

**Medical School - Plovdiv  
FACULTY OF PHARMACY**

**Name of the course:**  
“Pharmaceutical Botany”

**Leve of study:**  
Masters /M/

**Format of study:**  
Lectures, Labs, Field practise, self-study

**Duration of study:**  
One semester

**Credits:**  
Lectures 30 hrs, labs 45 hrs, field practise 48 hrs

**Teaching tools:**  
Powerpoint presentations, discussions, close study of microscope slides and herbarium sheets, collecting of plants during the field practise and taxnomic identification using dichotomous keys

**Evaluation:**  
Practical quizzes during the semeter; final written and oral exam

**Final Grade:**  
Based on the scores on the practical quizzes and the final exams

**Additional considerations taken into the final grade:**  
Class participation; undertsnading of plant morphology and histology; plant identification; submitting mounted herbarium sheets from the field practise

**Exam:**  
Yes /writtend and oral/

**State exam:**  
No

**Lead lecturer:**  
Tenured professor in the Department of Bioorganic Chemistry

**Department:** Bioorganic Chemistry

**Annotation**

The course is an overview of the major subfields of botany, including plant morphology, anatomy and systematics. The focus is on the medicinal plants of the Bulgarian flora but non-native species are studied as well, with emphasis on the plant parts used in pharmacy and medicine. The course is a basis for understanding the physiological processes in plants.

Pharmaceutical Botany is a pre-requisite for subsequent study in Pharmacognosy and for a successful career of the future pharmacists, working at conventional drugstores, at herbalist shops and at the storage facilities and in the distribution of medicinal plant products.

### MAJOR GOALS OF STUDY

Acquiring knowledge and expertise in botany. Introducing the students to:

- plant cytology
- plant histology
- plant embryology and organography
- plant diversity with emphasis on medicinal plants
- methods for morphological and anatomical identification of medicinal and poisonous plants and fungi and their active preparations
- basic therapeutical properties of plants

### EXPECTED OUTCOME

After completion of the course, the students are expected to

- to recognize the genetal characteristics of plant cells, tissues and vegetative organs
- to recognize the structure of flowers and inflorescences
- to recognize the logic behind and the significance of pollination and fertilization
- to recognize the structure and the diversity of seeds and fruits, as well as their adaptations for disperasal
- to know the classification of the plant and the fungal kingdoms
- to recognize the major plant and fungal lineages with some important Bulgarian representatives
- to recognize the structure and the specifics of different taxa
- to prepare temporary mounts and perform hsitological analysis of leaves, stems, roots and their modifications
- to recognize the major plant parts containing biologically-active compounds
- to identify the morphology of plant organs
- to recognize the major types of flowers and inflorescences
- to be familiar with the current progress in plant taxonomy and to be able to identify unknown plants using dichotomous keys
- to apply their knowledge in medicinal plants to biological, phytotherapeutical and pharmaceutical projects

### PLAN OF STUDY

Course	Exam	Credits			Credits, years/semesters						
	Semester	Total	Lectures	Labs	IV	V	VI	VII	VIII	IX	X
Pharmaceutical Botany	IV	75	30	45	2/3						

Field practise in Botany after Semester IV – 6 days / 8 hours = 48 hours

## **LECTURE OUTLINES**

### ***LECTURE 1 – 1 HOUR***

#### **BOTANY AS A SCIENCE, INTRODUCTION TO PHARMACEUTICAL BOTANY.**

1. Field of study, tasks and major divisions of botany.
2. Methods in botany.
3. Medicinal plants – human importance.
4. Botany and pharmacy.

### ***LECTURE 2 – 1 HOUR***

#### **CELL STRUCTURE OF PLANTS, GENERAL CHARACTERISTICS OF PLANT CELL, CELL WALL**

1. Modern view on the structure and the composition of plant cells.
2. Shape and size of plant cell.
3. Cell structures based on their metabolic roles.
  - 3.1. proplast
  - 3.2. paraplast
4. Unique plant cell structures – cell wall.
  - 4.1. function
  - 4.2. structure
  - 4.3. chemical composition
  - 4.4. formation and growth
  - 4.5. changes in the chemical composition

### ***LECTURE 3 – 2 HOURS***

#### **PLANT CELL – CYTOPLASM, ORGANELLES AND INCLUSIONS**

1. Cytoplasm.
  - 1.1. structure
  - 1.2. physical, chemical and physiological properties
2. Universal organelles
3. Plant-specific organelles- plastids.
  - 3.1. chloroplasts – structure, function and chemical composition
  - 3.2. chromoplasts - structure, function and chemical composition
  - 3.3. leucoplasts - structure, function and chemical composition
4. Vacuole.
  - 4.1. functions
  - 4.2. formation and development
  - 4.3. vacuolar content - chemistry
5. Ergastic inclusions.

