

DANYLO HALYTSKYI LVIV NATIONAL MEDICAL UNIVERSITY

Department of Medical Biology, Parasitology and Genetics



**APPROVED**  
First Vice-rector  
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*[Signature]*  
"25" 05 2023

2023

## WORKING PROGRAM OF THE DISCIPLINE

### «MODERN PROBLEMS OF MOLECULAR BIOLOGY»

(elective course)

**ББ 1.3**

for the training of specialists of the 2nd (master's degree) level of higher education  
education sector 22 «Public Healthcare»  
Specialty 226 «Pharmacy, Industrial Pharmacy»

Discussed and approved  
at the methodical meeting of the  
department of Medical Biology,  
Parasitology and Genetics  
Protocol No19 from "15" 05. 2023  
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«Approved»  
the profile methodical commission on  
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## INTRODUCTION

**Working Program of the discipline «Modern problems of molecular biology»** (elective course) according to the Higher Education Academic Standard of the 2<sup>nd</sup> (*master's degree*) level

Education sector 22 «*Healthcare*»

Specialty 226 «Pharmacy, Industrial Pharmacy» (Full-time education)

Education program of *Master of Pharmacy*

### **The description of the subject «Modern problems of molecular biology» (Annotation)**

«Modern problems of molecular biology» discipline (elective course) is studied by the I year students from specialty 222 «Medicine» and is a part of the Educational and Professional Program.

Working Program contains such chapters: «Molecular basis of heredity», «Molecular basis of hereditary diseases», «Modern issues of genetic technologies».

It lays the foundation in pharmaceutical students for their further mastering knowledge on the basic methods of chemical analysis of the structure and functions of biopolymers (proteins and nucleic acids); understanding of the molecular-genetic basis for the development of hereditary and multifactorial diseases and prospects for the application of the achievements of molecular biology in practical medicine.

This discipline provides a study of modern problems and achievements of molecular medicine, including molecular genetic diagnostics, pharmacology, gene therapy. The course includes lectures, practical classes, individual work of students and ends with a final credit. The study of the discipline «Modern problems of molecular biology» (elective course) lays the foundation for further mastering by students specialized knowledge and skills from theoretical and professional-practical clinical disciplines (Bioorganic chemistry, Pharmacology, Physiology, Medical genetics, etc.).

The types of lessons according to the Working Program are:

a) lectures; b) practical classes; c) individual student's work; d) consultations.

Structure of the discipline	Quantity of credits, hours, from them				Year of study, semester	Form of the final control
	Total	Auditory		ISW		
		Lectures (hours)	Practical classes (hours)			
<b>Name of the discipline:</b> «Modern problems of molecular biology»	3 credits 90 hours	10	20	60	I course (1 semester)	credit

**The subject** of the Academic discipline study is the biological basis of human vital functions at the molecular-genetic level,

**Interdisciplinary links:** the Academic discipline «Modern problems of molecular biology» (elective course) is integrated with the following biomedical disciplines: Medical biology, Biological and bioorganic chemistry, Genetics, Biophysics, Microbiology, Organic and inorganic chemistry, Neurocybernetics, Bioinformatics, etc.

### **1. Aim and goals of the discipline**

1.1. **The aim** of the course is to form knowledge and practical aptitude for further students' mastering the block of relevant disciplines, which provide natural-science (NS unit) and professional-practical (PP unit) preparation for understanding modern problems as well as achievements of molecular medicine.

#### **1.2. The ultimate goals of the course «Modern problems of molecular biology» are:**

1. To explain the the patterns of human organism vital functions manifestation at the molecular-biological and cellular levels.

2. To identify the manifestations of general biological laws during human ontogenesis.

3. To understand the molecular-genetic basis for the development of hereditary and multifactorial diseases, prospects for the application of advances in molecular biology in practical medicine.

4. To be able to explain the mechanisms of inherited human diseases phenotypic manifestation.

#### **1.3 Subject «Modern problems of molecular biology» provides the development of the following competencies:**

##### **1) general (3K):**

3K 01. The ability for abstract thinking, analysis and synthesis.

3K 02. Knowledge and understanding of the subject area and understanding of professional activity.

3K 03. The ability to communicate in the official language both orally and in writing.

3K 04. The ability to communicate in the foreign language t a level that ensures effective professional activity.

3K 05. The ability to evaluate and ensure the quality of work being performed.

3K 06. The ability to work as a team member.

