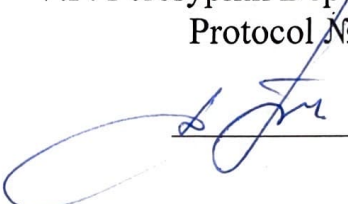



**NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL
SCIENCES OF UKRAINE**

V.F. Peresyphkin Department of Phytopathology

“APPROVED”
Dean of the Faculty of Plant Protection,
Biotechnologies and Ecology

Yulia KOLOMIETS
“18th” May 2023

“APPROVED”
V.F. Peresyphkin Department of Phytopathology
Protocol № 10 from “18th” April 2023
Head of the Department

Dmytro GENTOSH

“CONSIDERED”
Guarantor of education program
Plant Protection and Quarantine

Myroslav PIKOVSKYI

**WORKING EDUCATIONAL PROGRAM OF ACADEMIC DISCIPLINE
“GENERAL MYCOLOGY”**

Specialty	202-Plant Protection and Quarantine
Educational program	Plant Protection and Quarantine
Faculty	Plant Protection, Biotechnologies and Ecology
Developed by	Voloshchuk N.M., associate professor, Dr. PhD Bashta O.V., associate professor, Dr. PhD

KYIV – 2023

1. Description of Discipline “General Mycology”

Area of expertise, specialty, educational program, degree				
Field of knowledge	<i>20 Agricultural science and Food</i>			
Educational degree	<i>Bachelor</i>			
Specialty	<i>202 Plant Protection and Quarantine</i>			
Educational program	<i>Plant Protection and Quarantine</i>			
Characteristics of discipline				
Kind	Regulatory			
Total hours	180			
Number of credits ECTS	6			
Number of modules	4			
Course project (work)	-			
Control	Credit / Exam			
Indicators discipline for full-time and distance learning				
	Full-time education		External form of education	
Student's Year	2	2	3	3
Semester	3	4	5	6
Lectures	30 h	30 h	4 h	4 h
Practical, seminar classes	-	-		-
Laboratory classes	30 h	30 h		-
Independent work	45 h	45 h	176 h	176 h
Individual tasks	-	-	-	-
Number of weekly hours for full-time education: classroom independent student work	4 h	4 h		-

1. Purpose, tasks and competencies of the educational discipline

General mycology is one of the main profiling disciplines in the training of a specialist in plant protection. It is closely related to many general biological and special disciplines: botany, plant physiology, microbiology, soil science, agriculture, plant biochemistry and biotechnology, general and agricultural phytopathology, plant immunity, zoology, general and agricultural entomology, plant breeding, breeding and seed production.

The goal of general mycology as a science is to study the morphological and biological properties and distribution of fungi, their role and significance in human life and economic activity.

Fungi are an extremely numerous group of organisms. Currently, 110,000-120,000 of their species have been described and named, but there is evidence that there are no fewer of them than seed plants, i.e. 250,000-300,000. On average, more than 1,000 new species are described annually. It is believed that the number of species of fungi is even three to four times greater than that of flowering plants (E. Müller, V. Leffler, 1995).

Today, these organisms are used in biotechnology, at the same time, their large number brings significant damage to the cultivation of agricultural crops, since they occupy a large specific weight (85%) among pathogens (viruses, bacteria, phytonematodes, actinomycetes, mycoplasma organisms).

By their heterotrophy, fungi differ from plants, algae, and cyanobacteria (blue-green algae), which rely on carbon dioxide and sunlight as the only sources of carbon and energy, respectively; by their cell wall, they differ from animals and protozoa (as a rule, by their absence), and by the presence of a true nucleus - from prokaryotic bacteria.

In the process of implementing the program, students study the structure of mushrooms, their metabolism, the physiologically active substances they produce, the basics of taxonomy, the peculiarities of ecological groups of mushrooms, their importance in nature and human economic activity.

