

MINISTRY OF HEALTH OF UKRAINE  
NATIONAL UNIVERSITY OF PHARMACY  
Faculty of Pharmacy  
Department of Pharmacognosy and Nutriciology

PHARMACEUTICAL BOTANY



WORK PROGRAM  
of educational component

training	<u>for second Master's</u>
field of knowledge	<u>22 Healthcare</u>
in specialty	<u>226 Pharmacy, industrial pharmacy</u>
of educational program – English)	<u>Pharmacy for foreign students (Language of Instruction</u>
specialization	<u>226.01. Pharmacy</u>

2023 academic year

The work program of the educational component "Pharmaceutical Botany" in specialty 226 "Pharmacy, industrial pharmacy" educational program "Pharmacy for foreign students (Language of Instruction – English)" (4.10d)N for higher education applicants 1<sup>st</sup>-2<sup>nd</sup> years of study

EDUCATIONAL COURSE TEAM:

KYSLYCHENKO Viktoriya, Head of Pharmacognosy and Nutriciology Department, Doctor of Pharm. Sc., Professor; GONTOVA Tetiana, Professor of Pharmacognosy and Nutriciology Department, Doctor of Pharm. Sc., Professor; MASHTALER Viktoriya, Associate professor of Pharmacognosy and Nutriciology Department, Candidate of Pharm.Sc., Associate professor

Work program has been considered and approved at the Pharmacognosy and Nutriciology Department meeting

Record from "1" September, 2023 No. 1

Head of the Department  Prof. Viktoriya KYSLYCHENKO

Work program has been approved at the meeting of Methodical Commission of chemical disciplines

Record from «5» september, 2023 № 1

Head of the Specialized Committee  Prof. Victoriya GEORGIYANTS

## 1. Description of the educational component

**Language of study:** English.

**Status of the educational component:** compulsory.

**Prerequisites for studying the educational component:** Pharmaceutical botany as educational component is based on the study of biology with fundamentals of genetics, general and inorganic chemistry, information technology in pharmacy, Latin and Ukrainian languages.

The **subject** study of educational component "Pharmaceutical botany" includes plant cells and tissues, vegetative and generative organs of plants, some medicinal representatives of cyanobacteria, fungi, ferns, gymnosperms and angiosperms, their systematic, ecological, biocentric, geographical, and individual pharmacological characteristics, as well as plant communities.

**Information content of the educational component.** 8 ECTS credit 240 hours are assigned to the study of the educational component.

## 2. Objectives and tasks of the educational component

**The purpose of teaching the educational component** "Pharmaceutical botany" is

to achieve understanding of the structure, chemical composition, and functions of plant cells, tissues, organs, and organisms as a whole;

to learn theoretical fundamentals on the structure, classification, taxonomy, ecology, and geography of medicinal plants and fungi, their importance and use in medicine, pharmacy, etc.;

to master methods and procedures of macro- and microscopic analysis of plant organs;

to use knowledge of morphology, anatomy, and ecology of medicinal plants in specific situations;

to demonstrate the ability to draw conclusions as life forms, age of the plant, peculiar characteristics of environmental conditions of its existence; to determine diagnostic signs of organs and raw materials of medicinal plants based on macro- and microscopic analysis of plant objects;

to lay the basis for skills of determination and description of morphological and anatomical characteristics of particular organs of medicinal plants, being medicinal plant raw materials;

to acquire the skill to have a full picture about the plant and its ecology on the basis of the totality of individual morphological and anatomical, as well as ecological and geographical characteristics.

**The main tasks** of the educational component "Pharmaceutical botany" are knowledge of medicinal plants, their anatomical and morphological structure, fundamentals of their life, propagation, geographical distribution, classification, use, fundamentals of ecology, structure, development and distribution of plant groups on the Earth.

## 3. Competence and planned educational outcomes

Educational component "Pharmaceutical botany" ensures the acquisition of applicants for higher education the following **competences**:

- *integral*:

The ability to solve problems of a research and/or innovative nature in the field of pharmacy.

- *general*: GC 12. Ability to conduct research at an appropriate level.

- *special (professional, subject)*:

PC 2. The ability to collect, interpret and apply data necessary for professional activity, research and implementation of innovative projects in the field of pharmacy.

PC 10. The ability to ensure the proper storage of medicines and other products of the pharmacy assortment in accordance with their physicochemical properties and the rules of Good Storage Practice (GSP) in healthcare facilities.

Integrative final *program learning outcomes* (PLO), the formation of which is facilitated by the educational component:

PLO 17. Predict and determine the impact of environmental factors on the quality and consumer characteristics of medicinal products of natural and synthetic origin and other products of the pharmacy assortment, organize their storage in accordance with their physicochemical properties and the rules of Good Storage Practice (GSP).

As a result of studying the educational component, the applicant for higher education will be *know*:

- definition of pharmaceutical botany as a science, its tasks and connection with professionally oriented pharmaceutical education components and professional activity;
- role and significance of plants in nature and human life and activities, use in pharmacy and medicine;
- features of structure, classification, and functioning of plant cells and tissues, their diagnostic signs significant for identification of medicinal plant raw material;
- qualitative histochemical reactions for definition crystal inclusions, stock of products, secondary changes of cell membrane, etc;
- morphological structure and functions of plant vegetative organs, their diversity;
- regularities of anatomical structure and types of plant vegetative organs and their metamorphoses;
- common features of families and species-specific morphological and anatomical characteristics of medicinal plants, cyanobacteria, fungi; ecological conditions of their growth, resources, presence of certain groups of biologically active compounds, their significance, and use;
- elements of ecology, cenology, and geography of plants;

*be able to*:

- work with a microscope;
- make, study and describe microscope slides, carry out histochemical reactions;
- make a preparation, describe generative organs of the plant, compose flower formulas;
- determine, recognize plant organs and their metamorphoses by anatomical and morphological signs;
- according to morphological features, identify plants and their belonging to particular taxons;
- identify plants according to herbarium specimens, drawings, photos, in nature;
- describe and image external and internal structure of plant organs, summarize the results obtained, make conclusions and give reasons for them, fill out study results.

*possess*:

- botanical terminology;
- methods of light microscopy, cyto- and histochemistry, morphological segmentation, visual observation;
- techniques and skills of plant object imaging, making temporary microscope slides (surface slides of leaves, cross sections of axial organs), make preparations of generative organs.

#### 4. The educational component structure

Names of content modules and topics	The amount of hours				
	full time study				
	the whole amount	including			
1.		sem	pr. lessons	self-study	
1	2	3	4	5	6
<b>Module 1 Anatomy and morphology of plant vegetative organs</b>					
<b>Content module 1.</b> Structural-functional, and chemical features of plant cells, their signs that have diagnostic significance					
<b>Topic 1.</b> Introduction to pharmaceutical botany and anatomy of plants. Fundamentals of botanical microtechnique.	2.7	0.2	-	0.5	2