### ***LECTURE 4 – 2 HOURS***

#### **PLANT TISSUES – MERISTEMS, PARENCHYMA AND DERMAL TISSUE**

1. Definition and classification of plant tissues.
2. Meristems.
  - 2.1. structure
  - 2.2. function
  - 2.3. classification
3. Parenchyma.
  - 3.1. Ground parenchyma
  - 3.2. storage parenchyma
  - 3.3. assimilatory parenchyma (chlorenchyma)
  - 3.4. aerenchyma
  - 3.5. Water-storage parenchyma
  - 3.6. Parenchyma specialized in absorption
4. Dermal tissue.
  - 4.1. Epidermis and epidermal structures – structure, main and satellite functions
  - 4.2. Secondary dermal tissue – structure and function
  - 4.3. tertiary dermal tissue – bark (rhytidome)

### ***LECTURE 5 – 2 HOURS***

#### **PLANT TISSUES – SUPPORTIVE, VASCULAR AND SECRETORY TISSUES**

1. Supportive tissue.
  - 1.1. collenchyma – structure and function
  - 1.2. sclerenchyma – structure and function
  - 1.3. sclerenchyme fibers
  - 1.4. industrial fibers from plants
  - 1.5. sclereids
2. Vascular tissue.
  - 2.1. xylem – structure and function
  - 2.2. phloem – structure and function
  - 2.3. vascular bundles – types, structure and function
3. Secretory tissue – exo- and endosecretory tissue.

### ***LECTURE 6 – 2 HOURS***

#### **VEGETATIVE PLANT ORGANS – ROOT (*RADIX*), STEM (*CAULIS*) AND LEAF (*FOLIUM*)**

1. Root.
  - 1.1. morphology
  - 1.2. anatomy
  - 1.3. physiology
  - 1.4. Modified roots – types and roles
2. Stem.
  - 2.1. morphology
  - 2.2. anatomy
  - 2.3. physiology
  - 2.4. Modified roots – types and roles
3. Leaf.
  - 3.1. morphology

- 3.2. anatomy
- 3.3. physiology
- 3.4. Modified leaves

### **LECTURE 7 – 2 HOURS**

#### **REPRODUCTIVE PLANT ORGANS – FLOWER (*FLOS*), SEED (*SEMEN*) II FRUIT (*FRUCTUS*)**

- 1. Flower.
  - 1.1. Morphology and anatomy
  - 1.2. floral formulas and diagrams
- 2. Inflorescence.
  - 2.1. Building blocks
  - 2.2. classification
- 3. Pollination.
- 4. Seed – morphology and anatomy.
- 5. Fruit – structure and classification
- 6. Fruit and seed dispersal.

### **LECTURE 8 – 2 HOURS**

#### **PLANT SYSTEMATICS AND MACROCLASSIFIATION. CYANOBACTERIA**

- 1. Goals of plant systematics.
- 2. Botanical classification and nomenclature.
- 3. Taxa and taxonomic categories.
- 4. Macroclassification.
  - 4.1. of all life
  - 4.2. of plant kingdom
- 5. Prokaryotic algae (*Cyanoprokaryota*) – general characteristics, representative taxa and importance to humans.

### **LECTURE 9 – 2 HOURS**

#### **EUKARYOTIC ALGAE**

- 1. Red algae (*Rhodophyta*) – general characteristics, classification, representative taxa and significance
- 2. Diatoms (*Bacillariophyta*) – general characteristics, classification, representative taxa and significance
- 3. Brown algae (*Phaeophyta*) – general characteristics, classification, representative taxa and significance
- 4. Green Algae (*Chlorophyta*) – general characteristics, classification, representative taxa and significance

### **LECTURE 10 – 2 HOURS**

#### **SPORE-FORMING VASCULAR PLANTS**

1. Mosses (*Bryophyta*) – general characteristics, classification, representative taxa and significance
2. Lycopods (*Lycopodiophyta*) – general characteristics, classification, representative taxa and significance
3. Horsetails (*Equisetophyta*) – general characteristics, classification, representative taxa and significance
4. Ferns (*Polypodiophyta*) – general characteristics, classification, representative taxa and significance

### **LECTURE 11 – 2 HOURS**

#### **GYMNOSPERMS**

1. Seed plants (*Magnoliophyta*) – general characteristics classification.
2. Conifers (*Pinophytina*) – general characteristics classification.
  - 2.1. *Ginkgoaceae* - general characteristics, representative taxa and significance for pharmacy and medicine
  - 2.2. *Pinaceae* - general characteristics, representative taxa and significance for agriculture and pharmacy
  - 2.3. *Cupressaceae* - general characteristics, representative taxa and significance for pharmacy
  - 2.4. *Taxaceae* - general characteristics, representative taxa and significance for pharmacy
3. Cycads (*Cycadophytina*) – general characteristics classification.
  - 3.1. *Ephedraceae* - general characteristics, representative taxa and significance for pharmacy and medicine

### **LECTURE 12 – 2 HOURS**

#### **ANGIOSPERMS. DICOTS (*MAGNOLIOPSIDA*) - FAMILIES OF SUBCLASSES *MAGNOLIIDAE*, *RANUNCULIDAE*, *HAMAMELIDIDAE* И *CARYOPHYLLIDAE***

1. Angiosperms (*Magnoliophytina*) – general characteristics classification.
2. Dicots (*Magnoliopsida*) – general characteristics classification.
3. Subclass *Magnoliidae*.
  - 3.1. Families *Magnoliaceae* and *Lauraceae*) – general characteristics, medicinal and agricultural species (used parts and applications)
4. Subclass *Ranunculidae*.
  - 4.1. Families *Ranunculaceae*, *Berberidaceae*, *Papaveraceae*, *Fumariaceae* - general characteristics, medicinal taxa
5. Subclass *Hamamelididae*.
  - 5.1. Families *Fagaceae*, *Betulaceae*, *Juglandaceae* - general characteristics, medicinal and agricultural species
6. Subclass *Caryophyllidae*.
  - 6.1. Families *Caryophyllaceae*, *Chenopodiaceae*, *Polygonaceae* – general characteristics, medicinal and agricultural species

