

to the order from 23.03 2023 No. 244

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

DEPARTMENT OF BOTANY, DENDROLOGY AND FOREST TREE BREEDING



**“CONFIRMED”**

Dean of the Faculty of Plant Protection,  
biotechnology and ecology  
Yu.V. Kolomiets  
“ 01 ” 06 2023

**“APPROVED”**

at a meeting of the Department of Botany,  
Dendrology and Forest Tree Breeding  
Protocol № 11 from “15” 05 2023  
Head of Department  
Yu.M. Marchuk

**“REVIEWED”**

Program Coordinator "101 Ecology"  
Program Coordinator  
V.M. Boholubov

**PROGRAM OF THE COURSE**

**Biology I (botany)**

Specialty: 101 Ecology

Educational program: Ecology

Education and Research Institute of Forestry and Landscape-Park Management

Developers: Associate Professor of the Department of Botany, Dendrology and Forest Tree Breeding Andrii Churilov

Kyiv – 2023

## 1. Description of the course

### Biology I (botany)

<b>Field of knowledge, specialty, educational program, educational degree</b>				
Educational degree	<i>Bachelor</i>			
Specialty	<i>101 Ecology</i>			
Educational program	<i>Ecology</i>			
<b>Characteristics of the discipline</b>				
Type	<i>Required</i>			
Total number of hours	60			
Number of ECTS credits	2			
Number of modules	2			
Course project (work) (if available)	–			
Form of control	<i>Exam</i>			
<b>Indicators of academic discipline for full-time and part-time forms of education</b>				
	full-time form of education		part-time form of education	
Year of preparation	1		1	
Semester	1	2	1	2
Lectures		15 h.		6 h.
Practical, seminar classes				
Laboratory classes		30 h.		8 h.
Individual work		15 h.		46 h.
Educational practice		30 h.		
Number of weekly hours for full-time study:				
classroom -		3,5 h.		
independent student work -		1 h.		

## 2. Purpose, tasks and competencies of the discipline

The course is designed to enable students develop their future professional skills. Feature, that compared this course from other similar courses are professionally oriented specific focus on the requirements of future specialists in ecology, include material from cell structure and functions to structure and development of plant communities.

Presentation of General Botanical Material is allowing to have opportunities in floristical and geobotanical investigation of different terrestrial ecosystems. As examples for the practical study in plant histology, organography, morphological and anatomical features will be used as well as systematic, environmental and phytocoenotic association representatives into different plant communities.

The task of the botany course is as follows:

- to teach students to think in botanical categories, to be able to analyze natural phenomena and processes occurring in the plant world at different levels of the organization;
- master the methods of botanical research in the field and laboratory conditions;
- to study anatomical, morphological features, their role in plant life;
- to master the method of determining plants, their systematization;
- be able to analyze the ecological and coenotic properties of species and phytocenoses;
- provide information on rare species of plants and plant communities of Ukraine of different degrees of protection, primarily those listed in the "Red Book of Ukraine" and the "Green Book of Ukraine";
- to study the characteristics of vegetation of botanical and geographical zones of Ukraine;
- to find out the patterns of distribution of plants on the surface of the globe, natural areas of Ukraine.

As a result of studying the discipline the student must know:

- botanical and ecological-coenotic characteristics of edificators, co-dominants and indicator species of phytocenoses;
- the main anatomical and morphological features of the structure, economic properties of the main plants that occur in the phytocenoses of Ukraine;
- indicative properties of plants in relation to the main environmental factors, their role in determining habitat conditions;
- environmental factors and their impact on the development of natural and cultural plant groups;
- features of the impact of environmental factors on the environment and phytocenoses;
- types of vegetation of Ukraine, their latitudinal zonation and altitude zonation;
- methods and techniques of field geobotanical research of natural and derived plant groups;
- rare species and plant communities and botanical characteristics of the main structural elements of the ecological network of Ukraine.

be able to:

- work independently with a microscope, use laboratory and field instruments;
- correctly analyze the studied botanical objects and make scientifically sound conclusions;
- identify plants and assess their ecological adaptability and resource significance;
- independently conduct field geobotanical research of natural and field vegetation;
- correctly and qualitatively take samples of biological (plant) material for analysis;
- to establish research sites and accounting sites of monitoring studies;
- correctly design and interpret the results of field botanical research;
- make geobotanical descriptions, draw a geomorphological profile and link descriptions;

- based on the results of field research to provide an opinion on the current state of the land and predict its improvement and rational use of plant resources;
- apply knowledge of forest ecology for forestry;
- use ecological and phytocenotic classifications to determine forest vegetation conditions, habitats.

