

**BOGOMOLETS  
NATIONAL MEDICAL UNIVERSITY  
Educational and Scientific Institute of Medicine  
Department of Medical Biochemistry and Molecular Biology**

CONFIRMED

Vice-Rector of the Higher Education Institution  
National Medical University  
named after O.O. Bogomolets  
for scientific, pedagogical and educational work,  
Doctor of Medical Sciences, Professor

 Oleh VLAŠENKO

**WORK PROGRAM OF THE DISCIPLINE**

**"PATHOLOGICAL BIOCHEMISTRY"**

|                     |                                             |
|---------------------|---------------------------------------------|
| Educational level:  | <u>Second (Master's)</u>                    |
| Field of knowledge: | <u>22 "Health and Social Security"</u>      |
|                     | <u>222 "Medicine"</u>                       |
| Specialty:          | <u>Educational and professional program</u> |
| Educational         | <u>"Medicine" of the second</u>             |
| program:            | <u>(master's) level of higher education</u> |
|                     | <u>in the specialty 222 "Medicine"</u>      |

**2026 - 2027 academic year**

Work program of the academic discipline **"Pathological Biochemistry"** for applicants for higher education in the direction of training specialists of the second (master's) level of higher education, specialty 222 "Medicine".

**DEVELOPERS OF THE PROGRAM:** Head of the Department of Medical Biochemistry and Molecular Biology Ph.D. Biol. Associate Professor Yanitska L.V., Associate Professor of the Institution of Higher Education, Ph.D., Associate Professor Obernikhina N.V.

**The work program was discussed and approved at the meeting of the Department of Medical Biochemistry and Molecular Biology**

Minutes No. 1 of August 26, 2026

**The work program was approved at the meeting of the Cycle Methodological Commission on Natural Sciences**

Minutes No. 1 of August 26, 2026

Head of the Department of Medical Biochemistry  
and Molecular Biology, Ph.D., Associate Professor

L.V. Yanitska

Chairman of the Cycle Methodological Commission  
in Natural Sciences, Ph.D., Associate Professor

L.V. Yanitska

## 1. Description of the discipline

| Name of indicators                                                                                  | Field of knowledge,<br>direction of training,<br>educational and qualification<br>level | Characteristics of the<br>academic discipline |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------|
|                                                                                                     |                                                                                         | Full-time study                               |
| Number of credits – 3.0                                                                             | Field of Knowledge<br>22 "Healthcare"                                                   | Selective                                     |
| Modules – 1                                                                                         | Specialty:<br>222 "Medicine"                                                            | Year of preparation                           |
| Content modules – 1                                                                                 |                                                                                         | III                                           |
| Individual research task                                                                            |                                                                                         | Semester                                      |
| Total credits/hours – 3/90                                                                          |                                                                                         | 5th or 6th                                    |
| Weekly hours for full-<br>time study:<br>classrooms – 2.6<br>independent work of a<br>student – 6.4 | Educational level:<br>Second (Master's)<br>Higher education level                       | Lectures                                      |
|                                                                                                     |                                                                                         | Hours 6                                       |
|                                                                                                     |                                                                                         | Practical                                     |
|                                                                                                     |                                                                                         | Hours 20                                      |
|                                                                                                     |                                                                                         | Laboratory                                    |
|                                                                                                     |                                                                                         | -                                             |
|                                                                                                     |                                                                                         | Independent work                              |
|                                                                                                     |                                                                                         | 64 Hours                                      |
|                                                                                                     |                                                                                         | Individual tasks:                             |
|                                                                                                     |                                                                                         | -                                             |
|                                                                                                     |                                                                                         | Type of control:                              |
|                                                                                                     |                                                                                         | Differentiated Credit                         |

The ratio of the number of hours of classroom classes to independent and individual work is (%): 29/71.

**2. The purpose of the discipline** - "Pathological Biochemistry" studies the violations of biochemical processes leading to pathologies; the basic principles that characterize the occurrence of pathological processes; contributes to the understanding and assimilation of knowledge about biochemical research methods that allow the use of qualitative and quantitative indicators for the diagnosis and treatment of the most common diseases; Together with other sciences, this discipline contributes to scientific progress in the field of preventive, therapeutic, diagnostic and rehabilitation medicine, which is a necessary component of the educational process in the training of a qualified doctor.

**Prerequisites of the discipline:**

- It is based on the study of anatomy, histology, physiology, biological chemistry by students and integrates with these disciplines.