<b>Topic 2.</b> Modern understanding of the structure of a plant cell. Structures of a plant cell that have diagnostic significance in microscopic analysis of plant raw materials.	17	1.5	-	5	10.5
<b>Topic 3.</b> Vacuoles and cell sap.	2.3	0.3	-	0.5	1.5
<b>Control of the content module 1</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>-</b>
<b>The whole amount of hours for the content module 1</b>	<b>24</b>	<b>2</b>	<b>-</b>	<b>8</b>	<b>14</b>
<b>Content module 2.</b> Structural-functional, and chemical features of plant tissues, their signs that have diagnostic significance					
<b>Topic 4.</b> Plant tissue and their classification.	0.7	0.1	-	0.1	0.5
<b>Topic 5.</b> Structural-functional and topographic characteristics of meristimatic, covering, basic and secretory tissues.	11.8	0.9	-	3.9	7
<b>Topic 6.</b> Structural-functional and topographic characteristics of mechanical and conducting tissues. Conductive bundles.	10	1	-	2	7
<b>Control of the content module 2</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>-</b>
<b>The whole amount of hours for the content module 2</b>	<b>24.5</b>	<b>2</b>	<b>-</b>	<b>8</b>	<b>14.5</b>
<b>Content module 3.</b> Morphological and anatomical structure and functions of vegetative plant organs					
<b>Topic 7.</b> Introduction to morphology and anatomy. Plant organs and integrity of a plant organism. Propagation of plants.	2.1	0.5	-	0.1	1.5
<b>Topic 8.</b> Anatomy of the root. Anatomy of the stem and rhizome of monocots.	14.4	3.5	-	3.9	7
<b>Topic 9.</b> Anatomy of the stem and rhizome of dicots. Anatomy of the stem of arboreal plants.	15	2	-	6	7
<b>Topic 10.</b> Anatomy of the leaf.	18	2	-	6	10
<b>Topic 11.</b> Morphology of the roots and shoots and their metamorphoses. Vegetative propagation.	18	4	-	4	10
<b>Control of the content module 3</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>-</b>
<b>The whole amount of hours for the content module 3</b>	<b>70.5</b>	<b>12</b>	<b>-</b>	<b>23</b>	<b>35.5</b>
<b>Semester credit from module 1</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>	<b>-</b>
<b>The whole amount of hours for Module 1</b>	<b>120</b>	<b>16</b>	<b>-</b>	<b>40</b>	<b>64</b>
<b>Module 2. Morphology of plantgenerative organs. A systematic review of some families of medicinal plants and mushrooms with elements of phytoecology and phytocenology</b>					
<b>Content module 4.</b> Structure and function of generative organs of plants, their taxonomic and diagnostic signs. Sexual propagation of plants					
<b>Topic 12.</b> Generative organs of flowering plants. Morphology of the flower and inflorescence.	8.2	0.4	-	3.8	4
<b>Topic 13.</b> Sexual propagation of flowering plants.	0.8	0.1	-	0.2	0.5
<b>Topic 14.</b> Morphology of the fruit, seed and collective fruit.	6.5	0.5	-	2	4
<b>Control of the content module 4</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>-</b>
<b>The whole amount of hours for the content module 4</b>	<b>17.5</b>	<b>1</b>	<b>-</b>	<b>8</b>	<b>8.5</b>
<b>Content module 5.</b> Systematics of plants. An overview of some families of Ranunculidae, Caryophyllidae, Dilleniidae, Rosidae and Liliidae subclasses, and their medicinal representatives					
<b>Topic 15.</b> Introduction to plant taxonomy. Fundamentals of botanical classification. Angiosperms. System of Magnoliophyta.	1.4	0.2	-	0.2	1
<b>Topic 16.</b> An overview of Brassicaceae and Leguminosae families and their medicinal representatives.	8.6	0.8	-	1.8	6
<b>Topic 17.</b> An overview of Ericaceae and Rosaceae families and their medicinal representatives.	10.4	1	-	3.4	6
<b>Topic 18.</b> An overview of Polygonaceae and Apiaceae families and their medicinal representatives.	9.6	0.6	-	4	5
<b>Topic 19.</b> An overview of Alliaceae and Poaceae families and their medicinal representatives.	2	0.4	-	0.6	1
<b>Control of the content module 5</b>	<b>2</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>-</b>
<b>The whole amount of hours for the content module 5</b>	<b>34</b>	<b>3</b>	<b>-</b>	<b>12</b>	<b>19</b>

<b>Content module 6.</b> An overview of some families of Lamiidae and Asteridae subclasses and their medicinal representatives, some medicinal representatives of monocotyledons and dicotyledons, gymnosperms, ferns, algae, fungi, and lichens classes. Elements of phytoecology and geobotany					
<b>Topic 20.</b> An overview of Solanaceae and Lamiaceae families and their medicinal representatives	10	1	-	4	5
<b>Topic 21.</b> An overview of Asteraceae family and its medicinal representatives.	11.5	1	-	4.5	6
<b>Topic 22.</b> An overview of flowering medicinal plants of different families common in Ukraine.	11	1	-	4	6
<b>Topic 23.</b> An overview of medicinal representatives of gymnosperms, ferns, algae, fungi, and lichens common in Ukraine.	6.8	0.5	-	0.3	6
<b>Topic 24.</b> Elements of phytoecology and geobotany. Protection of flora, rational use and preservation of medicinal plant resources.	3.7	0.5	-	0.2	3
<b>Control of the content module 6</b>	<b>2</b>	-	-	<b>2</b>	-
<b>The whole amount of hours for the content module 6</b>	<b>45</b>	<b>4</b>	-	<b>15</b>	<b>26</b>
<b>Semester credit from module 2</b>	<b>1</b>	-	-	<b>1</b>	-
<b>Semester exam</b>	<b>22.5</b>	-	-	-	<b>22.5</b>
<b>The whole amount of hours for Module 2</b>	<b>120</b>	<b>8</b>	-	<b>36</b>	<b>76</b>
<b>The whole amount of hours for the course</b>	<b>240</b>	<b>24</b>	-	<b>76</b>	<b>140</b>

## 5. The content of educational component

### MODULE 1

#### *Content module 1. Structural-functional, and chemical features of plant cells and tissues, their signs that have diagnostic significance*

#### **TOPIC 1. Introduction to pharmaceutical botany. Fundamentals of botanical microtechnique.**

*The content of the topic is revealed* by general understanding about position of plants in the systems of organic world, their role and importance in human life. Botany as a science, its subject and sections. The history of botany development in Ukraine, prominent Ukrainian scientists-botanists. Educational component "Pharmaceutical botany", its aim, tasks, methods, and objects of study, relation to pharmacognosy and other professionally oriented educational components.

Phytocytology and phytohistology, their methods and study objects, significance in macro- and microscopical analysis of plant materials. Familiarization with the content, techniques, safety and carrying out of laboratory works.

#### **TOPIC 2. Modern understanding of the structure of a plant cell. Structures of a plant cell that have diagnostic significance in microscopic analysis of plant raw materials.**

Modern understanding of the structure of a plant cell, its components: protoplast and protoplast derivatives. Cell nucleus. Cytoplasm organelles. A notion of protoplast derivatives.

Distinctive features of plant cells from the cells of procaryotes, fungi, and animals.

Components of a plant cell that have diagnostic significance in microscopic analysis of plant objects.

Plastids: their types, structure, pigments, and functions. Significance and use of plastid pigments in pharmacy.

Inclusions of a plant cell, their classification, and diagnostic significance in microscopic analysis of plant raw materials.

Storage inclusions. Storage carbohydrates, their classification. Soluble carbohydrates: sites of synthesis, significance and practical use. Insoluble polysaccharide starch, its formation, types, properties, and form of accumulation. Starch grains: formation, types, structure, reactions of detection. Storage proteins: chemical origin, localization, and form of accumulation. Aleurone grains: formation, types, structure, reactions of detection. Fatty oil: localization and form of accumulation, differences from essential oil, reactions of detection.

Excretory crystalline inclusions: formation, localization, chemical origin, morphostructure, reactions of detection, diagnostic significance in microscopic analysis of plant raw materials.

A cell wall: formation, structure, chemical composition, properties, and functions. Secondary



chemical and structural changes of the membrane, their significance, reactions of detection. Plasmodesmata and pores. Diagnostic significance of a cell membrane in microscopic analysis of plant raw materials. The diagnostic value of the cell membrane in the microscopic analysis of plant material.

### **TOPIC 3. Vacuoles and cell sap.**

Vacuoles: formation, development, and functions. Composition of cell sap (nutrients and bioactive substances), its use.

Control of the content module 1.

### ***Content module 2. Structural-functional, and chemical features of tissues, their signs that have diagnostic significance***

### **TOPIC 4. Plant tissue and their classification.**

The relationship and interaction of cells in the plant organism.

Plant tissues: definition, classification on the basis of origin, morphology, functions, location. Significance and use of structural features of plant tissues in microscopic analysis of plant raw materials.

### **TOPIC 5. Structural-functional and topographic characteristics of meristematic, covering, basic and secretory tissues.**

Meristematic tissues or meristems: functions, structural features, classification, significance.

Covering tissues: functions, classification. Epidermis, epiblema, or rhizodermis, periderm, cork: location, formation, structure, functioning, diagnostic significance in microscopic analysis of plant objects.

Basic tissues: functions, classification. Assimilative, storage, water and gas accumulative tissues, their functions, structure, location in the organs, diagnostic significance in microscopic analysis.

Excretory or secretory tissues and structures: functions, classification. Exogenous and endogenous secretory tissues and structures: peculiarities of structure and functioning, taxonomic and diagnostic significance. Chemical origin, significance and use of biologically active secrets..

### **TOPIC 6. Structural-functional and topographic characteristics of mechanical and conducting tissues. Conductive bundles.**

Mechanical tissues: functions, classification. Collenchyma, sclerenchyma (sclerenchymatous fibers, sclereids): types, structural features, location in the organs, diagnostic significance in microscopic analysis.

