of poisoning by "volatile" poisons.
2. Means of detoxification of the body in case of poisoning with "volatile" poisons.
3. Methods of isolating "volatile" poisons from biological material, food products, and environmental objects: steam distillation, dry air distillation.
4. Methods of purification and concentration of "volatile" poisons in distillates.

- Schematic diagram of the study of biological material for "volatile" poisons during general and targeted analysis using a combination of methods.
5. Individual representatives of the group of "volatile" poisons: hydrocyanic acid, aliphatic monoatomic alcohols (C1-C5), alkyl halides (chloroform, chloral hydrate, carbon tetrachloride), aldehydes (formaldehyde), acetone, phenol and its derivatives, acetic acid.
 6. Hydrocyanic acid and its derivatives. Physico-chemical properties, application, toxic effect on the body. The main patterns of behavior in the body and corpse. Antidotes. Features of isolation from corpse organs and biological fluids, detection reactions and methods of quantitative determination. Assessment of their sensitivity and specificity. Assessment of forensic chemical analysis results.
 7. Aliphatic monoatomic alcohols (C1-C5 alkanols). Physico-chemical properties, applications, mechanisms of toxic action on the body. The main patterns of behavior in the body and corpse. Features of isolation. Metabolism. Dichloroethane.
 8. Formation of ethanol in the body during diseases. The value of the relative ratio of ethanol in urine and blood for the diagnosis of alcoholic coma.
 9. Alkyl halides. Physico-chemical properties of chloroform, carbon tetrachloride, chloral hydrate. Application, toxic effect on the body. Basic patterns of behavior in the body. Features of isolation from corpse organs and biological fluids.
 10. Phenol and its derivatives (picric acid, picramic acid). Toxicological value. Detection methods.
 11. Tetraethyllead (TES).
 12. Fujiwara's reaction in the detection of chlorine-containing compounds: chloroform, carbon tetrachloride, chloral hydrate. Write reaction schemes. Specify a specific color.
 13. Preliminary test for chloral hydrate in urine. Write reaction schemes. Specify a specific color.
 14. Chlorine cleavage reaction in the detection of chlorine-containing compounds: chloroform, carbon tetrachloride, chloral hydrate. Write reaction schemes. Specify a specific color.
 15. Reaction with resorcinol in the detection of chlorine-containing compounds: chloroform, carbon tetrachloride, chloral hydrate. Write reaction schemes. Specify a specific color.
 16. Reaction with Fehling's reagent in the detection of chlorine-containing compounds. What compounds are opened by this reaction? Write reaction schemes. Specify a specific color.
 17. Polyhydric alcohols (ethylene glycol). Physico-chemical properties, application, toxic effect on the body. The main patterns of behavior in the body and corpse. Features of isolation from biological objects.
 18. Aldehydes (formaldehyde, acetaldehyde), monoatomic phenols (phenol, cresols), acetone, acetic acid. Physico-chemical properties, application, mechanisms of toxic action on the body.

19. Features of isolation of monoatomic phenols and acetic acid from objects of analysis.
20. Chemical reactions for the detection of formaldehyde, phenol, acetone, acetic acid. Assessment of their sensitivity and specificity.
21. Methods of quantitative determination of formaldehyde, phenol, acetic acid, acetone.
22. Detection of formaldehyde and acetaldehyde by the microdiffusion method in blood and urine.

Control work No. 1 - on questions of topics 1-3.

List of questions for control work No. 1.

1. Procedure and documentation of forensic toxicological (chemical-toxicological) examinations.
2. Preliminary tests (screening studies) in chemical-toxicological analysis and their role in drawing up a plan of chemical-toxicological analysis.
3. Definition of the terms "poisoning" and "poison".
4. General principles of classification of poisons: according to chemical structure, purpose of use (production purpose), degree of toxicity (hygienic), type of toxic effect (toxicological), selective toxicity, according to the method of isolation from objects of biological origin.
5. Classification of poisoning by the cause of occurrence (accidental, intentional), by the conditions (place) of development (domestic, industrial, medical). Division of intentional poisoning into criminal and suicidal. Classification of poisoning according to the clinical principle (acute, chronic, subacute poisoning); by ways of penetration into the body; nosological classification.
6. Metabolism (biotransformation) of poisons in the human body. I and II phases of metabolism.
7. Lethal synthesis.
8. Objects of chemical and toxicological research, their characteristics, preservation methods.
9. Rules for selection, transportation, acceptance of biological material for forensic chemical examination. Sample storage procedure.
10. Peculiarities of analysis of certain types of biological material depending on their nature, state, chemical properties of poisonous substances.
11. General principles of interpretation of forensic chemical research results.
12. General characteristics of the methods used to detect and quantify poisons in chemical-toxicological analysis (chemical, physical-chemical, biochemical, pharmacological). Their comparative characteristics (sensitivity, specificity).
13. Mineral acids: sulfuric (sulphate) acid. Detection, isolation and metabolism.
14. Mineral acids: nitric (nitric) acid. Detection, isolation and metabolism.
15. Mineral acids: hydrochloric (chloric) acid. Detection, isolation and metabolism.
16. Alkalis: sodium hydroxide (caustic soda). Detection, isolation and metabolism.

