

# NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCE

Department of Ecobiotechnology and Biodiversity

**“CONFIRMED”**

Dean of the Faculty of plant protection,  
biotechnologies and ecology  
\_\_\_\_\_ Julia KOLOMIETS  
“21” May 2026 p.

**“APPROVED”**

at the meeting of the department  
of Ecobiotechnology and Biodiversity  
Minutes № 13 dated “19” May 2026  
Head of Department  
of Ecobiotechnology and Biodiversity  
\_\_\_\_\_ Olena KVASKO

**«REVIEWED»**

Guarantor of the OP ‘Biotechnology and Bioengineering’  
\_\_\_\_\_ Olena KVASKO

## WORK PROGRAMME FOR THE ACADEMIC DISCIPLINE

### “BIOTECHNOLOGY FOR THE PRODUCTION OF MICROBIAL PREPARATIONS FOR AGRICULTURE”

Field of knowledge 16 ‘Chemical and Bioengineering’

Speciality 162 ‘Biotechnology and Bioengineering’

Educational programme Biotechnology and Bioengineering

Faculty of Plant Protection, Biotechnology and Ecology

Developers: Doctor of Agricultural Sciences, Associate Professor Boroday V.V.

## Description of the academic discipline

### **“Biotechnology for the production of microbial preparations for agriculture”**

The discipline ‘Biotechnology of microbial preparations for agriculture’ introduces students to modern environmentally friendly agricultural technologies, namely the theoretical and practical foundations of industrial production of microbial preparations for agriculture. The course covers the basics of creating biological preparations: selection of highly active strains of producer microorganisms, principles of creating nutrient media, optimisation of deep cultivation of producers, which ensures maximum titre of viable cells and synthesis of target metabolites, development of dosage forms and quality control standards for biological preparations.

<b>Field of knowledge, specialisation, educational programme, educational degree</b>		
Educational level	Bachelor	
Speciality	Speciality 162 ‘Biotechnology and Bioengineering’	
Educational programme	«Biotechnology and Bioengineering»	
<b>Characteristics of the academic discipline</b>		
Type	Mandatory	
Total number of hours	120	
Number of ECTS credits	4,0	
Number of content modules	2	
Course project (work) (if available)	30	
Form of assessment	Exam	
<b>Academic performance indicators for full-time and part-time forms of study</b>		
	full-time education	part-time study
Year of preparation (course)	3	
Semester	6	
Lectures	15 hours	
Practical, seminar classes	-	
Laboratory classes	30 hours	
Independent work	75 hours	
Individual tasks	-	
Number of weekly classroom hours for full-time study	3 hours	

## **1. Objectives, competencies and programme outcomes of the academic discipline**

**The aim of the discipline** is to provide students with a system of knowledge and practical skills for the creation, industrial production and application of highly effective, environmentally safe microbial preparations based on microorganisms to increase crop productivity and preserve soil fertility.

**The list of academic disciplines that precede the study are** “Biotechnology of microorganisms and virology”, “General biotechnology”, “Genetic foundations of biotechnology”, “Regulatory support of biotechnological production”.

### **Acquisition of competencies:**

**Integral competence (IC):** The ability to solve complex specialised tasks and practical problems characterised by complexity and uncertainty in biotechnology and bioengineering, or in the learning process involving the application of biotechnology and bioengineering theories and methods.

### **General competencies (GC):**

K01. Ability to apply knowledge in practical situations.

K05. Ability to learn and acquire modern knowledge.

K06. Skills for safe activity.

K09. Ability to preserve and multiply 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, technology and technologies, use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

### **Special (professional, subject-specific) competencies (SC):**

K12. Ability to use in-depth knowledge of chemistry and biology to the extent necessary to achieve other outcomes of the educational programme.

K14. Ability to work with biological agents used in biotechnological processes (microorganisms, fungi, plants, animals, viruses, their individual components).

K15. Ability to conduct experimental research on the improvement of biological agents, including inducing changes in the structure of the hereditary apparatus and functional activity of biological agents.

