

DANYLO HALYTSKY LVIV NATIONAL MEDICAL UNIVERSITY

Department of Pharmaceutical, Organic and Bioorganic chemistry



APPROVED

**Acting First pro-rector
for the Academic Work
Danylo Halytsky Lviv National
Medical University
assoc.prof. I.I. Solonyenko**

I.I. Solonyenko
«07» 07 2022

**EDUCATIONAL PROGRAM IN THE
ELECTIVE DISCIPLINE
"IDENTIFICATION OF ORGANIC COMPOUNDS"**

Second (master's) educational level

Field: 22 "Health"

**Specialty: 226 "Pharmacy, industrial pharmacy"
for second-year students of pharmaceutical faculty**

Discussed and approved
Department of Pharmaceutical, Organic
and Bioorganic chemistry
Proceedings No 21
"15" June 2022.
Head of Department
Prof. R.B. Lesyk

Approved
Methodical Commission
of Chemical and Pharmaceutical
Disciplines
Proceedings No 3
"21" June 2022.
Head of the Methodical ommission
assoc. prof. S.B.Bilous

Authors: ScD, PhD, prof. V.A. Muzychenko, PhD, associat. prof. N.Y.Shtoyko,
associate prof. I.Y. Subtelna

Program reviewers: PhD, associat. prof. Y.I.Bidnychenko.; PhD,
associat. prof. O.M.Roman

INTRODUCTION

The syllabus for elective discipline " Identification of organic compounds "

in accordance with the Project of Standard of Higher Education of *the second (master's) level*

Field: 22 "Health"

Specialty: 226 "Pharmacy"

Master's Degree Programme in Pharmacy

Description of the discipline (abstract)

The elective discipline "Identification of organic compounds" is devoted to the systematic study of methods and approaches to establish the structure and purity of organic compounds and the formation on this basis of creative chemical thinking necessary for successful mastering of disciplines and practical activities.

The main task of the elective discipline is to provide a scientific approach to solving problems such as pharmaceutical, phytochemical and chemical-toxicological analysis, quality assessment and technology of drug production and storage conditions, as well as laboratory diagnosis of diseases.

The training of specialists who need knowledge on the identification of organic compounds requires not only theoretical training, but also versatile practical skills and abilities in conducting a chemical experiment.

The objectives of the elective discipline are to determine the structure of organic molecules, both natural and synthetic, including drugs, their metabolites and endogenous compounds; study of the nature of functional groups; identifying the relationship between their molecular, electronic structure and methods of analysis; studying aspects of isolation, purification and analysis of organic compounds.

The structure of the discipline	Number of hours, of which				Year of study	Type of control
	Total year credits	Classroom		out of class work		
		Lectures	Seminars			
Identification of organic compounds	3.0 ECTS credits / 90 hours	10	20	60	2nd year (IV semester)	credit
For semesters						
	3.0 ECTS credits / 90 hours	10	20	60	2nd year (IV semester)	credit

The subject of study of the discipline is

- molecular structure of organic compounds;
- physical and chemical properties of organic compounds;
- reactivity of different classes of organic compounds;
- identification methods;
- methods of isolation and purification.

Interdisciplinary connections: - general and inorganic chemistry; analytical chemistry; biophysics; biology; biological chemistry; normal physiology; pathological physiology; pharmacology; histology.

•

1. The purpose and objectives of the discipline

1.1. The purpose of teaching an elective discipline:

- students learn the laws of the relationship between the structure and properties of organic compounds
- acquaintance with the basic physical methods of analysis of organic compounds as the main prerequisite for understanding the principles of their identification in medical-biological and clinical-diagnostic research
- study of the main approaches for the identification of organic compounds based on the analysis of analytical-functional groups
- acquisition of practical skills that will help the student in the future to master the methods of standardization and quality control of drugs and the principles of laboratory diagnosis.

1.2. The main objectives of the elective discipline are:

- to teach students the methods of isolation and purification of organic compounds
- to teach students the general principles of evaluation of chemical properties of organic compounds, which are the basis for the analysis of organic substances;
- to reveal the practical aspects of the use of physico-chemical methods of analysis in pharmaceutical and medical practice.

1.3. Competences and learning outcomes, the formation of which is facilitated by the discipline (relationship with the normative content of training of applicants for higher education, formulated in terms of learning outcomes in the Project of Standard of Higher Education).

In accordance with the requirements of the Project of Standard of Higher Education, the discipline provides students with the acquisition of **competencies**:

-*general*: 3K 2; 3K 3; 3K 4; 3K 6; 3K 7; 3K 9; 3K 10; 3K 11; 3K 12; 3K 14.