As a result of studying general mycology, the student should:

to know the task, purpose and objects of general mycology, the structure of mushrooms and their physiological properties, the peculiarities of growth in relation to the substrate, changes in mycelium, its resting stages, reproduction of various groups of mushrooms;

be able to independently determine the group to which fungi belong by the structure of the mycelium (higher, lower), isolate a micromycete and study its growth features, determine the method of reproduction, establish the ability to form an anamorph and teleomorph, find out the conditions of its existence and assign it to the group of parasitism (obligate and facultative saprotrophs and parasites).

Competence acquisition:

Integral competence (IC):

The ability to solve complex specialized tasks and practical problems of professional activity in plant protection and quarantine and to apply theoretical knowledge and methods of phytosanitary monitoring, inspection, analysis, expertise characterized by complexity and uncertainty of conditions.

General competences (GC)

GC 2. Ability to apply knowledge in practical situations.

GC 3. Knowledge and understanding of the subject area and understanding of professional activity.

GC 12. Skills of performing safe activities.

Program Learning Outcomes (PLO)

PLO 6. Correctly use appropriate methods of observation, description, identification, classification, cultivation of objects of agrobiocenoses and maintenance of their stability in order to preserve natural diversity.

PLO 16. Know the main historical stages of development of the subject area.

3. The program and structure of the academic discipline for:

- full-time full-time (correspondence) form of education;
- reduced period of full-time (correspondence) education.

Titles of modules and themes	Amount of hours											
	Full time, hrs.						Distance, hrs.					
	total	including					total	including				
		l	p	lab	ind.	indiv.w.		l	p	lab	ind.	indiv.w.
Content module 1. STRUCTURE OF FUNGI												
1.1 The structure of the vegetative body of	12	6		3		3	12	1			11	
1.2. Mycelium and its variations	16	6		5		5	16				16	
1.3Fungi as a constituent structure of the vegetative body of lichens	6	2		2		2	6				6	
Together according to the content module 1	34	14		10		10	34	1			33	
Content module 2. BIOCHEMICAL PROPERTIES OF FUNGI												
2.1. Nutrition of fungi	14	4		4		6	14	1			13	
2.2. Fungal metabolism	14	4		4		6	14				14	
2.3. Biologically active substances of fungi	28	8		12		8	28				28	
Together according to the content module 2	56	16		20		20	54	1			55	
Content module 3. GEOGRAPHICAL DISTRIBUTION AND ECOLOGICAL GROUPS OF FUNGI												
3.1 Geographic distribution of fungi	14	4		5		5	14	1			13	
3.2 Ecological groups of fungi	26	6		10		10	26				26	
Together according to the content module 3	40	10		15		15	40	1			39	
Content module 4. PROPAGATION OF FUNGI												
4.1 Vegetative	10	4		3		3	10	1			9	
4.2 Reproductive	40	16		12		12	40				40	
Together according to the content module 4	50	20		15		15	50	1			49	
Total hours	180	60		60		60	180	4			176	

4. Topics of seminar classes

№	Topic name	Hours
1	Not provided for in the working curriculum	
2		

5. Topics of practical classes

№	Topic name	Hours
1	Not provided for in the working curriculum	
2		

6. Topics of laboratory classes

№	Topic name	Hours
1	Microscopic study of fungal cells. Methods of staining the constituent parts of the cell.	2
2	Study of the morphological structure of the hypha of the fungus. Types of hyphal branching. Vegetative body in yeast fungi.	2
3	Mycelium structure. Fungal colony. Septated and non-septated mycelium. Morphological structure of appressoria, haustoria and anastomoses, clamp connections and pear-shaped swellings.	2
4	Resting stages of fungi: oidia, chlamydozoospores, hemes, films, cords, rhizoctonia, rhizomorphs, sclerotia, their morphological and microscopic structure.	2
5	Morphological structure of lichens.	2
6	Laboratory utensils, tools, equipment for laboratory research	2
7	Nutrient media, their components. Preparation and sterilization conditions.	2
8	Cultivation of fungi (influence of temperature and humidity).	2
9	The concept of "pure culture". Sowing methods for obtaining "pure cultures" of fungi.	2
10	Fungi growth, growth phases. Determination of fungal growth.	2
11	Study of the activity of fungal enzymes.	2
12	Study of antibiotic properties of fungi.	2
13	Study of toxin-forming fungi.	2
14	Study of the activity of volatile metabolites of fungi.	2
15	Study of non-volatile metabolites of fungi	2
16	Study of antagonistic properties of fungi	2
17	Elucidation of phytotoxic properties of fungi.	2

