

Ministry of Education and Science of Ukraine
Sumy National Agrarian University
Faculty of Agricultural Technologies and Environmental Management
Department of Ecology and Botany

Work program (syllabus) of the educational component

Microbiology with basics of virology

(selective)

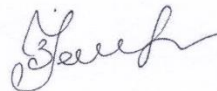
Educational program	Agronomy
Specialty	H1 Agronomy
Level of higher education	first level (bachelor's degree)

Sumy – 2026

Developer:  **Halyna ZHATOVA**, Professor, Candidate of Agricultural Sciences,
Professor of the Department of Ecology and Botany

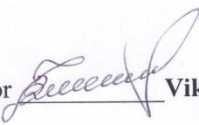
Considered, approved
and ratified at a meeting **Protocol No. 12 dated 08.05. 2026**
of the Department of
Ecology and Botany

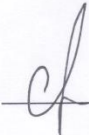
Manager
departments



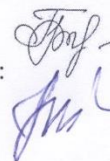
Inna ZUBTSOVA

Agreed:

Educational program guarantor  **Viktor ONYCHKO**

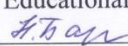
Dean of the faculty where the educational program is implemented  **Serhiy GORBAS**

A review of the work program (attached) was provided by:
BONDAIeva(attached)



Lyudmila

V. Trotsenko

Methodologist of the Department of Educational Quality,
licensing and accreditation  **Nadiya BARANIK**

Registered in the electronic database: date: 18.06. 2026.

Information on reviewing the work program (syllabus):

The academic year in which are introduced changes	Number of the appendix to the work program with a description of the changes	Changes reviewed and approved		
		Date and number of the minutes of the department meeting	Head of the Department	Guarantee educational programs

1. GENERAL INFORMATION ABOUT THE EDUCATIONAL COMPONENT

1.	Name OK	Microbiology with the basics of virulence		
2.	Faculty/Department	Agrotechnology and Environmental Management, Department of Ecology and Botany		
3.	Status OK	selective		
4.	Program/Specialty(s) that include OK for (to be filled in for mandatory OKs)	For mandatory OKs - the name of the OP is indicated,		
5.	OK can be offered for (to be filled in for selective OKs)	Provide a list of OPs to whom this OK can be taught 101 Ecology, 162 Biotechnology and Bioengineering		
6.	NRC level	Level 6		
7.	Semester and duration of study	4th semester, 15 weeks. /3rd semester		
8.	Number of ECTS credits	5, (150 hours)		
9.	Total hours and their distribution	Contact work (classes)		Independent work
		Lectures 30/8	Practical /seminar 30/8	90/134
10.	Language of instruction	Ukrainian		
11.	Teacher/Educational Component Coordinator	Zhatova G.O.		
12.	Contact information	K.34 in, (building of the Faculty of Veterinary Medicine) Gzhatova@ukr.net		

13.	General description of the educational component	OK forms knowledge about the characteristics of microorganisms, their biology and physiology, microbiological processes occurring in the soil and on plants, the role of microorganisms in the cycle of organic and inorganic substances in the biosphere, the consequences of the influence of environmental factors on microorganisms, ways to control the vital activity of microorganisms using various factors, methods of changing the genome of microorganisms, features of the use of microbiological preparations in agriculture, plant production and plant protection. The study of OK will allow us to effectively influence the activity of microorganisms in the coenoses of agricultural crops, evaluate, interpret and synthesize theoretical information and practical and research data in the field of plant production and plant protection, scientifically substantiate the use of bacterial fertilizers and microbiological plant protection products, taking into account their properties, apply the acquired knowledge of microbiology in practical activities in the development of plant protection measures against pathogens of various nature, the development of modern technologies for growing agricultural crops and maintaining a balanced state of agroecosystems.
14.	Purpose of the educational component	Master the basic concepts and principles of general microbiology.
15.	Prerequisites for studying OK, connection with other educational components of OP	1. The educational component is based on biology, inorganic chemistry 2. The educational component is the basis for soil science, plant physiology, biotechnology 3. The educational component is incompatible with metrology and standardization, radiobiology, environmental economics, and management organization
16.	Academic Integrity Policy	In the process of studying the discipline, students must adhere to the rules of academic integrity, defined by the "Regulations on the Organization of the Educational Process at Sumy National Agrarian University (https://drive.google.com/file/d/1THXbcZySe0C6UwlnG3Uy_V64uRngnbzk/view) and the "Code of Academic Ethics of Sumy National Agrarian University (https://drive.google.com/file/d/1aTo1TmzZSEnW9NyaCF98_HgSCcrhARn/view). When performing laboratory work, completing individual tasks, independent work, writing modular, credit and examination papers, the student must adhere to the rules of academic integrity. It is expected that the work completed by students will be their original (own) research or independently carried out analysis and generalization. Failure to cite sources, falsification of sources, plagiarism and borrowing, and interference with the work of other students are examples of possible academic dishonesty. The identification of signs of academic dishonesty in a student's written work is grounds for the instructor to reject it, regardless of the extent of the plagiarism.
17	Link to the course in Moodle	https://cdn.snau.edu.ua/moodle/course/view.php?id=1091