### **LECTURE 13 – 4 HOURS**

**ANGIOSPERMS. DICOTS (MAGNOLIOPSIDA) - FAMILIES OF SUBCLASSES  
DILLENIIDAE II ROSIDAE**

1. Subclass *Dilleniidae*.
  - 1.1. Families *Hypericaceae*, *Ericaceae*, *Primulaceae*, *Violaceae*, *Salicaceae*, *Cucurbitaceae*, *Brassicaceae*, *Tiliaceae*, *Malvaceae*, *Moraceae*, *Cannabaceae*, *Urticaceae*, *Euphorbiaceae* – general characteristics, medicinal and agricultural species
2. Subclass *Rosidae*.
  - 2.1. Families *Rosaceae*, *Fabaceae*, *Aceraceae*, *Hippocastanaceae*, *Rutaceae*, *Anacardiaceae*, *Linaceae*, *Geraniaceae*, *Rhamnaceae*, *Cornaceae*, *Araliaceae*, *Apiaceae*, *Caprifoliaceae*, *Valerianaceae* - general characteristics, medicinal and agricultural species

**LECTURE 14 – 2 HOURS**

**ANGIOSPERMS. DICOTS (MAGNOLIOPSIDA) - FAMILIES OF SUBCLASSES  
LAMIIDAE II ASTERIDAE**

1. Subclass *Lamiidae*.
  - 1.1. Families *Rubiaceae*, *Gentianaceae*, *Solanaceae*, *Convolvulaceae*, *Cuscutaceae*, *Boraginaceae*, *Scrophulariaceae*, *Plantaginaceae*, *Lamiaceae* - general characteristics, medicinal and agricultural species
2. Subclass *Asteridae*.
  - 2.1. *Asteraceae* - general characteristics, medicinal and agricultural species

**LECTURE 15 – 2 HOURS**

**ANGIOSPERMS. MONOCOTS (LILIOPSIDA) - FAMILIES OF SUBCLASS  
LILIIDAE**

1. Monocots (*Liliopsida*) – general characteristics classification.
2. Subclass *Liliidae*.
  - 2.1. Families *Melanthiaceae*, *Iridaceae*, *Liliaceae*, *Aliaceae*, *Amaryllidaceae*, *Asparagaceae*, *Dioscoreaceae*, *Orchidaceae*, *Poaceae*, *Araceae* - general characteristics, medicinal and agricultural species

**LAB OUTLINES**

**LAB1 – 3 HOURS**

**PLANT CELL**

Introducing students to the structure of the plant cell.

1. The microscope. Part of the microscope and microscopy techniques . preparing temporary mounts of plant specimens

2. Plant cell – discussion and powerpoint presentation
3. Discussion on the shape and the size of the plant cell
  - 3.1. observation of parenchyma and prosenchyma cells in the leaf of *Mnium punctatum*) – temporary mount
4. Discussion of plant cell-specific organelles
  - 4.1. observation of chloroplasts in cells of *Spirogyra sp.*) – temporary mount
  - 4.2. observation of leucoplasts in potato tuber (*Solanum tuberosum*) - temporary mount
  - 4.3. observation of chromoplasts in pepper fruit (*Capsicum annuum*) and carrot (*Daucus sativus*) - temporary mount
5. Ergastic inclusions in the plant cell
  - 5.1. observation of calcium oxalate crystals in dry onion scales (*Allium cepa*) - temporary mount
  - 5.2. observation of starch grains in potato tuber (*Solanum tuberosum*) - temporary mount
6. Клетъчна стена – дискусия
  - 6.1. observation of primary cell wall in elderberry stem pith (*Sambucus nigra*) - temporary mount

### **LAB2– 3 HOURS**

### **PLANT TISSUES – PARENCHYMA, AND DERMAL, SUPPORTIVE AND SECRETORY TISSUES**

Introducing students to the following types of plant tissue:

1. Parenchyma. Types of parenchyma – discussion and powerpoint presentation
  - 1.1. observation of storage parenchyma in rhizome of Lily of the Valley (*Convallaria majalis*) - temporary mount
  - 1.2. observation of aerenchyma in rush stem (*Juncus sp.*) - temporary mount
  - 1.3. observation of water storage parenchyma in *Bryophyllum leaves* - temporary mount
  - 1.4. observation of photosynthetic parenchyma (chlorenchyma) in plane tree leaf (*Platanus sp.*) - temporary mount
2. Dermal tissue. Primary dermal tissue (epidermis) - discussion and powerpoint presentation
  - 2.1. observation of epidermal cell types (pavement cells, stomata) in pelargonium leaf (*Pelargonium zonale*) - temporary mount
  - 2.2. observation of trichomes in mullein leaf (*Verbascum sp.*) and oleaster leaf (*Eleagnus angustifolia*) - temporary mount
3. Supportive tissue – discussion and powerpoint presentation
  - 3.1. observation of angular collenchyma in begonia petiole (*Begonia sp.*) - temporary mount
  - 3.2. observation of diffuse collenchyma in butterbur petiole (*Petasites sp.*) - temporary mount
  - 3.3. observation of fibers in flax stem (*Linum usitatissimum*) - permanent slide
  - 3.4. observation of sclereids in pear (*Pyrus sativa*) - temporary mount
4. Secretory tissue – discussion and powerpoint presentation
  - 4.1. observation of glandular trichomes in pelargonium leaf (*Pelargonium zonale*) - temporary mount



- 4.2. observation of resin ducts in pine needles (*Pinus sylvestris*) – permanent slide.

