

DANYLO HALYTSKY LVIV NATIONAL MEDICAL UNIVERSITY

Department of Biological Chemistry

APPROVED



The first vice-rector for scientific
and pedagogical work
Assoc. prof. I.I. Solonyenko

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**THE EDUCATIONAL PROGRAM
IN THE DISCIPLINE OF CHOISE
“Metabolism of drugs”**

**on training of specialists of the second (master’s) level of higher education
in the field of knowledge 22 “Health care”
in the specialty 226 “Pharmacy”**

for students of III year of pharmaceutical faculty

Discussed and approved
at the methodical meeting of the
department of Biological Chemistry
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Head of the Department
Prof. L.I. Kobylinska

[Signature]

Approved by the
specialized methodical commission in
physical and chemical disciplines
Protocol № 3 from 21.07.2022.
Head of the specialized methodical
commission
Prof. S.B. Bilous

[Signature]

[Signature]

THE PROGRAM IS ELABORATED BY:

Professor of the Department of Biochemistry I.S.Fomenko, PhD, Dr. of biol.sci

REVIEWERS:

Head of the Department of Biology, Parasitology and Medical Genetics Prof. Z.D. Vorobets, PhD, Dr. of biol.sci

Professor of the Department of Pharmaceutical, Organic and Biorganic Chemistry Prof. V.P. Muzychenko, PhD, Dr.pharm.sci.

INTRODUCTION

Program of study of academic discipline "Metabolism of drugs"

According to the Standard of higher education of the second (master's) level
fields of knowledge 22 "Health care"
specialty 226 "Pharmacy"
Master of Pharmacy educational program

Description of the educational discipline (annotation):

Course на русском языке "Metabolism of drugs" according to the academic program is an optional discipline, prepared for students of the 3rd year in the 6th semester. The discipline includes 90 hours (3,0 credits), including 10 hours of lectures, 20 hours of practical classes and 60 hours of the self-educational work.

In addition, during the optional course, students must prepare one control work. Students' academic load is described in credits ECTS - credits, which are credited to students with the successful studying of their correspondent section (credit).

Structure of educational discipline	Number of credits, hours, from which			Indiv idual students Work	Year of studies, semester	Kind of control
	Totally	Auditorium				
		Lectures (h)	Seminars (h)			
Title of discipline: Metabolism of drugs (two chapters)	3.0 credits / 90 h.	10	20	60	III year (VI semester)	Credit pass

The purpose of studying a course of choice is the diagnosis and correction of pathological conditions associated with the violation of metabolic processes with pharmaceutical drugs.

Interdisciplinary connections: course of choice «Metabolism of drugs» as educational discipline:

1) lays the groundwork for students to study clinical biochemistry, pharmacotherapy, clinical pharmacology, medical chemistry, toxicological chemistry, involves the integration of teaching with these disciplines; forms the ability to apply the acquired knowledge in the process of further education and professional activity; lays the foundation for professionally oriented thinking, healthy lifestyle and prevention of violations of the functions of the body in the process of human life;

2) lays the groundwork for study of clinical biochemistry, pharmacotherapy, clinical pharmacology, toxicology and clinical disciplines, involves the integration of teaching with these disciplines; forms the ability to apply the acquired knowledge in the process of further education and professional activity; lays the foundations of professionally oriented thinking, a healthy lifestyle and prevention of body function disorders in the course of human life.

3) lays the foundations for clinical diagnosis of the most common diseases, monitoring the course of the disease, monitoring the effectiveness of the use of medicines and measures aimed at preventing the occurrence and development of pathological processes;

1. The purpose and tasks of the educational discipline

1.1. The purpose of teaching the course of choice "Medicine Metabolism" is to acquaint students with the main processes of biotransformation of medicines in the human body and to study the biochemical mechanisms of action of various pharmaceuticals in the development of this or that pathology, their interaction and side effects.

1.2. The main tasks of studying the optional discipline "Medicine metabolism" are the preparation of a specialist with a sufficient amount of theoretical knowledge to carry out the most rational drug therapy for a specific patient, a specialist who knows the methodology of individual selection of effective and

safe drugs based on their metabolism and mechanism of action, taking into account the influence of nutritional factors, external factors and physiological state.

1.3. Competences and learning outcomes, the formation of which contributes to the discipline (relationship with the normative content of the training of higher education applicants, formulated in terms of learning outcomes in the Standard).