*General competencies (GC):*

**GC1.** Knowledge and understanding of the subject area and professional activity.

**GC8.** Ability to conduct research at an appropriate level.

*Professional (special) competencies (PC):*

**PC2.** Ability to critically understand basic theories, methods and principles of natural sciences.

**PC8.** The ability to justify the need and develop measures aimed at preserving landscape and biological diversity and forming an ecological network.

### **Program learning outcomes (PLO) of the programme:**

**PLO2.** Understand the main environmental laws, rules and principles of environmental protection and balanced nature use.

**PLO17.** To be aware of the responsibility for the effectiveness and consequences of the implementation of complex environmental protection measures.

### **3. Program and structure of the discipline for:**

– full-time (part-time) forms of study.

Names of modules and topics	Number of hours											
	full-time						part-time					
	total	include					total	include				
lect			lab		ind	lect			lab		ind	
1	2	3	4	5	6	7	8	9	10	11	12	13
<b>Content module 1</b>												
Section 1. Cytology, histology												
Topic 1. The plant cell		1		1		1		0,25		0,25		1
Topic 2. Plant tissues		1		2		1		0,25		0,25		1
Section 2. Organography												
Topic 3. Root		0,5		2		0,5		0,25		0,25		2
Topic 4. Stem		0,5		2		0,5		0,25		0,25		2
Topic 5. Leaf		0,5		1		0,5		0,25		0,25		2
Topic 6. Reproduction		0,5				0,5		0,25		0,25		2
Section 3. The system of the organic world: prokaryotes, fungi, lower plants												
Topic 7. Introduction to taxonomy. Viruses, Prokaryotes		0,5				0,5		0,25		0,25		2
Topic 8. Fungi and fungal organisms		0,5		4		0,5		0,25		0,25		3
Topic 9. Lichens		0,5		1		0,5		0,25		0,25		2
Topic 10. Algae		0,5		2		0,5		0,25		0,25		3
Total on the content module 1		6		15		6		2,5		2,5		20
<b>Content module 2</b>												
Section 4. Higher spore plants												

Topic 1. Mosses		0,5		0,5		0,5		0,25		0,5		2
Topic 2. Club mosses		0,5		0,5		0,5		0,25		0,5		2
Topic 3. Horsetails		0,5		0,5		0,5		0,25		0,5		2
Topic 4. Ferns		0,5		1		0,5		0,25		0,5		2
Section 5. Seed plants												
Topic 5. Gymnosperms		1		2		1		0,25		0,5		2
Topic 6. Flower, inflorescence		0,5		2		0,5		0,25		0,5		2
Topic 7. Fruits		0,5		1		0,5		0,25		0,5		2
Topic 8. Seeds		0,5		1		0,5		0,25		0,5		2
Chapter 6. Flowering plants												
Topic 9. Dicotyledons		1		2		1		0,25		0,25		2
Topic 10. Monocotyledons		1		2		1		0,25		0,25		2
Chapter 7. Fundamentals of geobotany												
Topic 11. Geography of plants		0,5		1		0,5		0,25		0,25		2
Topic 12. Phytocenology		1		0,5		1		0,25		0,25		2
Topic 13. Ecology of plants and phytocenoses		1		1		1		0,5		0,5		2
Total on the content module 2		9		15		9		3,5		5,5		26
Total hours:	60	15		30		15	60	6		8		46