### **LAB3 – 3 HOURS**

#### **VEGETATIVE PLANT ORGANS. STEM (CAULIS) – MORPHOLOGY AND ANATOMY**

Introducing students to the anatomy and morphology of stems

1. Discussion, powerpoint presentation and examination of herbarium sheets for stem morphology: shape, size, longevity, arrangement and branching
2. Stem Anatomy – discussion and powerpoint presentation
  - 2.1. observation of primary growth in monocot, maize stem (*Zea mays*) – permanent slide
  - 2.2. observation of primary growth in dicot, buttercup stem (*Ranunculus repens*) – permanent slide
  - 2.3. observation of secondary growth in linden tree branch (*Tilia cordata*) – permanent slide.

### **LAB4 – 3 HOURS**

#### **VEGETATIVE PLANT ORGANS. LEAF (FOLIUM) AND STEM (RADIX) – MORPHOLOGY AND ANATOMY**

Introducing students to the anatomy and morphology of leaves and roots

1. Discussion, powerpoint presentation and examination of herbarium sheets and fresh material for leaf morphology: attachment of leaves, lamina (shape, margin, size and texture), dissection of the lamina, venation
2. Leaf Anatomy - discussion and powerpoint presentation
  - 2.1. observation of bifacial leaf in laurel (*Laurus nobilis*) – permanent slide
  - 2.2. observation of equifacial leaf in iris (*Iris germanica*) – permanent slide
3. Discussion, powerpoint presentation and examination of herbarium sheets and fresh material for root morphology: types of roots and root systems
4. Root Anatomy - discussion and powerpoint presentation
  - 4.1. observation of primary growth in iris root (*Iris germanica*) - permanent slide
  - 4.2. observation of secondary growth in pear root (*Pyrus sativa*) - permanent slide.

### **LAB5 – 3 HOURS**

#### **REPRODUCTIVE PLANT ORGANS. FLOWER (FLOS) AND INFLORESCENCE (INFLORESCENTIA)**

Introducing students to the structure and functions of flowers and the diversity of inflorescence types

1. Discussion, powerpoint presentation and examination of herbarium sheets and fresh material for floral diversity

2. Discussion, powerpoint presentation and examination of different inflorescence types (simple, compound and mixed) on herbarium sheets and fresh material.

### **LAB6 – 3 HOURS**

#### **REPRODUCTIVE PLANT ORGANS. FRUITS (*FRUCTUS*). FRUIT DISPERSAL**

Introducing students to the formation, development, functions and classification of fruits and their dispersal mechanisms

1. Fruit general characteristics - discussion and powerpoint presentation
  - 1.1. observation of different fruit types - herbarium material and fresh fruits
  - 1.2. adaptations for fruit dispersal - observation of herbarium material.

### **LAB7 – 3 HOURS**

#### **PROKARYOTIC ALGAE. CYANOBACTERIA *CYANOPROCARYOTA*. EUKARYOTIC ALGAE. RED ALGAE (*RHODOPHYTA*)**

Introducing students to plant nomenclature, and the general characteristics of cyanobacteria (*Cyanoprocaryota*) and red algae (*Rhodophyta*)

1. Discussion and powerpoint presentation on the structure, reproduction, distribution and use in the pharmaceutical industry of cyanobacteria (*Cyanoprocaryota*). Microscopic observation of the following representative taxa:
  - 1.1. *Gloeocapsa turgida* - temporary mount
  - 1.2. *Spirulina platensis* - temporary mount
  - 1.3. *Gloeotrichia natans* - temporary mount
  - 1.4. *Aphanizomenon flos-aquae* - temporary mount
2. Discussion and powerpoint presentation on the structure, reproduction, distribution and use in the pharmaceutical industry of red algae (*Rhodophyta*). Microscopic and gross overview of the following species:
  - 2.1. *Bangia atropurpurea* - permanent slide
  - 2.2. *Porphyra leucosticta* - herbarium material
  - 2.3. *Corallina officinalis* - permanent slide
  - 2.4. *Lithothamnion sp.* - permanent slide.

### **LAB8 – 3HOURS**

#### **EUKARYOTIC ALGAE. DIATOMS *BACILLARIOPHYTA*, BROWN ALGAE (*PHAEOPHYTA*) AND GREEN ALGAE (*CHLOROPHYTA*)**

Introducing students to the general characteristics of diatoms (*Bacillariophyta*), brown algae (*Phaeophyta*) and green algae (*Chlorophyta*)

1. Discussion and powerpoint presentation on the structure, reproduction, distribution and use of diatoms (*Bacillariophyta*). Microscopic observation of the following representative taxa:
  - 1.1. *Pinnularia sp.* - temporary mount
  - 1.2. *Melosira varians* - temporary mount
2. Discussion and powerpoint presentation on the structure, reproduction, distribution and use of brown algae (*Phaeophyta*). General overview of the following species::

- 2.1. *Ectocarpus sp.* - herbarium material
- 2.2. *Laminaria saccharina* - herbarium material
- 2.3. *Cystoseira barbata* - herbarium material
- 2.4. *Fucus serratus* - herbarium material
3. Discussion and powerpoint presentation on the structure, reproduction, distribution and use in the pharmaceutical industry of green algae (*Chlorophyta*). Microscopic and gross overview of the following species::
  - 3.1. *Scenedesmus sp.* - temporary mount
  - 3.2. *Hydrodictyon reticulatum* - herbarium material
  - 3.3. *Ulothrix tenuissima* - temporary mount
  - 3.4. *Ulva sp.* - herbarium material
  - 3.5. *Enteromorpha intestinalis* - herbarium material.