According to the requirements of the discipline standard, students acquire the following *competencies*:

- *general*:
 - ability to act socially responsibly and civically; ability to apply knowledge in practical situations;
 - ability to apply knowledge in practical situations;
 - ability to think abstractly, analyze and synthesize, learn and be modernly educated;
 - knowledge and understanding of the subject area and understanding of professional activity;
 - ability to communicate in the state language both orally and in writing;
 - ability to communicate in a foreign language (mainly English) at a level that ensures effective professional activity;
 - skills in using information and communication technologies;
 - ability to conduct research at an appropriate level.
- *special (professional, subject)*:
 - ability to provide pre-medical assistance to the sick and injured people in extreme situations and emergencies; ability to ensure the rational use of prescription and OTC drugs and other products of the pharmacy assortment in accordance with the physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a specific disease and pharmacotherapeutic schemes of its treatment;
 - ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and body tissues, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication;
 - ability to develop methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological, technological and organoleptic control methods.

Detailing of competencies in accordance with the NQF descriptors in the form of the "Competence Matrix".

№	Competence	Knowledge	Skill	Communication	Autonomy and responsibility
1.	2	3	4	5	6
General competences					
GC1	The ability to act socially responsibly and civically	To know your social and public rights and responsibilities	To form one's civic consciousness, to be able to act in accordance with it	The ability to convey one's public and social position	Be responsible for your civic position and activities
GC2	The ability to apply knowledge in practical situations	To know the methods of applying knowledge in solving practical issues	To be able to use knowledge in various practical situations	To establish connections vertically and horizontally depending on the practical situation	To be responsible for the correctness of the decisions made in these situations
GC4	The ability to think abstractly, analyze and synthesize, learn and be modernly trained	To know methods of analysis, synthesis, possess abstract thinking and modern scientific knowledge	To be able to synthesize, analyze information, think abstractly and	To establish appropriate connections to achieve goals	To be responsible for the timely acquisition of modern knowledge

			make informed decisions		
GC6	The knowledge and understanding of the subject area and understanding of professional activity	To know the methods of acquiring basic knowledge in the subject area, to know the methods of applying this knowledge in professional activities	To be able to use the acquired subject knowledge in practice, when communicating	To establish connections vertically and horizontally depending on the practical situation	To be responsible for the timely acquisition of basic general and professional knowledge
GC8	The ability to communicate in the state language both orally and in writing, the ability to communicate in a foreign language (mainly English) at a level that ensures effective professional activity.	To know the state language and a foreign language (mainly English) to ensure effective professional activity	To be able to communicate in the national and foreign languages (English) for professional activities	To establish communication ties in the field of professional activity	To be responsible for the adequate use of the state and foreign (English) languages in professional activities
GC9	The skills in using information and communication technologies	To know the methods of information management and communication technologies	To be able to use communication technologies and analyze information	To establish appropriate connections to achieve goals	To be responsible for timely acquisition of knowledge and operation of information and communication
GC12	The ability to conduct research at an appropriate level	To know the methods of modern research	To be able to ensure the translation of modern research at the appropriate level	To establish relationships to ensure quality performance of work	To be responsible for the high-quality performance of work and conducting research at the modern level

Special (professional, subject) competences

PC4	The ability to ensure the rational use of prescription and OTC drugs and other products of the pharmacy assortment in accordance with the physicochemical, pharmacological characteristics, biochemical, pathophysiological features of a specific disease and pharmacotherapeutic schemes of its treatment	To know the principles of ensuring the rational use of prescription and OTC drugs in accordance with the physicochemical, biochemical, pathophysiological features of a specific disease and pharmacotherapeutic schemes of its treatment	To be able to apply theoretical knowledge based on biochemical and pathophysiological features of a specific disease for ensuring the rational use of prescription and OTC drugs	To communicate competently with patients and colleagues to ensure rational use of prescription and OTC medications	To be responsible for the correct provision of rational use of prescription and OTC drugs in accordance with the physicochemical, biochemical, pathophysiological features of a particular disease and pharmacotherapeutic schemes of its treatment
PC5	The ability to monitor the effectiveness and safety of the use of medicinal products by the population according to the data on their clinical and	To know the main biochemical and molecular basis of the functions of cells, organs and systems of the human body for the	To be able to apply the acquired theoretical knowledge to monitor the effectiveness and safety of the use of	To carry out competently consultative work among the population and colleagues in order to monitor	To be responsible for the quality of the performance of professional duties regarding the monitoring of the effectiveness and

