MINISTRY OF HEALTH OF UKRAINE
ODESA NATIONAL MEDICAL UNIVERSITY
Department of General and Clinical Pharmacology and Pharmacognosy

APPROVED
Vice-rector for scientific and pedagogical activity
_____ Eduard BURIACHKIVSKYI
«_01_» _09__ 2023 y.

THE WORKING PROGRAM ON THE SELECTIVE DISCIPLINE «THE BASICS OF PHARMACOGENETICS»

Level of higher education: second (master's)

Field of knowledge: 22 «Healthcare»

Speciality: 226 «Pharmacy, industrial pharmacy»

Educational and professional program: Pharmacy

2023

The program is based on the educational-professional program "Pharmacy, industrial pharmacy", training of specialists of the second (master's) level of higher education in the speciality 226 "Pharmacy, industrial pharmacy" in the field of knowledge 22 "Healthcare, approved by the Academic Council of ONMedU (protocol N8 from June 29, 2023).

Authors: D.Med.Sci., prof. Rozhkovskyi Y.V., D.Med.Sci., prof. Antonenko P.B., academic of NAMS U, D.Med.Sci., prof. Kresyun V.Yu., Ph.D., associate professor Lobashova K.H., Ph.D., associate professor Shemonayeva K.F., Ph.D., senior teacher Ostapchuk K.V., Ph.D., senior teacher Antonenko K.O., assistant professor Al Nadavi N.J.

The program has been discussed at a meeting of the Department of General and Clinical Pharmacology and Pharmacognosy (Protocol № 1 from August 28, 2023 y.)

Head of the department _____ Yaroslav ROZHKOVSKYI

Approved by a guarantor of the EPP _____ Liana UNGURYAN

The program has been approved at the meeting of the subject cyclic methodical commission on pharmaceutical disciplines of ONMedU
Protocol № 1 від 29.08.2023 y.

Head of the subject cyclic methodical commission on pharmaceutical disciplines of ONMedU _____ Natalia FIZOR

Reviewed and approved at the department meeting _____
Protocol № 1 from "28" 08 2023 y.

Head of the department _____ (_____)
(signature) *(Name, SURNAME)*

Reviewed and approved at the department meeting _____
Protocol № 1 from "29" 08 2023 y.

Head of the department _____ (_____)
(signature) *(Name, SURNAME)*

1. Description of the discipline:

Name of indicators	Field of knowledge, specialty, specialization, level of higher education	Characteristics of the discipline	
The total number of: Credits – 3 Hours - 90 Content sections - 2	Field of knowledge: 22 «Healthcare» Speciality: 226 «Pharmacy, industrial pharmacy» Level of higher education: second (master's)	*Full-time education, Selective discipline*	
		Year of study	*5*
		Semester	*IX - X*
		Lectures	*-*
		Seminar classes	*30 hrs.*
		Independent classes	*60 hrs.*
		Including individual tasks	*0*
		Form of final control	*Pass*

2. The purpose and tasks of the educational discipline — competencies, program learning results

The purpose: learning a complex of knowledge, abilities, skills of rational and safe for human health use of medicines, taking into account human genetic polymorphism, which should reduce the frequency or prevent the occurrence of unwanted effects for planning and carrying out own research, for solving significant problems in the field of professional activity, science, performance of functional duties related to the rational choice of medicines

Task:

- providing students with theoretical knowledge about the hereditary mechanisms of a person, which determine the peculiarities of the action of medicines in an individual person;
- acquiring knowledge about the most clinically significant polymorphisms affecting the effectiveness and toxicity of pharmacotherapy;
- acquiring knowledge about predicting the effect of drugs in an individual according to his genetic characteristics: the ability to use available literature data/databases, as well as to adjust the dose of medicines accordingly.

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

- intergal competency (IK):

The ability to solve problems of a research and/or innovative nature in the field of pharmacy and to critically consider and solve practical problems in professional pharmaceutical activity using the provisions, theories and methods of fundamental, chemical, technological, biomedical and socio-economic sciences; integrate knowledge and solve complex issues, formulate judgments based on insufficient or limited information; clearly and unambiguously convey one's own knowledge, conclusions and their validity to a professional and non-professional audience. Ability to continue learning with a high degree of autonomy.