2. LEARNING OUTCOMES BY EDUCATIONAL COMPONENT AND THEIR RELATIONSHIP WITH PROGRAM LEARNING OUTCOMES

Learning outcomes for EC: After completing the study of the educational component (discipline), the student will be able to:	How is PLO assessed?				
	PLO 5 Conduct literary search Ukrainian and foreign languages and analyze received information.	PLO 6 Demonstrate knowledge and understanding of fundamental disciplines in the volume required for possession appropriate skills in agronomy branches	PLO 10 Analyze and interpret knowledge of general and special professional training in volume, necessary for specialized professional jobs in the industry agronomy	PLO L14 Integrate and improve production processes growing agricultural products according to current requirements.	
LOA 1. Use basic knowledge main divisions of agricultural science (plant breeding, agriculture, breeding and seed production, agrochemistry, fruit growing, vegetable growing, soil science, feed production, mechanization V plant growing, plant protection).	X				oral interview: carried out before and during laboratory work to control the mastery of theoretical provisions necessary for the performance of practical tasks;
LOA 2. Analyze, evaluate, interpret and synthesize theoretical information and practical, production and research data in the fields of agricultural production				x	testing: carried out in the form of express control on test tasks selected randomly from test tasks concluded course instructor, serves to monitor students' independent work
LOA 3. Solve a wide range of problems and tasks in the process of growing agricultural crops, by understanding their biological characteristics and using both theoretical and practical methods			X		control for conducting laboratory notebook students: carried out during and at the end of laboratory work and shows progress implementation practical tasks and documentation results laboratory work
LOA 4. Ability to evaluate, interpret and synthesize theoretical information and practical, production and research data in the fields of agricultural production.		X			test paper: involves a written response to the theoretical question

3. CONTENT OF THE EDUCATIONAL COMPONENT (COURSE PROGRAM)

Topic. List of issues to be addressed within the topic	Distribution within the overall time budget				Recommended reading*
	Classroom work			Independent work	
	Lec	P.z / semin.z	Lab. z.		
Topic 1: History of microbiology . Morphology of microorganisms. Stages of development. Works of L. Pasteur, R. Koch, I. Mechnikov, S. Vynogradsky. Directions of development of modern microbiology.	2	2			1-3, 11-12, electronic resources
Topic 2. Morphology, biology and physiology of microorganisms. Structure of a bacterial cell. Morphology of bacteria. Types of bacterial cells. Structure of a bacterial cell Biology and physiology of bacteria. Spore formation in bacteria Bacterial reproduction/ Movement in bacteria	2/2	4/4		/10	1-3, 11 electronic resources
Topic 3: Systematics of microorganisms. The concept of systematics. Main groups of bacteria and microorganisms. Mushrooms. Features of morphology and physiology	2	4		10/20	1-3, 11-12, electronic resources
Topic 4: Viruses. Features of structure and infection. Virus taxonomy Features of plant viruses/Viroids as a group of pathogens. Bacteriophages.	2			/30	3,9,11, electronic resources
Topic 5: Main groups of phytopathogenic bacteria The concept of bacteriosis. Pathogenicity and virulence. Main groups of phytopathogenic bacteria. Morphological and physiological features of plant pathogens. Symptoms of diseases.	2			10/20	1-3, 12 electronic resources
Topic 6: Microorganisms and the Environment Physical factors: humidity, temperature, oxygen. Chemical factors: pH, toxic substances, salt concentration. The concept of sterilization. Flow cultivation. Growth characteristics.	2/2	4		12/20	1-11, electronic resources
Topic 7: Relationships between microorganisms and other organisms. Classification of groups of microorganisms in relation to biotic factors. Symbiotic and antagonistic effects. The concept of antibiotics. Microorganisms - producers of antibiotics. Infection and immunity in plants, animals, humans	2/2	4		8/10	1-11, electronic resources
Topic 8: Nutrition, metabolism and energy. Transformation of carbon compounds by microorganisms. Types of nutrition of microorganisms Classification of nutrition types. Fermentation and respiration. Alcoholic fermentation. Features and pathogens	2/2			10/10	1-4, 10-12, electronic resources
Topic 9: Lactic acid fermentation. Features and pathogens. Use in the national economy. Lactic acid fermentation in the preparation of feed: silage, haylage				/14	1-11, electronic resources