	pharmaceutical characteristics, as well as taking into account subjective signs and objective clinical, laboratory and instrumental criteria for the examination of the patient	establishment of clinical and pharmaceutical characteristics in order to monitor the effectiveness and safety of the use of medicinal products by the population	medicinal products 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 the examination of the patient	the effectiveness and safety of the use of medicinal products by the population according to data on their clinical and pharmaceutical characteristics	safety of the use of medicinal products by the population according to the data on their clinical and pharmaceutical characteristics
PC6	The ability to identify medicinal products, xenobiotics, toxins and their metabolites in biological fluids and tissues of the body, to conduct chemical and toxicological studies for the purpose of diagnosing acute poisoning, drug and alcohol intoxication	To know the principles of biochemical methods for determining medicines, xenobiotics, toxins and their metabolites in biological fluids and body tissues	To be able to interpret received research results for the determination of drugs, xenobiotics, toxins and their metabolites in biological fluids and body tissues	To use competently professional terms in the scientific community and use them in documentation	To be responsible for the correct interpretation obtained research results for the determination of drugs, xenobiotics, toxins and their metabolites in biological fluids and body tissues
PC20	The ability to develop methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances using physical, chemical, physico-chemical, biological, microbiological, pharmacotechnological and pharmacoleptic control methods	To know the main biochemical and physicochemical methods for development methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances	To be able to apply various research methods for development methods of quality control of medicinal products, including active pharmaceutical ingredients, medicinal plant raw materials and auxiliary substances	To use competently professional terms in the scientific community and communicate with colleagues when conducting physico-chemical, biological and biochemical research methods for the development of methods of quality control of medicinal products	To be responsible for accuracy and professionalism and correct interpretation of the results of biochemical studies in the development of methods of quality control of medicinal products

Learning outcomes:

- Integrative final program learning outcomes, the formation of which is facilitated by the optimal discipline “Metabolism of drugs”:
- PRL1. To conduct professional activities in social interaction based on humanistic and ethical principles; to identify future professional activity as socially significant for human health.
- PRL2. To apply knowledge of general and professional disciplines in professional activities.

- PRL4. To demonstrate the ability to independently search, analyze and synthesize information from various sources and use these results to solve typical and complex specialized tasks of professional activity.
- PRL7. To perform professional activities using creative methods and approaches.
- PRL8. To carry out professional communication in the state language, use oral communication skills in a foreign language, analyzing specialized texts and translating foreign language information sources.
- PRL9. To carry out professional activities using information technologies, information databases, navigation systems, Internet resources, software tools and other information and communication technologies.
- PRL10. To adhere to the norms of communication in professional interaction with colleagues, management, consumers, work effectively in a team.
- PRL12. To analyze information obtained because of scientific research, generalize, arrange and use it in professional activities.
- PRL16. To determine the influence of factors affecting the processes of absorption, distribution, deposition, metabolism, and excretion of the medicinal product and are determined by the condition, features of the human body and the physico-chemical properties of medicinal products.
- PRL17. To use the data of clinical, laboratory and instrumental studies to monitor the effectiveness and safety of the use of medicinal products.
- PRL18. To choose biological objects of analysis, determine xenobiotics and their metabolites in biological environments, and evaluate the results obtained considering their distribution in the body.
- PRL25. To contribute to the preservation of health, in particular the prevention of diseases, the rational prescription and use of medicinal products. To faithfully fulfill one's professional duties, to comply with the legislation on the promotion and advertising of medicinal products. To possess psychological communication skills to achieve trust and mutual understanding with colleagues, doctors, patients, consumers.

Results of studying for the discipline:

As a result of studying the academic discipline "Biological Chemistry", the student should **know:**

- the indications and contraindications for the use of drugs;
- the processes of biotransformation of drugs in the body;
- the mechanism of action and methods of withdrawal;
- peculiarities of drug metabolism in various diseases.

To be able to

- provide a comparative characteristic of drugs in terms of effectiveness, safety, mechanism of action, indications for use, etc.;
- to determine manifestations of side effects of drugs, symptoms of overdose, to know the methods of their prevention and the principles of treatment;
- to predict the effects of drug interactions when combined, medicines and food components, drugs and alcohol.

2. Information contents of the educational discipline

3.0 IECTS credits 90 hours are provided for the studying of course "Metabolism of drugs"

The course "Metabolism of drugs" is divided into 2 chapters:

Chapter1. General characteristics of biotransformation of drugs.

Topic 1. General characteristics of ADME (Absorption – Distribution – Metabolism – Excretion), phases I and II of drugs biotransformation. General characteristics of ADME. Relationship between

physicochemical and structural properties of molecules with their main pharmacokinetic parameters, such as absorption, distribution, metabolism and excretion.