3K 07. The ability to realize the own rights and responsibilities as a member of society, to recognize the values of civil (free democratic) society and the need for its sustainable development, the rule of law, human and civil rights and freedoms in Ukraine.

3K 08. The ability to preserve and multiply the moral, cultural, scientific values and achievements of society based on understanding the history and patterns of development of the subject area, its place in the general system of knowledge about nature and society and in the development of society, techniques and technologies, to use different types and forms of motor skills for recreation and a healthy lifestyle.

3K 09. The ability to apply information and communication technologies.

##### **2) special (professional) (ΦK):**

ΦK 01. The ability to integrate knowledge and solve complex problems of pharmacy/industrial pharmacy in broad or multidisciplinary contexts.

ΦK 07. The ability to conduct sanitary-educational work among the population to prevent common diseases of internal organs, prevention of infectious and parasitic diseases, and to promote early

detection and maintaining adherence to treatment of these diseases according to their medical-biological and microbiological peculiarities.

### Matrix of competencies

No	Competence	Knowledge	Skills	Autonomy and responsibility
1	The ability to use in pharmacist practice knowledge of modern achievements in molecular biology.	To know how to interpret the importance of molecular-genetic methods for hereditary and infectious diseases diagnosis in forensic medicine.	Be able to solve situational problems, to identify the primary structure of the protein, the number of amino acids, the molecular weight of the polypeptide according to the gene structure encoding it.	1. Be responsible for the acquirement of relevant knowledge and skills. 2. Be responsible for the measures that preserve the environment within the own competence.
2	The ability to use in pharmacist practice knowledge of cytological basis of heredity, mechanisms of hereditary and acquired human diseases development.	To apply knowledge of molecular basis of heredity, the mechanisms of hereditary and acquired human diseases development in the physician practice. To know and understand modern achievements in molecular biology.	Be able to analyze the structure of pro- and eukaryotic genes, to determine the types of mutations (gene or chromosomal) Be able to analyze the complex mechanisms of human traits inheritance.	1. Be responsible for the acquirement of relevant knowledge and skills. 2. Be responsible for the measures that preserve the environment within the own competence.
3	The ability to apply the knowledge of peculiarities of human ontogenesis and effects of pharmaceuticals on its various stages	To know the peculiarities of human ontogenesis in diagnosis and treatment of various human diseases.	Be able to develop measures for reduction the degree of pathological condition manifestation in patients with hereditary pathology.	1. Be responsible for the acquirement of relevant knowledge and skills. 2. Be responsible for the measures that preserve the environment within the own competence.
4	The ability to estimate the impact of environmental factors on human health, to use the own professional activity for	To know how to conduct the own professional activities to preserve the environment.	Be able to choose the appropriate methods of human heredity investigation for diagnosis of different hereditary diseases.	1. Be responsible for the acquirement of relevant knowledge and skills. 2. Be responsible for the measures that preserve the environment within

	protection of the environment and conducting sanitary-educational work.			the own competence.
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### Learning outcomes (IPH):

Integrative final program learning outcomes, for the formation of which contributes an academic discipline «Modern problems of molecular biology»:

IPH 01. To possess specialized conceptual knowledge in the field of pharmacy and related fields, taking into account modern scientific achievements, and to be able to apply them in professional activities.

IPH 03. To possess specialized knowledge and abilities/skills for solving professional problems and tasks, including for the purpose of improving knowledge and procedures in the field of pharmacy.

IPH 04. To communicate freely in the national and English languages orally and in writing to discuss professional problems and results of activities, presentation of scientific research and innovative projects.

IPH 06. To develop and make 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 collective, taking into account public and industrial interests, the general strategy and existing limitations, determine the optimal ways to achieve goals.

IPH 10. To provide the sanitary and educational work among the population for the purpose of prevention and in case of outbreaks of dangerous infectious, viral and parasitic diseases.

After studying the discipline «Modern problems of molecular biology» students should *know*:

- Structure and functions of nucleic acids.
- Molecular mechanisms of intercellular signaling and transmembrane transport.
- Classification of genes, structural genes organization in eukaryotes.
- Molecular mechanisms and role of replication, repair, and recombination processes.
- Molecular mechanisms of hereditary information realization.
- Principles of gene expression regulation in pro- and eukaryotes.
- General features of viruses, prokaryotes, and eukaryotes genomes organization.
- Modern methods of the human genome study.
- Classification of mutational variability, molecular mechanisms of mutational variability.
- Molecular mechanisms of certain mutagenic factors action and methods of mutagenic activity study, mechanisms of antimutagens action.
- Molecular mechanisms of ontogenesis.
- Regulation of the cell cycle. Molecular mechanisms of cell death (apoptosis, necrosis).
- Molecular mechanisms of tumor development.
- Modern methods of molecular genetic diagnostics and their application in medicine.
- The concept of biotechnology and genetic engineering.
- Principles of transgenic organisms construction, possibilities of their application in biotechnology and medicine.