K19. Ability to draw up technological schemes for the production of biotechnological products for various purposes.

K20. Ability to develop technological schemes for the production of biotechnological products for various purposes.

K22. Ability to apply methods and means of automated design of production facilities for biotechnological products for various purposes in practice.

K23. Ability to evaluate the effectiveness of a biotechnological process.

### **Programme learning outcomes (PR):**

PR03. Be able to calculate the composition of nutrient media, determine the specifics of their preparation and sterilisation, and control the quality of raw materials

and finished products based on knowledge of the physical and chemical properties of organic and inorganic substances.

PR04. Be able to apply the provisions of regulatory documents governing the procedure for product certification, production certification, requirements for the organisation of quality management systems at enterprises, rules for the preparation of technical documentation and the conduct of technological processes, based on the knowledge gained during practical training.

PR13. Be able to carry out technical and economic justification of the production of biotechnological products for various purposes (determining the need for the target product and calculating production capacity).

PR14. Be able to justify the choice of biological agent, nutrient medium composition and cultivation method, necessary auxiliary work and the main stages of the technological process.

PR16. Based on the knowledge gained during practical training at enterprises and institutions, be able to perform product calculations and calculations for technological equipment.

PR20. Be able to calculate the main criteria for evaluating the effectiveness of the biotechnological process (growth parameters of biological agents, speed of synthesis of the target product, synthetic capacity of biological agents, economic coefficient, yield of the target product from the substrate, productivity, cost of the nutrient medium, etc.).

PR22. Be able to take into account social, environmental, ethical, economic aspects, occupational health and safety requirements, industrial hygiene and fire safety when developing technical solutions. Be able to use various types and forms of physical activity for active recreation and a healthy lifestyle.

PR25. Be able to use methods of microscopic research, monoclonal antibody technologies, antigens, immunodiagnostics, identification of antigens in plant tissues, isoenzymes and reserve proteins, DNA markers, basic principles of PCR, DNA probes, molecular genetic markers.

## 2. Programme and structure of the academic discipline

Names of content modules and topics	Number of hours													
	Full-time education							Part-time education						
	week s	in total	including					in tot al	including					
			l	p	lab	in d	ind p		l	p	la b	in d	imd p.	
<b>Module I. Theoretical foundations of microbial biotechnology in agriculture</b>														
<b>Topic 1.</b> The role of agrobiotechnology in modern agriculture	1-3	23	2		6		15							
<b>Topic 2.</b> Biotechnology for producing biofungicides, bioinsecticides, and biofertilisers	4-6	25	4		6		15							
<b>Topic 3.</b> Biostimulants and biodestructors of microbial origin in plant growing	7-9	23	2		6		15							
Total for content module 1	9		8		18		45							
<b>Module II. General principles of production and registration of biological products</b>														
<b>Topic 5.</b> Technologies for cultivation, stabilisation and	10-12	25	4		6		15							

formulation of preparations													
<b>Topic 6.</b> Quality control and certification of biological products	13-15	24	3		6		15						
Total for content module 2	6		7		12		30						
<i>Total hours</i>	15	120	15		30		75						

### 3. Lecture topics

№	Topic title	Number of hours
<b>Module I. Theoretical foundations of microbial biotechnology in agriculture</b>		
1	The role of biological products in modern agricultural production, classification and environmental aspects of use	2
2	Microbial biofertilisers for improving mineral nutrition of plants	2
3	Microbial biofungicides and bioinsecticides, biological plant protection	2
4	Microbial plant growth biostimulants	2
<b>Module II. General principles of production and registration of biological products</b>		
5	Microbial preparations for bioremediation and soil remediation.	2
6	The main stages of creating microbial preparations.	2
7	Registration of microbial biological products and entry into the domestic and international markets.	3