- *special (professional)*: ФК 2; ФК 4; ФК 5; ФК 6; ФК 7; ФК 15; ФК 19; ФК 20.

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

Matrix of competences

No	Competence	Knowledge	Skills	Communication	Autonomy and responsibility
1.	“3K.2” Ability to apply knowledge in practical situations	Know the methods of implementing knowledge in solving practical problems	Be able to use professional knowledge to solve practical situations	Establish links with practitioners	Be responsible for the timeliness of decisions
2.	“3K.3” The striving to save the environment	To know the problems of environmental protection, the requirements of the sanitary and hygienic regime and the conditions of labor protection		Develop measures to preserve and protect the environment	Be responsible for the implementation of environmental protection measures within its competence
3.	“3K.4” The ability to abstract thinking, analysis and synthesis; the ability to study and to be trained up-to date	Know the current trends in the industry and analyze them	Be able to analyze professional information, make informed decisions, acquire Be able to form requirements for environmental protection, compliance with sanitary and hygienic regime and conditions of labor protection; interpret the requirements of laws and regulations on labor protection; draw conclusions about the presence of harmful factors during the performance of professional duties; to provide labor protection of pharmaceutical personnel modern knowledge	Establish appropriate connections to achieve goals	Be responsible for the timely acquisition of modern knowledge
4.	“3K.6” Knowledge and understanding of the subject area and comprehension of the profession	Know the structure and features of professional activity	Be able to carry out professional activities that require updating and integration of knowledge	To form a communication strategy in professional activity	Be responsible for professional development with a high level of autonomy
5.	“3K. 7” Ability to adapt and act in a new situation	Know the elements of working and social adaptation; factors of successful adaptation to the new environment. decision-making	Be able to form an effective strategy of personal adaptation to new conditions	Interact with a wide range of people (colleagues, management, experts in other fields) in the event of new situations with the elements unpredictability	Be responsible for decision making
6.	“3K.10” Ability to choose	Know the tactics and strategies	Be able to choose ways and	Use communication	Be responsible for the choice

	communication strategy, ability to work in a team and with experts from other fields of knowledge / types of economic activity	of communication, laws and ways of communicative behavior	strategies of communication to ensure effective teamwork	strategies and interpersonal skills	and tactics of communication
7.	“3K.11” Ability to assess and ensure the quality of performed work	Know the methods of evaluating performance indicators	Be able to ensure the quality of professional work	Establish connections to ensure quality work	Be responsible for the quality of work
8.	“3K.12” Ability to perform research at the appropriate level	Know the components of the health care system, planning and evaluating research	Search for scientific sources of information; to make a choice of methods of carrying out scientific research; use methods of mathematical analysis and modeling, theoretical and experimental research in pharmacy	Use information data from scientific sources	Be responsible for the development and implementation of planned projects
9.	“3K 14”. Ability to preserve and multiply moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies, active recreation and a healthy lifestyle	Critical understanding of problems in the field and on the border of fields of knowledge	Ability to solve problems in new or unfamiliar environments with incomplete or limited information, taking into account aspects of social and ethical responsibility		Ability to continue studies with a high degree of autonomy
10.	“ΦΚ 2”. Ability to provide advice on prescription and over-the-counter drugs and other products of the pharmacy range; pharmaceutical care in the selection and sale of over-the-counter drugs by assessing the risk / benefit, compatibility, indications and contraindications based on the health status of a particular patient, taking into account biopharmaceutical, pharmacokinetic, pharmacodynamic and physicochemical characteristics of the drug and other pharmaceutical products.	Know the physicochemical properties of drugs	Provide information on the regime, timing and requirements for storage of drugs of various dosage forms at home in accordance with list 4, using knowledge of chemical, physicochemical, properties	Provide counseling and pharmaceutical care when dispensing over-the-counter drugs	Be responsible for the provision of pharmaceutical care when dispensing over-the-counter drugs

