NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE

Department of Ecobiotechnology and Biodiversity

"**CONFIRMED**"
Dean of the Faculty of plant protection, biotechnologies and ecology
_____ Julia KOLOMIETS
"_" _____ 2025 p.

"**APPROVED**"
at the meeting of the department of Ecobiotechnology and Biodiversity
Minutes № 10 dated "21" May 2025
Head of Department
of Ecobiotechnology and Biodiversity
_____ Olena KVASKO

"**REVIEWED** "
Guarantor of the AP "Biotechnologies and bioengineering"
_____ Olena KVASKO

CURRICULUM OF ACADEMIC DISCIPLINE

" INDUSTRIAL BIOTECHNOLOGY"

Area of knowledge 16 "Chemical and Bioengineering"
Specialty 162 "Biotechnologies and bioengineering"
Academic programme Biotechnologies and bioengineering
Faculty of plant protection, biotechnologies and ecology
Developed by: **A**ssociate professor, Doctor of Agr.Science Boroday V.V.

Kyiv – 2025

Description of the discipline
"Industrial Biotechnology"

The discipline of "Industrial Biotechnology" provides students with a comprehensive understanding of the principles and technologies involved in large-scale production using biological systems. This course delves into the utilization of microorganisms and cell cultures as producers, focusing on optimizing their cultivation conditions and scaling up bioprocesses from laboratory to industrial levels, modern biotechnological equipment and master effective methods for isolating and purifying target products. Furthermore, the course explores genetic and metabolic engineering strategies aimed at enhancing strain productivity.

Area of knowledge, specialty, academic programme, academic degree		
Academic degree	Biotechnology	
Specialty	162 «Biotechnology and bioengineering »	
Academic programme	«Bachelor»	
Characteristics of the discipline		
Type	regulatory	
Total number of hours	120	
Number of ECTS credits	4,0	
Number of content modules	2	
Course project (work)	30	
Form of assessment	Exam	
Indicators discipline for full-time and distance learning		
	full-time form of education	external form of education
Year of study	3	
Term	6	
Lectures	45	
Practical classes and seminars	-	
Laboratory classes	45 h	
Self-study	30 h	
Number of hours per week for full-time students	6,0 h	

1. Aim, competences and expected learning outcomes of the discipline

"Industrial Biotechnology"

Aim of study of discipline is a capture to knowledge and abilities of cultivation of separate strains of industrial microorganisms students, by the methods of selection of biological agents for the receipt of separate products, government of cultivation of microorganisms, control of quality of the got product, directions of application of products of biotechnology, determination of them processes bases ecological safety, especially created on the basis of the genetically modified microorganisms. A course foresees preparation of bachelor and leans against knowledge of disciplines which form a specialist for different industries of national economy, including agroindustrial production.

Acquisition of competences:

Integral competence (IC): The ability to solve complex specialized tasks and practical problems characterized by complexity and uncertainty in biotechnology and bioengineering, or in the process of learning that involves the application of biotechnology and bioengineering theories and methods.

General competence (GC):

K01. Ability to apply knowledge in practical situations

K05. Ability to learn and master modern knowledge

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 engineering, to use various types and forms of physical activity for active recreation and leading a healthy lifestyle.

Special (professional) competence (SC):

K14. Ability to work with biological agents used in biotechnological processes (microorganisms, fungi, plants, animals, viruses, their individual components).K16. Consideration of the commercial and economic context in the design of biotechnological products for various purposes (industrial, food, pharmaceutical, agricultural, etc.).

K18. Ability to select and use appropriate equipment, tools and methods for the implementation and control of biotechnological products for various purposes.

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

K22. Ability to evaluate the effectiveness of the biotechnological process.

K24. Ability to comply with biosafety, biosecurity and bioethics requirements

Expected learning outcomes (ELO):

ELO 03. To be able to calculate the composition of nutrient media, determine the features of their preparation and sterilization, to control the quality of raw materials and finished products based on knowledge of the physical and chemical properties of organic and inorganic substances.