Conducting elements: functions, classification. Vessels or trachea, tracheids, sieve cells and sieve tubes with companion cells, their formation, functions, structural peculiarities and functioning, diagnostic significance in microscopic analysis.

Conducting tissues: phloem and xylem, their functions, formation, components.

Conductive bundles: formation, structure, types, location in organs, taxonomic and diagnostic significance.

Educational research work "Definition and description of plant tissue".

Control of the content module 2.

### ***Content module 3. Morphological and anatomical structure and functions of vegetative plant organs***

### **TOPIC 7. Introduction to morphology and anatomy of plants. Plant organs and integrity of a plant organism. Propagation of plants.**

Morphology and anatomy as sections of botany, their aim, tasks, methods and objects of study.

Basic concepts of morphology (polarity, symmetry, metamery, unlimited growth, etc.). Evolution of body in phototrophs. Plant organs. Analogous and homologous organs. Morphological-anatomical and physiological integrity of a plant organism.

Propagation of plants: definition, forms, significance.

### **TOPIC 8. Anatomy of the root. Anatomy of the stem and rhizome of monocots.**

Root: root zones, their structure and functions. Regularities of anatomical structure of roots, relationship with functions. The structure of the roots of monocotyledonous and dicotyledonous plants in the zone of absorption and conduction, types according to the structure of the axial cylinder and origin. Characteristics significant for description and diagnostics of roots.

Stem: regularities of anatomical structure of stems and rhizomes, relationship with functions. Features of the anatomical structure of stems of herbaceous and xylophyte plants, types of structure according to origin and structure of the axial cylinder. The structure of the rhizomes of monocotyledonous plants. Characteristics significant for description and diagnostics of stems and rhizomes.

**TOPIC 9. Anatomy of the stem and rhizome of dicots. Anatomy of the stem of arboreal plants.**

Regularities of anatomical structure of stems and rhizomes dicotyledonous herbaceous plants, types of structure according to the origin and structure of the axial cylinder. Regularities of anatomical structure of stems of woody plants. Peculiarities of anatomical structure of stems of woody plants of angiosperms and gymnosperms. Signs that are important for the description and diagnosis of stems and rhizomes.

**TOPIC 10. Anatomical structure of the leaf.**

Anatomy of the leaf. The relationship between anatomical structure and functions of the leaf, regularities of tissue location. Types anatomical structure of the leaf blade of angiosperms and conifers. Structural features of veins. Anatomical characteristics of the epidermis and mesophyll of the lamina taken into consideration in microscopic identification of medicinal plant raw materials.

Influence of ecological factors on morphology and microstructure of leaves.

**TOPIC 11. Morphology of the roots and shoots and their metamorphoses. Vegetative propagation.**

Vegetative organs of plants: formation, functional integrity, significance, features that have diagnostic significance in macroscopic analysis of plant raw materials, use in pharmacy and medicine.

Root: definition, functions. Types of roots, their origin. Types of root systems. Specialization and metamorphoses of roots used in pharmacy and medicine (roots of *Daucus carota*, *Petroselinum crispum*, etc., stem-roots of *Beta vulgaris*, *Raphanus sativus*, root tubers of *Ipomoea batatas*, *Cyperus esculentus*, *Dahlia*, etc.), as well as mycorrhiza, bacteriorrhiza, contractile roots, aerial, respiratory, haustorial roots.

Shoot: definition, functions, morphological structure, and difference from the root. The diversity of shoot structure depending on the presence of reproductive organs, its lifespan, location in the system shoots, type of growth, type of branching, length internodes, position in space, etc. Stem: definition, functions, morphological characteristics (form in cross-section, color, surface texture, pubescence, etc.).

Buds: definition, functions, structure, classification according to location (apical, lateral, supplementary), structure (vegetative, generative, mixed, open, closed), growth rhythms (resting, renewal); buds of medicinal plants (*Betula pendula*, *Pinus sylvestris*, *Populus nigra*).

Characteristics of metamorphoses of aerial shoots and their components by the example of medicinal plants (stolons of *Fragaria vesca*, tendrils of plants of *Vitis* and *Bryonia* genera, thorns of plants of *Crataegus* genus, phylloclades of *Ruscus aculeatus*, cladophylae of plants of *Schlumbergera* genus, or *Zygocactus*, stem-root of *Brassica oleracea* L. Var. *gongylodes*, etc), as well the shoots of succulent plants. Characteristics of metamorphoses of underground shoots by the example of medicinal plants (tubers of potatoes and *Helianthus tuberosus*, or *Jerusalem potato*; bulb of *Drimys maritima*, *Allium cepa*, garlic, bulb tubers of *Colchicum*; rhizomes of *Acorus calamus*, *Nuphar lutea*, *Hydrastis canadensis*, *Eleutherococcus senticosus*, *Zingiber officinale*, *Curcuma domestica*, *Rubia tinctorum*, *Potentilla erecta*, *Podophyllum peltatum*, *Rhodiola rosea*, *Polemonium caeruleum*, *Scopolia carniolica*, etc.).

A leaf as a part of the shoot: definition, functions, components. Ways of location and attaching leaves to the stem. Leaf mosaic. Variety of leaves (leaf formation, heterophylly). Types of venation. Types of leaves. The morphology of simple leaves with whole leaf blades by the example of medicinal plants (*Vaccinium vitis-idaea*, *Arctostaphylos uva-ursi*, *Fagopyrum esculentum*, *Echinacea angustifolia*, *Convallaria majalis*, *Urtica urens*, *Rozmarinus officinalis*, *Plantago major* and *Plantago lanceolata*, *Orthosiphon*, *Rumicis acetosae*, *Senecios platyphylloides*, *Solidago virgaurea*, *Nerium oleander*, *Nerium oleander*, *Laurus nobilis*, *Aerva lanatae*, *Cotinus coggygria*, *Salvia officinalis*, *Aloe arborescens*, plants of genera *Hamamelis*, *Gentiana*, *Eucalyptus*, etc.). Morphology of simple leaves with dissected leaf blades by the example of medicinal plants (*Malva sylvestris*, *Macleya microcarpa*, *Glaucium flavum*, *Tussilago farfara*, *Passiflora incarnata*, *Filipendula ulmaria*, *Artemisia vulgaris*, *Rheum palmatum*, *Delphinium elatum*, *Ficus carica*, *Viola tricolor*, *Humulus*



*lupulus, Cannabis sativa, Ribes nigrum, Chelidonium majus*, etc.). Compound leaves, their classification and characteristics by the example of medicinal plants (*Menyanthes trifoliata, Fragaria vesca, Rhus coriaria, Sambucus ebulus, Juglans regia, Aesculus hippocastanum, Glycyrrhiza glabra, Astragalus dasyanthus, Thermopsis lanceolata, Cassia acutifolia*, etc.).

Origin, structure and functions of leaf metamorphoses and their parts by the example of medicinal and other plants (thorns of *Berberis vulgaris, Robinia pseudoacacia, Euphorbia splendens*, plants of *Astragalus* genus; tendrils of *Pisum sativum, Lathyrus aphaca*; shoot scales of *Viscum album, Equisetum arvense, Tussilago farfara*, bulbous of *Allium cepa*, buds of *Populus nigra*; colorless sappy storage leaves of *Brassica oleracea* head; catching apparatus of plants of *Drosera, Nepenthes* genera; ocreas of plants of *Polygonum* genus; leaf sheath of *Foeniculum vulgare, Elymus repens*; phyllodes of *Acacia melanoxylon*, etc.).

Classification of life forms according to I. G. Serebriakov.

Vegetative propagation of plants, its biological significance. Natural and artificial propagation of medicinal plants.

Control of the content module 3.

**Semester module supervision 1**

## MODULE 2

**Content module 4. Structure and function of generative organs of plants, their taxonomic and diagnostic signs. Sexual propagation of plants**

**TOPIC 12. Generative organs of the plant. Morphology of the flower and inflorescence.**

Reproductive organs of plants, their function and evolution. Generative organs of flowering plants: definition, functions.