### 4. Topics of laboratory classes

№	Topic title	Number of hours
<b>Module I. Theoretical foundations of microbial biotechnology in agriculture</b>		
Work 1,2	Maintaining the viability of strains and preserving collections of microorganism cultures.	4
Work 3,4	Optimisation of the nutrient medium and conditions for deep cultivation of strains.	4
Work 5,6	Assessment of antagonistic activity of producer strains. Determination of compatibility of biological products with pesticides.	4
Work 7,8	Verification of the stimulating effect of biological preparations on seed germination energy.	4
<b>Module II. General principles of production and registration of biological products</b>		
Work 9,10	Modelling the composting process using destructors.	4
Work 11,12	Technology for preparing and stabilising the liquid form of a microbial preparation.	4
Work 13-15	Determination of the titre and viability of microorganisms in the finished biological product.	6

### 5. Topics for independent work

№	Topics for independent work	Number of hours
1	Consortia of bacteria and fungi as the basis for biological products.	20
2	Mechanisms of action of endophytic bacteria of the PGP group.	20
3	Mechanism of action of endophytic fungi of the PGP group.	15
4	Mechanisms of action of yeasts of the genus <i>Rhodotorula</i> of the PGP group.	15

### 6. Methods and means of diagnosing learning outcomes:

- oral or written examination;

- interview;
- testing;
- defence of practical work;

### **7. Teaching methods:**

- problem-based learning method;
- practice-oriented learning method;
- learning through research method;
- educational discussions and debates method;
- teamwork and brainstorming method

### **8. Assessment of learning outcomes.**

The assessment of higher education applicants' knowledge is based on a 100-point scale and is converted into a national assessment in accordance with the current 'Regulations on Examinations and Tests at the National University of Life and Environmental Sciences of Ukraine'.

#### **8.1. Distribution of points by type of educational activity**

Type of educational activity	Learning outcomes	Assessment
<b>Module I. Theoretical foundations of microbial biotechnology in agriculture</b>		
Laboratory work 1,2. Maintaining the viability of strains and preserving collection cultures of microorganisms.	PR14. Be able to justify the choice of biological agent, nutrient medium composition and cultivation method, necessary auxiliary work and the main stages of the technological process. This includes knowledge of the characteristics of pre-fermentation processes. This includes knowledge of the characteristics of maintaining the viability of strains and preserving collection cultures of microorganisms.	<b>15</b>
Laboratory work 3,4. Optimisation of the nutrient medium and conditions for submerged cultivation of strains.	PR03. Be able to calculate the composition of nutrient media, determine the specifics of their preparation and sterilisation, and control the quality of raw materials and finished products based on knowledge of the physical and chemical properties of organic and inorganic substances. This includes knowing the principles of optimising the nutrient medium and conditions for deep cultivation of strains.	<b>15</b>
Laboratory work 5,6. Evaluation of the antagonistic activity of producer strains. Determination of the compatibility of biological products with pesticides.	PR25. Be able to use methods of microscopic research, monoclonal antibody technologies, antigens, immunodiagnostics, identification of antigens in plant tissues, isoenzymes and reserve proteins, DNA markers, basic principles of PCR, DNA probes, molecular genetic markers. This includes knowing the specifics of assessing the antagonistic activity of producer strains and determining the compatibility of biological products with pesticides.	<b>15</b>
Laboratory work 7,8. Verification of the stimulating effect of biological preparations on seed germination energy.	PR03. Be able to calculate the composition of nutrient media, determine the specifics of their preparation and sterilisation, and control the quality of raw materials and finished products based on knowledge of the physical and chemical properties of organic and inorganic substances. This includes knowing the principles of optimising the nutrient medium and conditions for deep cultivation of strains. Including knowledge of the specifics of testing the stimulating effect of biological products on seed germination energy.	<b>15</b>
Independent work 1, 2. Consortia of bacteria and fungi as the basis for biological products. Mechanisms of action of endophytic bacteria of the PGPB group.	PR14. Be able to justify the choice of biological agent, nutrient medium composition and cultivation method, necessary auxiliary work and the main stages of the technological process. This includes knowledge of the characteristics of pre-fermentation processes. Including knowledge of consortia of bacteria and fungi as the basis of biological products, mechanisms of action of endophytic bacteria of the PGPB group.	<b>10</b>