- Potential environmental consequences of the genetically modified organisms application.
- Principles of animal cloning and the value of the method for biology and medicine.
- Principles of gene therapy, its achievements and prospects.

***be able:***

- to identify (schematically) the primary structure of the protein, quantity of amino acids, molecular weight of polypeptide, according to the sequence of nucleotides present in the gene, encoding it;
- to determine changes in protein structure due to gene mutations.
- to determine the types of gene mutations when solving situational problems and analyzing the diagrams; types of chromosomal and genomic mutations during analysis of karyotypes;
- to analyze the electropherogram of DNA and to determine the presence of infectious agent DNA, mutations in human genes.

## 2. Informational content of the discipline

For discipline studying is given 3 credits ECTS / 90 hours.

### Structure of the discipline «Modern problems of molecular biology»:

Working Program of the Academic discipline contains the following chapters: «Molecular basis of heredity», «Molecular basis of hereditary diseases», «Modern issues of genetic technologies».

### 3. Structure of the studying discipline

Names of chapters and topics	Total	Lectures	Practical classes	Individual student's work
<b>Chapter 1. Molecular basis of heredity</b>				
Topic 1. Subject and tasks of molecular biology. Practical significance and methods of molecular biology. General characteristics of macromolecules. Methods of molecular biology. Molecular mechanisms of intercellular signaling and transmembrane transport.	7	2		5
Topic 2. Macromolecules as objects of molecular biology study. DNA replication and reparation.	9		4	5
Topic 3. Genomic organization in non-cellular and cellular organisms. Regulation of gene expression.	18	2	6	10
<b>Chapter 2. Molecular basis of hereditary diseases</b>				
Topic 4. Molecular-genetic methods in medicine	12		2	10
Topic 5. Molecular mechanisms of ontogenesis. Problems of mutagenesis and molecular mechanisms of hereditary diseases.	12		2	10
Topic 6. Cell cycle and its regulation.	14	2	2	10

Apoptosis.				
<b>Chapter 3. Modern issues of genetic technologies</b>				
Topic 7. Methods of DNA diagnostics. The concept of genetic engineering.	7	2		5
Topic 8. Transgenic organisms. Gene therapy. Molecular cloning. Cloning of organisms and cells.	11	2	4	5
<b>Total 90 hours / 3 credits ECTS</b>	<b>90</b>	<b>10</b>	<b>20</b>	<b>60</b>
<b>Final control</b>	<b>Crcredit</b>			

#### 4. Thematic plan of lectures

No	Topic	Hours
1.	Subject and tasks of molecular biology. The main stages of development. Prospects for the application of modern advances in molecular biology in clinical medicine.	2
2.	Genomic organization in non-cellular and cellular organisms. Regulation of gene expression.	2
3	Cell cycle. Genetic mechanisms of carcinogenesis.	2
4	Genetic engineering. Transgenic organisms. Gene therapy: prospects for application in medicine.	2
5	Cell engineering. Cloning of organisms. Biological and ethical problems of cloning.	2
<b>Total</b>		<b>10</b>

#### 5. Thematic plan of practical classes

No	TOPIC	Hours
1	Molecular mechanisms of DNA replication.	2
2	DNA repair. Mechanisms of damaged DNA repair. Hereditary diseases with defects in DNA repair.	2
3	Genome structure and molecular mechanisms of gene expression in viruses.	2
4	Genome structure and molecular mechanisms of gene expression in eukaryotes.	
5	Molecular mechanisms of gene expression in prokaryotes. Genome structure and molecular mechanisms of gene expression in pro- and eukaryotes.	2
6	Organization of human genome.	2
7	Molecular mechanisms of mutations.	2
8	Cell cycle regulation. Molecular bases of oncogenetics.	2



9	Gene therapy. Transgenic organisms.	2
10	Cloning of organisms and cells. Therapeutic cloning and its prospects in medicine.	2
<b>Total</b>		<b>20</b>