Flower: definition, origin. Buds used in medicine (*Syzygium aromaticum, Styphnolobium japonicum*). Symmetry of the flower. Parts of a flower and their function: pedicel and the receptacle, their morphological characteristics; perianth: morphological and functional characteristics, types; sex of the flower; the structure of stamens, their functions, assignment of pollen, types androecium; the structure and functions of the pistil, ovary position, types of gynoecium. Flower formula. Monoecious and dioecious plants. Morphology of flowers of medicinal plants (*Glaucium flavum, Linum usitatissimum, Rubus idaeus, Saponaria officinalis, Digitalis grandiflora and Digitalis purpurea, Robinia pseudoacacia, Lamium album, Borago officinalis, Primula veris, Convallaria majalis, Persica vulgaris, Polemonium caeruleum, Scopolia carniolica, Ribes nigrum, Allium cepa*, as well as plants of *Papaver, Malva, Hibiscus, Verbascum, Kalanchoe, Paeonia, Gentiana* genera, etc.).

Inflorescence: definition, biological role, structure and classification. Morphological characteristics of monopodial and sympodial inflorescences by the example of medicinal plants (*Centaurea cyanus, Chamomilla recutita, Calendula officinalis, Pyrethrum, Digitalis grandiflora, Convallaria majalis, Plantago major and Plantago lanceolata, Primula veris, Allium cepa, Artemisia vulgaris, Levisticum officinale, Centella asiatica, Malus pumila, Pyrus communis, Prunus cerasus, Populus nigra, Saponaria officinalis, Radix Sambuci ebuli, Lavandula spica, Centaurium erythraea, Oryza sativa, Zea mays, Elymus repens, Verbena officinalis, Cassia acutifolia, Panax, Eleutherococci senticosi, Bergenia crassifolia, Filipendula ulmaria, Borago officinalis*, etc.).

Biological role, diagnostic significance and practical use of flowers and inflorescences in pharmacy, medicine and other fields.

**TOPIC 13. Sexual propagation of flowering plants.**

Seed propagation flowering plants, processes of pollination and fertilization, formation of a seed and a fruit.

**TOPIC 14. Morphology of the fruit, seed and collective fruit.**

Fruit: definition, origin, structure, and functions. Part of the fruit, their origin and peculiarities of structure. Classification and characteristics of fruits according to their morphological and morphogenetic signs. Morphology of fruits by the example of medicinal plants (*Illicium verum, Berberis vulgaris, Vitis vinifera, Punica granatum, Olea europaea, Prunus padus, Zea mays, Oryza sativa, Allium cepa, Amorpha fruticosa, Ricinus communis, Trigonella foenum-graceum, Styphnolobium japonicum, Cassia acutifolia, Nigella damascena, Citrus limon, Anisum vulgare, Carum carvi, Coriandrum sativum, Anethi graveolentis, Foeniculum vulgare, Rubus idaeus*, as well as plants of *Gossypium, Papaver, Ribes, Malus, Sorbus, Rosa* genera, etc.).

A compound fruit: origin, structure, significance. Morphology of compound fruits by the example of medicinal plants (*pineapple*, *Alnus glutinosa*, *Morus*, *Ficus carica*, *Humulus lupulus*, etc.).

A seed: structure, classification according to its origin and the site of accumulation of nutrients. Distribution of seeds and fruits. Peculiarities and use of medicinal plant seeds (*Datura metel*, *Citrullus vulgaris*, *Linum usitatissimum*, *Coffea*, *Juglans regia*, *Amygdalus communis*, *Ricinus communis*, as well as plants of *Strophanthus*, *Strychnos nux-vomica*, *Sesamum*, *Armeniaca*, *Vitis*, *Sinapis*, *Cucurbita*, *Oenothera*, *Persica*, *Nigella genera*, etc.). Biological role, diagnostic significance and practical use of fruits, stems and seeds in pharmacy, medicine and other fields.

Control of the content module 4.

**Content module 5. Systematics of plants. An overview of some families of Ranunculidae, Caryophyllidae, Dilleniidae, and Rosidae subclasses, and their medicinal representatives**

**TOPIC 15. Introduction to plant taxonomy. Fundamentals of botanical classification. Angiosperms. System of Magnoliophyta.**

Introduction to taxonomy. Aim, objectives, methods, and objects of taxonomy, its sections. Modern phylogenetic systems. Taxonomic categories and taxons. Botanical nomenclature. The diversity of living organisms. The concept of lower and higher plants, their characteristics and classification. The concept of chemosystematic characteristics.

Progressive signs of the organization of angiosperms. System of Magnoliophyta by A. L. Takhtajan, its fundamental differences from other modern Botanical systems. General characteristics of angiosperms, comparative characteristics of the classes of dicotyledons and monocotyledons. Families that are widely distributed and include valuable medicinal plants.

**TOPIC 16. An overview of Brassicaceae and Leguminosae families and their medicinal representatives.**

General characteristics of the families *Brassicaceae* and *Fabaceae*. Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance, and use of representatives of the following families: *Brassicaceae* (*Brassica juncea*, *Brassica nigra*, *Capsella bursa-pastoris*, *Erysimum canescens* Roth.); *Leguminosae* (*Astragalus dasyanthus*, *Melilotus officinalis*, *Ononis arvensis*, *Phaseolus vulgaris*, *Robinia pseudoacacia*, *Styphnolobium japonicum*, *Glycyrrhiza glabra*, *Thermopsis lanceolata*);

**TOPIC 17. An overview of Ericaceae and Rosaceae families and their medicinal representatives.**

General characteristics of *Ericaceae* and *Rosaceae families*. Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance, and use of representatives of the following families: *Ericaceae* (*Ledum palustre*, *Vaccinium vitis-idaea*, *Vaccinium Oxycoccus*, *Arctostaphylos uva-ursi*, *Vaccinium myrtillus*); *Rosaceae* (*Photinia melanocarpa*, *Crataegus sanguinea*, *Sorbus aucuparia*, *Rubus idaeus*, *Amygdalus communis*, *Potentilla erecta*, *Sanguisorba officinalis*, *Fragaria vesca*, *Prunus padus*, *Rosa canina*, *Rosa majalis*).

**TOPIC 18. An overview of Polygonaceae and Apiaceae families and their medicinal representatives.**

General characteristics of *Polygonaceae* and *Apiaceae families*. Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance, and use of representatives of the following families: *Polygonaceae* (*Persicaria bistorta*, *Persicaria hydropiper*, *Persicaria maculosa*, *Polygonum aviculare*, *Fagopyrum esculentum*, *Rumex confertus*); *Apiaceae* (*Pimpinella anisum*, *Carum carvi*, *Coriandrum sativum*, *Anethum graveolens*, *Daucus carota*, *Pastinaca sativa*, *Petroselinum sativum Hoffm*, *Foeniculum vulgare*).

**TOPIC 19. An overview of Poaceae family and its medicinal representatives.**

General characteristics of *Poaceae* family. Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance, and use of representatives of the following family: (*Zea mays*, *Avena sativa*, *Triticum aestivum*, or *Triticum aestivum*).

Control of the content module 5.

**Content module 6. An overview of some families of Lamiidae, Asteridae, and Liliidae subclasses and their medicinal representatives, some medicinal representatives of monocotyledons and dicotyledons, gymnosperms, ferns, algae, fungi, and lichens classes. Elements of phytoecology and**

**geobotany**

**TOPIC 20. An overview of Solanaceae and Lamiaceae families and their medicinal representatives.**

General characteristics of *Solanaceae and Lamiaceae families*. Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance, and use of representatives of the following families: *Solanaceae* (*Atropa belladonna, Hyoscyamus niger, Datura stramonium, Solanum tuberosum, Capsicum annuum*). *Lamiaceae* (*Origanum vulgare, Melissa officinalis, Mentha piperita, Rosmarinus officinalis, Leonurus quinquelobatus Gilib., Thymus serpyllum, Thymus serpyllum, Salvia officinalis*).

**TOPIC 21. An overview of Asteraceae family and its medicinal representatives.**

General characteristics of *Asteraceae* family. Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance, and use of representatives of the following family: *Asteraceae* (*Arnica montana, Achillea millefolium, Echinacea purpurea, Taraxacum officinale, Arctium lappa, Calendula officinalis, Inula helenium, Tussilago farfara, Tanacetum vulgare, Artemisia absinthium, Silybum marianum, Chamomilla recutita, Chamomilla suaveolens Pursh., Helichrysum arenarium, Bidens tripartita*).

**TOPIC 22. An overview of flowering medicinal plants of different families common in Ukraine.**

Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance and use of plants most widespread in Ukraine (*Althaea officinalis, Betula pendula, Vinca minor, Glaucium flavum, Sambucus nigra, Valeriana officinalis, Alnus glutinosa, Aesculus hippocastanum, Adonis vernalis, Juglans regia, Quercus robur, Rhamnus cathartica, Hypericum perforatum, Viburnum opulus, Convallaria majalis, Urtica dioica, Rhamnus frangula, Acorus calamus, Schisandra chinensis, Tilia cordata, Digitalis purpurea, Hippophae rhamnoides, Plantago major, Primula veris, Humulus lupulus, Allium cepa, Allium sativum, Chelidonium majus*).