**Corrections of the discipline:**

- study by students of pathological physiology, pathomorphology, pharmacology, which involves the integration of teaching with these disciplines and the formation of skills to apply knowledge of the biochemistry of pathological processes that take place in the body of a sick person.

**Post-details of the academic discipline:**

lays the foundations for clinical diagnosis of the most common diseases, monitoring the course of the disease, monitoring the effectiveness of treatment and measures aimed at preventing pathological processes, which is an important component of the doctor's future activities.

**Learning outcomes.**

*know:*

- biochemical mechanisms of the occurrence of pathological processes in the human body;
- features of diagnosing the physiological state of the body and the development of pathological processes based on biochemical studies;
- biochemical indicators are normal and in the event of pathological processes for the diagnosis of the most common diseases;

*be able to:*

- to explain the biochemical mechanism of the development of pathological processes on the basis of laboratory studies;
- analyze the results of biochemical studies and changes in indicator enzymatic parameters that are used to diagnose the most common human pathologies;
- to interpret the biochemical mechanisms of the occurrence of pathological processes in the human body and the principles of their correction;

*is able to demonstrate:*

- ability to process the results of biochemical studies and changes in biochemical parameters that are used to diagnose the most common human diseases;
- the ability to interpret the biochemical mechanisms of the occurrence of pathological processes in the human body and the principles of their correction;

*have the following skills:*

- conducting basic biochemical studies to identify normal and pathological components of biological fluids and biopsies;
- elaboration of the results of biochemical studies and changes in biochemical indicators;

- application of the results of laboratory biochemical studies for the diagnosis of diseases.  
*independently decide:*
- elaboration of the results of biochemical studies and changes in biochemical indicators;
- use of data from the results of biochemical studies to assess human health and diagnose diseases.

### **Criteria for evaluating learning outcomes**

#### *Criteria for evaluating learning outcomes:*

- Assessment of students' educational activities is regulated by the Regulations on "[The Procedure for Assessing Students' Knowledge during the Current and Final Control in the Discipline at O.O. Bogomolets NMU](#)" (minutes of the meeting of the Academic Council of O.O. Bogomolets NMU No. 4 dated 28.11.2023).
- Current control involves 100% of the survey of students in the group with mandatory assessment of all components of the lesson: independent work of the student, test control, oral questioning, written task and solving a situational problem. At each practical lesson, the teacher assesses the student's knowledge in points in accordance with the "Regulations for conducting practical classes and evaluating current control" and converts the points into an assessment on a four-point national scale ("5", "4", "3", "2").

The grade "Excellent" is given to the applicant who has qualitatively performed the applicant's independent work (SRZd), took an active part in the discussion of the most difficult questions on the topic of the lesson, gave at least 90% of the correct answers to standardized test tasks, answered written tasks without errors, completed practical work and solved a situational problem with the design of the scheme of biochemical reactions (the structure of the main biomolecules) and a full explanation of the medical and biological significance.

The grade "Good" is given to the applicant who has qualitatively completed the SRH, participated in the discussion of complex questions on the topic of the lesson, gave at least 75% of the correct answers to standardized test tasks, but made some minor mistakes in answering written tasks, performing practical work and solving a situational problem (when drawing up a scheme of biochemical reactions and explaining the medical and biological significance).

The grade "Satisfactory" is received by the applicant who has completed the SRZD, did not take an active part in the discussion of the most difficult questions on the topic, gave at least 60% of the correct answers to standardized test tasks, made significant mistakes in answering written tasks, performing practical work and solving a situational problem (drawing up a scheme of biochemical reactions and explaining medical and biological significance).

The grade "Unsatisfactory" is given to an applicant who did not perform the SRH qualitatively or did not perform the SRH at all, did not take part in the discussion of questions on the topic of the lesson, gave less than 60% of correct answers to standardized test tasks, made gross mistakes in answering written tasks or did not give answers to them at all, did not perform practical work, did not solve a situational problem and did not draw up a scheme of biochemical reactions with an explanation of medical and biological significance.