#### 4. Topics of laboratory classes

No.	Topic names	Quantity hours
1	The structure of the microscope and the technique of working with it. Plant cell structure. Plastids. Spare nutrients. Starch and aleurone grains. Movement of the cytoplasm. Vacuoles, cell juice, pigments.	1
2	Integumentary tissues. Primary cover tissues. Secondary and tertiary integumentary tissues.	1
3	Mechanical tissues. Conductive tissues. Vascular bundles.	1
4	Organography. Root morphology and metamorphosis. Zones of the root, the primary anatomical structure of the root	1
5	Secondary anatomical structure of the root. Features of anatomical structure of root	1
6	Morphological structure of the shoot. Anatomical structure of the Monocot stems.	1
7	Anatomical structure of the stem of herbaceous dicotyledonous plants. Vascular bundle types. Anatomical structure of the Dicot stems	0,5
8	Macroscopic structure of a woody stems.	0,5
9	Anatomical structure of herbal plant stems	1
10	Leaf. Leaf morphology. Anatomical structure of a corn leaf and a Japanese camellia. Features of the structure of pine needles	1
11	Fungy. Division of chytridiomycota. Class chytridiomycetes Chytridiomycetes. Department of oomycota. Class oomycetes. Department of zygomycot.	1
12	Division of Ascomycota. Class of marsupial fungi or ascomycetes (Assomyces)	2
13	Division of Basidiomycota. Class basidiomycetes or basidiomycetes	2

	(Basidiomycetes). Lichens, lichenized mushrooms (Lishenes)	
14	Division of green algae (Chlorophyta). Department of Charophyta. Class choral (Charophyceae).	0,5
15	Class liverworts (Marchantiopsida). Class deciduous, or true mosses (Bryorsida)	1
16	Ferns. The structure of sporophytes and gametophytes of the male thyroid, floating salvinia	1
17	Angiosperms. Class pine, or coniferous (Pinopsida)	2
18	Flower morphology. Flower formula and diagram. Types of inflorescences	1
19	Flower anatomy. The structure of the anther, ovary and seed germ.	1
20	Fetal formation. Structure Classification of fruits. Fertility	2
21	Methods of plant herbarium. Morphological analysis plan and technique for determining flowering plants. Identification of plants from the families Ranunculaceae	2
22	Identification of plants from the families Boraginaceae, cabbage (Brassicaceae) Definition of plants from the families Rosaceae, legumes (Fabaceae). Identification of plants from families of families lily (Liliaceae), fine-legged (Poaceae), sedge (Cyperaceae).	2
23	The structure of the phytocenosis and its functioning (on the example of forest groups of NPP "Holosyivskiy")	2,5
	Total	30

## 5. Topics of independent students work

1. The history of the development of microscopic technology and the role of microscopes for cytological research
2. Metamorphoses as ecological adaptations of plants to their habitat conditions
3. The development of ideas about the classification of living organisms and the system of the organic world
4. Evolution of the plant world: basic concepts of plant development
5. Phytoindication method, its application and opportunities for improving environmental research

## 6. Control questions, sets of tests to determine the level of knowledge acquisition by students.

1. The emergence and development of cellular theory of the structure of organisms. The main provisions of this theory.
2. Differences between plant and animal cells.
3. The flow of substances into the cell.
4. Osmotic properties of plant cells. Phenomena of turgor, plasmolysis and deplasmolysis.
5. Cell wall - its formation, structure and modifications.
6. Plasmodesma and pores. Types of pores, their meaning.
7. The nucleus - structure, chemical composition, physical properties. The value of the nucleus for the plant cell.
8. Cytoplasm - chemical composition, structure, functions.
9. Physiologically active substances - antibiotics, volatile acids, vitamins, auxins, alkaloids, glycosides, inhibitors, saponins. Their significance.