**TOPIC 23. An overview of medicinal representatives of gymnosperms, ferns, algae, fungi, and lichens common in Ukraine.**

Morphological and ecological characteristics, presence of certain groups of biologically active substances, resources, significance and use of plants and fungi most widespread in Ukraine: *Ginkgo biloba (Ginkgoaceae), Pinus sylvestris (Pinaceae), Juniperus communis (Cupressaceae), Equisetum arvense (Equisetophyta); Dryopteris filix mas (L.) Schott (Filicopsida, or Pteridophyta); Laminaria, Fucus (Phaeophyceae); Spirulina (Cyanobacteria, or Cyanomycota); Fungus betulinus, or Inonotus obliquus, or chaga mushroom, Amanita muscaria (mushrooms); Cetraria (Lichenes)*.

**TOPIC 24. Elements of phytoecology and geobotany. Protection of flora, rational use and preservation of medicinal plant resources.**

Plant ecology. Environmental factors, their influence on plants; ecological groups of plants in relation to moisture, light, soil. Seasonal development of plants, phenophases.

Plant communities, or phytocenoses, their characteristics. Areas and their types. The concept of flora and vegetation. The concept of plants cosmopolitans, endemics, relicts. Types of vegetation.

Plant resources of Ukraine, their rational use, preservation, and measures of environmental protection.

Control of the content module 6.

**Semester module supervision 2**

**Semester exam**

**6. Topics of lectures**

№	Name of topic	The amount of hours
		full time study
1.	Introduction to pharmaceutical botany and anatomy of plants. Fundamentals of botanical microtechnique.	2
2.	Modern understanding of the structure of a plant cell. Structures of a plant cell	

	that have diagnostic significance in microscopic analysis of plant raw materials.		
3.	Vacuoles and cell sap.		
4.	Plant tissue and their classification.	1	
5.	Structural-functional and topographic characteristics of formative, ground, primary, and secretory tissues.		
6.	Structural-functional and topographic characteristics of mechanical and conducting tissues. Conductive bundles.	1	
7.	Introduction to morphology and anatomy. Plant organs and integrity of a plant organism. propagation of plants.	4.5	
8.	Vegetative organs. Morphology of the root and shoot and their metamorphoses. Vegetative propagation.		
9.	Anatomy of the root.	5.5	
10.	Anatomy of the stems of the above-ground shoots and rhizomes.		
11.	Morphology and anatomy of the leaf.	2	
	<b>The amount of hours by module 1</b>	16	
	<b>Module 2</b>		
12.	Generative organs of flowering plants. Morphology of the flower and inflorescence.	0.5	
13.	Sexual propagation of flowering plants.		
14.	Morphology of the fruit, seed and collective fruit.	0.5	
15.	Introduction to plant taxonomy. Fundamentals of botanical classification. Angiosperms. System of Magnoliophyta.	0.2	
16.	An overview of Brassicaceae and Leguminosae families and their medicinal representatives.	0.8	
17.	An overview of Ericaceae and Rosaceae families and their medicinal representatives.	1	
18.	An overview of Polygonaceae and Apiaceae families and their medicinal representatives.	0.6	
19.	An overview of Poaceae family and its medicinal representatives.	0.4	
20.	An overview of Solanaceae and Lamiaceae families and their medicinal representatives.	2	
21.	An overview of Asteraceae family and its medicinal representatives.		
22.	An overview of flowering medicinal plants of different families common in Ukraine.	1	
23.	An overview of medicinal representatives of gymnosperms, ferns, algae, fungi, and lichens common in Ukraine.	0.5	
24.	Elements of phytocology and geobotany. Protection of flora, rational use and preservation of medicinal plant resources.	0.5	
	<b>The amount of hours by module 2</b>	8	
	<b>The whole amount of hours</b>		24

### 7. Topics of seminars

Not foreseen by the work program

### 8. Topics of practical lessons

№	Name of topic	The amount of hours
		full time study
1.	Introduction to pharmaceutical botany and anatomy of plants. Fundamentals of botanical microtechnique.	7.8
2.	Modern understanding of the structure of a plant cell. Structures of a plant cell	

	that have diagnostic significance in microscopic analysis of plant raw materials	
3.	Vacuoles and cell sap. Control of the content module 1.	0.2
4.	Plant tissue and their classification.	4
5.	Structural-functional and topographic characteristics of meristimatic, covering, basic and secretory tissues.	
6.	Structural-functional and topographic characteristics of mechanical and conducting tissues. Conductive bundles. Control of the content module 2.	4
7.	Introduction to morphology and anatomy. Plant organs and integrity of a plant organism. Propagation of plants.	4
8.	Anatomy of the root. Anatomy of the stem and rhizomes of monocots	
9.	Anatomy of the stem and rhizomes of dicots. Anatomy of the stem of arboreal plants.	4
10.	Anatomy of the leaf. Educational research work	8
11.	Morphology of the root and shoot and their metamorphoses. Vegetative propagation. Control of the content module 3.	7
	<b>Semester credit from module 1</b>	1
12.	Generative organs of flowering plants. Morphology of the flower and inflorescence.	4
13.	Sexual propagation of flowering plants.	
14.	Morphology of the fruit, seed and collective fruit. Control of the content module 4.	4
15.	Introduction to plant taxonomy. Fundamentals of botanical classification. Angiosperms. System of Magnoliophyta.	4
16.	An overview of Brassicaceae and Leguminosae families and their medicinal representatives.	
17.	An overview of Ericaceae and Rosaceae families and their medicinal representatives.	3.6
18.	An overview of Polygonaceae and Apiaceae families and their medicinal representatives.	4
19.	An overview of Poaceae family and its medicinal representatives. Control of the content module 5.	0.4
20.	An overview of Solanaceae and Lamiaceae families and their medicinal representatives	4
21.	An overview of Asteraceae family and its medicinal representatives.	4
22.	An overview of flowering medicinal plants of different families common in Ukraine.	
23.	An overview of medicinal representatives of gymnosperms, ferns, algae, fungi, and lichens common in Ukraine.	6
24.	Elements of phytoecology and geobotany. Protection of flora, rational use and preservation of medicinal plant resources. Control of the content module 6.	1
	<b>Semester credit from module 2</b>	1
<b>The whole amount of hours</b>		<b>76</b>

### 9. Topics of laboratory lessons

Not provided for in the working curriculum

### 10. Self-study work

№	Name of topic	The amount of hours
		full time study
1.	Introduction to pharmaceutical botany and anatomy of plants. Fundamentals of botanical microtechnique.	2



2.	Modern understanding of the structure of a plant cell. Structures of a plant cell that have diagnostic significance in microscopic analysis of plant raw materials.	10.5
3.	Vacuoles and cell sap.	1.5
4.	Plant tissue and their classification.	0.5
5.	Structural-functional and topographic characteristics of formative, ground, primary, and secretory tissues.	7
6.	Structural-functional and topographic characteristics of mechanical and conducting tissues. Conductive bundles.	7
7.	Introduction to morphology and anatomy. Plant organs and integrity of a plant organism. Propagation of plants.	1.5
8.	Anatomy of the root. Anatomy of the stem and rhizome of monocots.	7
9.	Anatomy of the stem and rhizome of dicots. Anatomy of the stem of arboreal plants	7
10.	Anatomy of the leaf.	10
11.	Morphology of the root and shoot and their metamorphoses. Vegetative propagation	10
<b>The amount of hours by module 1</b>		<b>64</b>
<b>Module 2</b>		
12.	Generative organs of flowering plants. Morphology of the flower and inflorescence.	4
13.	Sexual propagation of flowering plants.	0.5
14.	Morphology of the fruit, seed and collective fruit.	4
15.	Introduction to plant taxonomy. Fundamentals of botanical classification. Angiosperms. System of Magnoliophyta.	1
16.	An overview of Brassicaceae and Leguminosae families and their medicinal representatives.	6
17.	An overview of Brassicaceae and Rosaceae families and their medicinal representatives.	6
18.	An overview of Leguminosae and Apiaceae families and their medicinal representatives.	5
19.	An overview of Poaceae family and its medicinal representatives.	1
20.	An overview of Solanaceae and Lamiaceae families and their medicinal representatives	5
21.	An overview of Asteraceae family and its medicinal representatives.	6
22.	An overview of flowering medicinal plants of different families common in Ukraine.	6
23.	An overview of medicinal representatives of gymnosperms, ferns, algae, fungi, and lichens common in Ukraine.	6
24.	Elements of phytoecology and geobotany. Protection of flora, rational use and preservation of medicinal plant resources.	3
<b>Semester exam</b>		<b>22.5</b>
<b>The amount of hours by module 2</b>		<b>76</b>
<b>The whole amount of hours</b>		<b>140</b>