11.	<p>“ФК 4”. Ability to ensure rational use, obtain the necessary information from identified sources to ensure conditions for quality and safe pharmaceutical care of prescription and over-the-counter drugs and other pharmaceutical products in accordance with physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a particular disease and its pharmacotherapeutic regimen.</p> <p>“ФК 5” Ability to monitor the effectiveness and safety of the use of drugs by the population according to the data on their clinical and pharmaceutical characteristics, as well as taking into account subjective signs and objective clinical, laboratory and instrumental criteria for examination of the patient</p>	<p>Know the chemical structure of drugs; relationship "chemical structure - pharmacological action"</p> <p>Know the principles of clinical, laboratory and instrumental evaluation of the effectiveness / ineffectiveness and safety of drugs</p>	<p>Carry out a comparative characterization of drugs in accordance with list 1b, taking into account the chemical structure, mechanism of action and pharmacological properties in order to determine the advantages and disadvantages of individual drugs.</p> <p>Collect, recognize and identify from various sources, analyze and interpret information on adverse reactions and / or lack of efficacy of the drug</p>	<p>Obtain the necessary information from identified sources to ensure the conditions for quality and safe pharmaceutical care</p> <p>To draw conclusions based on the analysis of information on side effects of drugs</p>	<p>Be responsible for the soundness of management decisions to improve the quality of pharmaceutical care</p> <p>Be responsible for analyzing information on the efficacy and safety of medicines</p>
12.	<p>“ФК 6” Ability to identify drugs, xenobiotics, toxins and their metabolites in body fluids and tissues, to conduct chemotoxicological studies to diagnose acute poisoning, drug and alcohol intoxication</p>	<p>Know the physicochemical properties of drugs of inorganic and organic nature; aliphatic monohydric and polyhydric alcohols, alkyl halides; aldehydes, ketones, monohydric phenols and organic acids; mineralization of organic medicinal compounds; chemical and instrumental methods of analysis. Qualitative and quantitative analysis.</p> <p>Know the physicochemical properties of drugs</p>	<p>Taking into account the distribution of toxins in the body, metabolism, and other factors, select biological objects of analysis and evaluate the results obtained, using the physicochemical and pharmacological characteristics of toxic substances</p>	<p>Analyze drugs and their metabolites in body fluids and tissues</p>	<p>Be responsible for the results of chemical and toxicological research</p>
13.	<p>“ФК 7” Ability to ensure proper storage of medicines and other products of the pharmacy range in accordance with their physicochemical properties and the rules of Good Storage Practice (GSP) in health care facilities.</p>	<p>Ensure appropriate storage conditions for toxic, narcotic and equivalent drugs, as well as dosage forms with them</p>	<p>Ensure appropriate storage conditions for toxic, narcotic and equivalent drugs, as well as dosage forms with them</p>	<p>Carry out constant monitoring of proper storage of medicines and medical devices at pharmaceutical enterprises</p>	<p>Be responsible for the storage of medicines and medical devices in accordance with Good Storage Practice (GSP) in healthcare facilities</p>
14.	<p>“ФК 15”. Ability to organize and</p>	<p>Know the methods of extraction</p>	<p>Stabilize pharmaceuticals,</p>	<p>Choose the optimal</p>	<p>Be responsible for compliance</p>

	participate in the production of medicines in the context of pharmaceutical companies, including the selection and justification of the technological process, equipment in accordance with the requirements of Good Manufacturing Practice (GMP) with the appropriate development and design of the necessary documentation. Determine the stability of drugs	and synthesis of organic compounds; methods of isolation and purification of organic compounds	taking into account the biological, physico-chemical, technological properties of active substances and excipients, using the necessary reagents	technological process of manufacturing drugs of industrial production	with Good Manufacturing Practice.
16.	“ФК 19” Ability to organize and control the quality of medicines in accordance with the requirements of the current State Pharmacopoeia of Ukraine and good practices in pharmacy, to determine methods of sampling for control of medicines and to standardize them in accordance with current requirements, to prevent the spread of falsified medicines	Know the physicochemical properties of drugs; methods of qualitative and quantitative analysis of drugs	Determine the main physical characteristics of drugs (melting point, boiling point and pour point) by physical methods	Carry out quality control of medicines and their certification.	Be responsible for certifying and preventing the spread of counterfeit medicines
17.	“ФК 20”. Ability to develop methods for quality control of medicines, including active pharmaceutical ingredients, medicinal plant raw materials and excipients using physical, chemical, physicochemical, biological, microbiological, pharmacotechnological and pharmacoorganoleptic control methods	Know the elemental analysis and analysis by functional groups; functional analysis of organic compounds by functional groups; general methods of analysis of inorganic and organic drug compounds; chromatographic methods of identification, optical activity and specific rotation. spectral methods of analysis	Determine the functional groups of active substances of organic nature in accordance with list 1a in raw materials, intermediate products, finished products	Develop methods of quality control of pharmaceutical products.	Be responsible for the validity of the developed quality control methods

Learning outcomes:

Integrative final learning outcomes, the formation of which contributes to the discipline: PPH 1; PPH 2; PPH 4; PPH 10; PPH 12; PPH 14; PPH 16; PPH 17; PPH 30; PPH 32.

“PPH 1” carry out professional activities in social interaction based on humanistic and ethical principles; identify future professional activities as socially significant for human health.