Modular test 1.		<b>30</b>
<b>Total for Module 1</b>		<b>100</b>
<b>Module II. General principles of production and registration of biological products</b>		
Laboratory work 9,10. Modelling the composting process using destructors.	PR12. Using microbiological, chemical, physical, physicochemical and biochemical methods, be able to perform chemical control (determination of the concentration of disinfectant solutions, titration agents, concentration of nutrient medium components, etc.), technological control (concentration of carbon and nitrogen sources in the culture fluid during the process; concentration of the target product); microbiological control (determination of the microbiological purity of nutrient media after sterilisation, microbiological purity of biological agents, etc.), microbiological purity and sterility of biotechnological products for various purposes. This includes the ability to model composting processes using destructors.	<b>20</b>
Laboratory work 11,12. Technology for preparing and stabilising the liquid form of a microbial preparation.	PR13. Be able to carry out technical and economic justification of the production of biotechnological products for various purposes (determining the need for the target product and calculating production capacity). PR04. Be able to apply the provisions of regulatory documents governing the procedure for product certification, production certification, requirements for the organisation of quality management systems at enterprises, rules for the preparation of technical documentation and the conduct of technological processes, based on the knowledge gained during practical training. PR16. Based on the knowledge gained during practical training at enterprises and institutions, be able to perform product calculations and calculations for technological equipment. PR20. Be able to calculate the main criteria for evaluating the effectiveness of a biotechnological process (growth parameters of biological agents, speed of synthesis of the target product, synthesis capacity of biological agents, economic coefficient, yield of the target product from the substrate, productivity, cost of the nutrient medium, etc.).	<b>20</b>
Laboratory work 13-15. Determination of the titre and viability of microorganisms in the finished biological product.	PR14. Be able to justify the choice of biological agent, nutrient medium composition and cultivation method, necessary auxiliary work and the main stages of the technological process. This includes knowledge of the characteristics of pre-fermentation processes. This includes knowledge of the characteristics of fermentation and post-fermentation processes. PR22. Be able to take into account social, environmental, ethical, economic aspects, occupational health and safety requirements, industrial hygiene and fire safety when developing technical solutions. Be able to use various types and forms of physical activity for active recreation and a healthy lifestyle. This includes being able to determine the titre and viability of microorganisms in a finished biological product.	<b>20</b>
Independent work 3,4. Mechanism of action of endophytic fungi of the PGP group. Mechanisms of action of yeasts of the genus <i>Rhodotorula</i> of the PGP group.	PR14. Be able to justify the choice of biological agent, nutrient medium composition and cultivation method, necessary auxiliary work and the main stages of the technological process. This includes knowledge of the characteristics of pre-fermentation processes. Including knowledge of the characteristics of fermentation and post-fermentation processes. Including knowledge of the characteristics of the mechanisms of action of endophytic fungi of the PGP group, the mechanisms of action of yeasts of the <i>Rhodotorula</i> genus of the PGP group.	<b>10</b>
Modular test 2.		<b>30</b>
<b>Total for module 2</b>		<b>100</b>
<b>Coursework</b>	<b>(M1 + M2)/2*0,7 ≤ 70</b>	
<b>Exam</b>	<b>30</b>	
<b>Total for the course</b>	<b>(Coursework + exam) ≤ 100</b>	

## 8.2. Knowledge assessment scale for higher education applicants

Higher education applicant rating, points	Assessment according to the national system (exams/tests)
90-100	excellent
74-89	good
60-73	satisfactory
0-59	unsatisfactory

## 8.3. Assessment policy

<b>Deadline and Resit Policy</b>	Assignments that are submitted late without valid reasons will receive a lower grade. Modules may be retaken with the lecturer's permission if there are valid reasons (e.g., sick leave).
<b>Academic Integrity Policy</b>	Cheating during tests and exams is prohibited (including the use of mobile devices). Coursework and essays must contain correct text references to the literature used.
<b>Attendance Policy</b>	Attendance at classes is compulsory. For objective reasons (e.g. illness, international internship), training may take place individually (online, subject to agreement with the dean of the faculty).