### 3. Structure of the discipline:

| Name of content modules and topics                                                                                                                          | Number of hours |          |                   |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------|-------------------|-----|
|                                                                                                                                                             | Denna form      |          |                   |     |
|                                                                                                                                                             | Total           | Lectures | Practical classes | CPC |
| 1                                                                                                                                                           | 2               | 3        | 4                 | 5   |
| Topic 1 Pathobiochemistry of digestion. Biochemical foundations of nutrition and its disorders.                                                             | 9.5             | 0.5      | 2                 | 7   |
| Topic 2. Violation of energy generation and conservation, exposure to inhibitors and disconnectors of oxidative phosphorylation.                            | 9.5             | 0.5      | 2                 | 7   |
| Topic 3. Violation of the regulatory function of vitamins A and D, antioxidant function of vitamins E and C, the development of hypo- and hypervitaminosis. | 9.5             | 0.5      | 2                 | 7   |

|                                                                                                                                                                                     |           |          |           |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------|-----------|-----------|
| Topic 4. Violation of the coenzyme functions of B vitamins (B1, B2, B3, B5, B6, B9, B12), the development of hypo- and vitamin deficiencies.                                        | 9.5       | 0.5      | 2         | 7         |
| Topic 5. Pathobiochemistry of carbohydrate metabolism. The role of insulin, glucagon, adrenaline, glucocorticoids in the regulation of blood glucose levels.                        | 8.5       | 0.5      | 2         | 6         |
| Topic 6. Pathobiochemistry of lipid metabolism, the role of hormones in its regulation. Obesity, steatosis, atherosclerosis. Dyslipoproteinemia.                                    | 8.5       | 0.5      | 2         | 6         |
| Topic 7. Pathobiochemistry of amino acid metabolism and metabolism of nitrogen-containing compounds.                                                                                | 9         | 1.0      | 2         | 6         |
| Topic 8. Pathobiochemistry of connective tissue and muscular system. Pathobiochemical markers of osteogenesis and resorption.                                                       | 8.5       | 0.5      | 2         | 6         |
| Topic 9. Impaired detoxification function, liver, diseases of the hepatobiliary system. Jaundice.                                                                                   | 9         | 1.0      | 2         | 6         |
| Topic 10. Pathobiochemistry of blood: hemolytic anemias, hemoglobinoses. Plasma proteins as markers of pathogenesis. Non-protein nitrogen-containing components of blood and urine. | 8.5       | 0.5      | 2         | 6         |
| <b>Total</b>                                                                                                                                                                        | <b>90</b> | <b>6</b> | <b>20</b> | <b>64</b> |

## 5. Lecture topics

| №<br>salary | Topic name                                                                                | h |
|-------------|-------------------------------------------------------------------------------------------|---|
| 1           | Pathobiochemistry of digestion and energy generation. Hyper- and hypovitamin deficiencies | 2 |

|              |                                                                                                                                                                                                          |          |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| 2            | Pathobiochemical disorders of carbohydrate metabolism.<br>Pathobiochemical disorders of lipid metabolism.<br>Pathobiochemistry of amino acid metabolism and metabolism of nitrogen-containing compounds. | 2        |
| 3            | Pathobiochemistry of connective tissue and muscular system.<br>Pathobiochemistry of liver detoxification function.<br>Pathobiochemistry of blood.                                                        | 2        |
| <b>Total</b> |                                                                                                                                                                                                          | <b>6</b> |

**6. Seminar classes are not provided in the curriculum.**

**7. Topics of practical classes**

| №<br>salary                | Topic name                                                                                                                                             | h |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 3 YEAR (V or VI semesters) |                                                                                                                                                        |   |
| 1                          | Pathobiochemistry of digestion. Biochemical bases of nutrition and its disorders.                                                                      | 2 |
| 2                          | Disruption of energy generation and conservation, exposure to inhibitors and disconnectors of oxidative phosphorylation.                               | 2 |
| 3                          | Violation of the regulatory function of vitamins A and D, the antioxidant function of vitamins E and C, the development of hypo- and hypervitaminosis. | 2 |
| 4                          | Violation of the coenzyme functions of B vitamins (B1, B2, B3, B5, B6, B9, B12), the development of hypo- and vitamin deficiencies.                    | 2 |
| 5                          | Pathobiochemistry of carbohydrate metabolism. The role of insulin, glucagon, adrenaline, glucocorticoids in the regulation of blood glucose levels.    | 2 |
| 6                          | Pathobiochemistry of lipid metabolism, the role of hormones in its regulation. Obesity, steatosis, atherosclerosis. Dyslipoproteinemia.                | 2 |
| 7                          | Pathobiochemistry of amino acid metabolism and metabolism of nitrogen-containing compounds.                                                            | 2 |

|              |                                                                                                                                                                           |           |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 8            | Pathobiochemistry of connective tissue and muscular system.<br>Pathobiochemical markers of osteogenesis and resorption.                                                   | 2         |
| 9            | Impaired detoxification function, liver, diseases of the hepatobiliary system. Jaundice.                                                                                  | 2         |
| 10           | Blood pathobiochemistry: hemolytic anemias, hemoglobinosis.<br>Plasma proteins as markers of pathogenesis. Non-protein nitrogen-containing components of blood and urine. | 2         |
| <b>Total</b> |                                                                                                                                                                           | <b>20</b> |

## 8. Topics of laboratory classes.

Nope.