- general competencies (GK):

- GK02 – An ability to know and understand the subject area and professional activity.
- GK03 – An ability to communicate in the national language in written form and orally.
- GK05 – The ability to evaluate and ensure the quality of the work performed.
- GK09 - Ability to use information and communication technologies.
- GK11 - Ability to apply knowledge in practical situations.
- GK15 - Knowledge and understanding of the subject area and understanding of professional activity.
- GK 16 - The ability to conduct experimental research at the appropriate level.

- special (professional, subject):

- SK02 - Ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

- SK03 - 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.

- SK04 - The 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

- SK08 - 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 based on data on the health status of a specific patient.

- SK21 - The ability to ensure the rational use of prescription and non-prescription drugs in accordance with the physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a specific disease and pharmacotherapeutic schemes of its treatment.

- SK25 - The ability to demonstrate and apply in practical activities communicative communication skills, fundamental principles of pharmaceutical ethics and deontology, based on moral obligations and values, ethical standards of professional behavior and responsibility in accordance with the Code of Ethics of Pharmaceutical Workers of Ukraine and WHO guidelines.

- program learning results (PLR):

- PLR 01. To have and to apply specialized conceptual knowledge in the field of pharmacy and related fields, taking into account modern scientific achievements.
- PLR 02. Critically understand scientific and applied problems in the field of pharmacy.
- PLR 03. To have specialized knowledge and skills/skills for solving professional problems and tasks, including for the purpose of further development of knowledge and procedures in the field of pharmacy.
- PLR 06. Developing and making effective decisions to solve complex/complex problems of pharmacy personally and based on the results of joint discussion; formulate the goals of one's own activity and the activity of the team, taking into account social and industrial interests, the general strategy and existing limitations, determine the optimal ways to achieve goals.
- PLR 08. To develop and implement innovative projects in the field of pharmacy, as well as related interdisciplinary projects taking into account technical, social, economic, ethical, legal and environmental aspects.
- PLR 09. Formulate, argue, clearly and concretely convey to specialists and non-specialists, including those seeking higher education, information based on own knowledge and professional experience, the main trends in the development of world pharmacy and related industries.
- PLR 13. To record cases of side effects when using medicinal products of natural and synthetic origin; evaluate factors that can affect the processes of absorption, distribution, deposition, metabolism and excretion of drugs and are determined by the condition and characteristics of the human body and the pharmaceutical characteristics of drugs.
- PLR 27. Perform professional activities using creative methods and approaches.
- PLR 29. Carry out professional activities using information technologies, "Information databases", navigation systems, Internet resources, software and other information and communication technologies.

- PLR 32. Analyze information obtained as a result of scientific research, summarize, systematize and use it in professional activities.
- PLR 33. Determine the influence of factors that affect the processes of absorption, distribution, deposition, metabolism and excretion of the medicinal product and are determined by condition, features of the human body and physico-chemical properties of medicinal products.
- PLR 34. Use the data of clinical, laboratory and instrumental studies to monitor the effectiveness and safety of the use of medicinal products.

As a result of studying the academic discipline, the student must:

To know:

- *Factors affecting the absorption, distribution, biotransformation and elimination of drugs from the body;*
- *Factors affecting the effects of medicinal products;*
- *Genetic factors of the patient affecting the effectiveness and safety of medicines;*
- *Requirements and indications that exist in relation to pharmacogenetic tests;*
- *Indications for pharmacogenetic testing;*
- *Interpretation of the results of pharmacogenetic testing and possible changes in the regimen of prescribing drugs according to the results of pharmacogenetic testing.*

be capable to:

- *To predict changes in the pharmacokinetics of drugs in the presence of genetic polymorphism in patients;*
- *Evaluate the obtained results of pharmacogenetic tests;*
- *Choose the dosing regimen of medicines or provide for the replacement of medicines depending on the test data;*
- *Use primary sources and electronic databases that provide information on known genetic polymorphisms*

3. Content of the academic discipline

Content module 1. *Basic pharmacogenetics*

Topic 1. The establishment and development of pharmacogenetics. The basis of individual human sensitivity to the drugs.

The concept of pharmacogenetics. History and stages of emergence of pharmacogenetics. The concept of alleles and single-nucleotide polymorphisms in genes and their influence on the pharmacokinetics and pharmacodynamics of medicinal products.