17. Alkalis: potassium hydroxide. Detection, isolation and metabolism.
18. Alkalis and ammonia (ammonia): ammonium hydroxide, ammonia (ammonia). Detection, isolation and metabolism.
19. Alkali metal salts: nitrites. Detection, isolation and metabolism.
20. Salts of alkali metals: nitrates. Detection, isolation and metabolism.
21. A group of substances isolated by distillation ("volatile" poisons). General characteristics of the group. Physico-chemical properties, structure and effect on the body.
22. Methods of isolating "volatile" poisons from biological material, food products and environmental objects: steam distillation.
23. Methods of distillate analysis: chemical and gas-liquid chromatography (GC).
24. Types of chemical reactions used in the analysis, assessment of their sensitivity and specificity.
25. Preparation of biological material for steam distillation. Selection of methods and conditions of distillation.
26. Schematic diagram of the study of biological material for "volatile" poisons during general and targeted analysis using a combination of methods.
27. Individual representatives of the group of "volatile" poisons: hydrocyanic acid, aliphatic monoatomic alcohols (C1-C5), ethylene glycol, alkyl halides (chloroform, chloral hydrate, carbon tetrachloride, 1,2-dichloroethane), aldehydes (formaldehyde, acetaldehyde), acetone, phenol, cresols, acetic acid.
28. Hydrocyanic acid and its derivatives. Physico-chemical properties, application, toxic effect on the body. The main patterns of behavior in the body and corpse. Antidotes. Features of isolation from corpse organs and biological fluids, detection reactions and methods of quantitative determination. Assessment of their sensitivity and specificity. Assessment of forensic chemical analysis results.
29. Aliphatic monoatomic alcohols (C1-C5). Physico-chemical properties, applications, mechanisms of toxic action on the body. The main patterns of behavior in the body and corpse. Features of isolation. Chemical reactions to alcohols. Evaluation of their sensitivity and specificity. Detection of alcohols in urine, blood, distillates by GC method.
30. Formation of ethanol in the body during diseases. The value of the relative ratio of ethanol in urine and blood for the diagnosis of alcoholic coma. First aid for alcohol poisoning and means of detoxification of the body.
31. Polyhydric alcohols (ethylene glycol). Physico-chemical properties, application, toxic effect on the body. The main patterns of behavior in the body and corpse. Features of isolation from biological objects.
32. Alkyl halides. Physico-chemical properties of chloroform, carbon tetrachloride, 1,2-dichloroethane, chloral hydrate. Application, toxic effect on the body. Basic patterns of behavior in the body. Features of isolation from corpse organs and biological fluids. Chemical reactions for detection of alkyl halides, evaluation of their sensitivity and specificity.

33. Aldehydes (formaldehyde, acetaldehyde), monoatomic phenols (phenol, cresols), acetone, acetic acid. Physico-chemical properties, applications, mechanisms of toxic action on the body.

34. Features of isolation of monoatomic phenols and acetic acid from objects of analysis.

35. Chemical reactions for the detection of formaldehyde, phenol, acetone, acetic acid. Evaluation of their sensitivity and specificity.

36. Methods of quantitative determination of formaldehyde, phenol, acetic acid, acetone.

37. Detection of formaldehyde and acetaldehyde by the microdiffusion method in blood and urine.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 4. Toxicological characteristic of the group of substances isolated from biological material by mineralization («metallic» poisons). Denitration. Examination of the compound of Barium, Lead., Manganese, Chromium, Silver, Copper and Zinc.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of the group of substances isolated from biological material by mineralization («metallic» poisons), denitration, examination of the compound of Barium, Lead., Manganese, Chromium, Silver, Copper and Zinc; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min

	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 85-122.

<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. Prohaska, Thomas; Irrgeher, Johanna; Benefield, Jacqueline; Böhlke, John K.; Chesson, Lesley A.; Coplen, Tyler B.; Ding, Tipping; Dunn, Philip J. H.; Gröning, Manfred; Holden, Norman E.; Meijer, Harro A. J. (4 May 2022). "Standard atomic

weights of the elements 2021 (IUPAC Technical Report)". Pure and Applied Chemistry. doi:10.1515/pac-2019-0603. ISSN 1365-3075.

2. "IIT Kharagpur Study Finds 20% of India Has High Arsenic Levels in Groundwater". The Wire. PTI. 11 February 2021. Retrieved 23 May 2023.

Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London. 2020: I-1298. www.webofpharma.com

Pharmacopoea USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologycheskoj-y-toksykologycheskoj-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

Questions for student self-preparation for the class:

1. General characteristics of the group (compounds of barium, lead, manganese, chromium, argentum, copper, cadmium, stibium, arsenic, bismuth, zinc, thallium, and mercury). Field of application, toxicological significance. Qualitative detection and quantitative determination of "metallic" poisons.
2. Characteristics of modern general and separate methods of mineralization. The choice of the mineralization method depends on the nature of the object and the studied "metallic" poison.
3. Denitration of mineralizate and its preparation for research.
4. Fractional research method. Theoretical provisions. Selection of research objects.
5. Scheme of the fractional method of analysis (according to O.M. Krylova).
6. Characteristics of reagents used in the fractional method for masking interfering ions, isolation and analysis of "metallic" poisons.
7. General characteristics of methods of quantitative determination of "metallic" poisons in fractional analysis. The choice of method depends on the content of the poison. Possible errors during the analysis.
8. Lead compounds (plumbum). Toxicological significance, methods of qualitative and quantitative analysis in biological material.
9. Barium compounds. Toxicological significance, methods of qualitative and

quantitative analysis in biological material.

10. Manganese (manganese) compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

11. Copper (copper) compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

12. Compounds of silver (argentum). Toxicological significance, methods of qualitative and quantitative analysis in biological material.

13. Chromium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

14. Zinc compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 5. Research of the liquid part of the mineralizate for the presence and content of Cadmium, Thallium, Bismuth, Antimony and Arsenic. Isolation of Mercury from biological material and its study in the destructate.

Control work № 2.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of the group of substances isolated from biological material by mineralization («metallic» poisons), denitration, examination of the compound of Cadmium, Thallium, Bismuth, Antimony and Arsenic, Mercury; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min

	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (writing control work - auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 85-122.