## 9. Independent work

| Preparation for practical classes                                                                                                                                              | Number of hours | Type of control                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------------------------------------------------|
| 1. Independent study of theoretical issues for practical classes.<br>2. Completing tasks in a workbook for independent study of the topic.<br>3. Preparation for test control. | 64              | According to the criteria for evaluating the practical lesson |

## 10. Individual tasks

Applicants for higher medical education who perform AT LEAST 70% of test tasks on the topics of the course are allowed to perform individual work of the student (IRS).

- ✓ 30 points – co-author from the scientific and pedagogical department of the department in an article of category A, B, Scopus, Web of Science (in Ukrainian or foreign publications).
- ✓ 30 points – abstracts of the scientific report + prizes at the competition of student scientific works of NMU and at the student scientific conference "Molecular Medicine: Molecular Approach to Pathology and Therapy", provided that additional points are NOT accrued during the study of the discipline "Molecular Biology".
- ✓ 20 points – abstract of the scientific report + speech at the student scientific conference "Molecular Medicine: Molecular Approach to Pathology and Therapy", provided that additional points are NOT awarded when studying the discipline "Molecular Biology".
- ✓ 15 points – abstracts of a scientific report at conferences + a speech at a meeting of the student scientific circle of the department.

- ✓ 10 points – abstracts of a scientific report at a conference OR a speech at a meeting of the student scientific circle of the department (!! if there are several authors, then the points are divided in proportion to the number of authors or speakers).
- ✓ 5 points – a speech at a practical lesson with a presentation of a scientific report (!! if there are several speakers, then the points are divided in proportion to the number of speakers), NO MORE THAN TWO SPEECHES.

## 10. Teaching methods

10.1. Methods of organization and implementation of educational and cognitive activities in the study of the discipline:

*Verbal:* safety briefing for laboratory tests, lecture, story, explanation, educational discussion.

*Visual:* demonstration, illustration.

*Practical:* laboratory research.

10.2. The methods are different in the logic of transmitting and perceiving educational information:

*The analytical* method involves the logical decomposition of the whole into parts in order to study their essential features and properties.

*Inductive* - generalization of the studied paths of biochemical transformations from single to general.

*Deductive* - based on the study of educational material from general to separate, single.

*The traductive* implies conclusions from the single to the singular, from the partial to the partial, from the general to the general.

10.3. Methods of different levels of independence of thinking:

*Problem* involves the creation of a problem situation by the teacher, assistance to applicants in identifying and "accepting" a problem task.

*Partially-exploratory* includes applicants in the search for ways, techniques and means of solving a cognitive task.

*The research method* is aimed at involving applicants in the independent solution of a cognitive task using the necessary equipment.

## **11. Methods and forms of control, distribution of points received by applicants**

*Current control:*

- independent work of the student in the workbook, which is carried out outside of classroom time.
- test control (performance of standardized test tasks of format "A" from collections of tasks for passing the test exam "Step 1");
- oral survey of theoretical material, based on the student's elaboration of theoretical issues from the methodological recommendations of the department;
- performance of practical work with the obligatory formulation of conclusions on the results of biochemical studies;
- solution of a situational problem close to clinical cases in medicine.

### **Distribution of points received by students during the current control:**

| Trad. Evaluation | point | Conversion to points |                |               |      |                 |       |
|------------------|-------|----------------------|----------------|---------------|------|-----------------|-------|
|                  |       | oral                 | tests. Control | Prakt. Skills | oral | situation. Task | SRZd* |
| "5"              | 17    | 3.0                  | 3.0            | 2.5           | 2.8  | 3.0             | 2.7   |
| "4"              | 14    | 2.5                  | 2.5            | 2.0           | 2.3  | 2.5             | 2.2   |
| "3"              | 12    | 2.1                  | 2.1            | 1.8           | 2.1  | 2.1             | 1.8   |
| "2"              | 0     | 0                    | 0              | 0             | 0    | 0               | 0     |

SRS\* - independent work of the student

\* Independent work of the applicant is a generally mandatory task that the applicant must complete for each practical lesson (synopsis according to theoretical issues, performing tasks in a workbook, preparing a protocol for practical work, studying vocabulary and terminology, working out additional literature in Ukrainian and English according to the methodological recommendations of the department).