### **LAB9 – 3 HOURS**

#### **SPORE PLANTS. MOSSES (*BRYOPHYTA*), LYCOPODS (*LYCOPODIOPHYTA*), HORSETAILS (*EQUISETOPHYTA*) AND FERNS (*POLYPODIOPHYTA*)**

Introducing students to the general characteristics of mosses, *Bryophyta*, lycopods *Lycopodiophyta*, horsetails *Equisetophyta* and ferns (*Polypodiophyta*)

1. Discussion and powerpoint presentation on the structure, reproduction, life cycle, distribution and use in the pharmaceutical industry of types of *Bryophyta*. Microscopic and gross overview of the following species::
  - 1.1. *Funaria hygrometrica* - herbarium material
  - 1.2. *Sphagnum sp.* - herbarium material и temporary mount
  - 1.3. *Marchantia polymorpha* - herbarium material
2. Discussion and powerpoint presentation on the structure, reproduction, life cycle, distribution and use of horsetails (*Equisetophyta*). Microscopic и gross overview of the following species::
  - 2.1. *Equisetum arvense* - herbarium material
  - 2.2. *Equisetum arvense* - cross section през лятно стъбло, temporary mount
  - 2.3. *Equisetum arvense*, observation of spores - temporary mount
  - 2.4. *Equisetum telmateia* - herbarium material
  - 2.5. *Equisetum palustre* - herbarium material
  - 2.6. *Equisetum ramosissimum* - herbarium material
3. Discussion and powerpoint presentation on the structure, reproduction, life cycle, distribution and use of lycopods (*Lycopodiophyta*). Gross overview of the following species:
  - 3.1. *Lycopodium clavatum* - herbarium material
  - 3.2. *Selaginella helvetica* - herbarium material
4. Discussion and powerpoint presentation on the structure, reproduction, life cycle, distribution, biological activity of materials and use in the pharmaceutical industry of ferns (*Polypodiophyta*). General overview of the following species::
  - 4.1. *Polypodium vulgare* - herbarium material
  - 4.2. *Dryopteris filix-mas* - herbarium material
  - 4.3. *Pteridium aquilinum* - herbarium material
  - 4.4. *Asplenium trichomanes* - herbarium material
  - 4.5. *Ceterach officinarum* - herbarium material
  - 4.6. *Phyllitis scolopendrium* - herbarium material.

### **LAB10 – 3 HOURS**

#### **SEEDPLANTS. CONIFERS (*PINOPHYTINA*) AND CYCADS (*CYCADOPHYTINA*). IDENTIFICATION OF CONIFERS**

Introducing students to the general characteristics and representative taxa of conifers and cycads, acquiring skills to use dichotomous keys and identifying plants

1. Discussion and powerpoint presentation; general characteristics, reproduction, plant part used, mechanism of action and application in the pharmaceutical industry of conifers and ginkgo (*Pinophytina*). General overview of the following species::
  - 1.1. *Ginkgo biloba* - herbarium material
  - 1.2. *Ginkgo biloba* - structure of male and female cones, fixed material
  - 1.3. *Pinus sylvestris* - herbarium material
  - 1.4. *Pinus sylvestris* - structure of male and female cones, fixed material
  - 1.5. *Juniperus communis* - herbarium material
  - 1.6. *Juniperus oxycedrus* - herbarium material
  - 1.7. *Juniperus sabina* - herbarium material
  - 1.8. *Taxus baccata* - herbarium material
2. Discussion and powerpoint presentation; general characteristics, reproduction, plant part used, mechanism of action and application in the pharmaceutical industry of cycads (*Cycadophytina*). General overview of the following species::
  - 2.1. *Ephedra distachya* - herbarium material
3. Identifying gymnosperms
  - 3.1. using a key
  - 3.2. identifying fresh material.

### **LAB11 – 3 HOURS**

#### **SEED PLANTS ANGIOSPERMS (*MAGNOLIOPHYTINA*). BUTTERCUP (*RANUNCULACEAE*), POPPY (*PAPAVERACEAE*), FUMITORY (*FUMARIACEAE*) AND CARNATION (*CARYOPHYLLACEAE*) FAMILIES**

Introducing students to the general characteristics and representative taxa of the buttercup family (*Ranunculaceae*), the poppy family (*Papaveraceae*), the fumitory family (*Fumariaceae*) and pink family (*Caryophyllaceae*)

1. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the buttercup family (*Ranunculaceae*). General overview of the following species::
  - 1.1. *Adonis vernalis* - herbarium material
  - 1.2. *Helleborus odorus* - herbarium material
  - 1.3. *Ranunculus repens* - хербариен снимков материал
  - 1.4. *Nigella sativa* - herbarium material
  - 1.5. *Caltha palustris* - herbarium material
  - 1.6. *Clematis vitalba* - herbarium material
  - 1.7. *Consolida regalis* - herbarium material
2. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of

representative taxa of the poppy family (*Papaveraceae*). General overview of the following species::

- 2.1. *Papaver rhoeas* - herbarium material
  - 2.2. *Papaver somniferum* - herbarium material
  - 2.3. *Glaucium flavum* - herbarium material
  - 2.4. *Chelidonium majus* - herbarium material
3. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the fumitory family (*Fumariaceae*). General overview of the following species::
- 3.1. *Fumaria officinalis* - herbarium material
  - 3.2. *Corydalis solida* - herbarium material
4. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the pink family (*Caryophyllaceae*). General overview of the following species::
- 4.1. *Herniaria hirsuta* - herbarium material
  - 4.2. *Saponaria officinalis* - herbarium material
  - 4.3. *Lychnis coronaria* - herbarium material
  - 4.3. *Stellaria media* - herbarium material.