Butyric acid fermentation. Pathogens. Chemistry. Acetone-butyl fermentation and fermentation of pectic substances					
Topic 10: Butyric acid fermentation fermentation. Features and pathogens. Use in the national economy. Acetone-butyl fermentation and fermentation of pectin substances.	2	4			1-11, electronic resources
Topic 11: Development of views on the role of microorganisms in soil formation. Formation of soil microbiology. Soil as a living system. Transformation of nitrogen compounds in the soil.	2	2			1-11, electronic resources
Topic 12: Biological fixation of molecular nitrogen. Biological significance of nitrogen fixation. The role of microorganisms in the process of nitrogen fixation: symbiotic and non-symbiotic nitrogen fixers. Features of nodule bacteria. Enzymes and process chemistry	2	2/4			1-11, electronic resources

Topic 13: Soil micropopulation, methods determination of composition and activity. Factors determining the development and composition of soil coenosis.Food chains and ecological groups in the soil. Features of the microflora of different soils. Methods of accounting.The influence of environmental factors on the development of soil microflora	2	2		10	1-11, electronic resources
Topic 14: The role of microorganisms in the primary soil-forming process. Microorganisms of the root zone and surface of plants. The role of rhizosphere and epiphytic microorganisms in plant life. Features of rhizosphere microorganisms. Microbiological processes in the formation of humus Microbiological processes in the soil	2			25	1-9, electronic resources
Topic 15: Microbiological foundations of soil fertility improvement and plant protection. Bacterial fertilizers Production of hormones, vitamins, enzymes, antibiotics, plant growth stimulants. Plant protection products and insecticides of microbiological origin. Bacterial fertilizers.	2	2		5	1-9, electronic resources
	30/8	30/8		90/134	

4. TEACHING AND LEARNING METHODS

LOA	Teaching methods (work that will be carried out by the teacher during classroom lessons, consultations)	Hours	Teaching methods (what types of learning activities should the student perform independently)	Hours
LOA 1. Use basic knowledge of the main divisions of agricultural science (plant production, agriculture, breeding and seed production, agrochemistry, fruit growing, vegetable growing, soil science, feed production, mechanization in plant production, plant protection).	Lecture, multimedia presentations	15/5	working with educational and scientific literature processing additional material on relevant topics keeping records, notes; preparation of reports	20/30
LOA 2. Evaluate, interpret and synthesize theoretical information and practical, production and research data in agricultural production sectors	Lecture, multimedia presentations conducting practical work	15/5	practical methods: laboratory work, analysis of work performed during practical work	25/40

			tasks and preparation for the defense of practical work, teamwork, self-assessment	
LOA 3. Solve a wide range of problems and tasks in the process of growing crops, by understanding their biological characteristics and using both theoretical and practical methods	Lecture, multimedia presentations presentations and practical work	15/3	practical methods: - laboratory work implementation individual task;	25/34
LOA 4 Be able to apply professional competence to apply for primary positions with agronomic specialties	Conducting lectures using multimedia presentations and practical work	15/3	practical methods: laboratory work completion of individual tasks and teamwork, self-assessment	20/30
		60/16		90/134