ELO 04. To be able to apply the provisions of regulatory documents governing the procedure for product certification, production certification, requirements for the organization of quality management systems at enterprises, rules for the preparation of technical documentation and technological process, based on the knowledge gained during practical training.
ELO 08. Be able to isolate and identify microorganisms of different systematic groups from natural substrates. Determine the morphological, cultural, physiological and biochemical properties of various biological agents.
ELO 09. Be able to prepare basic nutrient media for the cultivation of various biological agents. Evaluate the growth characteristics of biological agents on media of different composition.
ELO 12. Using microbiological, chemical, physical, physicochemical and biochemical methods, be able to carry out chemical control (determination of the concentration of disinfectant solutions, titration agents, concentration of culture medium components, etc.), technological control (concentration of carbon and nitrogen sources in the culture liquid during the process; concentration of the target product); microbiological control (determination of the microbiological purity of culture media after sterilisation, microbiological purity of a biological agent, etc,)
ELO 13. To be able to carry out a feasibility study for the production of biotechnological products for various purposes (determination of the need for the target product and calculation of production capacity).
ELO 14. To be able to justify the choice of biological agent, composition of the culture medium and method of cultivation, necessary auxiliary works and the main stages of the technological process.
ELO 16. Based on the knowledge gained during internships at enterprises and institutions, be able to make product calculations and calculations of technological equipment.
ELO 22. To be able to take into account social, environmental, ethical, economic aspects, labour protection, occupational health and safety and fire safety requirements when formulating technical solutions. Be able to use different types and forms of physical activity for active recreation and healthy lifestyle.

2. Programme and structure of the discipline

“Industrial biotechnology”

Modules and topics	Number of hours											
	Full-time form						Part-time form					
	Total	including					Total	including				
		Lec	pr	lab	ind	ind		Lec	pr	lab	ind	ind
Module 1. Fermentation processes in the biotechnology industry												
Topic 1. History and achievements of industrial biotechnology.	15	8		5		5						
Theme 2. General characteristics of industrial strains of microorganisms.	17	7		5		5						
Total for module 1	32	15		10		30						

Module 2. Main stages of biotech process												
Topic 1. Classification and characterization of the fermentation process.	15	8		5		15						
Theme 2. Characteristics of the main stage biotech industries	17	7		5		15						
Total for module 2	32	15		10		10						
Topic 3. Biotechnology products of microbial synthesis.	16	8		5		5						
Theme 4. Industrial biotechnology in agriculture.	16	7		5		5						
Course project	32											
Total for module 3	31	15		10		30						
Total hours	120	45		30		45						

3. Topics of lectures

No.	Topic	Hours
	Module 1. Fermentation processes in the biotechnology industry	
1	History and achievements of industrial biotechnology	4
2	Methods of Industrial Biotechnology	4
3	Upstream Processing. Raw materials for fermentation media	4
4	UPS. Large scale sterilization	4
5	Metabolic pathways for the biosynthesis of industrial biotechnology products	4
6	The types of metabolism of microorganisms	4
	Module 2. Main stages of biotech process	
7	Microorganisms producentes. Methods of isolation, improvement.	4
8	The main ways of producer microorganisms overproduction, characteristics of growth curve	4
9	Structure and types of fermenters. Classification of fermentation procsses	4
10	Stages of Downstream Processing	4

4. Topic of laboratory classes

Number	Topic	Hours
	Module 1 Fermentation processes in the biotechnology industry	
Lab 1	Equipment and Materials of Laboratory of Industrial Biotechnology. Methods of sterilization equipment and culture media. Principles and methods for culturing microorganisms-producers	4
Lab 2	Principles of nutrient media in biotech manufacturing. Cultivation of microorganisms - antagonists on selective nutrient media	4
	Module 2. Main stages of biotech process	
Lab 3,4	Initial screening of microorganisms - antagonists in rhizosphere of plants. Isolation of pure cultures of microorganisms - antagonists	6
Lab 5,6	The investigation of microbial antagonism. Determination of the sensitivity of microorganisms to antibiotics.	6
Lab 7	Citric Acid Production by *Aspergillus niger*	6