### Tasks for Self-study work

1. To find out the aim and objectives of pharmaceutical botany, its relation to professionally oriented and other education components; main sections of botany and their significance.
2. To analyze general structure of the protoplast, its components and derivatives.
3. To compare the structure of a plant cell those of cyanobacteria, fungi, and animals.
4. To learn characteristics of plant cell structures that have diagnostic significance in microscopic analysis of plant objects: plastids, crystalline inclusions of calcium oxalate and calcium carbonate, storage inclusions, cell membrane.
5. To learn histochemical reactions for crystalline and storage inclusions, chemical composition of the cell membrane.
6. To learn the functions, structure and significance of vacuoles, composition of cell sap and use of its substances.
7. To understand the relationship and interaction of cells in the plant organism, principles for plant tissue classification.
8. To master structural-functional and topographic characteristics of different types of tissues: formative, ground, primary, secretory, mechanical and conductive, as well as conductive bundles,



find out and understand their diagnostic features and significance in microscopic analysis.

9. To analyze the origin and characteristics of various types of roots, types of root systems, roots metamorphoses.
10. To learn the features of morphological structure of roots that have diagnostic significance in macroscopic analysis of plants and plant raw materials, use in pharmacy and medicine.
11. To learn the features that have diagnostic significance in macroscopic analysis of plants and plant raw materials, use in pharmacy and medicine.
12. To compare the structure of the shoot and the root, determine general and distinctive features of the structure.
13. To determine structural features of buds, to learn their classification and significance.
14. To analyze the diversity of morphological structure of shoots according to the way of their growth, type of branching, length of internodes, position in space, shape of cross-section of the stem, etc.
15. To determine structural features of shoot metamorphoses.
16. To learn morphological features of the structure of leaves and their parts, types of leaves and principles of their classification, their diversity.
17. To master structural-functional characteristics of leaf metamorphoses, to compare them with similar metamorphosis of shoots.
18. To understand the relationship between morphological structure of vegetative organs and the influence of environmental factors on the plant.
19. To get acquainted with different forms of plant propagation, learn the main methods of propagation of medicinal plants.
20. To analyze and compare anatomical structure of vegetative organs, their metamorphoses, and leaves.
21. To learn general and distinctive features of organ structure depending on the type of structure due to its origin, the type of structure of the axial cylinder, belonging of the plant to a certain life form, a particular systematic group, etc.
22. To determine characteristics significant for description and diagnostics of stems and rhizomes.
23. To learn the information about plant generative organs, their definition, origin, and functions.
24. To learn the functions, general structural features of inflorescences, principles of their classification, species-specific, significance and use in medicine.
25. To compare the structure of inflorescences within classification groups (simple monopodial and compound monopodial inflorescences, sympodial inflorescences, thyrus) and among the groups.
26. To master the origin, functions, general structural characteristics of the flower, structural peculiarities and classification of its parts, significance, and use in medicine.
27. To explain the relationship between peculiar characteristics of the structure of flower parts and belonging of the plant to a particular family.
28. To learn the principles of composing a flower formula.
29. To understand and be able to identify the features on the basis of which gender of the flower and monoecious or dioecious plants are determined.
30. To master the origin, functions and general structure of fruits, principles of their classification, species-specific characteristics of the variety of fruits, significance, and use in medicine.
31. To explain the relationship between peculiar characteristics of the structure of fruits and belonging of the plant to a particular family or families.
32. To clarify the issue of formation, functions and general structure of fruits, principles of their classification, significance and usage in medicine.
33. To compare the structure of seeds of monocotyledonous and dicotyledonous plants.
34. To determine the purpose, objectives, methods, and objects of plant taxonomy, its sections; to get acquainted with such notions of taxonomy as taxonomic categories and taxons, botanical nomenclature.
35. To learn the classification of plant organisms, the main characteristics of such groups of organisms as higher and lower plants; progressive features of organization of angiosperms.
36. To determine and compare structural characteristics of the representatives of dicotyledons and monocotyledons.

37. To learn morphological and ecological characteristics, information about presence of certain groups of biologically active substances, resources, significance, use, Ukrainian and Latin names of the representatives of Polygonaceae, Ericaceae, Brassicaceae, Rosaceae, Leguminosae, Apiaceae, Solanaceae, Lamiaceae, Asteraceae, and Poaceae families.
38. To analyze, compare and distinguish species-specific characteristics of the structure of morphologically close representatives within Sinapis genus, Rosa genus; Polygonum genus (Polygonum hydropiper L. and Polygonum persicaria L.); Thymus gender, and morphologically close species of Ericaceae family: bearberry and cowberry.
39. To learn morphological and ecological characteristics, information about presence of certain groups of biologically active substances, resources, significance, use, Ukrainian and Latin names of flower plants most widespread in Ukraine, such as Althaea officinalis, Betula pendula, Vinca minor, Glaucium flavum, Sambucus nigra, Valeriana officinalis, Alnus glutinosa, Aesculus hippocastanum, Adonis vernalis, Juglans regia, Quercus robur, Rhamnus cathartica, Hypericum perforatum, Viburnum opulus, Convallaria majalis, Urtica dioica, Rhamnus frangula, Acorus calamus, Schisandra chinensis, Tilia cordata, Digitalis purpurea, Hippophae rhamnoides, Plantago major, Primula veris, Humulus lupulus, Allium cepa, Allium sativum, Chelidonium majus.
40. To learn morphological and ecological characteristics, information about presence of certain groups of biologically active substances, resources, significance, use, Ukrainian and Latin names of some representatives of gymnosperms and ferns, such as: Ginkgo biloba (Ginkgoaceae), Pinus sylvestris (Pinaceae), Juniperus communis (Cupressaceae), Equisetum arvense (Equisetophyta).
41. To find out structural features of cells and body of brown algae by the example of representatives of Laminaria and Fucus genera. To learn information about presence of certain groups of biologically active substances, resources, significance, use, Ukrainian and Latin names of representatives.
42. To find out structural features of cells and body of cyanobacteria by the example of representative of Spirulina genus. To learn information about presence of certain groups of biologically active substances, resources, significance, use, Ukrainian and Latin names of the representative.
43. To find out structural features of cells and body of fungi by the example of representatives of Inonotus obliquus or chaga mushroom, and Amanita muscaria genera. To learn information about presence of certain groups of biologically active substances, resources, significance, use, Ukrainian and Latin names of representatives.
44. To learn biotic and abiotic environmental factors, features, on the basis of which plants are referred to certain ecological groups.
45. To analyze the morphological and anatomical structure of hydrophyte, hygrophyte, mesophyte, and xerophyte plants, and to explain the influence of the ecological factor.
46. To link morphological changes in the plant body with phenological phases of seasonal development.
47. To learn the signs and characteristics of plant communities, different habitat types.
48. To define the concepts of flora and vegetation, cosmopolitan plants, endemic plants, relict plants.
49. To get acquainted with the information about the issue of plant resources of Ukraine, their rational use and conservation, environmental activities.

## 11. Criteria and evaluation order of educational outcomes

### Scheme of accrual and distribution of points for full-time higher education applicants

Module 1														Sum
Current testing and independent work														
Content module 1				Content module 2				Content module 3						
T1	T2	T3	CM1 T1-T3	T4	T5	T6	CM2 T4-T6	T7	T8	T9	T10	T11	CM3 T7-T11	
-	5-8	1-2	9-15	0.5-1	2.5-4	3-5	9-15	0.5-1	5.5-9	9-15	3-5	3-5	9-15	60-100

Module 2																Sum
Current testing and independent work																
Content module 4				Content module 5						Content module 6						
T12	T13	T14	CM4 T12-14	T15	T16	T17	T18	T19	CM5 T15-19	T20	T21	T22	T23	T24	CM6 T20-24	
3-5	0.5-1	2.5-4	12-20	0.5-1	3.5-4	2-4	1-2	1-2	10-17	3-5	3-5	3-5	0.5-1	0.5-1	14-23	60-100

The criteria for evaluating the knowledge and skills of students of higher education from the educational component "Pharmaceutical Botany" were developed in accordance with the "Regulations on the procedure for evaluating students' knowledge in the credit-modular organization of the educational process at the NUPh". The evaluation of the success of a higher education student in the educational component is a rating, presented on a one-point scale and defined according to the ECTS system and the traditional scale adopted in Ukraine.