10. Spare nutrients produced by the plant cell. Their significance.
11. Endoplasmic reticulum - types, structure, functions.
12. Ribosomes - chemical composition, structure, functions.
13. Modern ideas about the structure and origin of mitochondria, their functions.
14. The vacuolar system of a plant cell and its physiological significance. Cell juice - its chemical composition, value.
15. Plastids - origin, types, structure, meaning.
16. Spherosomes of lysosomes - chemical composition, structure, functions.
17. Lysosomes - chemical composition, structure, functions.
18. Golgi apparatus - structure, physicochemical properties, functions.
19. Mitosis. Phases of mitosis. Their content.
20. Mitosis, meiosis, amitosis - essence, features, significance.
21. The concept of tissue. Tissue classification.
22. Generative tissues (meristems) - classification, structure, function.
23. Integumentary tissues - classification, structure, functions.
24. Basic tissues (performing) - classification, functions.
25. Mechanical fabrics - classification, structure features.
26. Conductive tissues - classification, structure, functions.
27. The concept of phloem and xylem, their components.
28. Types of conducting beams.
29. Excretory tissues. The value of selection products.
30. Excretory tissues. Elements of external secretion.
31. Excretory tissues. Elements of internal secretion.
32. Organs are analogous and homologous.
33. Symmetry, tropisms, polarity of vegetative organs of plants.
34. Types of roots and root systems.
35. Primary anatomical structure of the root.
36. Development of nodule bacteria on the roots of legumes, their importance for agriculture. Bacterial fertilizers.
37. Features of the anatomical structure of the roots of carrots, radishes and beets.
38. The transition from the primary anatomical structure of the root to the secondary.
39. Secondary anatomical structure of the root.
40. The concept of "shoot", its morphology. Types of stem branching.
41. Primary anatomical structure of the stem.
42. Anatomical structure of a sunflower stalk.
43. Anatomical structure of the stem of flax and hemp: commonalities in structure and differences.
44. Anatomical structure of the stem of a tree plant. Annual rings.
45. Features of the anatomical structure of the leaves of representatives of different systematic groups.
46. Anatomical structure of a leaf of heterogeneous mesophilic type.
47. Evolution of forms of sexual process.
48. Sexual reproduction, its advantages over asexual and vegetative.
49. Primitive forms of sexual process - conjugation, zyogamy, plasmogamy, gametangium.

50. Asexual reproduction - the essence, positive and negative features.
51. Vegetative reproduction in representatives of different systematic groups, advantages and disadvantages in comparison with sexual reproduction.
52. Archegonial plants - general characteristics, classification.
53. Department of Moss-like. Marchant development cycle.
54. Class Real mosses. The development cycle of cuckoo flax.
55. Division Horsetail - general characteristics, classification.
56. The cycle of development of horsetail.
57. Department Plaunopodobnye. General characteristics, classification.
58. The cycle of development of isosporous plaun.
59. Class to Shilnikov. The development cycle of variegated plaun.
60. Department of Ferns - general characteristics, classification. The development cycle of variegated ferns.
61. The concept of alternation of asexual and sexual generations (haploid and diploid phases of development) - on the example of a male fern.
62. Divergence in plauns and ferns, its evolutionary significance.
63. Comparative characteristics of gymnosperms and angiosperms.
64. General characteristics of the division of gymnosperms, their evolutionary connections with other archegonial plants.
65. Classification of gymnosperms, a brief description of the classes.
66. To reveal the phylogenetic connections of the Gnet class. The main features of the structure that indicate its intermediate position.
67. Signs that allow us to speak of seed ferns as an intermediate group between ferns and cycads.
68. What are the main subclasses of the class of conifers. Give their brief description. The most important representatives, their importance in nature and economy.
69. Cycle of development of gymnosperms on the example of Scots pine.
70. Flower - definition, structure, morphological types.
71. Basic theories of the origin of the flower.
72. The structure of the pistil. Megasporogenesis and development of female gametophyte in flowers.
73. The structure of the stamen. Microsporogenesis and formation of the male gametophyte in angiosperms.
74. Types of pollination. Adaptation to cross-pollination. Features of pollen structure in flowers of insect-, water- and wind-pollinated plants.
75. The structure of the flower of cereals.
76. Double fertilization, its biological significance.
77. Apomixis and its varieties.
78. Types of inflorescences and their biological significance.
79. Development and structure of different types of seeds.
80. Development, structure, types and classification of fruits.
81. Department of Angiosperms (Flowers), general characteristics, time of occurrence, their development.
82. Plant families of Magnoliophyta.
83. Basic concepts of plant geography.