18	Soil fungi, methods of their isolation.	2
19	Identification of species isolated from soil.	2
20	Air fungi, water fungi, methods of their isolation.	2
21	Identification of species isolated from air and water.	2
	Phytopathogenic fungi, methods of their isolation.	4
22	Methods of identifying species of fungi that cause plant diseases.	1
23	Fungi that cause mycosis and mycotoxicosis. Research and identification methods.	2
24	Endo- and exogenous method of spore formation during asexual reproduction.	4
25	Sexual reproduction of lower fungi. Planogamy Zygogamy Oogamy	2
26	Reproduction of marsupial mushrooms. Formation of bags and ascospores.	2
27	Yeast reproduction	1
28	Fruit bodies of marsupial mushrooms.	2
29	Reproduction of basidial fungi. Basidia, its structure	2
30	Study of the compatibility of the mycelium of basidial fungi	2
Total		60

7. Topics of independent studies

№	Topic name	Hours
1	Morphological diversity of fungal spores.	10
2	Influence of the substrate on the branching and formation of mycelial changes.	10
3	Symbiosis of fungi and algae, features of development and existence	5
4	Fungi are objects of biotechnology	10
5	Fungi are objects of the food industry	10
6	The role of fungal organisms in crop production	10
7	Fundamental and molecular methods in mycology.	5
Total		60

8. Samples of control questions, tests to determine the level of knowledge acquisition by students

1. Prevalence of mushrooms, their role in nature and human life.
2. Emergence of mushrooms.
3. The main stages of the development of mycology.

4. The significance of mushrooms (mycology) for various fields of knowledge and practical human activity.
5. The main stages of the development of mycology.
6. Biochemical features of fungi and organisms similar to them.
7. Definition of a fungal organism.
8. Comparison of the cell wall composition of fungi and similar organisms.
9. Comparison of reserve substances in fungi, plants and animals.
10. Features of nuclear division in fungi.
11. Growth of fungal hyphae.
12. Ultrastructure and cytological features of fungi.
13. Micromorphology of the thalamus.
14. The main modifications of hyphae depending on the function and growth phase.
15. Definition of holo- and eucarpy.
16. Comparison of plant tissue with mycelial tissue.
17. The main types of hyphae.
18. The main types of aggregation of hyphae.
19. Genetic and morphological features of reproduction, organs of sexual and asexual reproduction as the basis of systematics of fungi.
20. The main types of mushroom reproduction.
21. The main types of asexual reproduction.
22. Types of spores of asexual reproduction.
23. Types of planospores.
24. The main phases of the sexual process.
25. Peculiarities of the sexual process of various systematic groups of fungi.
26. Types of compatibility.
27. Parasexual process.
28. Main types of life cycles.
29. Principles of taxonomy and nomenclature of fungi.
30. Main systematic categories.
31. Scheme of subordination of taxonomic categories.
32. A brief description of the main subkingdoms of fungi.
33. Ecological adaptations of fungi and organisms similar to them, their role in the circulation of substances in ecosystems.
34. Comparison of the fungal biomass of biocenoses with the biomass of other groups of organisms.
35. Transfer of fungal spores.
36. Water and soil fungi.
37. Fungi are destroyers of soil and litter organic matter.
38. Symbiosis of fungi with algae and higher plants.
39. Lichens.
40. Ecto- and endomycorrhiza.
41. Fungi are parasites of higher plants.