5. Topics of self-study

№	Topic	Hours
1	Transformation of organic compounds. Examples of transformations and advantages of using microbial transformations	14

	compared to chemical synthesis methods.	
2	Types of microbial transformations. Microorganisms that carry out transformations.	10
3	Production of steroid preparations. Production of isolimic, ketoglutaric, malic, succinic acids.	10
4	Protein production. Producer strains. Raw material base. The process of growing microorganisms. Requirements for the quality of the finished product.	10
5	Microbiological production of renewable energy sources. Production of lower alcohols, acetone, methane by bioconversion of organic waste and vegetable raw materials.	10
6	Methane producing bacteria. Prospects of hydrogen production. Heat production by aerobic oxidation of organic substances (waste).	10
7	Use of microorganisms for oil and coal extraction. Microbiological extraction of metals.	10
8	Food toxic infections and toxicosis. General principles of microbiological control of finished products in the food industry.	10
9	Microscopic control. Accounting on special media. Sanitary and hygienic control of equipment, production materials, hands and clothing of workers. Control scheme, principles of scheme construction depending on the specificity of production.	10

6. Methods of assessing expected learning outcomes:

- oral or written survey;
- interview;
- test;
- defending laboratory works, projects;

7. Teaching methods *(select necessary or add):*

- problem-based method;
- practice oriented studying method;
- project education method;
- research based method;
- learning discussions and debates method;
- team work, brainstorm method

8. Results assessment.

The student's knowledge is assessed by means of a 100-point scale converted into the national grades according to the "Exam and Credit Regulations at NULES of Ukraine" in force

8.1. Distribution of points by types of educational activities

Educational activity	Results	Assessment
Module 1. Fermentation processes in the biotechnology industry		
Laboratory work 1. Equipment and Materials of Laboratory of Industrial Biotechnology. Methods of sterilization equipment and culture media. Principles and methods for	***ELO*** 09. Be able to prepare basic nutrient media for the cultivation of various biological agents. Evaluate the growth characteristics of biological agents on media of different composition. Including knowing about methods for sterilizing equipment and culture media.	**10**

culturing microorganisms-producers. Including knowing about methods for sterilizing equipment and culture media.		
Laboratory work 2. Principles of nutrient media in biotech manufacturing. Cultivation of microorganisms - antagonists on selective nutrient media	***ELO*** 03. To be able to calculate the composition of nutrient media, determine the features of their preparation and sterilization, to control the quality of raw materials and finished products based on knowledge of the physical and chemical properties of organic and inorganic substances. Including knowing the principles of preparing nutrient media in biotechnological production	**10**
Self-study 1. Upstream processes and fermentation	***ELO*** 14. To be able to justify the choice of biological agent, composition of the culture medium and method of cultivation, necessary auxiliary works and the main stages of the technological process. Including knowing the features of pre-fermentation processes	**15**
Self-study 2. Fermentation process	***ELO*** 14. To be able to justify the choice of biological agent, composition of the culture medium and method of cultivation, necessary auxiliary works and the main stages of the technological process. Including knowing the features of fermentation processes	**35**
Module control work 1.		**30**
Total for module 1		**100**
Module 2. Main stages of biotech process		
Laboratory work 3,4. Initial screening of microorganisms - antagonists in rhizosphere of plants. Isolation of pure cultures of microorganisms - antagonists	***ELO*** 08. Be able to isolate and identify microorganisms of different systematic groups from natural substrates. Determine the morphological, cultural, physiological and biochemical properties of various biological agents. Including knowing about the isolation of microorganisms that produce biologically active substances from the soil, researching their biological activity. Including being able to determine antagonism between microorganisms.	**10**
Laboratory work 5,6. The investigation of microbial antagonism. Determination of the sensitivity of microorganisms to antibiotics.	***ELO*** 12. Using microbiological, chemical, physical, physicochemical and biochemical methods, be able to carry out chemical control (determination of the concentration of disinfectant solutions, titration agents, concentration of culture medium components, etc.), technological control (concentration of carbon and nitrogen sources in the culture liquid during the process; concentration of the target product); microbiological control (determination of the microbiological purity of culture media after sterilisation, microbiological purity of a biological agent, etc,)	**10**