84. The main environmental factors in the life of the plant: classification, role in life, phytoindication value.

85. The structure of the phytocenosis: tiers, sinusivity

## 6. Teaching methods.

The Department of Botany, Dendrology and Forest Breeding in the educational process in the discipline uses various forms and methods of teaching: lectures, laboratory classes, exams, tests, programmed written and oral control, writing essays, presentations at classes and student conferences, passing colloquia, making drawings and preparations, herbarium collection, design, visualization, identification of plants, geobotanical descriptions of vegetation, preparation of plant samples for analytical research, analysis of the economic condition of forest lands, promotion of ecological knowledge, etc. The use of these forms and methods makes it possible to significantly intensify the educational process in botany, systematize and deepen botanical knowledge, skills and abilities of students of NULES of Ukraine, contributes to the formation of their worldview and personality, improves the quality of professional training of future professionals.

## 7. Forms of control.

Control of knowledge (current and final) is carried out in accordance with the credit-module system of the educational process.

Current - during laboratory work, individual tasks, current tests, control of mastering a certain module (module control). Modular control is carried out in the form of test control of knowledge from each content module of the discipline. One set of tests is formed of 30 tasks per module. There are 30 questions in each task, 4-5 answers to each question, from which the student must choose the correct ones. Each content module is evaluated on a 100-point scale (100%).

Final - includes credit (end of the first semester), exam (end of the second semester), credit for internship (end of the second semester). The test of educational practice involves the delivery of a systematic herbarium of plants. The maximum possible number of conditional points for a student's study is 70% (coefficient 0.7) and 30% (coefficient 0.3) falls on the exam of the total number of conditional points.

Up to 10 additional points are awarded by the decision of the department for performance of works that are not provided by the curriculum, but contribute to improving the level of knowledge and skills of students in the discipline (report at a student conference, winning a prize in competitions, making stands, etc.). According to the decision of the department, the rating of educational work can be influenced by the penalty rating (with a negative sign) - up to 5 points.

**8. Distribution of points received by students.** Assessment of student knowledge is on a 100-point scale and is translated into national assessments according to table. 1 "Regulations on examinations and tests in NULES of Ukraine"

Student rating, points	Grade according to national system	
	exams	final tests

<b>90-100</b>	<b>Excellent</b>	<b>Credited</b>
<b>74-89</b>	<b>Good</b>	
<b>60-73</b>	<b>Satisfactory</b>	
<b>0-59</b>	<b>Unsatisfactory</b>	<b>Not Credited</b>

To determine the student's rating for mastering the discipline RDIS (up to 100 points), the obtained rating for certification (up to 30 points) is added to the rating of the student (listener) for academic work RNR (up to 70 points):  $R\ DIS = R\ HP + R\ AT$ .

### **EDUCATIONAL PRACTICE IN BOTANY**

Educational practice in the course "Biology I (Botany)" is the final stage in the study of the theoretical course, aims to consolidate the knowledge gained during laboratory-practical classes and lectures. It is held in the spring and summer by laboratory-excursion method teams of 5 students.

Duration of training practice 5 days (30 hours). The training practice provides for 3 days - field work (sightseeing botanical excursions to forests in the vicinity of Kyiv, collection of plants from different types of phytocenoses to the herbarium, laying plants for drying, field geobotanical descriptions), 2 - chamber (plant identification, herbarium design, forms of geobotanical descriptions of vegetation). During fieldwork, students master the following topics.