Topic 2. The characteristics of pharmacogenetic tests - their informativeness, interpretation of results, and practical application.

Conditions for introducing pharmacogenetic tests into clinical practice. The use of pharmacogenetic tests according to the data of the Food Drug Administration (FDA), Pharmacogenetic Working Group (DPWG).

Topic 3. Pharmacokinetics of the drugs in the human body. Absorption and distribution of the drugs.

Pharmacokinetics of medicines. Ways of administration of medicines. Types of absorption and their main mechanisms. Distribution of drugs and the body. Deposit of medicines.

Topic 4. Drugs' biotransformation in the human body.

Stages of biotransformation. Drug metabolism, its types. Enzymes of the CYP-450 family. Ways of excretion and elimination of drugs from the body. The concept of the main pharmacokinetic parameters (bioavailability, absorption rate constant, half-elimination period, steady-state concentration, drug clearance). Genetic features of pharmacokinetics.

Topic 5. The enzymes of the drugs' metabolism.

The significance of the genotypes of "ultra-rapid metabolizers", "rapid metabolizers", "moderate metabolizers", "slow metabolizers". Prevalence of different genotypes in the population. The influence of genotypes of *CYP-450, N-acetyltransferase, glutathione-S-transferase,* etc. on the biotransformation of medicinal products.

Topic 6. The basics of the drugs' pharmacodynamics.

Definition of the concept of "pharmacodynamics". The concept of receptor agonists, antagonists. Synergism, potentiation, antagonism of drugs. Types of action of drugs. Factors affecting pharmacodynamics and pharmacokinetics. Types of doses. The wideness of therapeutic action. The significance of the dependence "concentration (dose) - effect" in pharmacology. Peculiarities of the action of drugs during their repeated use. The concept of accumulation, tolerance, dependence. The influence of pharmacogenetic factors on the effect of drugs.

Content module 2. Special pharmacogenetics

Topic 7. Pharmacogenetics of the drugs that affect hemostasis.

Medicines affecting platelet aggregation, blood coagulation and fibrinolysis. Classification of means used for the prevention and treatment of thrombosis. General characteristics of agents that reduce platelet aggregation. Mechanism of action. Classification of anticoagulants. Pharmacokinetics, pharmacodynamics of heparin. Indications and contraindications for use. Side effect. CYP2C9 and VKORC1 polymorphisms and their significance for the action of oral anticoagulants. CYP2C19 polymorphism and its significance for clopidogrel action.

Topic 8. Pharmacogenetics of the drugs that regulate the function of the cardiovascular system (beta-blockers, statins, etc.).

Pharmacodynamics and pharmacokinetics of statins. OATP1B1 transporter polymorphism and its significance for the pharmacokinetics and pharmacodynamics of statins. Beta-blockers. Classification. Mechanisms of action. Pharmacodynamics. Comparative characteristics of beta-blockers (propranolol, atenolol, metoprolol, bisoprolol, carvedilol). *CYP2D6* polymorphism and its significance for the action of beta-blockers.

Topic 9. Pharmacogenetics of the psychotropic drugs.

General characteristics of antipsychotics, classification. General characteristics. Mechanism of antipsychotic action of neuroleptics. Pharmacological effects of aminazine. Droperidol, haloperidol, clozapine, chlorprothixene, sulpiride. Comparative characteristics, indications for use. Side effects of antipsychotics. Pharmacology of antidepressants. Classification, comparative characteristics. Side effects of antidepressants. *CYP2D6* and *CYP2C19* polymorphism and its effect on the effect of antipsychotics, tricyclic antidepressants, selective serotonin reuptake inhibitors.

Topic 10. Pharmacogenetic features that determine the sensitivity to anticonvulsants and analgesics.

Antiepileptic drugs. Classification of antiepileptic drugs by indication for use. Phenobarbital, diphenine, carbamazepine, clonazepam, ethosuximide, sodium valproate, lamotrigine. Comparative characteristics, side effects of antiepileptic drugs. *CYP2C9* and *HLA-B*15:02* genotype and its influence on the safety of phenytoin, carbamazepine use.