Topic 2. General characteristics phases I and II of drugs biotransformation in liver. Electron transport chains in the membranes of the endoplasmic reticulum of hepatocytes, the sequence of components. Biological role of cytochrome P-450, classification of cytochromes, their characteristics.

Topic 3 Types of reactions of biotransformation of chemical compounds in the liver. Microsomal oxidation reactions; inducers and inhibitors of microsomal oxygenases. Biochemical mechanisms of conjugation reactions in hepatocytes. Functional value of reactions with glucuronic acid, with PAPS, glutathione, glycine, methylation reactions and acetylation. Application of Kvik's tests for the diagnosis of detoxification function of the liver.

Topic 4 Inducers and inhibitors of microsomal oxidation. The notion of "inducer" of enzymes. Classification of substances that can cause induction of microsomal enzymes. Mechanism of action of induction of enzymes. Inhibitors of microsomal monooxygenase. The concept of the emergence of tolerance to drugs. Phenomenon of arising from repeated and combined use of drugs. Addiction, cumulation, (drug dependence).

Topic 5 Characteristics and physiological significance of the main proteolytic enzymes. Concept of inhibitors of proteolytic enzymes. Drugs that inhibit proteases: contrikal (gordox, tracyllol), allopurinol, proserin and others, their mechanisms of action.

Chapter 2. Molecular mechanisms of action of drugs. Influence of exogenous and endogenous factors on drug metabolism. Side effects of medicines.

Topic 6. Molecular mechanisms of action of antibiotics. Molecular mechanisms of action of antibiotics - inhibitors of transcription and translation. Mechanisms of antibiotic resistance development and ways to overcome it. Conditions of rational use of antibiotics. The notion of dysbiosis, pre- and probiotics. Principles of effective and safe use of antibiotics, pre- and probiotics.

Topic 7. Molecular mechanisms of action of NSAIDs. The role and place of anti-inflammatory drugs in the treatment of inflammation, as the most common type of pathological process. Classification and nomenclature of modern NSAIDs depending on chemical structure, origin and degree of selectivity to cyclooxygenases. Modern ideas about the mechanism of action of nonsteroidal anti-inflammatory drugs (NSAIDs) from the position of cyclooxygenase concept. Comparative characteristic of traditional and modern NSAIDs. New approaches for the creation of NSAIDs with an unconventional mechanism of action. Comparative characteristics of steroid and nonsteroidal anti-inflammatory drugs.

Topic 8. Molecular mechanisms of action of antihypertensive drugs. Modern treatment of arterial hypertension. Role of angiotensin-converting enzyme in the formation of pathological process. Classification and nomenclature of modern antihypertensive drugs. Side effects of these medications. Scientific perspectives in the development of new antihypertensive drugs.

Topic 9. Molecular mechanisms of action of antitumor drugs. Modern theory of tumorigenesis. Classification of antitumor drugs, their advantages and disadvantages. Development of antitumor drugs safe for the patient's body/

Topic 10. Mechanisms for the implementation of the pharmacological action of drugs. The nature and essence of the interaction of medicinal substances with the components of cell membranes. The concept of receptors. Interaction of drugs with receptors. Participation of receptors and potential-dependent channels in the mechanisms of action of drugs. Classification and characterization of drugs that block receptors, their application in practical medicine. Biochemical mechanisms of their action. Influence of nutrition factors and the environment on drug metabolism. Classification of side effects of drugs. Side effects of medicinal products: drug allergy, embryotoxic, teratogenic, fetotoxic, mutagenic, carcinogenic effects. Specific undesirable (organotropic) action of medicinal products. Basic principles and types of interaction of therapeutic agents. Effects of therapeutic agents in combination therapy: synergism, potentiation, antagonism.