<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. Prohaska, Thomas; Irrgeher, Johanna; Benefield, Jacqueline; Böhlke, John K.; Chesson, Lesley A.; Coplen, Tyler B.; Ding, Tipping; Dunn, Philip J. H.; Gröning, Manfred; Holden, Norman E.; Meijer, Harro A. J. (4 May 2022). "[Standard atomic](#)

weights of the elements 2021 (IUPAC Technical Report)". *Pure and Applied Chemistry*. doi:10.1515/pac-2019-0603. ISSN 1365-3075.

2. Henry Arnaud, Celia (April 26, 2022). "Structure of Pepto-Bismol active ingredient solved". *Chemical & Engineering News*. 100 (44): 34–

35. doi:10.1021/cen-10044-cover6. ISSN 0009-2347. S2CID 254899845.

Retrieved 15 April 2023.

Information resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoea USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevticheskoj-byologycheskoj-y-toksykologycheskoj-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

Questions for student self-preparation for the class:

1. General characteristics of the group (compounds of Barium, Lead, Manganese, Chromium, Argentum, Copper, Cadmium, Stibium, Arsenic, Bismuth, Zinc, Thallium, and Mercury). Field of application, toxicological significance. Qualitative detection and quantitative determination of "metallic" poisons.
2. Characteristics of modern general and separate methods of mineralization. The choice of the mineralization method depends on the nature of the object and the studied "metallic" poison.
3. Denitration of mineralizate and its preparation for research.
4. Bismuth compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
5. Cadmium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
6. Arsenic compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
7. Stibium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

8. Compounds of Thallium. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
9. A group of substances that are isolated from biological material by mineralization ("metallic" poisons). General characteristics of the group: compounds of Cadmium, Stibium, Arsenic. Scheme of metabolism.
10. Destructive mineralization of biological material.
11. Denitration of mineralizate when isolating mercury compounds.
12. Compounds of Mercury. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

Control work No. 2 - on questions of topics 4, 5.

List of questions for control work No. 2.

1. General characteristics of the group (compounds of Barium, Lead, Manganese, Chromium, Argentum, Cuprum, Cadmium, Stybium, Arsenic, Bismuth, Zinc, Thallium and Mercury). Field of application, toxicological significance. Qualitative detection and quantitative determination of "metallic" poisons.
2. Characteristics of modern general and separate methods of mineralization. The choice of the mineralization method depends on the nature of the object and the studied "metallic" poison.
3. Denitration of mineralizate and its preparation for research.
4. Fractional research method. Theoretical provisions. Selection of research objects.
5. Scheme of the fractional method of analysis (according to O.M. Krylova).
6. Characteristics of reagents used in the fractional method for masking interfering ions, isolation and analysis of "metallic" poisons.
7. General characteristics of methods of quantitative determination of "metallic" poisons in fractional analysis. The choice of method depends on the content of the poison. Possible errors during the analysis.
8. Lead compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
9. Barium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
10. Manganese compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
11. Copper compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
12. Argentum compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
13. Chromium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

14. Zinc compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
15. Cadmium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
16. Thallium compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
17. Bismuth compounds. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
18. Compounds of Stybius. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
19. Compounds of Arsen. Toxicological significance, methods of qualitative and quantitative analysis in biological material.
20. Destructive mineralization of biological material.
21. Denitration of mineralizate when isolating mercury compounds.
22. Compounds of Mercury. Toxicological significance, methods of qualitative and quantitative analysis in biological material.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 6. Group of toxic substances which are isolated from the biological material with acidified water or with acidified ethanol (drugs or “medicinal” poisons). Research of model "acid" chloroform extracts the presence of pyrazolone derivatives, xanthine derivatives (methylated derivatives of purine), derivatives of barbituric acid and salicylic acid.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of the group of substances isolated from biological material with acidified water or with acidified ethanol (drugs or “medicinal” poisons), research of model "acid" chloroform extracts the presence of pyrazolone derivatives, xanthine derivatives (methylated derivatives of purine), derivatives of barbituric acid and salicylic acid; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
-------------------	-----------------------	------------------------	------

Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 128-209.

<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. Singh, Omender; Juneja, Deven (2019). *Principles and Practice of Critical Care Toxicology*. Jaypee Brothers Medical Publishers Pvt. Limited. ISBN 978-93-5270-674-7. For barbiturate overdose, urinary alkalinization with sodium bicarbonate may be beneficial. The optimum urinary pH which needs to be achieved is >7.5 and urine output should be more than 2 mL/kg/min.

2. Suddock, Jolee T.; Cain, Matthew D. (2020), "*Barbiturate Toxicity*", *StatPearls*, Treasure Island (FL): StatPearls Publishing, PMID 29763050, retrieved 5 August 2020.

Information resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoeia USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologycheskoj-y-toksykologycheskoj-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbmua.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

www.cochrane.org

Questions for student self-preparation for the class:

1. A group of substances that are isolated by extraction with polar solvents. General characteristics of the group. Physico-chemical properties, structure and effect on the body of poisonous and potent substances of organic nature.

2. Preliminary preparation of the object, the nature of the solvent, the pH of the solution, the nature of the acid, the degree of ionization, methods of protein precipitation. Characteristics of solvents that are most often used for isolation. Modern general and personal methods of isolation with polar solvents (acidified alcohol, acidified water) V.P. Kramarenka, Valova, V.I. Popova.

3. Methods of cleaning hoods from biological material from accompanying impurities. The choice of method depends on the condition, type and method of isolating poison from biological material.

4. Features of the metabolism of salicylic acid derivatives (aspirin, sodium salicylate, methyl salicylate, salicylamide).