42. Predatory mushrooms.
43. Symbiosis of fungi with insects.
44. Micromorphology and ecology of chytrid fungi.
45. Morphology of the thallus and spores of chytrid fungi.
46. Vegetative development cycle of chytrid fungi.
47. Sexual reproduction of chytridiomycetes.
48. Development cycle of anaerobic fungi.
49. Morphology, origin, structure and functions of hydrogenosomes
50. Evolutionary adaptations of fungi to life on land using the example of Zygomycetes and Microsporidia.
51. Structure of the thalamus of zygomycetes.
52. Asexual reproduction of zygomycetes.
53. Features of spore formation in zygomycetes.
54. Sexual reproduction of zygomycetes.
55. Evolutionary adaptations to life on land.
56. Features of the microsporidia spore structure.
57. Life cycle of microsporidia.
58. Micromorphology of organisms similar to fungi on the example of slimes.
59. Characteristics of mucous membranes.
60. Features of the structure of mucous membranes.
61. Micromorphology of organisms similar to mushrooms. Oomycetes.
62. Sexual and asexual reproduction of mucous membranes.
63. Characteristics of oomycetes.
64. Sexual and asexual reproduction of oomycetes.
65. The main directions of the evolution of fungi on land.
66. Ecological adaptations of glomero- and ascomycetes.
67. Characteristics of glomeromycetes.
68. Symbiosis with algae and higher plants.
69. The main groups of marsupial fungi, the number of representatives, the morphology of the thallus.
70. Asexual reproduction of yeast.
71. Sexual reproduction of yeast.
72. The main groups of marsupial fungi, their characteristic biochemical and ultrastructural features.
73. Characteristics of discomycetes: way of life, volume, representatives.
74. Sexual process in Discomycetes.
75. Characteristics of plectomycetes.
76. Cleisto- and apothecia, their structure.
77. Micromorphology and genetics of "unfinished fungi".
78. Characteristics of unfinished mushrooms.
79. The main types of spores of incomplete mushrooms.
80. Types of conidia formation.
81. The main "classes" of unfinished mushrooms.

82. Comparison of holo- and anamorphs.
83. Genus *Aspergillus*, main representatives, distribution, significance in nature and human life.
84. Origin and formation of basidial fungi, their life cycles.
85. Characteristics of the department.
86. The role of buckles in cell division.
87. The main types of basidia.
88. The main groups of basidial fungi, peculiarities of their micromorphology.
89. Characteristics of rusty fungi.
90. The life cycle of representatives of rusty and sooty fungi.
91. Characteristics of the yeast class.
92. Life cycle of holobazidiomycetes.
93. Mechanism of basidiospores separation.
94. Formation of Hartig's grid.
94. Genus *Penicillium*, main representatives, distribution, significance in nature and human life.
95. The genus *Fusarium*, main representatives, distribution, significance in nature and human life.
96. Genus *Alternaria*, distribution, importance in nature and human life.
97. The genus *Sclerotinia*, distribution, significance in nature and human life.
98. Genus *Trichoderma*, main representatives, distribution, significance in nature and human life.
99. Antagonism of fungal organisms
100. Production of antibiotic substances by fungi and their identification
101. Production of mycotoxins and their identification
102. Production of enzymes by fungi and their identification
103. Production of growth-stimulating substances by fungi and their identification
104. Production of phytotoxic substances by fungi and their identification
105. Cultivation of myxomycetes
106. Types of nutrient media, conditions for their sterilization
107. Sterilization of laboratory dishes and tools for mushroom cultivation
108. Primary metabolism of fungi
109. Secondary metabolism of fungi
110. Laboratory methods of diagnosis of secondary metabolites of fungi

НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ			
The first level of higher education (undergraduate) Specialty 202- Protection and quarantine of plants	V.F. Peresyphkin Phytopathology Department 2023-2024 education year	Paper № From discipline General mycology	Approved Head of Department 2023 p.

1	Describe the structure of stolons and pear-shaped swellings, their role in the development cycle of fungi.
2	Explain the concept of "Pure fungal culture", describe the ways of obtaining it

Test tasks of various types

Question 1. Lichens are symbiotic formations:	
1	viruses and bacteria
2	mycoplasma organisms and actinomycetes
3	fungi and algae
4	viroids and flower parasites
5	rickettsiae and plants
Question 2. Fungi are :	
1	eukaryotic
2	prokaryotic
3	cellless
4	deprived of a cell wall
5	enucleated organisms
Question 3. The number of described types of fungi:	
1	up to 10 thousand
2	up to 50 thousand
3	up to 100 thousand
4	more than 100 thousand
5	over a million
Question 4. Nutrient media include:	
1	Sugars
2	Preservatives
3	Salt
4	Vegetables fruits
5	Grain
Question 5. Fungi appeared :	
1	1 300 000 years ago
2	4 000 000 years ago

