MINISTRY OF HEALTH OF UKRAINE

ODESSA NATIONAL MEDICAL UNIVERSITY

Department of Pharmaceutical Chemistry and Drug Technology

APPROVED

Vice-rector for scientific and pedagogical work

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September 1st, 2024

WORKING PROGRAM IN THE DISCIPLINE RELATIONSHIP BETWEEN STRUCTURE AND ACTION OF MEDICINES

Level of higher education: second (master's degree)

Field of knowledge: 22 «Health care»

Specialty: 226 «Pharmacy, industrial pharmacy»

Educational and professional program: Pharmacy, industrial pharmacy

2024

The working program is based on the educational and professional program "Pharmacy, industrial pharmacy" for the training of specialists of the second (master's) level of higher education in the specialty 226 "Pharmacy, industrial pharmacy" of the field of knowledge 22 "Health care", approved by the Scientific Council of ONMedU (protocol no. 10 of June 27, 2024).

Developers: prof. Gelmboldt V.O., as. Shyshkin I.O., senior lecture Nikitin O.V.

The work program was approved at the meeting of the Department of Pharmaceutical Chemistry and Drug Technology
Protocol No. 1 dated August 29, 2024.

Head of the department _____ Volodymyr GELMBOLDT

Agreed with the EPP guarantor _____ Liana UNHURIAN

Approved by the subject cycle methodical commission for pharmaceutical disciplines of ONMedU
Protocol No. 1 dated August 30, 2024

Head of the subject cycle methodical commission for pharmaceutical disciplines of ONMedU

_____ Natali FIZOR

Reviewed and approved at the department meeting _____
_____

Protocol № ___ from "___" _____ 20__.

Head of the department _____ _____
(signature) *(First name Surname)*

Reviewed and approved at the department meeting _____
_____

Protocol № ___ from "___" _____ 20__.

Head of the department _____ _____
(signature) *(First name Surname)*

1. Description of the academic discipline:

Name of indicators	Field of knowledge, specialty, specialization, level of higher education	Characteristics of the academic discipline
Total number: Credits: 3 Hours: 90 Content modules: 1	Field of knowledge 22 "Health care" Specialty 226 "Pharmacy, industrial pharmacy" Level of higher education second (master's)	*Full-time education* *Elective discipline* *Year of preparation: 3* *Semesters V* *Lectures (0 h.)* *Practical (30 h.)* *Independent work (60 h.)* *The form of final control is credit*

2. The purpose and tasks of the educational discipline

Goal: in-depth assimilation of fundamental knowledge in the field of chemistry, which is the basis of studying a cycle of chemical disciplines that will be widely used in practical work. The course on the relationship between the structure and properties of medicinal substances is also a component of some aspects of the courses in physical and colloid chemistry, chemical technology, pharmaceutical chemistry and biochemistry and includes a description of classes of organic compounds, including biologically active organic compounds.

Task:

1. acquiring skills in using chemical and reference literature;
2. study of theoretical foundations of organic chemistry, study of classical methods of synthesis, isolation and properties of various organic compounds;
3. establishing the relationship between the structure, reactivity and properties of organic compounds to the extent necessary for further study and understanding of the main chemical processes occurring at the molecular level in order to know the qualitative reactions to the main functional groups;
4. mastering of separate physical and chemical methods of identification of organic compounds.

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

General competencies (GC):

- GC 01. Ability to think abstractly, analyze and synthesize, learn and be modernly educated.
- GC 05. The ability to evaluate and ensure the quality of the work performed.
- GC 10. The ability to act socially, responsibly and consciously.
- GC 11. Ability to apply knowledge in practical situations.
- GC 15. Knowledge and understanding of the subject area and understanding of professional activity.
- GC 16. The ability to conduct experimental research at the appropriate level.

Professional competencies (PC):

- PC 01. Ability to integrate knowledge and solve complex pharmacy problems in broad or multidisciplinary contexts.
- PC 02. Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.
- PC 08. The ability to consult on prescription and non-prescription drugs and other products of the pharmacy assortment; pharmaceutical care during the selection and sale of medicinal products of natural and synthetic origin by assessing the risk/benefit ratio, compatibility, taking into account biopharmaceutical, pharmacokinetic, pharmacodynamic and physicochemical and chemical

features, indications/contraindications for use guided by data on the health status of a specific patient.