2. Structure of the discipline "Metabolism of drugs"

Topic	Lectures	Seminars	Independent student's work	Individual work

Chapter 1. General characteristics of biotransformation of drugs.				
Topic 1. General characteristics of ADME (Absorption – Distribution – Metabolism – Excretion), phases I and II of biotransformation of drugs	2	2		Working with educational literature, lecture notes, completing test tasks, filling in tables, working on the Internet, viewing computer materials
Topic 2. General characteristics phases I and II of drugs biotransformation in liver.		2		
Topic 3 Types of reactions of biotransformation of chemical compounds in the liver.	2	2		
Topic 4 Inducers and inhibitors of microsomal oxidation.		2		
Topic 5 Characteristics and physiological significance of the main proteolytic enzymes.		2		
Totally in chapter 1.	4	10	30	
Chapter 2. Molecular mechanisms of action of drugs. Influence of exogenous and endogenous factors on drug metabolism. Side effects of medicines.				
Topic 6. Molecular mechanisms of action of antibiotics.	2	2		Working with educational literature, lecture notes, completing test tasks, filling in tables, working on the Internet, viewing computer materials
Topic 7. Molecular mechanisms of action of NSAIDs.	2	2		
Topic 8. Molecular mechanisms of action of antihypertensive drugs		2		
Topic 9. Molecular mechanisms of action of antitumor drugs	2	2		
Topic 10. Mechanisms for the implementation of the pharmacological action of drugs.		2		
Totally in chapter 2.	6	10	30	
Totally hours 120/3.0 credits ECTS	10	20	60	
Summary control	Credit			

3. Thematic plan of lectures for course “Metabolism of drugs”

No	Theme	Hours
Chapter 1. General characteristics of biotransformation of drugs.		
1	Biochemistry and clinical biochemistry of liver. Mechanisms of action of hepatoprotective drugs.	2
2	Microsomal oxidation. Phases of biotransformation of Drugs and endogenous toxic compounds. Microsomal oxidation reactions. II phase of biotransformation of medicines. Conjugation reactions in the liver.	2
	Totally	4
Chapter 2. Molecular mechanisms of action of drugs. Influence of exogenous and endogenous factors on drug metabolism. Side effects of drugs		
3	Antibiotics - inhibitors of transcription and translation, their mechanism of action.	2
4	Biochemical mechanisms of action of nonsteroidal anti-inflammatory drugs.	2
5	Molecular mechanisms of action of antitumor drugs.	2
	Totally	6
	Totally per course	10

4. Themes of seminars

№	Theme	Hours
Chapter 1. General characteristics of biotransformation of drugs.		
1	Topic 1. General characteristics of ADME (Absorption – Distribution – Metabolism – Excretion), phases I and II of biotransformation of drugs	2
2	Topic 2. General characteristics phases I and II of drugs biotransformation in liver.	2
3	Topic 3 Types of reactions of biotransformation of chemical compounds in the liver.	2
4	Topic 4 Inducers and inhibitors of microsomal oxidation.	2
5	Topic 5 Characteristics and physiological significance of the main proteolytic enzymes.	2
	Totally	10
Chapter 2. Molecular mechanisms of action of drugs. Influence of exogenous and endogenous factors on drug metabolism. Side effects of drugs.		
6	Topic 6. Molecular mechanisms of action of antibiotics.	2
7	Topic 7. Molecular mechanisms of action of NSAIDs.	2
8	Topic 8. Molecular mechanisms of action of antihypertensive drugs	2
9	Topic 9. Molecular mechanisms of action of antitumor drugs	2
10	Topic 10. Mechanisms for the implementation of the pharmacological action of drugs.	2
	Totally	10
	Totally per course	20

5. Individual work

№	Theme	Hours
Chapter 1. General characteristics of biotransformation of drugs.		
1	Atypical reactions to drugs with hereditary metabolic diseases. Hereditary defects of enzyme systems, which are manifested in the use of drugs.	4
2	The receptor theory of the action of drugs. The main properties of the receptors. Types of receptors. Classification of substances depending on the nature of interaction with receptors	4
3	Main principles of the use of drugs depending on the meal. Influence of the nature of nutrition on the pharmacokinetic and pharmacodynamic properties of drugs.	4
4	Specificity of the use of drugs during pregnancy.	4
5	Dependence of drug metabolism on age characteristics.	3
6	Drug dependence. Her kinds, manifestations. Physiological mechanisms of dependence. Medical and social aspects of drug dependence.	4
7	Physiological role and features of serotonin metabolism. Agonists and serotonin receptor antagonists. Their significance in clinical practice.	3
8	Interaction of medicinal products, types of side effects of drugs, complications of drug therapy.	4
	Totally	30
Chapter 2. Molecular mechanisms of action of drugs. Influence of exogenous and endogenous factors on drug metabolism. Side effects of drugs.		
1	Deficiency of vitamins in patients with diseases of the organs of the digestive system	4