Laboratory work 7. Citric Acid Production by *Aspergillus niger*	***ELO*** 09. Be able to prepare basic nutrient media for the cultivation of various biological agents. Evaluate the growth characteristics of biological agents on media of different composition. Including knowing the principles of preparing nutrient media in biotechnological production	**10**
Self-study 3. Different types of industrial biotechnological process	***ELO*** 14. To be able to justify the choice of biological agent, composition of the culture medium and method of cultivation, necessary auxiliary works and the main stages of the technological process. Including knowing the different types of industrial biotechnological process	**40**
Module control work 2.		**30**
Total for module 2		**100**
Class work		**(M1 + M2)/2*0,7 ≤ 70**
Exam/credit		**30**
Total for year		**(Class work + exam) ≤ 100**
Course project/work		**100**

8.2. Scale for assessing student's knowledge

Student's rating, points	National grading (exam/credits)
90-100	excellent
74-89	good
60-73	satisfactory
0-59	unsatisfactory

8.3. Assessment policy

Deadlines and exam retaking rules	Works that are submitted late without valid reasons will be assessed with a lower grade. Module tests may be retaken with the permission of the lecturer if there are valid reasons (e.g. a sick leave).
Academic integrity rules	Cheating during tests and exams is prohibited (including using mobile devices). Term papers and essays must have correct references to the literature used
Attendance rules	Attendance is compulsory. For good reasons (e.g. illness, international internship), training can take place individually (online by the faculty dean's consent)

9. Teaching and learning aids:

- e-learning course of the discipline (*https://elearn.nubip.edu.ua/course/view.php?id=2302) MANDATORY*;
- references to digital educational resources;
- textbooks, manuals, tutorials;
- guidelines for studying a discipline by full-time and part-time students;

10. Recommended sources of information

1. Навчальний посібник для дисципліни "Industrial biotechnology", Бородай В.В., Кляченко О.Л., Мельничук М.Д. «Laboratory Manual for Industrial biotechnology». Київ: ТОВ «Аграр Медіа Груп», 2022. 300 с.
2. Wittmann, C., & Liao, J. (2016). Industrial Biotechnology (1st ed.). Wiley. Retrieved from https://www.perlego.com/book/991782/industrial-biotechnology-products-and-processes-pdf (Original work published 2016)
3. Boroday V.V. Industrial biotechnology: text book for "Bachelor" students of speciality 162 «Biotechnology and bioengineering. Publishing house “Komprint”, 2020. 267 p.
4. Біотехнологія мікробного синтезу: навчальний посібник. НУБіП України. Патика Т.І., Патика М.В. Вінниця: ТОВ «Нілан-ЛТД», 2018: 272.
5. Загальна (промислова) біотехнологія: навчальний посібник/ М.Д. Мельничук, О.Л.Кляченко, В.В.Бородай, Ю.В.Коломієць. Вінниця: ТОВ «Нілан-ЛТД», 2014. 253 с.
6. Буценко Л.М., Пенчук Ю.М., Пирог Т.П. Технології мікробного синтезу лікарських засобів: навч. посіб. К.: НУХТ, 2010.- 323 с.
7. Біотехнологія: Підручник / В.Г. Герасименко, М.О. Герасименко, М.І. Цвіліховський та ін.; Під общ. ред. В.Г. Герасименка. К.: Фірма «ІНКОС», 2006. 647 с.
8. Пирог Т.П. Загальна мікробіологія: підручник / Пирог Т.П. К.: НУХТ, 2004. 471 с.
9. Пирог Т.П. Загальна біотехнологія: підручник / Т.П. Пирог, О.А. Ігнатова. К.: НУХТ, 2009. 336 с.
10. Юлевич О. І., Ковтун С. І., Гиль М. І. Біотехнологія : навчальний посібник. Миколаїв : МДАУ, 2012. 476 с.
11. https://link.springer.com/chapter/10.1007/978-3-540-88546-7_30
12. https://galychyna.com.ua/
13. https://obolon.ua/ua
14. https://zakon.rada.gov.ua/laws/show/771/97-%D0%B2%D1%80#Text