“PPH 2” to apply knowledge of general and professional disciplines in professional activities;

“PPH 4” to use the results of independent search, analysis and synthesis of information from various sources for solving typical tasks of professional activity;

“PPH 10” Adhere to the norms of communication in professional interaction with colleagues, management, consumers, work effectively in a team.

“PPH 12” to use methods of performance indicators evaluation; to reveal reserves for improving of labor productivity.

“PPH 14” to determine the advantages and disadvantages of drugs of different pharmacological groups, taking into account their chemical, physicochemical, biopharmaceutical, pharmacokinetic and pharmacodynamic features. To recommend to consumers over-the-counter medicines and other products of the pharmacy range with the provision of counseling and pharmaceutical care.

“PPH 16”. to determine factors influencing the processes of absorption, distribution, deposition, metabolism and excretion of the drug and due to the condition, features of the human body and physicochemical properties of drugs.

“PPH 17” to use data from clinical, laboratory and instrumental studies to monitor the effectiveness and safety of drugs.

“PPH 30” to ensure quality control of medicines and document its results. Manage quality risks at all stages of the life cycle of medicines.

“PPH 32” to determine the main organoleptic, physical, chemical, physicochemical and pharmacotechnological indicators of medicines, to substantiate and choose methods of their standardization, to carry out statistical processing of results in accordance with the requirements of the current State Pharmacopoeia of Ukraine.

Learning outcomes for the elective discipline:

to know:

- basic principles of classification and structural organization of organic compounds;
- features of the relationship structure - properties of organic compounds;
- methods of isolation and purification of organic compounds;
- theoretical principles of physicochemical methods of analysis;
- main reactions of identification of analytical-functional groups

to be able:

- use chemical and reference literature, work with tabular and graphic material;
- use the data of physical and chemical analysis;
- determine the physical constants of organic compounds to identify organic compounds;
- purify liquid and crystalline organic compounds, establish their purity;
- to carry out qualitative reactions to the main functional groups;
- independently analyze an unknown organic compound.

•

2. Information volume of the discipline

3.0 ECTS credits, 90 hours, are allocated for the study of the academic discipline.

Topic 1. Structure of organic compounds. The most important classes of organic compounds are the basis for the identification of organic compounds. Relationship structure - activity (property). Methods of isolation and purification of organic compounds. Sensitivity and selectivity of chemical reactions. Approaches to the characteristics of organic compounds: the most important physicochemical constants, elemental analysis.

Structure of organic compounds. The most important classes of organic compounds are the basis for the identification of organic compounds. Relationship structure - activity (property). Methods of isolation and purification of organic compounds. Sensitivity and selectivity of chemical reactions.

Approaches to the characteristics of organic compounds: the most important physicochemical constants, elemental analysis.

Topic 2. Physical methods of analysis: spectroscopic methods of research (NMR, EMR, IR, UV), mass spectrometry, diffractometry, chromatographic methods Chemical methods of identification of organic compounds: general requirements, approaches to choice.

Physical methods of analysis: spectroscopic methods of research (NMR, EMR, IR, UV), mass spectrometry, diffractometry, chromatographic methods Chemical methods of identification of organic compounds: general requirements, approaches to choice.

Topic 3. Identification by analytical-functional groups: saturated-, unsaturated hydrocarbons, arenes,

Identification of alkanes and cycloalkanes. Identification of alkenes, alkynes, alkadienes. Identification of arenes.

Topic 4. Identification by analytical-functional groups: alcohols, phenols, amines.

Identification of mono- and polyhydric alcohols. Identification of mono- and polyatomic phenols. Identification of aliphatic and aromatic amines.

Topic 5. Identification by analytical-functional groups: carbonyl compounds, carboxylic acids and their

Identification of carboxylic acids. Identification of amides, esters, halides, nitriles, anhydrides.

Topic 6. Identification by analytical-functional groups: heterofunctional compounds (amino acids, hydroxy acids, monosaccharides).

Identification of amino alcohols and aminophenols. Identification of oxoacids. Identification of α -, β - and γ -hydroxy acids. Identification of aromatic hydroxy acids. Identification of α -, β - and γ -amino acids. Identification of aromatic amino acids. Identification of monosaccharides.

Topic 7. Identification of heterocyclic compounds (N- and S-containing heterocycles).

Identification of five-membered heterocyclic compounds (pyrrole, furan, thiophene). Identification of six-membered heterocyclic compounds.

Topic 8. Identification of the main classes of biologically active compounds (proteins, proteins).

Identification of proteins and proteins.

Topic 9. Identification of the main classes of biologically active compounds (di- and polysaccharides).

Identification of disaccharides. Identification of polysaccharides.