General characteristics of narcotic analgesics. The concept of opiate receptors. Mechanism of action. Pharmacology of morphine hydrochloride. Features of the effect of the drug on the central nervous system. Omnopon, codeine phosphate, promedol, fentanyl, pentazocine, tramadol, buprenorphine. Comparative characteristic. Indications for the use of analgesics. Side effects. The significance of *CYP2D6* and *CYP3A4* polymorphisms for the action of codeine, tramadol and fentanyl.

Topic 11. Pharmacogenetic features that determine the sensitivity anticancer and antimicrobial drugs.

Significance of *NAT2*, *SLCO1B1*, *GSTM1*, and *GSTT1* polymorphisms for antimicrobial activity. Antitumor drugs (antimetabolites, alkylating compounds, glucocorticoids, enzyme preparations). Indications for use, side effect. Polymorphism of thiopurine S-methyltransferase, dihydropyrimidine dehydrogenase, UDP-glucuronyltransferase.

Topic 12. Adverse reactions that depend on genetic polymorphism.

Principles of classification of adverse drug reactions. Etiopathogenetic mechanisms of their occurrence, as well as factors affecting the safety of drug use. Genetic polymorphism of *glucose-6-phosphate dehydrogenase, butyrylcholinesterase*.

Topic 13. Checkup of practical skills and theoretical knowledges. Final class. Final control of the studied course.

4. Structure of academic discipline

Topic	Amount of hours		
	Total	including	
		Seminars	Self-preparing
Content module 1. *Basic pharmacogenetics*.			
Topic 1. The establishment and development of pharmacogenetics. The basis of individual human sensitivity to the drugs	6,0	2,0	4,0
Topic 2. The characteristics of pharmacogenetic tests - their informativeness, interpretation of results, and practical application	6,0	2,0	4,0
Topic 3. Pharmacokinetics of the drugs in the human body. Absorption and distribution of the drugs	4,0	2,0	2,0
Topic 4. Drugs' biotransformation in the human body	4,0	2,0	2,0
Topic 5. The enzymes of the drugs' metabolism	4,0	2,0	2,0
Topic 6. The basics of the drugs' pharmacodynamics	6,0	2,0	4,0
Total for content module 1	30,0	12,0	18,0
Content module 2. Special pharmacogenetics			
Topic 7. Pharmacogenetics of the drugs that affect hemostasis	10,0	2,0	8,0
Topic 8. Pharmacogenetics of the drugs that regulate the function of the cardiovascular system (beta-blockers, statins, etc.)	14,0	2,0	12,0
Topic 9. Pharmacogenetics of the psychotropic drugs	8,0	4,0	4,0
Topic 10. Pharmacogenetic features that determine the sensitivity to anticonvulsants and analgesics	6,0	2,0	4,0
Topic 11. Pharmacogenetic features that determine the sensitivity anticancer and antimicrobial drugs	14,0	4,0	10,0

Topic 12. Adverse reactions that depend on genetic polymorphism	6,0	2,0	4,0
Topic 13. Checkup of practical skills and theoretical knowledges. Final class. Final control of the studied course	2,0	2,0	-
Total for content module 2	60,0	18,0	42,0
Overall	**90**	**30**	**60**

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

5.1 TOPICS OF SEMINAR CLASSES

№№	Topics	Hrs
1.	Pharmacogenetics. Introduction. Clinical meaning of pharmacodynamics genes' polymorphisms	2
2.	Methods of pharmacogenetic study of the drugs' biotransformation and transport. The interpretation and informativeness of pharmacogenetic tests	2
3.	Drugs' pharmacokinetics (absorption, distribution) and their dependence from human genetic factors	2
4.	Drugs' biotransformation and excretion, and their dependence from human genetic factors	4
5.	The basics of pharmacodynamics of the drugs	2
6.	Pharmacogenetics of the drugs that act on hemostasis	2
7.	Genes' polymorphism that determine the effectiveness of cardiovascular agents	2
8.	Genes' polymorphism that determine the effectiveness of psychotropic agents	4
9.	Genetic polymorphism that determine the effectiveness of the anticonvulsants and analgesics	2
10.	Genetic polymorphism that determine the effectiveness of the antimicrobial and anticancer agents	4
11.	The adverse reactions that depend on genetic polymorphism.	2
12.	Control of practical skills and theoretical knowledge. Final class. Final control of learnt material the discipline.	2
	Total	**30**