- PC 17. The ability to carry out pharmaceutical development and participate in the production of medicinal products of natural and synthetic origin in the conditions of pharmaceutical enterprises in accordance with the requirements of Good Manufacturing Practice (GMP).
- PC 19. Ability to organize and carry out quality control of medicinal products of natural and synthetic origin in accordance with the requirements of the current edition of the State Pharmacopoeia of Ukraine, quality control methods (QCM), technological instructions, etc.; to prevent the distribution of low-quality, falsified and unregistered medicinal products.
- PC 20. Ability to develop and evaluate methods of quality control of medicinal products of natural and synthetic origin, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological, pharmaco-technological methods; carry out standardization of medicinal products in accordance with current requirements.
- PC 24. Ability to use knowledge of regulatory and legislative acts of Ukraine and recommendations of proper pharmaceutical practices in professional activity.

Program learning outcomes (PLO):

- PLO 01. Have and apply specialized conceptual knowledge in the field of pharmacy and related fields, taking into account modern scientific achievements.
- PLO 11. Determine the advantages and disadvantages of drugs of natural and synthetic origin of various pharmacological groups, taking into account their chemical, physicochemical, biopharmaceutical, pharmacokinetic, pharmacodynamic features and the type of dosage form. Recommend to consumers medicinal products and other products of the pharmacy assortment with the provision of advisory assistance and pharmaceutical care.
- PLO 19. Develop technological documentation for the manufacture of medicinal products, choose rational technology, manufacture medicinal products in various dosage forms according to the prescriptions of doctors and the requirements (orders) of medical and preventive institutions, prepare them for release.
- PLO 22. Ensure and carry out quality control of medicinal products of natural and synthetic origin and document its results; draw up quality certificates and analysis certificates taking into account the requirements of the current edition of the State Pharmacopoeia of Ukraine, quality control methods (QCM), technological instructions, etc.; take measures to prevent the distribution of low-quality, falsified and unregistered medicinal products.
- PLO 23. Determine the main chemical and pharmaceutical characteristics of medicinal products of natural and synthetic origin; choose and/or develop quality control methods with the aim of their standardization using physical, chemical, physico-chemical, biological, microbiological and pharmaco-technological methods in accordance with current requirements.
- PLO 25. Observe the norms of the sanitary and hygienic regime and the requirements of safety equipment when carrying out professional activities.
- PLO 32. Analyze information obtained as a result of scientific research, summarize, systematize and use it in professional activities.
- PLO 36. Plan and implement professional activities on the basis of normative legal acts of Ukraine and recommendations of proper pharmaceutical practices.
- PLO 40. Ensure quality control of medicinal products and document its results. To carry out quality risk management at all stages of the life cycle of medicinal products.

As a result of studying the academic discipline, the student of higher education should:

to know:

1. basic principles of classification, nomenclature and structural isomerism of organic compounds;
2. types of chemical bonds, conjugated systems, electronic effects, acidity and basicity of organic compounds as the main basis of their reactivity;

3. principles of classification of organic reactions according to the direction, the method of bond breaking and the mechanism of their progress;
4. structure, nomenclature, isomerism, methods of extraction and chemical properties of hydrocarbons, halogen-, oxygen-, sulfur- and nitrogen-containing derivatives of hydrocarbons, heterofunctional compounds, heterocyclic compounds, biopolymers and bioregulators.

be able to:

1. use chemical and reference literature, work with tabular and graphic material;
2. independently carry out theoretical elemental analysis of organic compounds;
3. determine the physical constants of organic compounds (melting point, boiling point, specific rotation);