Topic 10. Identification of the main classes of biologically active compounds (lipids). Quantitative analysis - the basis for clinical laboratory diagnosis: basic methods.

Identification of saponification and non-saponification lipids.

Quantitative analysis - the basis for clinical laboratory diagnosis: basic methods.

3. The structure of the discipline

TOPIC	Lectures	Seminars	Out of class work	Individual work
Topic 1. Structure of organic compounds. The most important classes of organic compounds are the basis for the identification of organic compounds. Relationship structure - activity (property). Methods of isolation and purification of organic compounds. Sensitivity and selectivity of chemical reactions. Approaches to the characteristics of organic compounds: the most important physicochemical constants, elemental analysis	2	2	12	-
Topic 2. Physical methods of analysis: spectroscopic methods of research (NMR, EMR, IR, UV), mass spectrometry, diffractometry, chromatographic methods Chemical methods of identification of organic compounds: general requirements, approaches to choice.	2	2	12	
Topic 3. Identification by analytical-functional groups: saturated-, unsaturated hydrocarbons, arenes,	1	2	4	
Topic 4. Identification by analytical-functional groups: alcohols, phenols, amines.	1	2	4	
Topic 5. Identification by analytical-functional groups: carbonyl compounds, carboxylic acids and their functional derivatives.	1	2	4	
Topic 6. Identification by analytical-functional groups: heterofunctional compounds (amino acids, hydroxy acids, monosaccharides).	1	2	4	
Topic 7. Identification of heterocyclic compounds (N- and S-containing heterocycles).		2	4	

Topic 8. Identification of the main classes of biologically active compounds (proteins, proteins)	1	2	4	
Topic 9. Identification of the main classes of biologically active compounds (di- and polysaccharides)	1	2	4	
Topic 10. Identification of the main classes of biologically active compounds (lipids). Quantitative analysis - the basis for clinical laboratory diagnosis: basic methods		2	8	
Total hours 90 / 3.0 ECTS credits	10	20	60	
Final control				Credit

4. Thematic plan of lectures

№	TOPIC	Number of hours
1.	Structure of organic compounds. The most important classes of organic compounds are the basis for the identification of organic compounds. Relationship structure - activity (property). Methods of isolation and purification of organic compounds. Sensitivity and selectivity of chemical reactions. Approaches to the characteristics of organic compounds: the most important physicochemical constants, elemental analysis	2
2	Physical methods of analysis: spectroscopic methods of research (NMR, EMR, IR-, UV-), mass spectrometry, diffractometry, chromatographic methods. Chemical methods of identification of organic compounds: general requirements, approaches to choice.	2
3	Identification by analytical-functional groups: saturated-, unsaturated hydrocarbons, arenes, alcohols, phenols, amines, carbonyl compounds, acids and their functional derivatives	2
4	Identification by analytical-functional groups: heterofunctional compounds (amino acids, hydroxy acids, monosaccharides). Identification of heterocyclic compounds (N- and S-containing heterocycles). Identification of the main classes of biologically active compounds (proteins, proteins)	2
5.	Identification of the main classes of biologically active compounds (di- and polysaccharides), lipids. Quantitative analysis - the basis for clinical laboratory diagnosis: basic methods	
Together		10
Number of lecture hours from the elective discipline		10

5. Thematic plan of seminars

№ 3/II	TOPIC	Number of hours
1.	Structure of organic compounds. The most important classes of organic compounds are the basis for the identification of organic compounds. Relationship structure - activity (property). Methods of isolation and purification of organic compounds. Sensitivity and selectivity of chemical reactions. Approaches to the characteristics of organic compounds: the most important physicochemical constants, elemental analysis	2
2.	Physical methods of analysis: spectroscopic methods of research (NMR, EMR, IR-, UV-), mass spectrometry, diffractometry, chromatographic methods. Chemical methods of identification of organic compounds: general requirements, approaches to choice..	2
3.	Identification by analytical and functional groups: saturated, unsaturated hydrocarbons, arenes.	2
4.	Identification by analytical-functional groups: alcohols, phenols, amines.	2
5.	Identification by analytical-functional groups: carbonyl compounds, carboxylic acids and their functional derivatives.	2
6.	Identification by analytical-functional groups: heterofunctional compounds (amino acids, hydroxy acids, monosaccharides).	2
7.	Identification of heterocyclic compounds (N- and S-containing heterocycles).	2
8.	Identification of the main classes of biologically active compounds (proteins, peptides).	2
9.	Identification of the main classes of biologically active compounds (di- and polysaccharides).	2