5. EVALUATION BY EDUCATIONAL COMPONENT

5.1. Summative assessment

№	Summative assessment methods	Points / Weight in the overall score	Date of compilation
Module 1			
1.	Laboratory work 1. Preparation of temporary micropreparations	5 points /5%	Up to 2 weeks
2.	Laboratory work 2. Fixation and staining of the preparation	5 points /5%	Up to 3 weeks
3.	Laboratory work 3. Gram stain	5 points /5%	Up to 4 weeks
4.	Laboratory work 4. Preparation of culture media and sterilization methods	5 points /5%	Up to 5 weeks
5.	Laboratory5. Quantitative accounting of microorganisms in various environments. Determination of the qualitative composition of air by the method of bacterial sedimentation	5 points /5%	Up to 6 weeks
6.	Laboratory6. Determination of the qualitative composition of air microflora. Colony microscopy	5 points /5%	By week 7
7.	Modular control	20 points /20%	
Module 2			
1.	Laboratory 7 Homoenzymatic lactic acid fermentation. Pathogens.	5 points /5%	Up to 8 weeks
2.	Laboratory work 8. Butyric acid fermentation. Fermentation of pectin substances. Pathogens	5 points /5%	By week 9
3.	Laboratorywork 9.Accounting for microorganisms in soil by the method plates	5 points /5%	Up to 10 weeks
4.	Laboratory work 10. Determination of the quantitative and qualitative composition of soil microorganisms	5 points /5%	Up to 11 weeks
5.	Laboratory work 11. Molecular nitrogen fixation. Isolation of azotobacter from soil	5 points /5%	Up to 12 weeks
6.	Laboratory 12. Molecular nitrogen fixation by microorganisms. Symbiotic nitrogen fixers: nodule bacteria	5 points /5%	By week 13
7.	Modular control	20 points / 20%	By week 15

5.2.1. For the assessment of expected learning outcomes, the following is provided:

Component ²	Unsatisfactorily	Satisfactorily	Okay	Perfectly
Modules				
Laboratory work 1. Preparation of temporary micropreparations	<i>Obaliv</i>	<i>1-2 points</i>	<i>3-4 points</i>	<i>5 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Laboratory work 2. Fixation and staining of the preparation				
	<i>Obaliv</i>	<i>1-2 points</i>	<i>3-4 points</i>	<i>5 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Laboratory work 3. Gram stain				
	<i>Obaliv</i>	<i>1-2 points</i>	<i>3-4 points</i>	<i>5 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Laboratory work 4. Preparation of culture media and sterilization methods	<i>Obaliv</i>	<i>1-2 points</i>	<i>3-4 points</i>	<i>5 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Laboratory work 5. . Quantitative accounting of microorganisms in various environments. Determination of the qualitative composition of air by the method of bacterial sedimentation	<i>Obaliv</i>	<i>1-2 fish</i>	<i>3-4 points</i>	<i>5 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Laboratory work 6. Determination of the qualitative composition of microflora air. Colony microscopy	<i>Obaliv</i>	<i>1-2 points</i>	<i>3-4 points</i>	<i>5 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Modular control (multiple choice test)	0-20 points			
	Scored based on the number of correct answers			
Module 2				
Laboratory work 7. Homofermentative lactic acid fermentation. Pathogens.	<i>0 points</i>	<i>1 points</i>	<i>2 points</i>	<i>3 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and a opinion and your vision of the chosen problem.

Laboratory work 8. Butyric acid fermentation. Pathogens	<i>Ovals</i>	<i>1 ball</i>	<i>2 points</i>	<i>3 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and your vision of the chosen problem.
Laboratory work 9. Accounting for microorganisms in the soil using the method plates	<i>Ovals</i>	<i>1 ball</i>	<i>2 points</i>	<i>3 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, with some exceptions.	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and one's own opinion and vision of the chosen problem have been formed.
Laboratory work 10. Determination of the quantitative and qualitative composition of soil microorganisms	<i>Ovals</i>	<i>1 ball</i>	<i>2 points</i>	<i>3 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, with some exceptions.	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and a opinion and your vision of the chosen problem.
Laboratory work 11. Molecular nitrogen fixation. Isolation of Azotobacter from soil	<i>Ovals</i>	<i>1 ball</i>	<i>2 points</i>	<i>3 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, except for exceptions	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and a opinion and your vision of the chosen problem.
Laboratory work 12. Molecular nitrogen fixation by microorganisms. Symbiotic nitrogen fixers: nodule bacteria	<i>Ovals</i>	<i>1 ball</i>	<i>2 points</i>	<i>3 points</i>
	Practical work not completed or completed incorrectly	Most requirements have been met, but some issues remain unresolved,	All task requirements have been met, with some exceptions.	All requirements and tasks have been fulfilled, the results obtained have been clearly interpreted, and our own opinion and your vision of the chosen problem.
Module control: test, oral interview, written test (at the discretion of the teacher)	0-20			
	Scored based on the number of correct answers			

5.3. Formative assessment:

Formative assessment is a source of information about the success of learning outcomes for both teachers and students. Formative assessment is usually carried out during the study of the EC. The results of students' performance of assessment tasks help the teacher in making decisions about the nature of further learning.