2	Influence of drugs (diuretics and sulfanilamides) on the occurrence of acute pancreatitis	4
3	Potassium medicines used to treat cardiovascular diseases.	3
4	Characteristics of vascular disorders in myocardial infarction and their pharmacological correction.	4
5	Biochemical mechanisms of action of β -adrenoblockers and calcium channel blockers.	4
6	Biochemical mechanisms of toxic lesions of the body, toxic substance abuse. Biochemical bases of use of pharmaceuticals at their treatment.	4
7	Features of the approach to the choice of diuretic drug, depending on the presence of concomitant diseases (effects on lipid and carbohydrate metabolism).	3
8	The role of excitatory and inhibitory amino acids in the interneuronal transmission of impulses in the central nervous system. Means influencing GABA-ergic pulse transmission.	4
	<i>Totally</i>	30
	<i>Totally per course</i>	60

6. Individual tasks

Individual tasks are creative, exploratory, and contribute to the development of cognitive activity of students. Individual tasks students perform independently under the direction of a teacher. These are additional tasks that allow the student to deepen their knowledge of discipline, for example, preparing a speech at the conference and printing abstracts on the topics of the department at the annual conference, multimedia presentations on the specified topics

7. Teaching methods

- methods of organization and implementation of educational and cognitive activities (explanatory and illustrative; reproductive);
- methods of stimulation and motivation of educational and cognitive activity (problematic presentation; partially research);
- methods of control and self-control for the effectiveness of educational and cognitive activities.

The methods of educational activity according to the curriculum are:

- lectures,
- practical classes,
- individual student's work (ISW)

The structure of practical work includes a control work and a practical part.

Practical work is carried out in the form of situational problems, multimedia presentations, using the case method.

Independent work is checked and discussed in a practical lesson.

8. Control methods:

Methods of oral control and self-control:

- Individual survey;
- Frontal survey;
- Programed survey.

Methods of written control and self-control:

- Control written work;
- Control test tasks

During the study of the discipline "Metabolism of drugs", all types of student activities are subject to control, both current (at each class) and final (credit).

1. *Current control* of the theoretical preparation of sections in the form of a test or survey is carried out during classroom training. Practical classes are evaluated on a traditional four-point scale.

Assessment of current educational activities. During the evaluation of mastery of each topic for the current educational activity, the student is given grades on a 4-point (traditional) scale, taking into account the approved evaluation criteria for the relevant discipline. At the same time, all types of work provided by the educational program are taken into account. The student must receive a grade in each topic. Forms of assessment of current educational activities should be standardized and include control of theoretical and practical training. Estimates given on a traditional scale are converted into points.

The grade "5" is given if the student is capable of independent study of the material; establishes and substantiates cause-and-effect relationships; is able to apply the studied material to make own reasoned judgments in practical activities; independently finds information (in scientific literature, mass media, Internet, uses computer programs, etc.); solves professional orientation tasks independently, freely uses terminology; independently solves and performs 91-100% of the total number of tests.

The grade "4" is given if the student has mastered most of the educational material, is able to reproduce it with some inconsistencies, has stable skills in working with the text of the textbook, can independently master most of the given material, formulates basic concepts, gives examples, knows basic terms; confirms the expressed judgment with one or two arguments; performs practical tasks independently, completes them without drawing complete conclusions; answers lack logic; performs 75-90% of the total number of tests.

A student receives **grade "3"** if he knows more than half of the educational material, is able to reproduce it with the help of the teacher, can highlight and remember the main provisions of the educational material, can confirm part of the answers with examples; performs practical tasks, prepares them and formulates conclusions in accordance with the purpose of the research; performs 50-74% of tests.

The grade "2" is given if the student attends classes, reproduces its topic and some concepts, is unable to complete practical work and complete it, completes less than 50% of tests.

The theoretical component involves testing or interviewing students on the topic of the lesson, checking and evaluating extracurricular (independent) work. Control of practical training is conducting an experiment, writing a protocol and drawing up relevant conclusions. The student's independent work (working on topics that are not included in the classroom work), provided by the work curriculum, is evaluated at the end of the study of the chapter, and is included in the chapter rating.

2. *Final control (credit)* for full-time and part-time education is conducted in the form of an exam according to the schedule.

9. Form of the final control of the study (select: a score, a differentiated score, an exam)

Credit is a form of final control, which consists in assessing the student's mastering of the training material solely on the basis of the results of certain types of work on the practical, seminary or laboratory sessions. The credit is conducted after the completion of the study, before the beginning of the examination session.

10. The scheme of calculation and distribution of students' points:

For the discipline "Metabolism of drugs" the form of final control is the credit pass. The maximum number of points a student can score for the current educational activity for admission to the exam is **120 points**.

The minimum number of points that a student must score for the current training for admission to the exam is **72 points**.