5. Toxic concentrations of salicylates in blood serum.

6. Peculiarities of the metabolism of barbituric acid derivatives: barbamil, barbital, phenobarbital, sodium ethaminal, benzonal, hexenal.
7. Microcrystalloscopic reactions to barbiturates. What reagents are used to perform these reactions. Characteristics of final products.
8. Murexide test for barbiturates. What exactly barbiturates give this reaction? Schemes of reactions. Which barbiturates do not give this reaction? Does this reaction belong to the express analysis?
9. Peculiarities of the metabolism of p-aminophenol derivatives (phenacetin, paracetamol).
10. Paracetamol is formed as a result of the dealkylation reaction during the metabolism of the drug ...?
11. Peculiarities of the metabolism of pyrazolone derivatives (analgin, antipyrine, amidopyrine, butadione).
12. Peculiarities of the metabolism of purine derivatives (caffeine, theophylline, theobromine).
13. Methods of qualitative detection and quantitative determination of caffeine.
14. Methods of qualitative detection and quantitative determination of theobromine.
15. Methods of qualitative detection and quantitative determination of theophylline.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 7. Research of model "alkaline" chloroform extracts for the presence of tropane derivatives (atropine, scopolamine, cocaine), quinoline derivatives, isoquinoline (narcotine, narceine, papaverine, morphine, codeine, ethylmorphine, heroin), acyclic alkaloids (ephedrine, pseudoephedrine) according to with the help of color, precipitation and microcrystallographic reactions.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of model "alkaline" chloroform extracts (chloroform extracts of alkaline medium) for detection of derivatives of tropane (atropine, scopolamine, cocaine), quinoline derivatives (quinine, quinidine, quinzolon), isoquinoline (narcotine, narceine, papaverine, morphine, codeine, ethylmorphine, heroin), acyclic alkaloids (ephedrine, pseudoephedrine) with the help of color, precipitation and micro crystallographic reactions; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 157-214.
<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. Gresnigt, Femke M.J.; Gubbels, Nanda P.; Riezebos, Robert K. (2021-01-01). "[The current practice for cocaine-associated chest pain in the Netherlands](#)". *Toxicology Reports*. **8**:23–27. doi:10.1016/j.toxrep.2020.12.011. ISSN 2214-7500. PMC 7770504. PMID 33384944.

2. "[AusPAR: Atropine sulfate monohydrate](#)". Therapeutic Goods Administration (TGA). 31 May 2022. Archived from the original on 31 May 2022. Retrieved 12 June 2022.

3. Jump up to: "[Atropine sulfate](#)". *dailymed.nlm.nih.gov*. U.S. National Library of Medicine. Archived from the original on 26 July 2020. Retrieved 30 October 2019. Information resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoeia USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologycheskoj-y-toksykologycheskoj-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM). <https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

Questions for student self-preparation for the class:

1. Peculiarities of the metabolism of tropane derivatives (atropine, scopolamine, cocaine, ecgonine).
2. When poisoned by which alkaloid of the tropane group, a drug addict develops a complex of symptoms called "crack dance"?
3. Peculiarities of the metabolism of quinoline derivatives (quinine, quinidine).
4. Oxyquinine and dioxyquinine are metabolites of quinine, which are formed by the oxidation of which cycle of the quinine molecule?
5. What metabolite is formed during the oxidation of the quinuclidine cycle of the

quinine molecule?

6. Thaleiochin reaction. What compound is it used to detect? Does it refer to express analysis? Write a diagram.
7. Detection of quinine in urine (or blood plasma). Methodology of this experiment. What is this reaction called and why did it get that name?
8. Methods of qualitative detection and quantitative determination of atropine.
9. Methods of qualitative detection and quantitative determination of cocaine.
10. Methods of qualitative detection and quantitative determination of quinine.
11. Peculiarities of the metabolism of isoquinoline derivatives (morphine).
12. Peculiarities of the metabolism of isoquinoline derivatives (codeine).
13. Peculiarities of the metabolism of isoquinoline derivatives (papaverine).
14. Peculiarities of the metabolism of isoquinoline derivatives (narcotine).
15. Peculiarities of the metabolism of isoquinoline derivatives (heroin).
16. Qualitative and quantitative analysis of morphine.
17. Qualitative and quantitative analysis of codeine.
18. Qualitative and quantitative analysis of papaverine.
19. Qualitative and quantitative analysis of narcotine.
20. Qualitative and quantitative analysis of heroin.
21. Qualitative and quantitative analysis of ephedrine.
22. Qualitative and quantitative analysis of pseudoephedrine.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 8. Research of model "alkaline" chloroform extracts for the presence of phenothiazine derivatives, 1,4-benzodiazepine derivatives, p-aminobenzoic acid derivatives, oxypiperidine derivatives, 2-substituted propionic acid derivatives (ibuprofen), imidazoline derivatives (clofelin); poisons of natural origin (plants, mushrooms, animals and insects). Express analysis. *Control work № 3.*

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic of model "alkaline" chloroform extracts (chloroform extracts of alkaline medium) for detection of phenothiazine derivatives, 1,4-benzodiazepine derivatives, p-aminobenzoic acid derivatives, oxypiperidine derivatives, 2-substituted propionic acid derivatives (ibuprofen), imidazoline derivatives (clofelin); poisons of natural origin (plants, mushrooms, animals and insects); to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (writing control work - auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 256-283.
<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. Caio H. P. Rodrigues, Lívia S. Mariotto, Aline T. Bruni. Acute, chronic, and *post-mortem* toxicity: a review focused on three different classes of new psychoactive substances. *Forensic Toxicology*. V. 41,187–212 (2023).
2. Kelly Francisco da Cunha, Karina Diniz Oliveira, Jose Luiz Costa. Green analytical toxicology method for determination of synthetic cathinones in oral fluid samples by microextraction by packed sorbent and liquid chromatography–tandem mass spectrometry. *Forensic Toxicology*. (2023).
3. Islam MB, Islam MI, Nath N, Emran TB, Rahman MR, Sharma R, Matin MM. Recent Advances in Pyridine Scaffold: Focus on Chemistry, Synthesis, and Antibacterial Activities. *Biomed Res Int*. 2023 May 18; 2023: 9967591. [doi: 10.1155/2023/9967591](https://doi.org/10.1155/2023/9967591). [PMID: 37250749](https://pubmed.ncbi.nlm.nih.gov/37250749/); [PMCID: PMC10212683](https://pubmed.ncbi.nlm.nih.gov/PMC10212683/).

Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoea USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologicheskoj-y>

[toksykologicheskoj-hymyy/](http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologicheskoj-y-toksykologicheskoj-hymyy/)

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

www.cochrane.org

Questions for student self-preparation for the class:

1. Physical-chemical properties, chemical structure, application, toxicological characteristics, causes of poisoning, mechanisms of toxic action, toxicodynamics and toxicokinetics (pathways of entry into the body, metabolism, distribution, excretion) and methods of analysis of medicinal substances.

2. Synthetic medicinal substances: phenothiazine derivatives (aminazine, diprazine, etmosine, levomepromazine, thioridazine); 1,4-benzodiazepine derivatives (chlordiazepoxide, diazepam, oxazepam, mezepam, phenazepam, nitrazepam, clonazepam).
3. Synthetic medicinal substances: p-aminobenzoic acid derivatives (novocaine, novocaineamide).
4. Synthetic medicinal substances: derivatives of oxypiperidine (Promedol, Prosidol).
5. Synthetic medicinal substances: derivatives of 2-substituted propionic acid (ibuprofen), imidazoline derivatives (clonidine).
6. Physical-chemical methods of research of medicinal substances: chromatography in thin layers of sorbent (TLH), high-performance liquid chromatography (HPLC) and gas-liquid chromatography (HLC).
7. TLC-screening as a preliminary stage of identification in undirected chemical-toxicological analysis. Group developers in TLC.
8. Peculiarities of the metabolism of phenothiazine derivatives (aminazine, diprazine, tizercin).
9. Peculiarities of the metabolism of p-aminobenzoic acid (PABA) derivatives (novocaine, dicaine, novocaineamide).
10. Features of the metabolism of 1,4-benzodiazepine derivatives (chlordiazepoxide, diazepam, oxazepam, nitrazepam).
11. Peculiarities of the metabolism of synthetic derivatives of 2-substituted propionic acid (ibuprofen).
12. What symptoms of poisoning appear in a person with an overdose of ibuprofen?
13. Peculiarities of the metabolism of synthetic derivatives of imidazoline (clofelin).
14. Methods of qualitative detection and quantitative determination of ibuprofen.
15. Methods of qualitative detection and quantitative determination of nitrazepam.
16. Methods of qualitative detection and quantitative determination of diazepam.
17. Methods of qualitative detection and quantitative determination of oxazepam.
18. Methods of qualitative detection and quantitative determination of aminazine.
19. Methods of qualitative detection and quantitative determination of clofelin.
20. Methods of qualitative detection and quantitative determination of chlordiazepoxide.
21. Methods of qualitative detection and quantitative determination of diprazine.
22. Methods of qualitative detection and quantitative determination of tizercin.
23. Characterization and analysis of poisons of natural origin.
24. Plant poisons (phytotoxins) - ricin, dithyline, nicotine, strychnine, scopolamine, etc.
25. Poisons of animal origin (zootoxins) - tetrodotoxin.
26. Poisons of cap mushrooms and their classification.
27. Mechanisms of toxic action and clinical symptoms of poisoning when using poisonous mushrooms (pale toadstool, red fly agaric, false boletus, false morels) and conditionally edible mushrooms (morels, morels, porcini mushrooms, champignons, champignons).
28. Methods of isolation from objects of research and chemical-toxicological

analysis of cap mushroom poisons.

29. Diagnosis, emergency care, antidote and symptomatic therapy for mushroom poisoning.

30. Poisons of natural origin that require special methods of isolation from research objects: toxins of lower fungi or fungal poisons (mycotoxins), algae toxins (algotoxins) and microbial toxins.

Control work No. 3 - on questions of topics 6-8.

List of questions for control work No. 3.

1. A group of substances that are isolated by extraction with polar solvents. General characteristics of the group. Physico-chemical properties, structure and effect on the body of poisonous and potent substances of organic nature.

2. Characteristics of the solvents most often used for isolation. Modern general and personal isolation methods with polar solvents (acidified alcohol, acidified water)
V.P. Kramarenko, P.V. Valova, V.I. Popova

3. Methods of cleaning hoods from biological material from accompanying impurities. The choice of method depends on the condition, type and method of isolating poison from biological material.

4. Features of the metabolism of salicylic acid derivatives (aspirin, sodium salicylate, methyl salicylate, salicylamide).

5. Toxicological significance of salicylates.

6. Peculiarities of the metabolism of barbituric acid derivatives: barbamil, barbital, phenobarbital, sodium ethaminal, benzonal, hexenal.

7. Microcrystalloscopic reactions to barbiturates. What reagents are used to perform these reactions. Characteristics of final products.

8. Murexide test for barbiturates. What exactly barbiturates give this reaction? Schemes of reactions. Which barbiturates do not cause this reaction? Does this reaction belong to the express analysis?