### **LAB 12 – 3 HOURS**

#### **SEED PLANTS ANGIOSPERMS (MAGNOLIOPHYTINA). BEECH (FAGACEAE), BIRCH (BETULACEAE), ST. JOHN’S WORT (HYPERICACEAE), PRIMROSE (PRIMULACEAE), VIOLA (VIOLACEAE) AND CRUCIFER (BRASSICACEAE) FAMILIES**

Introducing students to the general characteristics and representative taxa of the beech family (*Fagaceae*), birch family (*Betulaceae*), St. John’s wort’s family (*Hypericaceae*), primrose (*Primulaceae*), viole family (*Violaceae*) and crucifers (*Brassicaceae*)

1. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the beech family (*Fagaceae*). General overview of the following species::
  - 1.1. *Fagus sylvatica* - herbarium material
  - 1.2. *Fagus orientalis* - herbarium material
  - 1.3. *Castanea sativa* - herbarium material
  - 1.4. *Quercus sp.* - herbarium material
2. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the birch family (*Betulaceae*). General overview of the following species::
  - 2.1. *Betula pendula* - herbarium material
  - 2.2. *Corylus avelana* - herbarium material
  - 2.3. *Alnus glutinosa* - herbarium material
3. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of

representative taxa of the St. John's wart family (*Hypericaceae*). General overview of the following species::

3.1. *Hypericum perforatum* (ЖЪЛТ кантарион) - herbarium material

4. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the primorose family (*Primulaceae*). General overview of the following species::

4.1. *Primula veris* - herbarium material

4.2. *Primula elatior* - herbarium material

4.3. *Lysimachia nummularia* - herbarium material

4.4. *Anagallis arvensis* - herbarium material

5. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the violet family (*Violaceae*). General overview of the following species:

5.1. *Viola odorata* - herbarium material

5.2. *Viola tricolor* - herbarium material

6. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the crucifers (*Brassicaceae*). General overview of the following species::

6.1. *Capsella bursa-pastoris* - herbarium material

6.2. *Alliaria officinalis* - herbarium material

6.3. *Nasturtium officinale* - herbarium material

6.4. *Armoracia rusticana* - herbarium material

6.5. *Brassica nigra* - herbarium material

6.6. *Erysimum diffusum* - herbarium material.

### **LAB13 – 3 HOURS**

#### **SEED PLANTS ANGIOSPERMS (MAGNOLIOPHYTINA). LINDEN (TILIACEAE), MARSHMALLOW (MALVACEAE), NETTLE (URTICACEAE) AND ROSE (ROSACEAE) FAMILIES**

Introducing students to the general characteristics and representative taxa of the linden tree family (*Tiliaceae*), the marshmallow family (*Malvaceae*), the nettle family (*Urticaceae*) and the rose family (*Rosaceae*)

1. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the linden tree family (*Tiliaceae*). General overview of the following species::

1.1. *Tilia tomentosa* - herbarium material

1.2. *Tilia platyphyllos* - herbarium material

1.3. *Tilia cordata* - herbarium material

2. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the marshmallow family (*Malvaceae*). General overview of the following species:

- 2.1. *Malva sylvestris* - herbarium material
- 2.2. *Althaea officinalis* - herbarium material
- 2.3. *Gossypium hirsutum* - herbarium material
3. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the nettle family (*Urticaceae*). General overview of the following species:
  - 3.1. *Urtica dioica* - herbarium material
  - 3.2. *Urtica urens* - herbarium material
  - 3.3. *Parietaria erecta* - herbarium material
4. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the rose family (*Rosaceae*). General overview of the following species:
  - 4.1. *Spiraea hypericifolia* - herbarium material
  - 4.2. *Rosa kazanlika* - herbarium material
  - 4.3. *Rosa canina* - herbarium material
  - 4.4. *Fragaria vesca* - herbarium material
  - 4.5. *Rubus idaeus* - herbarium material
  - 4.6. *Rubus ceasius* - herbarium material
  - 4.7. *Agrimonia eupatoria* - herbarium material
  - 4.8. *Geum urbanum* - herbarium material
  - 4.9. *Cydonia oblonga* - herbarium material
  - 4.10. *Crataegus monogina* - herbarium material
  - 4.11. *Malus sylvestris* - herbarium material
  - 4.12. *Prunus spinosa* - herbarium material
  - 4.13. *Amygdalus communis* - herbarium material
  - 4.14. *Cerasus vulgaris* - herbarium material
  - 4.15. *Laurocerasus officinalis* - herbarium material.