Assessment of the **current academic activity** (conducted during each class) - test written control, control of theoretical knowledge, practical skills and abilities.

Scores in balls are reflected in the calendar and thematic plans for practical lessons.

Evaluation criteria	Rating
<p><i>Theoretical training:</i> the applicant of higher education: firmly mastered the material, deeply and comprehensively knows the content of the topic, section or the whole discipline, logically thinks and builds answers, impeccably performed written non-auditing tasks; gave exhaustive answers to the teacher's theoretical questions.</p> <p><i>Practical training:</i> the applicant of higher education: freely uses acquired theoretical knowledge when analyzing practical material; flawlessly adheres to all the rules of conducting micro-and macroscopic analysis of raw material, is able to make temporary preparations, conduct microchemical reactions, dissect flowers or fruits; in full measure, by macro- and microscopic signs, determine the organs of plants and their diagnostic features; on an individual basis determines the plant and its belonging to a certain family, family; independently analyzed and summarized the information received, duly reflected the results of observations in the working journal</p>	<p>«4.5-5» (90-100%)</p>
<p><i>Theoretical training:</i> Higher education: he has mastered the material, confidently owns the basic theoretical material, reasonably teaches him; without significant errors performed written non-auditing tasks, answered theoretical questions of the teacher with minor disadvantages.</p> <p><i>Practical training:</i> the applicant of higher education has the necessary practical skills in micro- and macro-analysis, demonstrated the ability to make temporary preparations, conduct microchemical reactions, dissect flowers or fruit, but when performing the work assumed minor mistakes; defines macro-and microscopic signs of plant organs and their diagnostic features in incomplete volume; on an individual basis, determines the plant and its belonging to a certain family, family, but allows certain inaccuracies and errors in Latin names; when identifying a family or a plant, it is not always convincingly arguing the answer; independently analyzed and summarized the information received, but suggested a number of minor mistakes, inaccuracies that are not of a fundamental nature; his conclusions lack depth and clarity; duly reflected the results of observations in the work journal.</p>	<p>«4» (74-89%)</p>
<p><i>Theoretical training:</i> the applicant of higher education basically mastered theoretical knowledge of the topic in the amount that is considered necessary and sufficient for the implementation of the practical part of the class, oriented in the primary sources and recommended literature, but unconvincingly answers, confuses the concept, additional questions cause uncertainty; fulfilled written non-auditable assignments with errors.</p> <p><i>Practical training:</i> completed in full at least 60% of practical tasks; when performing micro-and macroscopic analysis with errors makes temporary preparations, conducts</p>	<p>«3-3.5» (60-73%)</p>

<p>microchemical reactions, prepares flowers or fruits; incompletely determines the organs of plants and their diagnostic features according to macro- and microscopic signs; when identifying a family or a plant, can not convincingly argue the answer, identifies at least 60% of the volume of plants proposed by the teacher, makes mistakes in Latin names; independently analyzed and summarized the information received, but suggested a number of errors, inaccuracies, his conclusions lacked depth and clarity; inaccurately and not completely compiled the results of observations in the working journal.</p>	
<p><i>Theoretical training:</i> the applicant of higher education did not master theoretical knowledge on a certain topic in the amount that is considered necessary and sufficient for the implementation of the practical part of the class, does not know the basic concepts and definitions, is almost not oriented in the primary sources and recommended literature, does not correspond to the theoretical issues of the teacher, confused basic concepts; did not perform written homeworks, or executed with a lot of errors.</p> <p><i>Practical training:</i> practical skills are not formed, gross errors are assumed in the manufacture of temporary preparations, microchemical reactions, preparation of flowers or fruits, can not determine the organs of plants and their diagnostic features by macro- and microscopic signs; when identifying a family or a plant can not convincingly argue the answer, defining less than 60% of the volume of plants proposed by the teacher, allows gross mistakes in Latin names. It is not able to independently analyze and generalize the information received, involves gross errors, inaccuracies in the conclusions; inaccurately and not completely compiled the results of observations in the working journal.</p>	<p>«0-2.5» (less 60%)</p>

**Criteria for evaluating current educational activities of full-time higher education applicants**

№ lesson	Topic of practical lesson	Types of assessment (% of the number of points for the type of activity)
1	Fundamentals of botanical microtechnology. Investigation of plant cell structures that have a diagnostic value in a microscopic analysis of plant raw material: plastids, crystalline inclusions, storage products.	-
2	<p>Investigation of plant cell structures having a diagnostic value in a microscopic analysis of plant material: cell wall.</p> <p>Individual work</p> <p>Learning control of CM 1 Test control on the topic "Plant cell"</p> <ul style="list-style-type: none"> <li>• Written control "Plant cell"</li> <li>• Computer control of tests for the license exam "Krok 1" on the topic "Plant cell"</li> </ul>	<p>Carrying out tasks of extracurricular independent work (10%) Completion of classroom work tasks (40%) Oral interview (20%) Written control (30%)</p> <p>100%</p> <p>Written control "Plant cell" (50%) Testing according to the test base of the licensing exam Krok 1 (50%)</p>
3	Plant tissues and their classification. The structure and location of meristematic, covering, secretory and basic tissues.	<p>Carrying out tasks of extracurricular independent work (10%) Completion of classroom work tasks (40%) Oral interview (20%) Written control (30%)</p>
4	Structure, function and location of mechanical and conductive tissues. Conductive bundles.	<p>Carrying out tasks of extracurricular independent work (10%) Completion of classroom work tasks (40%) Oral interview (20%) Written control (30%)</p>

	<p>Learning control of CM 2                      Test control on the topic "Plant tissues"                      • Written control "Plant tissues"                      • Computer control of tests for the license exam "Krok 1" on the topic "Plant tissues"</p>	<p>Written control "Plant tissues" (50%)                      Testing according to the test base of the licensing exam Krok 1 (50%)</p>
5	<p>Anatomy of the root. Anatomy of the stem and rhizome of grassy monocots.</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
6	<p>Anatomy of the stem and rhizomes of grassy monocots.                      Anatomy of the arboreal plants' stem.</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
7	<p>Anatomy of the leaf.</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
8	<p>Independent educational-research work «Microscopic analysis of the axial plant organ»</p>	<p>100%</p>
9	<p>Morphology of the vegetative organs (root, shoot, leaf and its parts).</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
10	<p>Learning control of CM 3                      Test control on the topic "Morphology and anatomy of plant vegetative organs"                      • Written control "Morphology and anatomy of plant vegetative organs"                      • Computer control of tests for the license exam "Krok 1" on the topic "Morphology and anatomy of plant vegetative organs"</p>	<p>Written control "Morphology and anatomy of plant vegetative organs" (50%)                      Testing according to the test base of the licensing exam Krok 1 (50%)</p>
11	<p>Morphological structure of the inflorescence and flower.</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
12	<p>Morphological structure of the fruits and multiple fruits.                       Independent educational-research work                       Learning control of CM 4                      Test control on the topic "Morphology of the generative organs"                      • Written control "Morphology of the generative organs"                      • Computer control of tests for the license exam "Krok 1" on the topic "Morphology of the generative organs"</p>	<p>Carrying out tasks of extracurricular independent work (20%)                      Completion of classroom work tasks (50%)                      Oral interview (30%)                       100%                       Written control "Morphology of the generative organs" (50%)                      Testing according to the test base of the licensing exam Krok 1 (50%)</p>
13	<p>The Brassicaceae (Mustard) Family; Fabaceae (Legume or Bean) Family, The Polygonaceae (Knotweed) Family</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
14	<p>The Rosaceae (Rose) Family, the Ericaceae (Heath) Family, the Poaceae (Grass) Family, the Alliaceae (Onion) Family</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
15	<p>The Apiaceae (Carrot) Family</p>	<p>Carrying out tasks of extracurricular independent work (10%)</p>