10.	Identification of the main classes of biologically active compounds (lipids). Quantitative analysis - the basis for clinical laboratory diagnosis: basic methods.	2
Together		20
Number of hours of practical classes on the elective subject		20

6. Thematic plan of out of class work of students

№	TOPIC	Number of hours	Type of control
1.	Structure of organic compounds. The most important classes of organic compounds are the basis for the identification of organic compounds. Relationship structure - activity (property).	4	Current control at seminars
2.	Methods of isolation and purification of organic compounds. Sensitivity and selectivity of chemical reactions.	4	
3.	Approaches to the characteristics of organic compounds: the most important physicochemical constants, elemental analysis	4	
4.	Physical methods of analysis: spectroscopic methods of research (NMR, EMR, IR, UV)	4	
5.	Physical methods of analysis: mass spectrometry, diffractometry, chromatographic methods	4	
6.	Chemical methods of identification of organic compounds: general requirements, approaches to selection.	4	
7.	Identification by analytical-functional groups: saturated-, unsaturated hydrocarbons, arenes	4	
8.	Identification by analytical-functional groups: alcohols, phenols, amines	4	
9.	Identification by analytical-functional groups: carbonyl compounds, acids and their functional derivatives	4	
10.	Identification by analytical-functional groups: heterofunctional compounds (amino acids, hydroxy acids, monosaccharides)	4	
11.	Identification of heterocyclic compounds (N- and S-containing heterocycles)	4	
12.	Identification of the main classes of biologically active compounds (proteins, proteins)	4	
13.	Identification of the main classes of biologically active compounds (di- and polysaccharides)	4	
14.	Identification of the main classes of biologically active compounds (lipids)	4	
15.	Quantitative analysis - the basis for clinical laboratory diagnosis: basic methods	4	
Together		60	
Together on an elective discipline		60	

7. Individual tasks

(history of diseases, forensic medical certificates, acts of toxicological research, courseworks and diploma, master's works)

There is not any in working curriculum.

8. Methods of studies

In the process of "Organic Chemistry" disciplines studying the following teaching methods are used for students:

- by the cognitive activity type:
 - explanatory-illustrative;
 - reproductive;
 - problematic presentation;
 - the logic of cognition;
 - analytical;
 - inductive;
 - deductive;
- according to the main stages of the process:
 - knowledge formation;
 - skills and abilities formation;
 - knowledge application;
 - generalization;
 - fixing;
 - assessment;
- by the system approach:
 - stimulation and motivation;
 - assessment and self-assessment;
- by sources of knowledge:
 - verbal – lecture, explanation;
 - visual – demonstration, illustration;
- according to the individual mental activity level:
 - problematic;
 - partially discovering;
 - explorative;
 - the method of problematic teaching.

When studying an elective discipline, students use textbooks, lecture notes, chemical computer programs, lab wares needed to perform experiments.

According to the curriculum, the methods of organization and implementation of educational activities are:

- a) lectures
- b) seminars
- c) out of class work of students.

Classes according to the methods of their organizations are seminar and laboratory, involve discussion and laboratory research to study certain classes of organic compounds on the properties of their functional groups, qualitative reactions, isolation and purification of organic compounds, the establishment of physicochemical constants.

Students also use exercises and solve situational problems.

The structure of the organization of classes includes:

- Discussion and explanation of the most difficult issues of the topic;
- Execution / Discussion of practical (laboratory) works, aspects of use and interpretation of results.
- The result of the lesson.

9. Methods of control

Types of control: current (routine) and final.

The current control is a regular check of educational trained achievements, fulfilled by the teacher according to syllabus of the discipline. It is carried out on each practical class according to the specific objectives, during the individual work of the teacher with the student for those topics which are not part of the structure of practical classes. The objective (standardized) control of theoretical and practical knowledge and skills of students is used. The following means of the level of students' knowledge assessment are used: testing, situational problems solving, laboratory research activities and their results interpreting and evaluating, practical skills evaluation. At each practical class the student gives answers on 10 questions (multiple choice questions on the topic of the practical classes, standardized questions, knowledge of which is necessary for understanding the current topic, the issue of a lecture course and individual work related to the current class, demonstrates knowledge and skills of practical abilities in accordance with the topic of the practical class).

The credit is the form of *final control* for the elective discipline "Identification of organic compounds" studying. Students, who completed all types of activities provided by the syllabus, attended all practical classes and were scored with the points number not less than the minimum.

10. The current control

The current control is realized during the practical classes and aims at checking the learning of educational material. It is recommended to apply objective (standardized) kind of control to check theoretical and practical knowledge of students.