9. Peculiarities of the metabolism of pyrazolone derivatives (analgin, antipyrine, butadione).

10. Peculiarities of the metabolism of purine derivatives (caffeine, theophylline, theobromine).

11. Methods of qualitative detection and quantitative determination of caffeine.
12. Methods of qualitative detection and quantitative determination of theobromine.
13. Methods of qualitative detection and quantitative determination of theophylline.
14. Peculiarities of the metabolism of tropane derivatives (atropine, scopolamine, cocaine, ecgonine).
15. When poisoned by which alkaloid of the tropane group, a drug addict develops a complex of symptoms called "crack dance"?
16. Peculiarities of the metabolism of quinoline derivatives (quinine, quinidine).
17. Oxyquinine and dioxyquinine are metabolites of quinine, which are formed by the oxidation of which cycle of the quinine molecule?
18. What metabolite is formed during the oxidation of the quinuclidine cycle of the quinine molecule?
19. Thaleiochin reaction. What compound is it used to detect? Does it refer to express analysis? Write a diagram.
20. Detection of quinine in urine (or blood plasma). Methodology of this experiment. What is this reaction called and why did it get that name?
21. Methods of qualitative detection and quantitative determination of atropine.
22. Methods of qualitative detection and quantitative determination of cocaine.
23. Methods of qualitative detection and quantitative determination of quinine.
24. Peculiarities of the metabolism of isoquinoline derivatives (morphine, codeine, papaverine).
25. Peculiarities of the metabolism of ephedrine and pseudoephedrine.
26. Peculiarities of heroin metabolism.
27. Methods of qualitative detection and quantitative determination of morphine.

28. Methods of qualitative detection and quantitative determination of codeine.
29. Methods of qualitative detection and quantitative determination of papaverine.
30. Methods of qualitative detection and quantitative determination of narcotics.
31. Methods of qualitative detection and quantitative determination of heroin.
32. Methods of qualitative detection and quantitative determination of ephedrine.
33. Methods of qualitative detection and quantitative determination of pseudoephedrine.
34. Toxicological characteristics of synthetic medicinal substances: phenothiazine derivatives (aminazine, diprazine, etmosine, levomepromazine, thioridazine).
35. Toxicological characteristics of synthetic medicinal substances: 1,4-benzodiazepine derivatives (chlordiazepoxide, diazepam, oxazepam, mezapam, phenazepam, nitrazepam, clonazepam).
36. Toxicological characteristics of synthetic medicinal substances: derivatives of p-aminobenzoic acid (novocaine, novocaineamide).

37. Toxicological characteristics of synthetic medicinal substances: oxypiperidine derivatives (promedol, prosidol).

38. Toxicological characteristics of synthetic medicinal substances: derivatives of 2-substituted propionic acid (ibuprofen).

39. Toxicological characteristics of synthetic medicinal substances: imidazoline derivatives (clofelin).

40. Peculiarities of the metabolism of phenothiazine derivatives (aminazine, diprazine, tizercin).

41. Peculiarities of the metabolism of p-aminobenzoic acid (*PABA*) derivatives (novocaine, dicaine, novocaineamide).

42. Peculiarities of the metabolism of 1,4-benzodiazepine derivatives (chlordiazepoxide, diazepam, oxazepam, nitrazepam).

43. Peculiarities of the metabolism of synthetic derivatives of 2-substituted propionic acid (ibuprofen).

44. Peculiarities of the metabolism of synthetic derivatives of imidazoline (clofelin).

45. Methods of qualitative detection and quantitative determination of tizercin.

46. Methods of qualitative detection and quantitative determination of ibuprofen.

47. Methods of qualitative detection and quantitative determination of nitrazepam.

48. Methods of qualitative detection and quantitative determination of diazepam.
49. Methods of qualitative detection and quantitative determination of oxazepam.
50. Methods of qualitative detection and quantitative determination of aminazine.
51. Methods of qualitative detection and quantitative determination of clofelin.
52. Methods of qualitative detection and quantitative determination of chlordiazepoxide.
53. Methods of qualitative detection and quantitative determination of diprazine.
54. Plant poisons (phytotoxins) - nicotine. Toxicological value, metabolism, methods of analysis.
55. Plant poisons (phytotoxins) - strychnine. Toxicological value, metabolism, methods of analysis.
56. Plant poisons (phytotoxins) - scopolamine. Toxicological value, metabolism, methods of analysis.
57. Plant poisons (phytotoxins) - cocaine. Toxicological value, metabolism, methods of analysis.
58. Plant poisons (phytotoxins) - aconitine. Toxicological value, metabolism, methods of analysis.
59. Plant poisons (phytotoxins) - quinine. Toxicological value, metabolism, methods of analysis.
60. Tetrodotoxin. Toxicological significance, methods of analysis.
61. Bufotoxins. Toxicological significance, methods of analysis.
62. Pumiliotoxins (A, B, C). Toxicological value, methods of analysis.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 9. Toxicological characteristics, methods of isolation and analysis of organophosphorus pesticides. Toxicological characteristics of "carbon monoxide" gas. Methods of detecting carboxyhemoglobin and carboxymyoglobin.

Control work № 4.

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic and methods of isolation of organophosphorus pesticides, of carbon monoxide, methods for determination of carboxygemoglobin and carboxymyoglobin; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min

	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training: test control and/or individual survey, verification of the performance of tasks of extracurricular independent work	Reproductive	20 min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (writing control work - auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 293-317.

<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. ["About Pesticide Registration"](#). Environmental Protection Agency. Jan 25, 2023. Retrieved 2023-12-13.

2. Jump up to: "[Approval of active substances](#)". [European Commission](#).

Retrieved 2023-12-13.

Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoeia USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologicheskoj-y-toksykologicheskoj-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbm.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

www.cochrane.org

Questions for student self-preparation for the class:

1. Classification of pesticides by direction of application, toxicity, form of use, chemical structure. Classification of insecticides.
2. Objects of chemical and toxicological analysis for PhOS. Methods of separation of PhOS from corpse organs, biological fluids, food products. The choice of the extractant depends on the condition, the nature of the research object and the poison.
3. Selection of the method of cleaning hoods containing PhOS, depending on the nature and amount of substances.
4. Chemical methods of PhOS analysis in extracts from biological material. Detection by functional-active groups and hydrolysis products. Assessment of analysis results.
5. Detection and identification of PhOS in extracts from biological material by TLC, GC and HPLC methods. Assessment of analysis results.
6. Methods of quantitative determination of PhOS (photocolorimetric, photometric by phosphorus, planimetric, enzymatic, GLC method) and their comparative assessment.
7. Ways and means of prevention of pesticide poisoning. Methods and methods of providing first aid in case of pesticide poisoning of various groups. Antidote therapy for PhOS poisoning.
8. A group of poisonous substances that are determined directly in biological

material — carbon monoxide (CO).

9. Physico-chemical properties, toxicological characteristics, mechanism of toxic action.

10. Acute poisoning and classification of carbon monoxide poisoning by degree of severity.

11. Detection of carboxyhemoglobin and carboxymyoglobin by chemical, spectroscopic and spectrophotometric methods.

12. Quantitative determination of carboxyhemoglobin and carboxymyoglobin by spectrophotometric and spectroscopic methods.

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

Control work No. 4 - on questions of topic 9.

List of questions for control work No. 4.

1. Classification of pesticides by direction of application, toxicity, form of use, chemical structure. Classification of insecticides.

2. Objects of chemical and toxicological analysis for PhS. Methods of separation of PhS from corpse organs, biological fluids, food products. The choice of the extractant depends on the condition, the nature of the research object and the poison.

3. Selection of the method of cleaning hoods containing PhS, depending on the nature and amount of substances.

4. Chemical methods of PhS analysis in extracts from biological material. Detection by functional-active groups and hydrolysis products. Assessment of analysis results.

5. Detection and identification of PhS in extracts from biological material by TLC, GC and HPLC methods. Assessment of analysis results.

6. Methods of quantitative determination of PhS (photocolorimetric, photometric by phosphorus, planimetric, enzymatic, GLC method) and their comparative evaluation.

7. Ways and means of prevention of pesticide poisoning. Methods and methods of providing first aid in case of pesticide poisoning of various groups. Antidote therapy for PhS poisoning.

8. A group of poisonous substances that are determined directly in biological material — carbon monoxide (CO).

9. Physico-chemical properties, toxicological characteristics, mechanism of toxic effect of CO.

10. Acute poisoning and classification of carbon monoxide poisoning by degree of severity.

11. Detection of carboxyhemoglobin and carboxymyoglobin by chemical, spectroscopic and spectrophotometric methods.

12. Quantitative determination of carboxyhemoglobin and carboxymyoglobin by spectrophotometric and spectroscopic methods.

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

14. Reaction with sodium hydroxide (Hoppe-Zeyler test).

15. Reaction with ammonium sulfide (Salkovsky-Katayama test).

16. Reaction with quinine and ammonium sulfide (Khoroshkevich-Marx test).

17. Reaction with potassium hexacyanoferrate (III) (Burger's test).

18. Reaction with potassium hexacyanoferrate (III) and potassium dichromate (Sidorov's test).

19. Reaction with potassium hexacyanoferrate (III) and acetic acid (Wetzel's test).

20. Reaction with tannin (Kunkel-Wetzel test).

21. Reaction with formaldehyde (Libman test).

22. Reaction with lead acetate (Rubner's test).

23. Reaction with cuprum sulfate (Zalessky test).

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.

Topic N 10. Combat poisonous substances. Classification. Toxicological value. Peculiarities of chemical and toxicological analysis. *Differential control.*

Competencies:

integral: the ability to solve tasks of a research and/or innovative nature in the field of pharmacy and in the field of industrial production of medicinal products.

general:

GC01. Ability to abstract thinking, analysis and synthesis.

GC02. Knowledge and understanding of the subject area; understanding of professional activity.

GC03. Ability to communicate in the national language both orally and in writing.

GC05. Ability to evaluate and ensure the quality of the work performed.

GC06. Ability to work in a team.

GC09. Ability to use information and communication technologies

GC10. Ability to make decisions and act in accordance with the principle of inadmissibility of corruption and any other manifestations of dishonesty.

professionals:

PC02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC03. Ability to solve pharmacy problems in new or unfamiliar environments in the presence of incomplete or limited information, taking into account aspects of social and ethical responsibility.

PC04. Ability to clearly and unambiguously convey one's own knowledge, conclusions and arguments in the field of pharmacy to specialists and non-specialists, in particular to people who are studying.

Purpose: to form systematized foundations of scientific knowledge regarding the toxicological characteristic and methods of analysis of combat poisonous substances, classification, peculiarities of chemical and toxicological analysis; to provide an approximate basis for further assimilation of educational material in practical classes.

Equipment: practical tasks (tests, calculation tasks, situational tasks), a workbook, a calculator, computer program.