**The first topic:** "Plants and the environment"; in natural conditions study the relationship between plants and the environment, the influence of environmental factors on the plant organism and vegetation. Students get acquainted with the life forms of plants and their ecologies: xerophytes, mesophytes, hygrophytes, hydrophytes, succulents, etc., as well as study the floristic composition of forest grass cover in different categories of forest areas (under forest tents, fellings, forest areas) and ecological coenotic properties of mixed and deciduous forest species study of composition. Students conduct morphological analysis and identification of plants; bookmarking of accounting plots to determine the nature of forest grass cover, to determine with the help of indicator plants the types of forest vegetation conditions; geobotanical description of the forest group and simultaneously collect plants for a systematic herbarium

**The second topic:** "Vegetation of phytocenoses derived from forest vegetation, their geobotanical and economic characteristics". Under the conditions of the topic, students study the floristic composition, conduct a geobotanical description of phytocenoses of fellings, crops to close, forest meadows, swamps, from typical areas select oblique sheaves of vegetation. Get acquainted with cultural and technical measures to improve phytocenoses. For the herbarium, students collect fodder, poisonous, medicinal, honey plants, synanthropic species, plants-indicators of soil conditions.

**The third topic:** "Plant resources, their enrichment and protection of rare and endangered plant species and plant communities of Ukraine". On the basis of botanical gardens, collection nurseries, students get acquainted with the diversity of plants in

Ukraine and other countries, study food, fodder, medicinal, technical, poisonous weeds and other groups of plants.

**The fourth topic:** "The structure of the forest phytocenosis and ecological-coenotic relationships of its price elements." On the basis of educational farms or state enterprises of the forest industry, students get acquainted with the structure of forest phytocenoses, floristic composition, stratification, coverage, viability of species, phenological, ecological and coenotic properties of coenotypes.

Students conduct a geobotanical description of the forest phytocenosis, make and analyze observations of the development of indicator plants and aliens, collect a herbarium of alien species and introducers.

**The fifth topic:** "Vegetation of botanical and geographical zones of Ukraine". During excursions to botanical gardens, students study the vegetation of botanical and geographical areas of Ukraine.

**The sixth topic:** "Floristic and coenotic diversity of vegetation of Ukraine". Based on floristic and coenotic analysis, students design herbarium material, determine the economic productivity and quality of plant raw materials and as a result give suggestions for improving and enriching plant complexes and transformation of natural lands into different types of agrophytocenoses taking into account zonal and regional ecosystems.

The internship begins with botanical excursions, during which students learn: different types of places of growth, the most important indicators of these types and their adaptation to environmental conditions and indicative and economic significance; rare and endangered species of local flora and measures for their protection.

To go on the tour, students must have certain equipment: for the team - a herbarium folder with a set of newspapers, writing instruments, a magnifying glass, tape measure or cord, altimeter, measuring rail and fork, test description forms, notebooks, plastic bags, labeling paper plants, digger, camera, GPS receiver.

During the processing of the collected material in the laboratory, students have the following tasks: to consolidate the method of morphological analysis of plants, the characteristics of families, to be able to use the determinant and identify the collected plants.

During the period of practice excursions are conducted:

1. Excursions to study the forest cover of coniferous forests.
2. Excursions to study the geobotanical study of deciduous forests.
3. Excursions to study synanthropic species in natural and derived phytocenoses.
4. Excursions to botanical gardens to study introduced plants.

## **PRACTICE REPORT**

Students must submit:

1. Practice diary, which records each day of work: the theme of the tour, collected plants, their biological and environmental characteristics.
2. Forms of geobotanical descriptions with the results of research.
3. List of collected plants in the amount of 120 species, arranged in a systematic manner according to the system of A. Takhtadjian.
4. The herbarium of plants is collected and issued according to the list.

5. Knowledge of Ukrainian and Latin names of species of plants and families to which they belong, as well as their economic and indicative significance.

### 11. Methodical support

- Tertyshnyy A.P. (2014). Botany with elements of plant ecology. Kyiv: Phytosociocentre. 562 p.
- Григора І.М., Алейніков І.М., Лушпа В.І., Шабарова С.І., Якубенко Б.Є. (2015) Курс загальної ботаніки. Київ: Фітосоціоцентр. 535 с.
- Григора І.М., Шабарова С.І., Алейніков І.М. (2015). Ботаніка. Київ: Фітосоціоцентр. 504 с.
- Якубенко Б.Є. (2015). Польовий практикум з ботаніки. Навчальний посібник . Київ: Фітосоціоцентр. 400 с.
- Чурилов А.М., Якубенко Б.Є. (2015). Ботаніка. Методичний посібник щодо користування лісотипологічним гербарієм. Київ: Видавничий центр НУБіП України. 176 с.
- Чурилов А.М. (2019). Особливості вивчення рослинного покриву лісів. Методичні рекомендації до польової практики для студентів спеціальності 205 «Лісове господарство». Київ. 205 с.