6. Independent work of a student of higher education

6.1 TOPICS OF SELF-PREPARATION CLASSIS (SPC)

№№	Topics	Hrs
1.	The emergence and development of pharmacogenetics. Basics of individual sensitivity of a person to the action of drugs.	4
2.	Genetic differences in drug receptors. Clinical significance of pharmacodynamic gene polymorphisms.	4
3.	Types of methods for determining genetic polymorphism	4
4.	Genetic factors that affect the biotransformation activity of the drugs	6
5.	Pharmacology of drugs affecting the blood coagulation system. Gene polymorphism, which determines the features of the action of anticoagulants, antiaggregants and their clinical significance	4

6.	Adverse reactions of drugs affecting leukopoiesis and blood coagulation. Methods of their prevention.	4
7.	Pharmacology of drugs affecting the renin-angiotensin system. Gene polymorphism, which determines the features of the action of ACE inhibitors and their clinical significance	4
8.	Pharmacology of beta blockers. Gene polymorphism affecting the pharmacokinetics and pharmacodynamics of beta-blockers.	4
9.	Pharmacology of statins. Gene polymorphism affecting the pharmacokinetics and pharmacodynamics of statins.	4
10.	Pharmacology of neuroleptics and antidepressants. Gene polymorphism affecting the pharmacokinetics and pharmacodynamics of antipsychotics and antidepressants.	4
11.	Pharmacology of analgesics. Gene polymorphism affecting the pharmacokinetics and pharmacodynamics of analgesics.	4
12.	Pharmacology of anticancer drugs. Gene polymorphism affecting the pharmacokinetics and pharmacodynamics of analgesics.	4
13.	Pharmacogenetic factor of the adverse effects development.	4
14.	Pharmacology of antimicrobial drugs. Gene polymorphism affecting the pharmacokinetics and pharmacodynamics of antimicrobial drugs.	6
	TOTAL:	**60**

7. Methods of study

Seminar classes: explanation, multimedia presentation, solving of pharmacotherapeutic and pharmacogenetics tasks, oral-discussion, testing.

Self-preparation activity: independent work with a textbook, conspectus, methodical recommendations; independent solution of typical pharmacotherapeutic and pharmacogenetic problems.

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

Forms of control and the evaluation system are carried out in accordance with the requirements of the standard program of the discipline and the Instruction on the evaluation system of students' educational activities.

Current control: oral survey, testing, assessment of performance of practical skills, solving pharmacotherapeutic and pharmacogenetic problems, assessment of activity in class. It is carried out at each seminar session with the help of: testing, structured written works, solving situational problems; analysis and assessment of instrumental research results and parameters characterizing changes in body function under the influence of drugs.

Final control: pass

Evaluation of the current educational activity in a practical session:

1. Evaluation of theoretical knowledge on the subject of the lesson:
   - methods: survey, solving the situational pharmacogenetic problem (the ability to predict the impact of genetic polymorphism on pharmacotherapy)
   - maximal score – 5, minimal score – 3, failure – 2.
2. Оцінка практичних навичок з теми заняття:
   - methods: assessment of the correctness of practical skills (solving situational problems, writing prescriptions)
   - maximal score – 5, minimal score – 3, failure – 2.

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

Current evaluation criteria in practical training:

Score	**Evaluation criteria**

«5»	The student knows the program in its entirety, illustrating the answers with various examples; gives exhaustively accurate and clear answers without any leading questions; teaches the material without errors and inaccuracies; performs practical tasks of varying degrees of complexity (knows the pharmacology of a drug or drug group thoroughly and is able to write a prescription within the scope of a situational task);
«4»	The student knows the entire program and understands it well, answers the questions correctly, consistently and systematically, but they are not exhaustive, although the student answers additional questions without mistakes; performs practical tasks, experiencing difficulties only in the most difficult cases (orients himself within the limits of the above-mentioned issues);
«3»	It is given to the student on the basis of his knowledge of the entire scope of the program on the subject and a satisfactory level of understanding of it. The student is able to solve simplified tasks with the help of leading questions; performs practical skills, experiencing difficulties in simple cases; is not able to give an answer systematically on his own, but answers correctly to directly asked questions (has a superficial idea of the drug).
«2»	The student does not know the material, does not know any of the above questions, or knows less than 50% of the questions and does not know how to write a prescription.