The calculation of the number of points for the current activity is based on the student's assessment on the 4-point scale (national) during the study of discipline, by calculating the arithmetic mean (CA), rounded to two decimal places. The resulting value is converted to a score on a multi-scale scale in the following way:

$$x = \frac{CA \times 120}{5}$$

For convenience, the table is converted into a 200-point scale:

**Calculation of average mark for the current activity into the multipoint scale for the disciplines,
that finish by the exam**

4- score scale	200-score scale
5	120
4.95	119
4.91	118
4.87	117
4.83	116
4.79	115
4.75	114
4.7	113
4.66	112
4.62	111
4.58	110
4.54	109
4.5	108
4- score scale	200-score scale
4.45	107
4.41	106
4.37	105
4.33	104
4.29	103
4.25	102
4.2	101
4.16	100
4.12	99
4.08	98
4.04	97
3.99	96
3.95	95
4- score scale	200-score scale
3.91	94
3.87	93
3.83	92
3.79	91
3.74	90
3.7	89
3.66	88
3.62	87
3.58	86
3.54	85
3.49	84
3.45	83
3.41	82
4- score scale	200-score scale
3.37	81
3.33	80

3.29	79
3.25	78
3.2	77
3.16	76
3.12	75
3.08	74
3.04	73
3	72
Less than 3	Insufficiently

Independent work of students is assessed during the current control of the topic in the relevant class. Assimilation of those that are imposed only on independent work is controlled by the final control.

Evaluation of final control.

An assessment of the exam consists of evaluating the test tasks and evaluating the theoretical tasks (including practical skills).

Criteria for evaluating test tasks:

Less than 25 tests - "**unsatisfactory**";

25 - 30 tests - "**satisfactory**";

31 - 36 tests - "**good**";

37 - 40 tests - "**excellent**".

The correct answer for 1 test is 1 point.

The minimum number of points for 40 tests is 25 points.

The maximum number of points for 40 tests is 40 points.

Criteria for evaluating theoretical tasks:

Each of the five theoretical tasks is estimated at 5 to 8 points:

Less than 5 points - "**unsatisfactory**";

5 points - "**satisfactory**";

7 points - "**good**";

8 points - "**excellent**".

The minimum number of points for 5 theoretical tasks is 25 points.

The maximum number of points for 5 theoretical tasks is 40 points.

For theoretical questions the student receives:

The assessment "**excellent**", if without errors answered the written theoretical tasks (including practical skills), substantiated the obtained results, that is: comprehensively and deeply learned the educational and practical material; in full mastered theoretical knowledge and practical skills.

The evaluation is "**good**" if some minor mistakes were made in the answers to the written theoretical tasks (including practical skills).

The assessment is "**satisfactory**" if significant mistakes were made in the answers to written theoretical tasks

The evaluation is "**unsatisfactory**" if gross mistakes were made in the answers to written questions or the student did not give answers to them at all.

The final control is conducted to evaluate the results of the training at a certain educational-qualifying level and at individual completed stages according to the national scale and the ECTS scale. Final control includes semester control and student attestation.

Semester control is conducted in the form of a semester exam or a set (differentiated score) from a specific academic discipline in the amount of study material determined by the work program of the discipline and in the terms set by the work curriculum, the individual student's curriculum.

A semester (differentiated) credit is a form of final control, which consists in assessing the student's mastering of the teaching material from a certain discipline solely on the basis of the results of all types of educational work provided by the working curriculum. The semester (differentiated) credit is exposed on the results of current control.

Determination of the number of points the student got from the discipline

An assessment from the disciplines, the final form of which is the score (differential grade), is based on the results of the current academic activity and is expressed on a two-point scale "enrolled" or "not enrolled". To enroll the student must receive for the current educational activity a ball not less than 60% of the maximum amount of points in discipline (120 points).

Discipline points are independently converted into both the ECTS and 4-point scale. The ECTS scores on the 4-point scale are not converted and vice versa. Points of students studying in one

specialty, taking into account the number of points scored from the discipline, are ranked on the ECTS scale as follows:

Table 3

Score ECTS	Statistical index
A	Best 10 % students
B	Next 25 % students
C	Next 30 % students
D	Next 25 % students
E	Last 10 % students

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:

Table 4

Points from a course	Score 4-point scale
From 170 to 200 points	5
From 140 to 169 points	4
From 139 points to the minimum the number of points that should be obtained by a student	3
Below is the minimum number of points that the student should collect	2

The ECTS mark on a traditional scale is not converted because the ECTS scale and the four-point scale are independent.