3. Content of the academic discipline

Topic 1. The effect of chemical modification on the properties of the medicinal substance.
Topic 2. Semi-synthetic penicillins (Amoxicillin, Ampicillin sodium). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.
Topic 3. Semi-synthetic cephalosporins (Cefaclor, Cefotaxime, Ceftriaxone sodium). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.
Topic 4. Phenothiazine derivatives (Chlorpromazine hydrochloride, Promethazine hydrochloride, Thioridazine). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.
Topic 5. ACE inhibitors. Classification. Relationship "structure-properties". Pharmaceutical analysis of drugs (Captopril, Enalapril) and modified fragments in the structure of drugs.
Topic 6. Fluoroquinolone derivatives (Norfloxacin hydrochloride, Ofloxacin, Lomefloxacin). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.
Topic 7. Derivatives of barbituric acid. Relationship "structure-properties". Pharmaceutical analysis of drugs (phenobarbital, sodium thiopental, hexenal) and modified fragments in the structure of drugs.
Topic 8. Sulfanilamides. Mechanism of action. Effect of stereoisomerism on properties. Pharmaceutical analysis of drugs (Streptocide, Norsulfasol sodium, Phthalazole).

4. **The structure of the academic discipline**

Names of topics	Number of hours of full-time education		
	In total	including	
		practical	IWS
Topic 1. The effect of chemical modification on the properties of the medicinal substance.	14	6	8
Topic 2. Semi-synthetic penicillins (Amoxicillin, Ampicillin sodium). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	12	4	8
Topic 3. Semi-synthetic cephalosporins (Cefaclor, Cefotaxime, Ceftriaxone sodium). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	10	4	6
Topic 4. Phenothiazine derivatives (Chlorpromazine hydrochloride, Promethazine hydrochloride, Thioridazine). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	12	4	8
Topic 5. ACE inhibitors. Classification. Relationship "structure-properties". Pharmaceutical analysis of drugs (Captopril, Enalapril) and modified fragments in the structure of drugs.	8	2	6

Topic 6. Fluoroquinolone derivatives (Norfloxacin hydrochloride, Ofloxacin, Lomefloxacin). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	10	2	8
Topic 7. Derivatives of barbituric acid. Relationship "structure-properties". Pharmaceutical analysis of drugs (phenobarbital, sodium thiopental, hexenal) and modified fragments in the structure of drugs.	12	4	8
Topic 8. Sulfanilamides. Mechanism of action. Effect of stereoisomerism on properties. Pharmaceutical analysis of drugs (Streptocide, Norsulfasol sodium, Phthalazole).	12	4	8
Total hours:	**90**	**30**	**60**

5. Topics of lectures / seminars / practical / laboratory lessons

5.1. Topics of lectures

Lecture lessons are not provided.

5.2. Topics of practical classes

№ i/o	Topic name	Number of hours
1	Topic 1. Practical lesson 1. The effect of chemical modification on the properties of the medicinal substance.	2
2	Topic 2. Practical lesson 2. Semi-synthetic penicillins (Amoxicillin). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
3	Topic 2. Practical lesson 3. Semi-synthetic penicillins (Ampicillin sodium). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
4	Topic 3. Practical lesson 4. Semi-synthetic cephalosporins (Cefaclor, Cefotaxime). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
5	Topic 3. Practical lesson 5. Semi-synthetic cephalosporins (Ceftriaxone sodium). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
6	Topic 4. Practical lesson 6. Phenothiazine derivatives (Chlorpromazine hydrochloride). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
7	Topic 4. Practical lesson 7. Phenothiazine derivatives (Promethazine hydrochloride, Thioridazine). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
8	Topic 5. Practical lesson 8. ACE inhibitors. Classification. Relationship "structure-properties". Pharmaceutical analysis of the drug (Captopril) and modified fragments in the structure of the drug.	2
9	Topic 5. Practical lesson 9. ACE inhibitors. Classification. Relationship "structure-properties". Pharmaceutical analysis of drug (Enalapril) and modified fragments in the drug structure.	2
10	Topic 6. Practical lesson 10.	2