3	900 000 years ago
4	500 000 years ago
5	simultaneously with plants
Question 6. What is the main building material of the cell wall of the fungus?	
1	cellulose
2	chitin and glucans
3	pectin
4	only glucans
5	absent
Question 7 The resting stages of fungi include:	
1	rhizoctonia
2	basidia
3	sclerotia
4	asci
5	gemes
Question 8. The main reserve substance of cells is :	
1	cellulose
2	chitin
3	glycogen
4	melanin
5	glucose

Question 9. Indicate the missing words: physiologically active substances of mushrooms are organic substances of various nature, which are characterized by activity in concentrations and significant specificity of action.

Question 10. Insert the missing word: enzymes are substances of a protein nature that are capable of various reactions of the transformation of substances and energy.

9. Teaching methods

The success of learning in general depends on the internal activity of students, on the nature of their activity, so the nature of activity, the degree of independence and creativity should be important criteria in choosing a method.

Explanatory - illustrative method. **Students** gain knowledge by listening to a story, a lecture, from educational or methodical literature, through an on-screen guide in a "ready-made" form. Perceiving and comprehending facts, assessments, conclusions, they remain within the limits of reproductive (reproductive) thinking. This method is used as widely as possible to transmit a large amount of information. It can be used to present and learn facts, approaches, assessments, conclusions.

Reproductive method. It is about applying what has been learned based on a pattern or rule. The activity of those who are taught is algorithmic, that is, it corresponds to instructions, orders, rules - in situations similar to the presented sample.

Problem presentation method. Using any sources and means, the teacher, before teaching the material, poses a problem, formulates a cognitive task, and then, revealing the system of proofs, comparing views, different approaches, shows a way to solve the task. Students become, as it were, witnesses and accomplices of scientific research.

Partial search, or heuristic method. Its essence is the organization of an active search for a solution to cognitive tasks proposed by the teacher (or independently formulated) either under the guidance of the teacher or on the basis of heuristic programs and instructions. The thinking process acquires a productive character, but it is gradually directed and controlled by the teacher or the students themselves on the basis of work on programs (in particular, computer ones) and with teaching aids. Such a method, one of the varieties of which is a heuristic conversation, is a proven method of activating thinking, encouraging knowledge.

Research method. After analyzing the material, setting problems and tasks, and brief oral or written instruction, the trainees independently study the literature, sources, conduct observations and measurements, and perform other research activities. Initiative, independence, creative search are most fully manifested in research activities. The methods of educational work directly turn into methods that imitate and sometimes implement scientific research.

10. Forms of control

Control of students' knowledge and skills (current and final) in the discipline "General mycology" is carried out in accordance with the credit-module system organization of the educational process.

Current - during the performance of laboratory works, individual tasks (descriptive works, writing essays), control of learning a certain module (module control) is carried out in the form of a test control of knowledge from each meaningful module of the educational discipline. One set of tests consists of 30 tasks per module. Each task has 30 questions, each question has 5 answers.

Final - includes an exam. The maximum possible number of conditional points for the student's educational classes is 70% (coefficient 0.7) and 30% (coefficient 0.3) is for the exam from the total number of conditional points.

By decision of the department, up to 10% of the total number of conditional points in the academic discipline is awarded for the performance of works that are not provided for in the curriculum, but contribute to increasing the level of

knowledge and skills of students in the academic discipline (presentation at the student conference, winning a prize at the Olympiads, making mock-ups, etc.) disciplines.