### **LAB14 – 3 HOURS**

#### **SEED PLANTS ANGIOSPERMS (*MAGNOLIOPHYTINA*). LEGUME (*FABACEAE*), CARROT (*APIACEAE*), GERANIUM (*GERANIACEAE*), PLANTAIN (*PLANTAGINACEAE*) AND FIGWORT (*SCROPHULARIACEAE*) FAMILIES**

Introducing students to the general characteristics and representative taxa of legumes (*Fabaceae*), the carrot family (*Apiaceae*), the geranium family (*Geraniaceae*), the plantain family (*Plantaginaceae*) and the figwort family (*Scrophulariaceae*)

1. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the legumes (*Fabaceae*). General overview of the following species::
  - 1.1. *Melilotus officinalis* - herbarium material
  - 1.2. *Galega officinalis* - herbarium material
  - 1.3. *Robinia pseudoacacia* - herbarium material
  - 1.4. *Ononis spinosa* - herbarium material
  - 1.5. *Laburnum anagyroides* - herbarium material
  - 1.6. *Anthyllis vulneraria* - herbarium material

2. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the carrot family (*Apiaceae*). General overview of the following species:
  - 2.1. *Conium maculatum* - herbarium material
  - 2.2. *Pimpinella anisum* - herbarium material
  - 2.3. *Anethum graveolens* - herbarium material
  - 2.4. *Foeniculum vulgare* - herbarium material
  - 2.5. *Eryngium campestre* - herbarium material
  - 2.6. *Angelica panicii* - herbarium material
  - 2.7. *Petroselinum crispum* - herbarium material
3. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the geranium family (*Geraniaceae*). General overview of the following species:
  - 3.1. *Geranium sanguineum* - herbarium material
  - 3.2. *Geranium robertianum* - herbarium material
  - 3.3. *Geranium macrorrhizum* - herbarium material
  - 3.4. *Pelargonium roseum* - herbarium material
4. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the plantain family (*Plantaginaceae*). General overview of the following species:
  - 4.1. *Plantago lanceolata* - herbarium material
  - 4.2. *Plantago major* - herbarium material
5. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the figwort family (*Scrophulariaceae*). General overview of the following species:
  - 5.1. *Euphrasia officinalis* - herbarium material
  - 5.2. *Digitalis grandiflora* - herbarium material
  - 5.3. *Digitalis lanata* - herbarium material
  - 5.4. *Veronica officinalis* - herbarium material
  - 5.5. *Verbascum densiflorum* - herbarium material
  - 5.6. *Verbascum phlomoides* - herbarium material
  - 5.7. *Linaria vulgaris* - herbarium material.

### **LAB15 – 3 HOURS**

#### **SEED PLANTS ANGIOSPERMS (MAGNOLIOPHYTINA). MINT (LAMIACEAE), SUNFLOWER (ASTERACEAE), LILIUM (LILIACEAE) AND GRASS (POACEAE) FAMILIES**

Introducing students to the general characteristics and representative taxa of the mint family (*Lamiaceae*), the daisy family (*Asteraceae*), the lily family (*Liliaceae*) and the grasses (*Poaceae*)

1. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of



representative taxa of the mint family (*Lamiaceae*). General overview of the following species:

- 1.1. *Mentha piperita* - herbarium material
- 1.2. *Thymus serpyllum* - herbarium material
- 1.3. *Melissa officinalis* - herbarium material
- 1.4. *Oryganum vulgare* - herbarium material
- 1.5. *Lavandula angustifolia* - herbarium material
- 1.6. *Satureja hortensis* - herbarium material
- 1.7. *Ocimum basilicum* - herbarium material
- 1.8. *Rosmarinus officinalis* - herbarium material
- 1.9. *Stachys sylvatica* - herbarium material
- 1.10. *Betonica officinalis* - herbarium material

2. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the daisy family (*Asteraceae*). General overview of the following species:

- 2.1. *Achillea millefolium* - herbarium material
- 2.2. *Achillea clypeolata* - herbarium material
- 2.3. *Solidago virga-aurea* - herbarium material
- 2.4. *Taraxacum officinale* - herbarium material
- 2.5. *Tussilago farfara* - herbarium material
- 2.6. *Chamomilla recutita* - herbarium material
- 2.7. *Artemisia vulgaris* - herbarium material
- 2.8. *Arctium lappa* - herbarium material
- 2.9. *Calendula officinalis* - herbarium material
- 2.10. *Cichorium inthybus* - herbarium material
- 2.11. *Centaurea cyanus* - herbarium material
- 2.12. *Bellis perennis* - herbarium material
- 2.13. *Helianthus annulus* - herbarium material

3. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the lily family (*Liliaceae*). General overview of the following species:

- 3.1. *Veratrum album* - herbarium material
- 3.2. *Convallaria majalis* - herbarium material
- 3.3. *Polygonatum odoratum* - herbarium material
- 3.4. *Colchicum autumnale* - herbarium material

4. Discussion and powerpoint presentation; morphology, plant parts used medicinally, mechanism of action and application in the pharmaceutical industry of representative taxa of the grasses (*Poaceae*). General overview of the following species:

- 4.1. *Hordeum vulgare* - herbarium material
- 4.2. *Cynodon dactylon* - herbarium material
- 4.3. *Zea mays* - herbarium material.

## SOURCES FOR INDEPENDENT WORK

1. **Rudall P.J.**, Anatomy of Flowering Plants. An Introduction to structure and Development. Cambridge Univ. Press., New York, 145 pp. 2007.
2. **Simpson M.G.**, Plant systematics. Elsevier Academic Press, Canada, 590 pp. 2006.