	Fluoroquinolone derivatives (Norfloxacin hydrochloride, Ofloxacin). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	
11	Topic 6. Practical lesson 11. Fluoroquinolone derivatives (Lomefloxacin). Relationship "structure-properties". Pharmaceutical analysis of drugs and modified fragments in the structure of drugs.	2
12	Topic 7. Practical lesson 12. Derivatives of barbituric acid. Relationship "structure-properties". Pharmaceutical analysis of drug (Phenobarbital) and modified fragments in the drug structure.	2
13	Topic 7. Practical lesson 13. Derivatives of barbituric acid. Relationship "structure-properties". Pharmaceutical analysis of drugs (Thiopental sodium, Hexenal) and modified fragments in the drug structure..	2
14	Topic 8. Practical lesson 14. Sulfanilamides. Mechanism of action. Effect of stereoisomerism on properties. Pharmaceutical analysis of drugs (Streptocide, Norsulfasol-sodium).	2
15	Topic 8. Practical lesson 15. Sulfanilamides. Mechanism of action. Effect of stereoisomerism on properties. Pharmaceutical analysis of the drug (Phthalazol).	2
In total		**30**

6. Independent work

№ i/o	**Types of IWS**	**Number of hours**
1	Preparation for practical training 1	4
2	Preparation for practical training 2	4
3	Preparation for practical training 3	4
4	Preparation for practical training 4	4
5	Preparation for practical training 5	4
6	Preparation for practical training 6	4
7	Preparation for practical training 7	4
8	Preparation for practical training 8	4
9	Preparation for practical training 9	4
10	Preparation for practical training 10	4
11	Preparation for practical training 11	4
12	Preparation for practical training 12	4
13	Preparation for practical training 13	4
14	Preparation for practical training 14	4
15	Preparation for practical training 15	4
In total		**60**

7. Teaching methods.

Practical classes: conversation, solving situational problems, conducting control of knowledge, abilities and skills of higher education students, posing a general problem by the teacher and discussing it with the participation of higher education students, performing control tasks, their verification, evaluation. Performance of laboratory work, in which students of higher education, under the guidance of a teacher, conduct educational experiments in specially equipped educational laboratories using equipment adapted to the conditions of the educational process.

Independent work: independent work with recommended basic and additional literature, with electronic information resources, independent work with a bank of test tasks.

8. Forms of control and assessment methods (including criteria for evaluating learning outcomes)

Current control: testing, oral survey, problem solving.

Final control: exam.

Assessment of the current educational activity in a practical session:

1. Assessment of theoretical knowledge on the topic of the lesson:
   - methods: survey, testing, solving a situational problem
   - maximum score – 5, minimum score – 3, unsatisfactory score – 2.
2. Assessment of practical skills on the subject of the lesson:
   - methods: assessment of the correctness of the performance of practical skills
   - maximum score – 5, minimum score – 3, unsatisfactory score – 2.

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

Criteria for current assessment in a practical lesson

Assessment	Assessment criteria
«5»	The applicant actively participates in the discussion of the most difficult questions on the topic of the lesson, gives at least 90% correct answers to standardized test tasks, answers written tasks without errors, performs practical work and draws up a protocol.
«4»	The applicant participates in the discussion of the most difficult questions on the topic, gives at least 75% correct answers to standardized test tasks, makes some minor mistakes in the answers to written tasks, performs practical work and draws up a protocol.
«3»	The applicant participates in the discussion of the most difficult questions on the topic, gives at least 60% correct answers to standardized test tasks, makes significant mistakes in answers to written tasks, performs practical work and draws up a protocol.
«2»	The applicant does not participate in the discussion of complex questions on the topic, gives less than 60% correct answers to standardized test tasks, makes gross mistakes in answers to written tasks or does not give answers to them at all, does not perform practical work and does not draw up a protocol.

Only those applicants who have fulfilled the requirements of the training program in the discipline, have no academic debt, their average score for the current educational activity in the discipline is at least 3.00, and they have passed the test control based on the tests "STEP-2" are admitted to the final control in the form of an exam. - 2" at least 90% (50 tasks).

The test control is conducted in the Educational and Production Complex of Innovative Technologies of Learning, Informatization and Internal Monitoring of the Quality of Education of the University in the last class before the exam.

Assessment of the results of the students' training during the final control – exam.