To assess current progress in learning and understand areas for further improvement,

5.		
No	Elements of formative assessment	Date
1	Verbal feedback from the instructor during laboratory work	During the semester
2	Group tasks. Discussion.	During the semester
3	Mastering observation skills and abilities	During the semester
4	Cooperation of applicants in a group and the ability to work focused	During the semester
5	Oral answers to individual questions during lectures and practical work	During the semester

Distribution of points received by applicants while studying for the EC

Current assessment														Suma
Content module 1 0-50 points							Content module 2 0-50 points							
T 1	T 2	T 3	T 4	T5	T6	M 1	T 7	T8	T 9	T10	T 11	T12	M 2	100
5	5	5	5	5	5	20	5	5	5	5	5	5	20	

Distribution of ECTS points based on the results of studies and semester (final) certification in the form of an exam:
up to 70 points – based on the results of module control during the semester;
up to 30 points – based on the results of the semester (final) certification.

Grading scale: national and ECTS

Total points for all types of learning activities	ECTS score	National scale assessment	
		for exam, course project (work), practice	for credit
90 – 100	A	excellent	enrolled
82-89	IN	good	
75-81	With		
69-74	D	satisfactorily	
60-68	E		
42-59	FX	unsatisfactory with the possibility of reassembly	not passed with the possibility of retaking
1-41	F	Unsatisfactory with mandatory re-study of the discipline	not passed with mandatory re-study of the discipline

6. LEARNING RESOURCES (LITERATURE)

6.1. Main sources

6.1.1. Textbooks, manuals

1. Pryplavko S. O., Gaviy V. M. General microbiology: teaching aids – Nizhyn: NDU named after M. Gogol, 2023. – 117 p. <https://files.znu.edu.ua/files/Bibliobooks/Inshi83/0062651.pdf>
2. Prylipko T. M., Koval T. V., Kostash V. B. Microbiology of food products: a textbook. – Kamianets-Podilskyi: Higher Education Institution "Podilsky State University", 2024. – 412 p.
3. Sytnyk I. O., Klymniuk S. I., Tvorko M. S. Microbiology, virology, immunology 2020, Ukrmedknyga, 392 p.
4. Shirobokov V. P. Medical Microbiology, Virology and Immunology, 2021, Nova Knyga, 920 p.
5. Yastremska L. S., Malinovska I. M. General microbiology and virology: textbook. Kyiv: NAU, 2020. 232
6. General microbiology and virology. Laboratory practical: textbook / L. B. Oryabinska, L. P. Dzyhun, L. O. Tytova. Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2022. 121 p.
7. Yevlash V. V. Workshop on Technical Microbiology, 2020, 186 p.
8. Lyuta V.A., Kononov O.V. Microbiology with microbiological research techniques, virology and immunology: textbook (Higher Education University I-III grades) - 2nd edition, 2023, Meschdytsyna, 184p.
9. Practical microbiology: a textbook / S. I. Klymnyuk, I. O. Sytnyk, V. P. Shirobokov; ed. by V. P. Shirobokov, S. I. Klymnyuk. Vinnytsia: Nova kniga, 2020. 576 p.
10. Serhiychuk M. G., Skivka L. M., Serhiychuk T. M. Microbiology. Volume 1— K.: FOP Maslakov, 2020. — 500 p. <https://biomed.knu.ua/institute-activity/educational/kafedry/kafedra-microbiology-and-immunology/biblioteka/4273-pidruchnik-mikrobiologiia.html>
11. Filimonova N. I., Silaeva L. F., Dyka O. M. and others Microbiology: a textbook for students of higher education. 2nd ed. — Kharkiv: National University of Physics and Technology: Golden Pages, 2019. — 676 p. <https://microbiology.nuph.edu.ua/wp-content/uploads/2022/10/mikrobiolohiia-2019.pdf>
12. Chorna T. M. «Microbiology» textbook. 2023, 412 p. <https://vpusp.vn.ua/wp-content/uploads/2023/01/pidruchnyk-mikrobiologiia-chorna-t.-m..pdf>
13. Madigan Michael, Kelly S. Bender, Daniel H. Buckley. Brock Biology of Microorganisms: 16th Edition, 2022, Pearson, 1224 p.
14. Joan L. Slonczewski, John W. Foster, Erik R. Zinser Microbiology: An Evolving Science (6th Ed.), [W. W. Norton & Company](https://www.wiley.com/uk/ebooks/9781119689701), 2023, 1432 p.
15. Microbiology: An Introduction (14th Gerard J. Tortora, Christine L. Case, Berdell R. Funke 2023, 960 .
16. Virus Taxonomy - Classification and Nomenclature of Viruses: Eighth Report of the International Committee on Taxonomy of Viruses. Academic Press; 2011.