11. Distribution of points received by students

The student's knowledge is assessed on a 100-point scale and translated into national assessments according to the table. 1 "Regulations on examinations and assessments at NUBiP of Ukraine" (order on implementation dated 04.26.2023, protocol No. 10)

Student rating, points	The assessment is national for the assembly results	
	exams	credits
90-100	excellent	credited
74-89	good	
60-73	satisfactory	
0-59	unsatisfactory	not credited

To determine the student's (student's) rating for mastering the **R_{dis}** discipline (up to 100 points), the obtained rating from the certification (up to 30 points) is added to the student's (student's) rating for the RPR educational work (up to 70 points):

$$R_{dis} = R_{EW} + R_{AT}$$

The basis for determining the criterion for assessing students' knowledge is the level of students' assimilation of educational material according to the accepted criterion and scale for assessing students' knowledge and skills.

The basis for determining the criterion for assessing students' knowledge is the level of students' assimilation of the educational material provided by the program of the educational discipline "General Mycology". The student's answer is evaluated in accordance with the existing provision on a four-point system: "excellent"; "fine"; "satisfactory" and "unsatisfactory". At the same time, the personal abilities of the student are taken into account, in particular, the ability to:

- to differentiate, integrate and unify knowledge from the discipline "General mycology" and, in particular, regarding the morphological and biological features of fungal organisms, their common features and differences between plants and animals, sensitivity to environmental conditions, and patterns of development, features of taxonomy, application in process of the method of mycological research;
- interpret data on the release of biologically active substances by mushrooms and their accumulation in plant products;

- analyze and evaluate specific situations regarding the distribution of fungal organisms in the environment, their migration depending on meteorological and anthropogenic factors;
- present the learned material from "General Mycology" logically and consistently.

According to the results of the tasks of the current and final control in the academic discipline "General mycology", the grade "excellent" (the sum of points is 90 or more) is given to students whose answers indicate a fluent command of the educational material, in particular, the distribution of fungi in nature, the structure of their cells (shell, protoplast, nucleus, etc.), the ability to secrete enzymes, antibiotics, toxins, vitamins that affect the body of other living organisms, to analyze the ways of finding products of the viability of fungi for the further development of pathogenic organisms, etc.

The grade "good" is given to the student for the sum of the points of the current and final control (74-89 points), which he scored under the condition of the ability to analyze the content of the tasks and practically apply them in the learning process. This refers to the morphological and biochemical characteristics of mushrooms; the plasticity of fungal organisms, their characteristic pleomorphism, adaptation to environmental conditions, acquire a different morphological form and form resting stages. The student has a good command of and uses literature materials, is able to independently renew his knowledge, independently make decisions about the methods of identification of mushroom species.

A grade of "satisfactory" is given to a student for the sum of the points scored in the current and final control (60-73 points), who in his answers demonstrated sufficient knowledge of the educational program material in the academic discipline, but failed to fully reveal the features of the structure and biochemistry of fungi and similar microorganisms, adaptation of mushrooms to environmental conditions, when answering he made mistakes in covering questions about ecological groups and reproduction of mushroom species.

The grade "unsatisfactory" is given to a student whose sum of points from the current and final control is 59 points and less, which indicates that he has mastered the main program material from the discipline "General mycology", did not reveal the essence of the task and did not cover most of the questions, did not show the ability to analyze and evaluate facts, draw correct conclusions about the characteristics of mushrooms as an independent kingdom of living organisms that take place in nature, did not familiarize himself with the literature, was not able to independently restore, professionally direct knowledge of the discipline.

Such a student, in order to receive a positive assessment, needs to continue to work more purposefully on mastering the material of the academic discipline.

11. Education-methodical support

Scientific and methodological support of the educational process includes: state education standards, curricula, educational programs from all normative and

selective educational disciplines; programs of educational, industrial and other types of practices; textbooks and training aids; instructional and methodical materials for seminar, practical and laboratory classes; individual educational and research tasks; control works; text and electronic versions of tests for current and final control, methodical materials for organizing students' independent work.

An electronic training course (ENC) General mycology/ N.M. Voloshchuk, O.V. Bashta has been developed for the discipline. website: URL:
<https://elearn.nubip.edu.ua/course/view.php?id=3104>

Bashta O.V., Voloshchuk N.M., Olifer D.R. Workbook for performing laboratory work in General mycology for applicants of the first (bachelor) level of higher education, specialty 202 Protection and quarantine of plants. Kyiv: Editorial and publishing department of NUBiP of Ukraine. 2023. 86 pages.