#### 6. Thematic plan of individual student's work

No	TOPIC	Hours	Type of control
1	Proteins, their role in providing of biological specificity. The concept of proteomics. Prion diseases.	5	Current control during practical classes
2	Mobile genetic elements. Molecular mechanisms of general genetic recombination.	5	
3	Nucleic acid research methods. Methods of DNA diagnostics. Molecular genetic research methods in forensic medicine.	5	
4	Modern methods of human karyotype study.	5	
5	Molecular mechanisms of cell aging.	5	
6	Molecular mechanisms of intercellular signaling and transmembrane transport	5	
7	Extranuclear heredity. Mitochondrial genome.	5	
8	Apoptosis: molecular mechanisms. Ways to realize the apoptosis program.	5	
9	Mutagenic factors. Methods for substances mutagenic activity determination.	5	
10	Genetic mechanisms of carcinogenesis.	5	
11	Gene therapy. Viral and non-viral vectors in gene therapy. Gene vaccines.	5	
12	Transgenic organisms. Recombinant drugs.	5	
<b>Total</b>		<b>60</b>	

7. **Individual tasks.** Preparing scientific reports, essays, multimedia thematic presentations for a scientific students' association meetings and for the Annual Student Scientific Conference.

#### 8. Teaching methods:

- Verbal methods: lecture, conversation;
- Visual methods: illustration, demonstration;
- Practical methods: practical work and solving situational problems to develop skills;
- Individual student's work with material understanding and learning;
- Using the educational computer programs on discipline.

## 9. Control methods:

- Current control is performed based on checking of theoretical knowledge and skills during practical classes.
- The study of the discipline ends with credit.

**Criteria for evaluation.** The teacher evaluates each student's knowledge at each practice according to four-mark (traditional) system, taking into account the approved evaluation criteria:

**Excellent ("5")** – the student perfectly mastered the theoretical material of the topic, demonstrates deep and comprehensive knowledge of the topic, the main concepts of scientific sources and recommended literature, thinks logically and answers thoroughly, freely uses the acquired theoretical knowledge in analyzing of practical material, expresses his attitude to certain problems, demonstrates high level of practical skills acquisition.

**Good ("4")** – the student has well mastered the theoretical material of the lesson, knows the basic aspects of primary sources and recommended literature; possess practical skills, expresses his views on certain issues, but assumes certain inaccuracies and errors in the logic of the presentation of theoretical content or in the implementation of practical skills.

**Satisfactory ("3")** – the student has mainly mastered the theoretical knowledge of the subject, is guided by primary sources and recommended literature, but answers unconvincingly, confuses concepts, additional questions cause the student uncertainty or lack of stable knowledge; answering questions of a practical nature, reveals inaccuracies in knowledge, is unable to assess facts and phenomena, relate them to future activities, makes mistakes in the implementation of practical skills

**Unsatisfactory ("2")** – the student has not mastered the study material of the topic, does not know the scientific facts, definitions, almost does not navigate in the original sources and recommended literature, there is no scientific thinking, practical skills are not formed.

Traditional scales are converted into the points.

**10. Current control** is performed based on a comprehensive assessment of the student's activities and acquired competencies (knowledge, practical skills, etc.), which includes control of the input level of knowledge, quality of practical work, level of theoretical training, and the results of the final knowledge control.

**Current control** is performed during the studying classes and is aimed at checking the mastering by students the learning material. The forms of current control are:

- a) tests with a choice of one correct answer (multiple choice questions), the definition of the correct sequence of actions, definition of correspondency, the definition of specific areas in a picture or diagram ("recognition");
- b) individual oral examination, interview;
- c) solving of typical situational problems;
- d) solving of typical problems from molecular biology;
- e) control of practical skills.

10.1. Evaluation of students' current educational activity is carried out at each practical (laboratory or seminar) class according to four-mark system, taking into account the approved evaluation criteria for the discipline and is represented in the Journal of Academic Performance. All types of

work and the list of competencies, provided by the program and methodical recommendations for the topic study, are taken into account. A student must receive a grade on each topic.

10.2. Individual work of students is estimated during current control on the relevant lesson. Mastering by students the learning material given only for individual student's work is checked during the final control.

### **11. Final control**

It is a form of final control, which is based on evaluation the student's results of mastering theoretical and practical material performed in certain types of practical classes.

**Credit** from the discipline is conducted after the completion the studying, before the examination session. All topics from current control should be successfully performed.

Students get a credit for a course, if the average score for current activity during the semester is at least "3" (120 points on a 200-point scale).

Grades from traditional the 4-point scale are converted into points on a multi-point (200-point) scale in accordance with the ECTS rating scale.