Class plan and organizational structure:

Name of the stage	Content of the stages	Levels of assimilation	Time
Preparatory	Organizational issues (checking the presence of students)	Familiarization	5 min
	Formation of motivation, activation of cognitive activity	Perception	5 min
	Control of the initial level of training:	Reproductive	20

	test control and/or individual survey, verification of the performance of tasks of extracurricular independent work		min
Basic	Debate and discussion of theoretical issues according to the subject of the class	Comprehension Understanding	15 min
	Solving situational problems	Application in practice Search creative activity	25 min
	Independent work of the student under the supervision of the teacher (auditory work of the student)	Application in practice Search creative activity	20 min
	Generalization of knowledge	Fixing	10 min
Final	Control of the final level of training (solving situational problems)	Playback	20 min
	General evaluation of the student's educational activity	Familiarization	10 min
	Informing students about the topic of the next lesson and tasks for independent work	Familiarization	5 min

Recommended literature:

Basic

1. Welchinska E.V. Toxicological and forensic chemistry (Criminal analysis). Poisonous substances and their biotransformation: textbook / E.V. Welchinska. — K.: PE Lopatina O.O., ISBN 978-617-7533-02-2, 2017. — p. 293-317.
<http://ir.librarynmu.com/handle/123456789/9123>

2. Materials of Lecturers. The department of medicinal chemistry and toxicology of pharmaceutical faculty of Bogomolets NMU. <https://www.youtube.com/@user-yj2fn5mz3x/>

Auxiliary

1. Caio H. P. Rodrigues, Lívia S. Mariotto, Aline T. Bruni. Acute, chronic, and *post-mortem* toxicity: a review focused on three different classes of new psychoactive substances. *Forensic Toxicology*. V. 41,187–212 (2023).

2. Marine Deville & Corinne Charlier. Cannabidiol in urine is not a proof of CBD consumption—lesson learned from urine sample analysis in routine caseworks. *Forensic Toxicology*. V. 41,213–220 (2023).

3. Keunhong Jeong, Junwon Choi. Theoretical study on the toxicity of 'Novichok' agent candidates // Royal Society Open Science. — 2019. — Т. 6, вип. 8 (7 серпня). — DOI:10.1098/rsos.190414.

4. Steindl, David; Boehmerle, Wolfgang; Körner, Roland; Praeger, Damaris; Haug, Marcel; Nee, Jens; Schreiber, Adrian; Scheibe, Franziska; Demin, Katharina; Jacoby, Philipp; Tauber, Rudolf (22 грудня 2020). Novichok nerve agent poisoning. *The Lancet*. doi:10.1016/s0140-6736(20)32644-1. ISSN 0140-6736. Архів оригіналу за 23 січня 2021.

5. "Nerve Agent Treatment – Autoinjector Instructions – CHEMM". chemm.nlm.nih.gov. Retrieved 27 July 2020.

6. "NERVE AGENTS". 3 September 2018. Archived from the original on 3 September 2018. Retrieved 27 July 2020.

Informational resources

European Pharmacopoeia online - pheur.edqm.eu

The British Pharmacopoeia 2021 - www.pharmacopoeia.com

The British Pharmacopoeia 2020. London.2020: I-1298. www.webofpharma.com

Pharmacopoea USP. www.usp.org.

Website of the Department of Medicinal Chemistry and Toxicology of O.O. Bogomolets

<http://nmu.ua/zagalni-vidomosti/kafedri/kafedra-farmatsevtycheskoj-byologicheskoy-y-toksykologicheskoy-hymyy/>

Distance learning platform LIKAR_NMU

<https://likar.nmu.kiev.ua/>

Official website of the Ministry of Health of Ukraine

<https://moz.gov.ua/>

International Journal of Medical Toxicology and Forensic Medicine (IJMTFM).

<https://journals.sbmu.ac.ir/ijmtfm>

Journal of Synthetic Organic Chemistry, Japan. <http://www.ssocj.jp/indexenglish>.

Journal of Organic Chemistry, USA. <https://doi.org/10.1021/acs.joc.0c02255>.

Synthetic Communications. Great Britain. <http://www.tandfonline.com/page/terms-and-conditions>

pubmed.ncbi.nlm.nih.gov

www.cochrane.org

Questions for student self-preparation for the class:

1. Classifications of toxic warfare agents (CWA).
2. Give the chemical formulas of the representatives of the "nerve paralytic agents (PhOS)" series: V, G, A: Zarin, Zoman, Tabun, Vi-gaz. Name the functional groups in the molecules of these compounds. On what reactions is the functional analysis of these compounds based?
3. What methods are used to determine Phosphorus in the molecules of representatives of the "nerve-paralytic agents (PhOS)" group?

4. Give the chemical formulas of representatives of the "irritants" group: Chlorpicrin, 1-chloroacetophenone, etc. Name the functional groups in the molecules of these compounds. On what reactions is the functional analysis of these compounds based?
5. What methods are used to determine halogens in molecules of representatives of the "irritants" group?
6. Give the chemical formulas of representatives of the "vesicants" group: Mustard (H, HD), Lewisite (L), Methylchloroarsine (MD), Phosgene-oxime (CX), etc. Name the functional groups in the molecules of these compounds. On what reactions is the functional analysis of these compounds based?
7. What methods are used to determine Sulfur and Arsenic in the molecules of representatives of the "vesicants" group?
9. Lewisite. Peculiarities of chemical structure, toxicological significance and methods of analysis.
10. Mustard (mustard gas). Peculiarities of chemical structure, toxicological significance and methods of analysis.
11. Adamsite. Peculiarities of chemical structure, toxicological significance and methods of analysis.
12. Cyanides. Peculiarities of chemical structure, toxicological significance and methods of analysis.
13. Asphyxiating CWA: phosgene, diphosgene. Peculiarities of chemical structure, toxicological significance and methods of analysis.
14. Organomercury CWA. Peculiarities of chemical structure, toxicological significance and methods of analysis.
15. Ricin. Peculiarities of chemical structure, toxicological significance and methods of analysis.
16. Chlorocyan. Peculiarities of chemical structure, toxicological significance and methods of analysis.
17. Qualitative reactions to Chlorine.
18. Qualitative reactions to Mercury.

The methodical development was made by:

head of the department of medicinal chemistry and toxicology, DM, professor Nizhenkovska I.V., professor of department, doctor of pharm. sc. Welchinska O.V., as. professor, PhD Golovchenko O.I.