12. Recommended Literature

Main:

1. Evolution of Fungi and Fungal-Like Organisms. Ed. S. Pöggeler, T. James 2d Edition. Springer Nature: Switzerland. 2023. 331 pp.
2. Fantastic Fungi: How Mushrooms Can Heal, Shift Consciousness, and Save the Planet by Paul Stamets. San Rafael: Earth aware. 2019. 353 pp.
3. Lowenfels J. Teaming with fungi: the organic grower's guide to mycorrhizae / Jeff Lowenfels. Other titles: Organic grower's guide to mycorrhizae Description: Portland, Oregon: Timber Press. 2017. 208 pp.
4. Norflus F. Using Open Resources to Teach Mycology / The American Biology Teacher (2021). Vol. 83 (8). P. 504–512.
5. Sheldrake M. Entangled life: how fungi make our worlds, change our minds and shape our future. NY: Random House. 2020. 345 p.
6. States of the World's Plants and Fungi. Royal Botanic Gardens Kew. 2020. 100 pp.
7. The Lives of Fungi: A Natural History of Our Planet's Decomposers. By Britt A. Bunyard. Princeton (New Jersey): Princeton. University Press. 2022. 288 pp.
8. The Fungi. Sarah C. Watkinson, Lynne Boddy, Nicholas Money. Third Edition. 2015. 452 p.
9. Ecology of mushrooms. Review: G.L. Antonyak, Z.I. Kalinets-Mamchur, I.O. Dudka, N.O. Babich, N.E. Panas. Ecology of mushrooms. Lviv. 2013. 628 p.

Addition:

1. Fungal Machines: Sensing and Computing with Fungi (Emergence, Complexity and Computation, 47) by A. Adamatzky. Switzerland: Springer. 2023. 570 pp.
2. Meetings with remarkable mushrooms: forays with fungi across hemispheres / Alison Pouliot. Chicago: The University of Chicago Press. 2023. 233 pp.

3. Mystical Mushrooms: Discover the Magic and Folklore of Fantastic Fungi by Aurora Kane. New York: Rock Point. 2023. 243 pp.
4. Bisko N.A., Lomberg M.L., Mitropolska N.Yu., Mykhaylova O.B. Collection of mushroom cultures (IBK). – /Institute of Botany named after M.G. Kholodny National Academy of Sciences of Ukraine. - Kyiv: "Alterpress". 2016. 120 p.
5. Koval E.Z., Rudenko A.V., Honcharuk V.V., Voloshchuk N.M. Penicillium in the environment. Part 1. Kyiv: Nauk. Dumka. 2014. 386 p.
6. Koval E.Z., Rudenko A.V., Honcharuk V.V., Voloshchuk N.M. Penicillium in the environment. Part 2: Determinant of penicillium and sources of their existence. - Kyiv: Nauk. Dumka. 2014. 386 p.
7. Prydyuk N.P. Mushroom flora of Ukraine. Bolbitievye and silk mushrooms. - Kyiv: LLC NPP. Interservice. 2015. 598 p.
8. Prodromus of spore plants of Ukraine: lichens [Text]: monograph / S. Ya. Kondratyuk [and others]; Under the editorship P. M. Tsarenko. Kyiv: Naukova dumka. 2021. 730 p.

Internet resources:

1. Educational and informational portal of the National University of Bioresources and Nature Management of Ukraine: website. URL: <https://elearn.nubip.edu.ua>
2. Fungi of Ukraine <http://www.cybertruffle.org.uk/>
3. Red Book of Ukraine: <http://redbook-ua.org/category/fungi/>
4. ASCOfrance <http://www.ascofrance.com/>
5. Forest pests: <http://www.forestryimages.org/pests.cfm>
6. Index Fungorum <http://www.indexfungorum.org/>
7. Mycobank <http://www.mycobank.org>
8. Mycorrhizal Associations: <http://mycorrhizas.info/evol.html>
9. Pyrenomycetes of South Western France <http://pyrenomycetes.free.fr/>
10. Xylariaceae: Home <http://mycology.sinica.edu.tw/Xylariaceae/>