Content of assessed activity	Scores
The answer to a theoretical question	2
The answer to a theoretical question	2
Solution of the calculation problem	1

Criteria for assessment the results of the students' training during final control - exam

Assessment	Assessment criteria
Perfectly «5»	The applicant worked systematically during the semester, showed during the exam versatile and in-depth knowledge of the program material, is able to successfully perform the tasks provided for in the

	program, mastered the content of the main and additional literature, realized the relationship of individual sections of the discipline, their importance for the future profession, showed creative abilities in understanding and using educational program material, demonstrated the ability to independently update and replenish knowledge; the level of competence is high (creative).
Good «4»	The applicant has demonstrated complete knowledge of the educational program material, successfully performs the tasks provided for by the program, has mastered the basic literature recommended by the program, has shown a sufficient level of knowledge in the discipline and is capable of their independent updating and renewal in the course of further education and professional activity; the level of competence is sufficient (constructive and variable).
Satisfactorily «3»	The applicant who has demonstrated knowledge of the main curriculum material in the amount necessary for further education and subsequent work in the profession, copes with the tasks provided for by the program, made some mistakes in the answers on the exam and when completing the exam tasks, but has the necessary knowledge to overcome the mistakes made mistakes under the guidance of a scientific and pedagogical worker; level of competence - average (reproductive).
Unsatisfactorily «2»	The applicant did not demonstrate sufficient knowledge of the main educational program material, made fundamental mistakes in the performance of tasks provided for by the program, cannot use the knowledge in further studies without the help of a teacher, did not manage to master the skills of independent work; the level of competence is low (receptive-productive).

9. Distribution of points received by higher education applicants

The obtained average score for the academic discipline for applicants who successfully mastered the work program of the academic discipline is converted from a traditional four-point scale to points on a 200-point scale, as shown in the table:

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

Traditional four-point scale	Multipoint 200-point scale
Perfectly («5»)	185 – 200
Good («4»)	151 – 184
Satisfactorily («3»)	120 – 150
Unsatisfactorily («2»)	Less than 120

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

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

The ECTS scale is a relative-comparative rating, which establishes the applicant's belonging to the group of better or worse among the reference group of fellow students (faculty, specialty). An "A" grade on the ECTS scale cannot be equal to an " perfectly " grade, a "B" grade to a "good" grade, etc. When converting from a multi-point scale, the limits of grades "A", "B", "C", "D", "E" according to the ECTS scale do not coincide with the limits of grades "5", "4", "3" according to the traditional scale. Acquirers who have received grades of "FX" and "F" ("2") are not included in the list of ranked

acquirers. The grade "FX" is awarded to students who have obtained the minimum number of points for the current learning activity, but who have not passed the final examination. A grade of "F" is given to students who attended all lessons in the discipline, but did not receive an average score (3.00) for the current academic activity and were not admitted to the final examination.

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

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

Assessment on the ECTS scale	Statistical indicator
A	Top 10% students
B	The next 25% students
C	The next 25% students
D	The next 25% students
E	The next 25% students

10. Methodical support:

- Working program of the academic discipline
- Syllabus of the academic discipline
- Textbooks:
- Multimedia presentations
- Situational tasks
- Methodical development of practical lessons
- Electronic bank of test tasks by subdivisions of the discipline.