## SYLLABUS PHARMACEUTICAL BOTANY

1. Goals, subfields and methods in botany . Pharamceutical botany – significance of medicinal plants.
2. Plant cell – shape, size, building blocks, plant-specific structures – cell wall (function, chemical composition, cell wall growth and changes in the chemical composition).
3. Plant cell. Cytoplasm – structure and functions; plant-specific organelles – plastids (types, structure and functions).
4. Plant cell. Vacuole (structure, functions and chemical composition of the vacuolar content) and ergastic inclusions.
5. Plant tissues– definition, classification. Parenchyma – structure, characteristics and functions.
6. Plant tissues– definition, classification. Dermal tissues – epidermis and epidermal structures – structure, main and accessory functions. Bark – structure and function.
7. Plant tissues– definition, classification. Supportive tissues – structure, function and types.
8. Plant tissues– definition, classification. Vascular tissues – types and function. Vascular bundles – structure of open and closed bundles.
9. Plant tissues– definition, classification. Secretory tissue – functions.
10. Plant organs – classification. Root (*Radix*) – morphology, anatomy and functions.
11. Stem (*Caulis*) – morphology and anatomy, functions.
12. Modified stems and roots – types и function.
13. Leaf (*Folium*) – morphology. Modified leaves.
14. Leaf (*Folium*) – anatomy. Function of leaves.
15. Flower (*Flos*) – morphology и anatomy. Types of flowers.
16. Inflorescences (*Inflorescentia*) –types. Pollination.
17. Seed (*Semen*) and fruit (*Fructus*) – development and structure. Types of fruits – classification. Fruit and seed dispersal.
18. Plant systematics – goals and questions. Botanical classification and nomenclature. Taxons and taxonomic categories. Macroclassification.
19. Cyanobacteria ( *Cyanoprokaryota*) – general characteristics, representative taxa and importance to humans.
20. Eukaryote algae (*Rhodophyta* and *Bacillariophyta*) – general characteristics, representative taxa and importance to humans.
21. Eukaryote algae (*Phaeophyta* and *Chlorophyta*) – general characteristics, representative taxa and uses.
22. Spore-bearing plants (*Bryophyta* and *Lycopodiophyta*) – general characteristics and medicinal plants.
23. Spore-bearing plants (*Equisetophyta* and *Polypodiophyta*) – general characteristics and medicinal plants.

24. Seed plants ( *Magnoliophyta*) –general characteristics, classification. Gymnosperms (*Ephedraceae* and *Ginkgoaceae*) - general characteristics and medicinal representatives.
25. Gymnosperms (Families *Pinaceae*, *Cupressaceae* and *Taxaceae*) – general characteristics, agricultural and medicinal representatives.
26. Angiosperms. *Magnoliopsida* – general characteristics. Families *Lauraceae* and *Magnoliaceae* – general characteristics, medicinal and agricultural species .
27. Families *Ranunculaceae* and *Berberidaceae* – general characteristics and medicinal plants.
28. Families *Papaveraceae* and *Fumariaceae* – general characteristics and medicinal plants.
29. Families *Fagaceae*, *Betulaceae* and *Juglandaceae* – general characteristics, medicinal and agricultural species.
30. Families *Caryophyllaceae*, *Polygonaceae* and *Chenopodiaceae* – general characteristics, medicinal and agricultural species.
31. Families *Clusiaceae*, *Ericaceae* and *Primulaceae* – general characteristics and medicinal plants.
32. Families *Violaceae*, *Salicaceae* and *Cucurbitaceae* – general characteristics, medicinal and agricultural species.
33. Families *Brassicaceae*, *Tiliaceae* and *Malvaceae* – general characteristics, medicinal and agricultural species.
34. Families *Moraceae*, *Cannabaceae* and *Urticaceae* – general characteristics, agricultural and medicinal species.
35. Families *Euphorbiaceae* and *Rosaceae* – general characteristics, medicinal and agricultural species.
36. Families *Fabaceae* and *Aceraceae* - characteristics, medicinal and agricultural species.
37. Families *Hippocastanaceae*, *Rutaceae* and *Anacardaceae* – general characteristics and medicinal plants.
38. Families *Linaceae*, *Geraniaceae* и *Rhamnaceae*– general characteristics and medicinal plants.
39. Families *Cornaceae*, *Araliaceae* and *Apiaceae* – general characteristics, medicinal and agricultural species.
40. Families *Caprifoliaceae*, *Valerianaceae* and *Rubiaceae* – general characteristics and medicinal species.
41. Families *Solanaceae*, *Convolvulaceae* and *Cuscutaceae* – general characteristics, medicinal and agricultural species.
42. Families *Boraginaceae* and *Scrophulariaceae* – general characteristics and medicinal plants.
43. Families *Plantaginaceae* and *Lamiaceae* – general characteristics, medicinal and agricultural species.
44. *Asteraceae* – general characteristics, medicinal and agricultural species.
45. *Liliopsida* – general characteristics. Families *Melanthiaceae* и *Iridaceae* – general characteristics, medicinal and economically-important species.
46. Families *Liliaceae*, *Aliaceae* and *Amaryllidaceae* – general characteristics, лечебни и използвани types.
47. Families *Asparagaceae*, *Dioscoreaceae* and *Orchidaceae* – general characteristics and medicinal plants.
48. Families *Poaceae* and *Araceae* – general characteristics, important food and medicinal plants.