When evaluating the educational activities achievements of each topic for the current educational activity, the student is assessed with grades in the 4-grading scale (national). It takes into account all types of activities provided for by the discipline syllabus. A student should gain an assessment from each topic for further conversion of 4- grading scale points into 200-grading scale points. The standardized control of the theoretical part includes 10 tasks. Five of them are the first level tests question, and another five are referred to the tasks of the second level and must be given a written response in addition to the test response. Theoretical students' self-preparation control is performed in writing by answering 10 questions. A correct answer to questions 1-5 is valued at 1 point, questions 6-10 valued at 2 point. The maximum score for the entire test is 15 points. The minimum score points number a student must gain for the successful assessment of the theoretical part is 8 points.

Assessment of practical skills of students - as a result of the implementation of the practical part - is formalized in the form of a protocol.

Criteria of assessment of current educational activity:

"Excellent" mark receives a student who actively participated in the discussion of the most difficult issues of the topic, gave at least 90% of correct answers to standardized tests, responded to written tasks without any mistake, performed practical work and filled in the protocol.

"Good" mark gets a student who participated in the discussion of the most difficult issues of the topic, gave at least 75% of correct answers to standardized tests, responded to written tasks with some insignificant mistakes, performed practical work and filled in the protocol.

"Satisfactory" mark receives a student who did not take part in the discussion of the most difficult issues of the topic, gave at least 60% of correct answers to standardized tests, responded to written tasks with a lot of mistakes, performed practical work and made the protocol.

"Unsatisfactory" mark receives a student who did not take part in the discussion of the most difficult issues of the topic, gave less than 60% of correct answers to standardized tests, responded to written tasks with gross mistakes or did not give answer, didn't perform practical work and didn't make the protocol.

The students' individual work issues and achievements which are provided by the syllabus in the content of practical training practical class activities, are evaluated during the current control of the topic at the appropriate practical class. The evaluation of the topics submitted for individual study and not included into the content of the practical class training is monitored during the final control.

11. Form of final control of study success

The final control is carried out upon completion of the study of the discipline in the form of the test (credit).

Semester test is a form of final control, which consists in assessing the student's mastery of educational material in a particular discipline solely on the basis of the results of all types of educational work provided for in the working curriculum. The semester credit is set based on the results of the current control.

Students who have completed all types of work provided for in the curriculum, and in the study of the discipline scored a number of points not less than the minimum, and also have no unfinished practical classes are admitted to the test.

12. Scheme of accrual and distribution of scores received by students is as follows:

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

The minimum number of points that a student score for the current academic activity to enroll in the discipline is 120 points.

The calculation of the number of points is based on the grades obtained by the student on a traditional scale during the study of the discipline during the semester, by calculating the arithmetic mean (AA), rounded to two decimal places. The resulting value is converted into points on a multi-point scale as follows:

$$X = (AA \times 200) / 5$$

For convenience, the table of recalculation on a 200-point scale is given:

Recalculation of the average mark for current activity into multi-point rate for disciplines, ending with test.

4-point rate	200- point rate	4-point rate	200- point rate	4-point rate	200- point rate	4-point rate	200- point rate
5	200	4.45	178	3.92	157	3.37	135
4.97	199	4.42	177	3.89	156	3.35	134
4.95	198	4.4	176	3.87	155	3.32	133
4.92	197	4.37	175	3.84	154	3.3	132
4.9	196	4.35	174	3.82	153	3.27	131
4.87	195	4.32	173	3.79	152	3.25	130
4.85	194	4.3	172	3.77	151	3.22	129
4.82	193	4.27	171	3.74	150	3.2	128
4.8	192	4.24	170	3.72	149	3.17	127
4.77	191	4.22	169	3.7	148	3.15	126
4.75	190	4.19	168	3.67	147	3.12	125
4.72	189	4.17	167	3.65	146	3.1	124
4.7	188	4.14	166	3.62	145	3.07	123
4.67	187	4.12	165	3.57	143	3.02	121
4.65	186	4.09	164	3.55	142	3	120
4.62	185	4.07	163	3.52	141	Менше 3	Недостатньо
4.6	184	4.04	162	3.5	140		
4.57	183	4.02	161	3.47	139		
4.52	181	3.99	160	3.45	138		
4.5	180	3.97	159	3.42	137		
4.47	179	3.94	158	3.4	136		

Students out-of classes works is assessed during the current verification of topic on the lesson.

Assessment of disciplines, the form of final control of which is a test is based on the results of current educational activities and is expressed on a two-point scale "credited" or "not credited". To be enrolled, a student must receive a score of at least 60% of the maximum amount of points in the discipline (120 points) for the current academic activity.

Points from discipline are converted into ECTS rate, and 4-point (national) rate.