Control of the independent work of applicants, which is provided for by the topic along with classroom work, is carried out during the current control of the topic in the corresponding classroom session

Final control

The study of the academic discipline ends with a test. Credit is given to the applicant who completed all the tasks of the work program of the academic discipline, took an active part in practical classes, completed and defended an individual assignment and has an average current grade of at least 3.0 and has no academic debt.

Assessment is carried out: at the last lesson. The credit score is the arithmetic average of all components on a traditional four-point scale and has a value that is rounded according to the statistics method with two decimal places after the decimal point.

9. Distribution of points received by higher education applicants

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

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

Tradional 4-points scale	Multi-point 200-point scale
Excellent («5»)	185 – 200
Good («4»)	151 – 184
Satisfactory («3»)	120 – 150
Unsatisfactory («2»)	Below 120

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

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

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

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

Score according to ECTS-scale	Statistical indicators
A	The best 10% applicants
B	Next 25% applicants
C	Next 30% applicants
D	Next 25% applicants
E	Next 10% applicants

10. Methodical resources:

1. Working program and syllabus of discipline.
2. Syllabus.
3. Plans of practical classes and self-preparation.
4. Text materials of seminar classes.
5. E-textbooks and methodical materials.
6. Medicines collection.

11. Questions for final class preparation

1. Pharmacogenetics. Clinical meaning of pharmacodynamics genes' polymorphisms.
2. Methods of pharmacogenetic study of the drugs' biotransformation and transport. The interpretation and informativeness of pharmacogenetic tests.
3. Drugs' pharmacokinetics (absorption, distribution) and their dependence from human genetic factors.
4. Drugs' biotransformation and excretion, and their dependence from human genetic factors.
5. Pharmacogenetics of the drugs that act on hemostasis.
6. Genes' polymorphism that determine the effectiveness of cardiovascular agents.
7. Genes' polymorphism that determine the effectiveness of psychotropic agents.
8. Genetic polymorphism that determine the effectiveness of the anticonvulsants and analgesics.
9. Genetic polymorphism that determine the effectiveness of the antimicrobial and anticancer agents.
10. The adverse reactions that depend on genetic polymorphism.

12. Recommended references

Basic:

1. Pharmacology: a textbook for students. medical and dental faculties of higher med. textbook institutions of Ukraine: ed. 4th correction. and reworked. / [I.C. Chekman, V.M. Bobyr′ov, V.J. Kresyun and others]. - Vinnytsia: New book, 2020. - 472 p.
2. Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation / Yui-Wing Francis Lam, Stuart R. Scott. - Academic Press, 2018. - 442 p.
3. Betram G Katzung Basic and Clinical Pharmacology, 14th Edition. - McGraw-Hill Medical, 2018.- 1235.
4. Goodman and Gilman's The Pharmacological Basis of Therapeutics / 13th edition. – Laurence L. Brunton, 2018. - 1440 p.

13. Electronic information resources:

1. http://moz.gov.ua

2. "State Register of Medicines of Ukraine" - Access mode: https://moz.gov.ua/derzhavnij-reestr-likarskih-zasobiv-ukraini

3. ATC-classification - Access mode: https://compendium.com.ua/uk/atc/

4. Online platform with protocols based on evidence-based medicine - Access mode: http://guidelines.moz.gov.ua/

5. Emergency medical care: pre-hospital stage. New clinical protocol / Order of the Ministry of Health of Ukraine 05.06.2019 No 1269 - Access mode: https://moz.gov.ua/uploads/2/12737-dn_20190605_1269_dod.pdf

6. State form of medicines 12th issue, 2020: - Access mode: https://www.dec.gov.ua/materials/chinnij-vipusk-derzhavnogo-formulyara-likarskih-zasobiv/

7. State Expert Center of the Ministry of Health of Ukraine http: // https://www.dec.gov.ua/

8. State Enterprise "Ukrainian Scientific Pharmacopoeial Center for Quality of Medicines" http://sphu.org/

9. National Scientific Medical Library of Ukraine http://library.gov.ua/

10. National Library of Ukraine named after VI Vernadsky http://www.nbuv.gov.ua/

11. Resource for predicting drug interactions (based on FDA instructions, in English) URL: http://www.drugs.com