	<p>Learning control of CM 5                      Test control on the topic "Plant systematics part 1"                      • Written control "Plant systematics part 1"                      • Computer control of tests for the license exam "Krok 1" on the topic "Plant systematics part 1"</p>	<p>Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p> <p>Written control "Plant systematics part 1" (50%)                      Testing according to the test base of the licensing exam Krok 1 (50%)</p>
16	<p>The Solanaceae (Potato) Family, the Lamiaceae (Mint) Family.                      Gymnosperm plants</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
17	<p>The Asteraceae (Sunflower) Family</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
18	<p>Medicinal plants of the different families</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
19	<p>Algae, mushrooms and lichens - diagnostic features, classification.                      Medicinal species of blue-green algae (spirogir), brown algae (laminaria, fucus), mushrooms (mushroom, chaga), lichens (citraria)</p>	<p>Carrying out tasks of extracurricular independent work (10%)                      Completion of classroom work tasks (40%)                      Oral interview (20%)                      Written control (30%)</p>
	<p>Learning control of CM 6                      Test control on the topic "Plant systematics part 2"                      • Written control "Plant systematics part 2"                      • Computer control of tests for the license exam "Krok 1" on the topic "Plant systematics part 2"</p>	<p>Written control "Plant systematics part 2" (50%)                      Testing according to the test base of the licensing exam Krok 1 (50%)</p>

**Criteria for evaluating independent educational and research work for full-time higher education applicants**

<b>Recommended criteria for evaluating independent educational and research work</b>	<b>Grade</b>
The research object is identified, its diagram is drawn and a full description of the research object is provided in accordance with the proposed points (90-100%)	<b>5</b>
The researched object was identified, its scheme was drawn and an incomplete description of the researched object was provided in accordance with the proposed points (74-89%)	<b>4</b>
The researched object was identified, its scheme was not drawn and an incomplete description of the researched object was provided in accordance with the proposed points (60-73%)	<b>3</b>

**Evaluation criteria for content modules 1-6 on Pharmaceutical botany for full-time higher education applicants**

<b>№ question</b>	<b>Recommended evaluation criteria for the theoretical part</b>	<b>Grade</b>
1-18	The applicant for higher education gave the correct answer to 16-18 test tasks of the ticket (90-100%)	<b>5</b>
	The applicant for higher education gave the correct answer to 14-15 test tasks of the ticket (74-89%)	<b>4</b>
	The applicant for higher education gave the correct answer to 11-13 test tasks of the ticket 11-13 (60-73%)	<b>3</b>
	The applicant of higher education gave the correct answer to 9 or fewer test tasks of the ticket (less than 60%)	<b>0-2</b>
<b>№ question</b>	<b>Recommended evaluation criteria for the practical part</b>	<b>Grade</b>



19, 20	The names of the objects are correctly given and a full description of the proposed points is given	5
	The names of not all objects are correctly provided and/or a partial description of the proposed points is given	4
	The names of the objects are incorrectly provided and/or an incomplete description of the proposed points is given	3

**Assessment criteria for the semester exam on Pharmaceutical botany for full-time higher education applicants**

№ task	Recommended evaluation criteria for the theoretical part	Scores	Grade
1	27-30 correct answers were received	54-60	5
	22-26 correct answers were received	44-52	4
	18-21 correct answers were received	36-42	3
	Less than 17 correct answers were received	0-34	0-2
<b>Recommended evaluation criteria for the practical part</b>			
2	A correct description of the proposed object was provided in 5 points	20	5
	A correct description of the proposed object was provided in 4 points	16	4
	A correct description of the proposed object was provided in 3 points	12	3
	A correct description of the proposed object was provided in 2 and less points	0-10	0-2
3	The Ukrainian and Latin names of the species of the medicinal plant and its family are given; the correct characteristics for 4 points were provided	20	5
	The Ukrainian and Latin names of the species of the medicinal plant and its family are given with minor errors; correct characteristics on 3 points were provided	16	4
	Ukrainian and/or Latin names of the species of the medicinal plant and its family are given; correct characteristics for 2 points were provided	12	3
	The Ukrainian and/or Latin names of the species of the medicinal plant and its family are not given; correct characteristics on 3 points were provided		
	The Ukrainian and/or Latin names of the species of the medicinal plant and its family are not given; correct characteristics on 2 and less points were provided	0-10	0-2
<b>Total</b>		<b>100</b>	

## 12. Forms of current and semester control of study success

**Current control** of theoretical and practical knowledge in the form of oral verification of the performance of tasks of extra-auditory independent work; selective oral survey; written control of assimilation of the material of the topic of each lesson, individual parts of the educational component, content modules; computer control of Licensing Exam tests on content module topics; oral defense of educational and research work, oral submission of the herbarium minimum.

**Control of content modules** - is carried out in the last classes of studying the topics of content modules. The form of knowledge diagnosis of higher education applicants is written control and testing based on the test base of the licensing exam Krok-1 (botany) in Ukrainian and English.

When studying the educational component "Pharmaceutical botany", higher education applicants take a semester exam. The Pharmaceutical botany exam is conducted in written form during the exam session, according to the schedule.

**The control form** is a semester credit and a semester exam.

## 13. Methodical support

1. Educational work program of education component
2. Work program of education component
3. Calendar-thematic plans of lectures and practical classes
4. Textbook (see p. 14, 15)
5. Methodical instruction for practical classes
6. Atlas (see p. 14)
7. Summary of lectures

8. Audio and video materials
9. Educational and educational-visual textbooks and materials (see p. 14)
10. Collection of test tasks for knowledge control and preparation for the license exam Krok-1 (see p. 14, 15).
11. A list of theoretical questions for independent work of higher education applicants
12. List of theoretical questions for control of content modules No. 1-6, semester exam.

## 14. Recommended Literature

### Basic

1. Pharmaceutical botany : textbook / T. M. Gontova [et al.]; edited by T. M. Gontova. – Ternopil : TSMU , 2013. – 380 p.
2. Сербін, А. Г. Фармацевтична ботаніка : підруч. для вузів / А. Г. Сербін, Л. М. Сіра, Т. О. Слободянюк ; за ред. Л. М. Сірої. – Вінниця : Нова Книга, 2015. – 488 с.
3. Test items with explains for preparing for license examination KROK-1 “Pharmacy” (BOTANY) / [Gontova T. M., Kriukowa Ya. S., Gaponenko V. P., Mashtaler V. V., Mala O. S.]; under the editorship of Kriukowa Ya. S. – Kh.: NUPh, 2017. – 91 p.
4. Фотогербарий лекарственных растений=Photoherbarium of medicinal plants : учеб. пособие для студентов вузов / Т. Н. Гонтовая [и др.]; под общ. ред. Т. Н. Гонтовой, В. П. Руденко. – Харьков : НФаУ : Золотые страницы, 2017. – 240с.

### Additional

1. Pharmaceutical botany. Anatomy, morphology and plant systematics: methodical instruction for practical classes for higher education students of the 2nd course / T. M. Gontova, V. P. Gaponenko, V. V. Mashtaler, O. S. Mala – Kh.: NUPh, 2019. – 78 p..
2. Атлас по анатомии растений (растительная клетка, ткани, органы) : учеб. пособие для студ. высш. учеб. заведений / А. Г. Сербин [и др.]. – Х. : Колорит, 2006. – 86 с.
3. Коновалова, Е. Ю. Ботанико-фармакогностический словарь. Русско-украинско-английско-немецко-французско-латинский : учеб. пособие для студентов высших учеб. заведений и фармац. ф-тов мед. вузов, биологических ф-тов высш. учеб. заведений III-IV уровней аккредитации. – К. : ЧП «Блудчий М.І.», 2010. – 688 с.
4. Пішак, В. П. Фармацевтична ботаніка : Морфологія / В. П. Пішак, В. В. Степанчук. – Чернівці : Медуніверситет, 2013. – 224 с.
5. Фармацевтична енциклопедія / гол. ред. ради та автор передмови В. П. Черних. – 3-тє вид. перероб. і допов. – К. : «МОРІОН», 2016. – 1952 с.

## 15. Information resources, including on the Internet

1. Сайт кафедри фармакогнозії та нутриціології. – <http://cnc.nuph.edu.ua>
2. Наукова бібліотека НФаУ – <http://lib.nuph.edu.ua>
3. Електронний архів НФаУ – <http://dspace.nuph.edu.ua>
4. Центр дистанційних технологій НФаУ – <https://pharmel.kharkiv.edu/>
5. Національна бібліотека України імені В. І. Вернадського – <http://www.nbuv.gov.ua>
6. НФаУ. Тести on-line – <http://tests.nuph.edu.ua/>