### **Distribution of points received by the applicant for the discipline:**

| Num<br>ber of<br>classes | Ongoing assessment and independent<br>work |     |     |     | IRZd* | Sum of points<br>per discipline |
|--------------------------|--------------------------------------------|-----|-----|-----|-------|---------------------------------|
|                          | «5»                                        | «4» | «3» | «2» |       |                                 |
| 10                       | 17                                         | 14  | 12  | 0   | 5-30  | 0-200                           |

IRZd\* - individual work of the applicant

Individual work of the applicant is carried out under the guidance of a teacher (supervisor), which contributes to the deepening of knowledge in the discipline in the form of preparing essays on research topics of the department (participation in research and registration of scientific results in the form of publications, speeches at conferences), obtaining prizes at the university or all-Ukrainian Olympiad.

The final form of control is a differentiated test, which consists in assessing the assimilation of the educational material of the discipline by the applicant on the basis of the results of current training, the implementation of individual and control measures. The total number of points for the discipline must be at least 111 points and not more than 200 points. When assigning a differentiated test, the applicant is given the right to retake unsatisfactory grades no later than three days before the final control in order to accumulate the minimum number of points for enrollment in the discipline.

Correspondence of scales of assessment of the quality of assimilation of educational material.

| National scale<br>score | Score in<br>points | Score on<br>the scale<br>ECTS | Explanation                                                           |
|-------------------------|--------------------|-------------------------------|-----------------------------------------------------------------------|
| «5»<br>Excellent        | 170-200            | A                             | Excellent (excellent performance with only a small number of errors). |
| «4»                     | 155-169            | B                             | Very good (above average with a few bugs).                            |

|                       |         |    |                                                                                   |
|-----------------------|---------|----|-----------------------------------------------------------------------------------|
| Good                  | 140-154 | C  | Good (in general, correct execution with a certain number of significant errors). |
| «3»<br>Satisfactory   | 125-139 | D  | Satisfactory (not bad, but with a significant number of drawbacks).               |
|                       | 111-124 | E  | Enough (performance meets the minimum criteria).                                  |
| «2»<br>Unsatisfactory | 60-110  | FX | Unsatisfactory (with the possibility of reassembly).                              |
|                       | 1-59    | F  | Unsatisfactory (with the obligatory re-study of the discipline).                  |

### **Policy of the academic discipline.**

Mandatory observance of academic integrity by students:

- independent performance of all types of work, tasks, forms of control, which provide for the mastering of the academic discipline;
- references to sources of information in case of using ideas, developments, statements, information;
- compliance with the norms of legislation on copyright and related rights;
- providing reliable information about the results of their own (educational, scientific, creative) activities, research methods and sources of information;
- In case of non-compliance with the norms and principles of academic integrity, points for the performance of any forms and types of control are canceled in full with the provision of a confirmed fact of plagiarism.

### **12. Methodological support:**

- work program of the academic discipline;
- syllabus of the academic discipline;
- textbooks, manuals in accordance with the list of references;
- multimedia lectures;
- methodological recommendations for practical classes;
- methodological recommendations for independent work of the student;
- Electronic version:

- <https://nmuofficial.com/zagalni-vidomosti/kafedri/departament-bioorganic-biological-chemistry/>
- <https://likar.nmu.kyiv.ua/>
- workbooks;
- electronic bank of test tasks STEP 1 for current and final control of students' academic performance;
- Cases of situational problems and clinical situations for current and final control of student performance with examples of solution.

### **13. Recommended Reading**

1. Biological Chemistry: textbook/ Yu. I. Gubskiy; Bogomolets National Medical University. - 3rd ed. - Vinnytsia: Nova Knyha, 2020. - 488 p.
2. Kaplan medikal USMLE Step-1 Lecture Notes 2020: biochemistry and Medical Genetics /ed. S.Turco. - New York: Kaplan Medical, 2020. - 403 p.

### **14. Information resources:**

- <https://nmuofficial.com/zagalni-vidomosti/kafedri/departament-bioorganic-biological-chemistry/>
- <https://likar.nmu.kyiv.ua/>