Points from ECTS rate can't be converted into 4-point rate and vice versa. Marks of students, who study in one specialty, and taking into account the number of points gained by him/her in the discipline are ranked by ECTS rate as follows:

ECTS Mark	Statistical index
A	Top 10% of students
B	Next 25% of students
C	Next 30% of students
D	Next 25% of students
E	Last 10% of students

A, B, C, D, E rankings are awarded to students of actual course, who study in one specialty and successfully completed the study of the discipline. Students who received FX, F ("2") ratings are not included in the list of ranked students. Students with an FX score after repassing the exam receive an "E" score automatically.

Score points for students who have successfully completed the program are converted to the traditional 4-point scale by the absolute criteria listed in the table below:

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

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

Objectivity of assessment students' educational activities is checked by statistical methods (correlation coefficient between the ECTS mark and mark by national scale).

13. Methodical support

1. Methodical instructions for preparation for practical classes and out of class work of students of the Faculty of Pharmacy:
2. Organic Chemistry. Methodical Guide for Practical Classes and Out-of Classes Work for Foreign Students of the Second Year of the Faculty of Pharmacy. Part 1 // Lesyk R., Muzychenko V., Kaminsky D et al., Львів : ЛНМУ імені Данила Галицького, 2021. 108p
3. Organic Chemistry. Methodical Guide for Practical Classes and Out-of Classes Work for Foreign Students of the Second Year of the Faculty of Pharmacy. Part 2 // Lesyk R., Muzychenko V., Kaminsky D et al., Львів : ЛНМУ імені Данила Галицького, 2021. 131p - lecture plan,
- 4. plans to take,
5. tasks for out of class work,
- 6. questions, tasks and test tasks for current and final control of knowledge and skills of students, after attestation monitoring of acquired knowledge and skills in the discipline

14. Literature/textbooks

The main literature

1. Josyf D. Komarytsia. Organic Chemistry. Handbook for pharmaceutical students. L'viv medical university. L'viv, 2000. – 151 P.
2. B.S. Zimenkovsky, V.A. Muzychenko, I.V. Nizhenkovska, G.O. Syrova. Biological and bioorganic chemistry. Aus Medicine Publishing. Kyiv. 2018. – 288 p.

Additional literature

1. T.W. Graham Solomons. Organic Chemistry. – 6th or 5th ed. John Wiley & Sons, Inc. New York Chichester Brisbane Toronto Singapore. – 1218 P.
2. Mary Ann Fox, James K. Whitesell. Organic Chemistry. – 2nd ed. Jones and Bartlett Publishers. Boston London Singapore. – 828 P.
3. Molly M. Bloomfield. Chemistry and the Living Organism. – 5th or 4th ed. John Wiley & Sons, Inc. New York Chichester Brisbane Toronto Singapore. – 746 P.
4. John D. Roberts, Marjorie C. Caserio. Basic Principles of Organic Chemistry. – 2nd ed. W. A. Benjamin, Inc. Menlo Park, California Reading, Massachusetts London Amsterdam Don Mills, Ontario Sydney. – 1596 P.
5. Robert Thornton Morrison, Robert Neilson Boyd. Organic Chemistry. – 4th ed. Allyn and Bacon, Inc. Boston, London, Sydney, Toronto. – 1370 P.
6. David C. Eaton. Laboratory Investigation in Organic Chemistry. McGRAW-HILL BOOK COMPANY, – 929 P.
7. Donald L. Pavia, Gary M. Lampman, George S. Kriz, Randall G. Engel. Introduction to Laboratory Techniques. Saunders College Publishing – 878 P.
8. Harold Hart, Leslie E. Crain, David J. Hart. Organic Chemistry. A Short Course. Houghton Mifflin Company. – 573 P..

15. Information resources

1. www.ncbi.nlm.nih.gov/PubMed – free access to the database of scientific data in the field of biomedical sciences.
2. <https://pubchem.ncbi.nlm.nih.gov/> free access to a database of scientific data in the field of biomedical sciences.
3. www.biochemistry.org.ua - the official site of the Institute of Biochemistry. O.B. Palladin of the National Academy of Sciences of Ukraine.
4. www.bpci.kiev.ua is the official website of the Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine.
5. www.xumuk.ru – articles on biochemistry in free access. www.pereplet.ru/cgi/soros/readdb.cgi - Soros Educational Journal - free access to popular science articles in biochemistry, biology and chemistry. www.chem.msu.su/rus/ - Russian chemical educational portal. The resource is part of the ChemNet virtual system, which combines a large number of information resources on chemistry.
6. www.bioorganica.org.ua - scientific publication presenting works on bioorganic and medical chemistry.