11. Questions for final control

1. Effect of alkyl groups on biological activity.
2. Influence of hydroxyl groups on biological activity.
3. Influence of halogens in organic structures on biological activity.
4. Influence of nitro and nitroso groups on biological activity.
5. Influence of the main nitrogen-containing groups on biological activity.
6. The influence of acidic groups and the influence of unsaturated fragments on biological activity.
7. Dependence of biological action on physical and chemical properties of medicinal substances.
8. Relationship between structure and biological activity.
9. Antibiotics of the penicillin series. Building Properties. Classification. Group reaction.
10. Amoxicillin. Structure. The "structure-activity" connection. Pharmaceutical analysis.
11. Ampicillin sodium. Structure. The structure-activity relationship. Pharmaceutical analysis.
12. Antibiotics of the cephalosporin series. Building Properties. Classification. Group reaction.
13. Cefaclor. Structure. The structure-activity relationship. Pharmaceutical analysis.
14. Cefotaxime. Structure. The structure-activity relationship. Pharmaceutical analysis.
15. Ceftriaxone sodium. The structure-activity relationship. Pharmaceutical analysis.
16. Chlorpromazine hydrochloride. The structure-activity relationship. Pharmaceutical analysis.
17. Promethazine hydrochloride. The structure-activity relationship. Pharmaceutical analysis.
18. Thioridazine. The structure-activity relationship. Pharmaceutical analysis.
19. Captopril. The structure-activity relationship. Pharmaceutical analysis.
20. Enalapril. The structure-activity relationship. Pharmaceutical analysis.
21. Norfloxacin hydrochloride. The structure-activity relationship. Pharmaceutical analysis.
22. Ofloxacin. The structure-activity relationship. Pharmaceutical analysis.
23. Lomefloxacin. The structure-activity relationship. Pharmaceutical analysis.
24. Medicinal products derivatives of barbituric acid. General methods of synthesis. Properties.

25. Phenobarbital. The structure-activity relationship. Pharmaceutical analysis.
26. Thiopental sodium. The structure-activity relationship. Pharmaceutical analysis.
27. Hexenal. The structure-activity relationship. Pharmaceutical analysis.
28. Streptocide. The structure-activity relationship. Pharmaceutical analysis.
29. Norsulfasol-sodium. The structure-activity relationship. Pharmaceutical analysis.
30. Phthalazole. The structure-activity relationship. Pharmaceutical analysis.

12. Recommended literature.

Basic:

1. Handbook of pharmaceutical chemictry Vol. 117 / L. Ohannesian, Antony J. Streeter. 2016.–582p.
2. Pharmaceutical Chemistry I – Laboratory Experiments and Commentary / Attila Almási, Zsuzsanna Rozmer, Pál Perjési. 2014. – 179 p.
3. Introduction to Pharmaceutical Chemical Analysis / S. Hansen, S. Pederson-Bjergaard, K. Rasmussen. 2012. – 496 p.
4. Europian Pharmacopoeia 10th. 2019. – 4255 p.

Additional:

1. Державна Фармакопея України : в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». – 2-е вид. – Х. : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2015. – Т. 1. – 1128 с.
2. Державна Фармакопея України : в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». – 2-е вид. – Х. : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2014. – Т. 2. – 724 с.
3. Державна Фармакопея України : в 3 т. / ДП «Український науковий фармакопейний центр якості лікарських засобів». – 2-е вид. – Х. : Державне підприємство «Український науковий фармакопейний центр якості лікарських засобів», 2014. – Т. 3. – 732 с.
4. Фармацевтична хімія / П.О. Безуглий, В.А. Георгіянц, І.С. Гриценко, І.В. та ін.: за ред. П.О. Безуглого. – Вінниця: Нова книга, 2017. – 456 с.
5. Фармацевтична хімія. Загальна та спеціальна фармацевтична хімія. Лікарські засоби неорганічної природи: лабораторно-практичні заняття. Навчальний посібник / Л.Г. Мішина. – Вінниця: ПП «ТД «Едельвейс і К»», 2010. – 384 с.
6. Chemical Analysis Modern Instrumentation Methods and Techniques 2nd Edition / F. Rouessac, A. Rouessac. 2007. – 599 p.
7. Pharmaceutical drug analysis / Addis Ababa. 2005. – 554 p.
8. Analytical Chemistry Series / John M., Chalmers, Alan J. Handley. 2003. – 384 p.
9. HANDBOOK OF MODERN PHARMACEUTICAL ANALYSIS Vol. 3 / Satinder Ahuja, Stephen Scypinski. 2001. – 587 p.

13. Information resources

1. Materials in the information system of ONMedU https://info.odmu.edu.ua/chair/pharmaceutical_chemistry/files/214/ua
2. Компендіум - лікарські препарати
3. European Pharmacopoeia (Ph. Eur.)
4. DrugBank онлайн