6.2. Methodological support

1. Zhatova G.O. Microbiology. Methodological instructions for laboratory classes for students of the areas of training for students of the specialty: 201 Agronomy/Sumy, 2025, p.97). Protocol No. 7 dated 13.01. 2025
2. Zhatova G.O. Microbiology Methodological guidelines for independent work for students of training areas for students of specialties: 201 "Agronomy", /Sumy, 2025, p.55) Protocol No. 7 dated 13.01. 2025
3. Zhatova G.O. Microbiology Lecture notes for students of specialty 201 Agronomy / Sumy, 2025, p.100), (minutes No. 7 dated 13.01. 2025)
4. Zhatova G.O. General Microbiology. Methodological instructions for laboratory classes for students of the areas of training for students of the specialty: 162 Biotechnology and Bioengineering. Sumy, 2023 Protocol No. 8 dated 02/20/2023
5. Zhatova G.O. General microbiology and virology: lecture notes – Sumy: Sumy National Agrarian University, 2023. 54 p. Protocol No. 8 dated 02/20/2023
6. Zhatova G.O. General microbiology and virology. Methodological guidelines for independent work for students of the specialty: 162 Biotechnology and bioengineering. Sumy, 2024, p.70. Protocol No. 10 dated 04/24/2024

6.3. Other sources

1. Ahmed M. Abdel-Azeem Industrial Microbiology and Biotechnology, 2022, Springer Nature, 822 p.
2. David R. Wessner, Christine Dupont, Trevor Charles Microbiology (3rd Ed.), 2022, Wiley, 960 p.
3. Gerard J. Tortora, Christine L. Case, Berdell R. Funke Microbiology: An Introduction (14th Ed.), 2023, Pearson., 960 p.
4. Przemysław Bernat Microbial Biotechnology in the Laboratory and Practice, 2023, Columbia University Press, 432 p.
5. Fields Virology. 6th Edition. Edited by D.M.Knipe, P.M.Howley. Wolters Kluwer/ Lippincott, Williams&Wilkins. Philadelphia - New-York. 2013r.
6. Halyna Zhatova, Volodymyr Trotsenko, Nadiia Trotsenko, Mykola Radchenko, Andrii Butenko, Liudmyla Bondarieva, & Inna Zubitsova Quinoa microbiota and its importance for sustainable crop production, (2025) J Name: Modern Phytomorphology Short name: MP ISSN: ISSN 2226-3063/ eISSN 2227-955V.: 19, 178-182 DOI: 10.5281/zenodo.20012

7. Zhatova, G. O. (2025). Soil microbiome: prospects and ways of management through agronomic practices. *Bulletin of Sumy National Agrarian University. Series: Agronomy and Biology*, 61(3), 82-91. <https://doi.org/10.32782/agrobio.2025.3.10>

6.4. Additional sources

1. <https://bio.libretexts.org/Bookshelves/Microbiology>
2. [https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_\(OpenStax\)](https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(OpenStax))
3. [https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_\(Kaiser\)](https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Kaiser))
4. [https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_\(Bruslind\)](https://bio.libretexts.org/Bookshelves/Microbiology/Microbiology_(Bruslind))
5. <http://www.ncbi.nih.gov>- National Center for Biotechnology Information (NCBI Web Site).
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