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

11. **Methodological support** (educational content (summary or extended plan of lectures), plans of seminars, independent work, questions, tasks or cases for current and final control of knowledge and skills of students, comprehensive control work, after attestation monitoring of the acquired knowledge and skills in the discipline).

12. Recommended literature

Main:

- Gubsky Yu. Bioorganic and biological chemistry. Book 2. Biological chemistry. Second edition. Medicine 2021. P. 546
- Satyanarayana U., Chakrapani U. "Biochemistry", Fourth Edition. – 2013. – 792 p.
- Harper's Illustrated Biochemistry. 30th edition. Lange Medical book. - 2015. – 927 p.
- Biochemistry. The Molecular Basis of Life / Trudy McKee, James R. McKee, 2015.- 928 p.
- Lehninger A. Principles of Biochemistry. – Sixth Edition. David L. Nelson and Michael M. Cox. – 2013. – 1010 p.
- MCQs in biochemistry 2nd edition / A. Ya. Sklyarov et al.: Lviv: Danylo Halytsky Lviv National Medical University Press, 2020. 319 p.
- MCQs / Prof. Sklyarov A.Ya., Lutsik M.D., Fomenko I.S., Klymyshin D.O., Nasadyuk C.M. – 2012. – 308 p.
- Lippincott Illustrated Reviews: Biochemistry. Denise R. Ferrier. Seventh edition. Wolters Kluwer, 2017. 2224 p.
- B. Testa, P. Jenner, GThe coming of age of drug metabolismH, Curr. Contents Life Sci. 1990, 33, 17.
- Drug Metabolism – from Molecules to ManH, Eds. D. J. Benford, J. W. Bridges, G. G. Gibson, Taylor & Francis, London, 1987.
- GConjugation Reactions in Drug MetabolismH, Ed. G. J. Mulder, Taylor & Francis, London, 1990.

12. Cytochrome P450. Structure, Mechanism, and BiochemistryH, 2nd edn., Ed. P. R. Ortiz de Montellano, Plenum Press, New York, 1996.
13. Enzyme Systems that Metabolise Drugs and Other XenobioticsH, Ed. C. Ioannides, John Wiley & Sons, Chichester, 2002.
14. GDrug-Drug InteractionsH, Ed. A. D. Rodrigues, Dekker, New York, 2002
15. Enzyme Systems that Metabolise Drugs and Other XenobioticsH, Ed. C. Ioannides, John Wiley & Sons, Chichester, 2002.
16. GDrug-Drug InteractionsH, Ed. A. D. Rodrigues, Dekker, New York, 2002

Optional:

1. A. Conti, M. H. Bickel, G History of drug metabolism: discoveries of the major pathways in the 19th centuryH, Drug Metab. Rev. 1977, 6, 1 – 50;
2. C. Bachmann, M. H. Bickel, G History of drug metabolism: the first half of the 20th centuryH, Drug Metab. Rev. 1986, 16, 185 – 253.
3. B. Testa, P. Jenner, Drug Metabolism: Chemical and Biochemical AspectsH, Dekker, New York, 1976.
4. Concepts in Drug MetabolismH, Eds. P. Jenner, B. Testa, Dekker, New York, 1980 and 1981, Part A and Part B.
5. [Pharmacokinetics of DrugsH, Eds. P. G. Welling, L. P. Balant, Springer, Heidelberg, 1994.
6. Conjugation-Deconjugation Reactions in Drug Metabolism and ToxicityH, Ed. F. C. Kauffman, Springer Verlag, Berlin, 1994.
7. Conjugation-Dependent Carcinogenicity and Toxicity of Foreign CompoundsH, Eds. M. W. Anders, W. Dekant, Academic Press, San Diego, 1994.
8. Handbook of Drug MetabolismH, Ed. T. F. Woolf, Dekker, New York, 1999.
9. Handbook of Drug-Nutrient InteractionsH, Eds. J. Boullata, V. T. Armenti, Humana Press, Totowa, 2004.
10. Drug Metabolism and TransportH, Ed. L. H. Lash, Humana Press, Totowa, 2005.
11. Cytochrome P450 ProtocolsH, Eds. I. R. Phillips, E. A. Shephard, Humana Press, Totowa, 2006.
12. B. Testa, GThe Metabolism of Drugs and Other Xenobiotics – Biochemistry of Redox ReactionsH, Academic Press, London, 1995.

13. Information resources:

<http://www.new.meduniv.lviv.ua>

Centre of testing – base of licenced test tasks KROK-1 <http://testcentr.org.ua/>