### **12. The scheme of calculation and distribution of points that are received by students:**

**Maximum quantity of points**, which student can collect for the current educational activity for admission to the exam (differentiated credit) makes 200 points.

**Minimum quantity of points**, which student can collect for the current educational activity for admission to the exam (differentiated credit) makes 120 points.

**The calculation of the number of points** is made on the basis of the collected student's marks on the traditional scale during the discipline study, by calculating the arithmetic mean (AM or average), rounded to two decimal places. The obtained value is converted into points according to the scoring scale as follows:

$$x = \frac{AM \times 200}{5}$$

The assessment of the discipline, the form of final control of which is credit, is based on the results of the assessment of current educational activities and is marked on a two-point scale: "pass" or "fail".

To pass the discipline, the student must collect for the current educational activity not less than 60% of the maximum amount of points (for a 200-point scale - not less than 120 points). Scores and grades ("pass" or "fail") the teacher puts in the examination sheet and in the student's record book (except for a failing grade).

The scores from discipline are converted to the ECTS scale. Grade F (failing grade)

Grade F (unsatisfactory with obligate repeat of the course) is awarded to students who have attended all classes in the discipline, but did not collect the minimum number of points for the current academic activity. Such students receive a grade "fail" and are not allowed to take the exam session.

The scores from discipline are converted to the ECTS scale and to the 4-point scale independently.

„A”, „B”, „C”, „D”, „E” ranking is made for students studying at one of the specialty and who have successfully completed study course.

Discipline points for students who have successfully completed the program are converted into traditional 4-point scale by absolute criteria, which are listed in the following table:

Points from discipline	Estimation on 4-point scale
From 170 to 200 points	5
From 140 to 169 points	4
From 139 points to minimal quantity of points, which student must collect	3
Less than minimal quantity of points, which student must collect	2

Objective evaluation of educational activities of students is tested by statistical methods (the correlation coefficient between ECTS score and score in a national scale).

### **13. Methodological support of the lecture course:**

1. Lecture theses from the discipline.
2. Methodical recommendations for lectures.
3. Presentations of lectures.
4. Platform for distance learning MISA.

### **Methodological support of practical classes:**

1. Methodical recommendations for practical classes for lecturers.
2. Methodical recommendations for practical classes for students.
3. Variants of test questions and tasks to check the initial level of knowledge on each topic.
4. Variants of situational tasks to check the mastering by students the learning topics.
5. Variants of tasks (theoretical and practical) for final control (credit).
6. The platform for distance learning MISA.

### **Logistical support**

1. Multimedia projector.

### **14. Recommended literature**

#### **Basic:**

1. Paryzhak S.Ya., Vorobets Z.D. Medical Biology. Textbook – Lviv: Qvart, 2020. – 426 p.
2. Bazhora Y.I., Bulyk R.Ye., Chesnokova M.M., Shevelenkova A.V., Smetyuk O.O., Lomakina Yu.V. Medical Biology: textbook. – Vinnytsia: Nova Knyha, 2018. – 448 p.: il.
3. Paryzhak S.Ya., Odnorih L.O. Medical biology and parasitology. Manual for the first-year students of the English department, the faculties of medicine and dentistry. – Lviv: Danylo Halytsky Lviv National Medical University, 2021. – 306 p.
4. Step 1. Lecture notes 2018 Biochemistry and Medical genetics. New York. Kaplan, Inc. – 2018 – 403 c.

#### **Additional:**

1. Bihunyak T.V. Medical biology / T.V. Bihunyak. – Ternopil: TSMU Ukrmedknyha, 2020. – 214 p.
2. Kaplan Medical's USMLE STEP 1. Biochemistry and Medical Genetics. Lecture notes. – 2018. – 432 p.
3. Pap E., Falus A., László V., Oberfrank F., Szalai C., Tóth S. Medical Genetics and Genomics. Edited by Typotex Kiadó. – Budapest University of Technology and Economics, 2016. – 206 p.
4. Rautenstrauss B.W., Liehr T. FISH technology. – Berlin: Springer, 2012, 494 p.

**Informational resources:**

1. Testing center – database of license tests Krok – 1 <http://testcentr.org.ua/>
2. OMIM (Online Mendelian Inheritance in Man) – An Online Catalog of Human Genes and Genetic Disorders <http://omim.org/>
3. NCBI databases <http://www.ncbi.nlm.nih.gov>
4. Encyclopedia of DNA elements <http://genome.ucse.edu/ENCODE/>