### 12. Recommended Books

- Войтюк Ю.О. Кучерява Л.Ф., Баданіна В.А., Брайон О.В. (1998). Морфологія рослин з основами анатомії та цитоембріології. Київ: Фітосоціоцентр. 216 с.
- Григора І.М., Алейніков І.М., Лушпа В.І., Шабарова С.І., Якубенко Б.Є. (2015). Курс загальної ботаніки. Київ: Фітосоціоцентр. 535 с.
- Григора І.М., Шабарова С.І., Алейніков І.М. (2015) Ботаніка. Київ: Фітосоціоцентр. 504 с.
- Григора І.М., Якубенко Б.Є. (2013). Геоботаніка. Київ: Арістей. 448 с.
- Костіков І.Ю. Джаган В.В., Демченко Е.М., Бойко О.А., Бойко В.Р., Романенко П.О. (2007). Ботаніка. Водорості та гриби. Київ: Арістей. 476 с.
- Нечитайло В.А., Кучерява Л.Ф. (2000). Ботаніка. Вищі рослини. Київ: Фітосоціоцентр. 432 с.
- Основи роботи в середовищі програм Turboveg та JUICE (2015). Укладачі: Куземко А.А., Буджак В.В., Чорней І.І., Токарюк А.І. Чернівці: Чернівецький національний університет. 64 с.

### 13. Information resources

**Biology: Botany (Еко):** <https://elearn.nubip.edu.ua/course/view.php?id=1164>

#### Plant Anatomy

- Plant Anatomy Database (англомовний ресурс, містить ілюстрації анатомічних зрізів вегетативних органів вищих рослин). Retrieved from: <https://anatomy.plb.ucdavis.edu/>
- Photographic Atlas of Plant Anatomy. University of Wisconsin and Iowa State University. Retrieved from: <https://botweb.uwsp.edu/Anatomy/>

#### Systematics of fungi

- Світ грибів України (ресурс присвячений різноманіттю справжніх грибів флори України, містить фотоілюстрації видів та відомості стосовно застосування у кулінарії). Retrieved from: <http://gribi.net.ua>

#### Databases on biological diversity

- iNaturalist. Retrieved from: <https://www.inaturalist.org>
- National Biodiversity Information Network Ukrbin. Retrieved from: <http://ukrbin.com>
- Global Biodiversity Information Facility (GBIF). Retrieved from: <https://www.gbif.org>

#### Systematics of higher plants

- Bryophyte Ecology (електронна книга англійською мовою про екологію мохоподібних, особливості їхньої біології та взаємодії із іншими організмами). Retrieved from: <https://digitalcommons.mtu.edu/bryophyte-ecology/>
- World Ferns (англомовний ресурс присвячений таксономії та біологічним і екологічним особливостям рослин з відділів плауноподібні та папоротеподібні). Retrieved from: <https://worldplants.webarchiv.kit.edu/ferns/>
- The Gymnosperm Database (англомовний ресурс присвячений таксономії та біологічним і екологічним особливостям рослин з відділу голонасінні). Retrieved from: <https://www.conifers.org/index.php>
- The Plant List (англомовний ресурс, присвячений сучасній систематиці і таксономії вищих рослин). Retrieved from: <http://www.theplantlist.org/>
- Plants of the World online (англомовний ресурс, присвячений сучасній систематиці і таксономії вищих рослин, наявні ілюстрації рослин). Retrieved from: <http://powo.science.kew.org/>

#### Geobotany

- Ukrainian geobotanical site. Retrieved from: <http://geobot.org.ua/>