## 9. Teaching and methodological support:

- electronic training course for the academic discipline (on the educational portal of the National University of Life and Environmental Sciences of Ukraine eLearn - <https://elearn.nubip.edu.ua/course/view.php?id=2012>);
- links to digital educational resources;
- methodological materials for studying the academic discipline for full-time and part-time higher education students.

## 10. Recommended sources of information

1. Enzymatic technologies for the production of microbial preparations for agriculture: textbook / Compiled by: O. V. Lobova. Kyiv: National University of Life and Environmental Sciences of Ukraine, 2020. 301 p.
2. Bouizgarne, Brahim & Arora, Naveen. (2022). Microbial BioTechnology for Sustainable Agriculture Volume 1. 10.1007/978-981-16-4843-4.
3. Arora, N. K., & Bouizgarne, B. (Eds.). (2024). Microbial Biotechnology for Sustainable Agriculture Volume 2. Springer Nature Singapore. <https://link.springer.com/book/10.1007/978-981-97-2355-3>.
4. Boroday V.V. Industrial biotechnology. Textbook (підручник з промислової біотехнології англійською мовою). К.: Видавничий центр Компрінт, 2020. 280 с.
5. Boroday V.V. et al. Textbook for the discipline 'Industrial biotechnology' (reprinted in 2015) 'Laboratory Manual for Industrial biotechnology' Kyiv: Agrar Media Group LLC, 2022. 300 p.
6. Biologically active substances in food products: methodological guidelines for laboratory work and independent work for students majoring in Chemistry (102) in

full-time programmes / compiled by G. O. Santalova. Kramatorsk: DDMA, 2023. 68 p.

7. Chemical and biopharmaceutical technologies: collection of scientific papers / by general ed. V. Bessarabov, V. Lubenets. Tallinn: Nordic Sci Publisher, 2023. 392 p.

8. Gumeniuk I., Boroday V., Symochko V. et al. The role of *Bradyrhizobium japonicum* exopolysaccharides in the formation of an effective symbiotic apparatus of soybean. *Agronomy Research*. 2020. Vol. 18, No. 3.

9. Borzykh O. I., Sergiienko V. G., Tytova L. V., Biliavska L. O., Boroday V. V., Tkalenko G. M. & Balan G. O. Potential of some bioagents in fungal diseases controlling and productivity enhancement of tomatoes. *Archives of Phytopathology and Plant Protection*, (2022). 55:15, 1750-1765.

10. Borodai V., Kolomiets Yul., Likhanov A., Zelena L., Butsenko L., Shemetun K., Churilov A., Blume Y. The Growth-promoting and Antipathogenic Effects of Microorganisms Isolated from *Solanum nigrum* L. and Inoculated in *Solanum lycopersicum* L. *The Open Agriculture Journal*. 16. (2022).

11. Bolokhovskiy, Vladyslav & Nagorna, Olga & Bolokhovska, Valentyna & Yakovenko, Dmytro & Boroday, Vira & Zelena, Liubov & Likhanov, Artur & Bukhonska, Yaroslava. (2024). The Role of Biologicals Azotohelp®, Liposam®, and Organic-Balance® as Mitigators of Abiotic Stress in Maize Plants. 10.4018/979-8-3693-8307-0.ch018. In book: Sustainable Soil and Water Management Practices for Agricultural Security. Information Science Reference; IGI Global. 495 – 526.

12. Madera-Santana TJ, Barreras-Urbina CG, Rodríguez-Félix F and Ancín M (2024) Editorial: Green technologies for the extraction of bioactive compounds, its use for the production of nanomaterials, and their application in the food industry. *Front. Sustain. Food Syst.* 8:1457532.