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Tatiana CALALB • Anatolie NISTREANU



PHARMACEUTICAL BOTANY

PRACTICAL GUIDE FOR LABORATORY WORKS



NICOLAE TESTEMITANU
STATE UNIVERSITY OF MEDICINE AND PHARMACY
OF THE REPUBLIC OF MOLDOVA
Department of pharmacognosy and pharmaceutical botany

CALALB TATIANA, NISTREANU ANATOLIE

PHARMACEUTICAL BOTANY
PRACTICAL GUIDE
FOR LABORATORY WORKS

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NICOLAE TESTEMITANU

**STATE UNIVERSITY OF MEDICINE AND PHARMACY
OF THE REPUBLIC OF MOLDOVA**

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of pharmaceutical disciplines of Nicolae Testemitanu SUMPh
(minutes 1 of 28.02.2017)**

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INTRODUCTION

These methodological guidelines for laboratory works on Pharmaceutical botany have been elaborated in accordance with the curriculum program of Pharmaceutical botany discipline and syllabus for the students Faculty of Pharmacy, *Nicolae Testemitanu* State University of Medicine and Pharmacy.

The methodological guidelines objective is to represent simple, useful practical schemes and instructions of morpho-anatomical analyses of plant organs and to develop in students practical abilities of knowledge application in identification taxonomy of plants.

The methodological guidelines for laboratory works in Pharmaceutical botany appear in an up-dated form in order to train modern pharmacist specialists in correspondence with modern requirements.

Vegetal cytology. Those aspects of plant cell which can be investigated with optical microscope such as: cell wall, plastids and vacuolar inclusions are introduced in this chapter. Specific cytological structures serve as cytological indices to identify medicinal vegetable products and medicinal plants.

Vegetal histology. It is a separate chapter. Naturally, definitive tissues there were assigned more space than for meristematic tissues. Histological preparations selected for the analyses will allow students to become familiar with specific histological structures that will be used to identify vegetable products and medicinal plants.

Organography. It is the largest chapter and includes the morphological and anatomical characteristics of vegetative (root, stem, and leaf) and reproductive (flower, fruit and seed) organs. Specific morpho-anatomical features that form a complex of indicators for description and identification of plants were highlighted for each plant organ.

Vegetal sistematics. It is a half of methodological indications in which students will study the principal systematic taxa and the main rules in order to identify the taxonomic position of species. Vegetal organisms will be studied in their evolution from lower and simpler forms to higher and more complex ones. It is provided to work with fresh or preserved botanical materials, temporary or permanent micropreparations, herbaria, botanical exhibits, drawings and specialty literature.

In developing the methodological guidelines it was taken into account that Pharmaceutical botany is a fundamental discipline with applicative character. Theoretical concepts of pharmaceutical botany are studied by carrying out practical thematic works aimed to form practical skills in preparing micropreparations, microscopic analysis, highlighting special morphological and anatomical indicators required to identify the taxonomy of plant species. Each theme contains theoretical topics for discussion, which will form the basis of theoretical knowledge that allow the students to carry out practical activity in the botany laboratory, individually or in small team.

Special equipment and botanical material necessary for the practical activity are provided for each laboratory work. The botanical material for analyses is selected carefully, besides classical objects biomaterials derived from medicinal plants are used. To avoid difficulties in testing and to enhance the efficacy analysis of microscopic preparations each laboratory work includes schemes, botanical drawings, and micrographs from literature and consulted by their own profile, which I hope will facilitate the understanding of the material.

The illustrations (which are presented) in the methodological guidelines, include simple schemes, drawings, micrographs, and also a part from the "Indicații metodice pentru lucrări de laborator la Botanica farmaceutică" (2005) and the author's own micrographs, the other part from different methodological works indicated in "Bibliography" was adapted.

The authors have tried to present the subject matter in an easily comprehensive way without scarifying the essential details and general classical principles. The authors intend to highlight and focus on medicinal plants.

This guide is intended for all interested in studying plants in general and especially medicinal ones, and first of all for the first-year students of the Faculty of Pharmacy. In the hope that it will be useful the authors thank you in advance for any suggestions to take them into account in a new edition.

The students will use the knowledge and practical skills formed within the laboratory works on Pharmaceutical botany to study and understand the following disciplines: Molecular biology, Pharmacognosy, Phytotherapy, Toxic plants and, generally, in formation of pharmacist specialist.

The authors acknowledge any suggestions, comments that will contribute to the development and improvement pharmacy education.

Chapter 1 . VEGETAL CYTOLOGY

1.1. MICROSCOPY TECHNIQUES AND METHODS OF VEGETABLE PRODUCTS ANALYSIS

PRACTICAL WORK nr. 1. Safety information and work rules in pharmaceutical botany laboratory

1.1. Safety rules for work in the pharmaceutical botany laboratory

1. Students are admitted to the laboratory works only after familiarization with safety.
2. Students are admitted to the laboratory works only in white coats, presence of the protocol album and all necessary supplies to carry out the work (simple pencil, color pencils, drawing ruler, eraser, gauze, blades, etc.).
3. Food consumption is not allowed in the laboratory.
4. Foreign objects on the worktable and inadmissible movements with sharps and cutting objects are not allowed.
5. Each student is required to keep his/her worktable, tools and equipment in order and clean.
6. At the beginning of every laboratory work two students are assigned to be responsible for keeping the laboratory clean in order.
7. Each student performs concrete practical activities.
8. Students use only received utensils and labeled reagents for practical activities.
9. In case of accidents (breaking vessel, spilling reagents etc.), keep calm and remove pieces of glass, wash the accident place with water, and urgently consult a doctor.
10. At the end of the laboratory work, each student leaves the working place tidy and clean and gives the received utensils, equipment and materials back to the responsible students (students on duty).

1.2. Rules for registration of laboratory work protocol

1. The protocol of the laboratory work is recorded in albums.
2. The student must fill in the album title page specifying the discipline name, academic group, name and surname of student and academic year.
3. The protocol of the laboratory work is recorded with a blue pen and drawings are made with simple pencil, if necessary with respective color pencils.
4. The serial number of laboratory work is respectively (keeping sequence), indicating the date and theme of the work.
5. Each laboratory work involves some practical activities on a particular subject.
6. Botanical drawings are made schematically fragments or entirely, keeping the proportions of components decreased (sometimes excluding some details).
7. Below the drawing it is obligatory to indicate the botanical name (morphological, anatomical, cytological scheme, type of section, organ, species, etc.)
8. All botanical drawings are necessarily accompanied by conventional signs and explanations in question.
9. Latin name of plant species is written correctly, fully and legibly.
10. At the end of each laboratory work the student writes a conclusion on the subject; the protocol is presented to the lecturer to be signed.

PRACTICAL WORK nr. 2. Optical apparatus, botanical laboratory utensils and chemical reagents

Materials and laboratory utensils: different types of magnifying glasses, different types of optical microscopes, pieces of gauze, needles, pieces of filter paper, cutting blades, pipettes, glass rod, scalpels, preparation glasses, coverslips (covering glasses), watch glasses, Petri boxes, bowls with chemical reagents, bowls with distilled water, different biological materials (samples of leaf, fruit, stem, root).

2.1. Types of magnifying optic apparatus

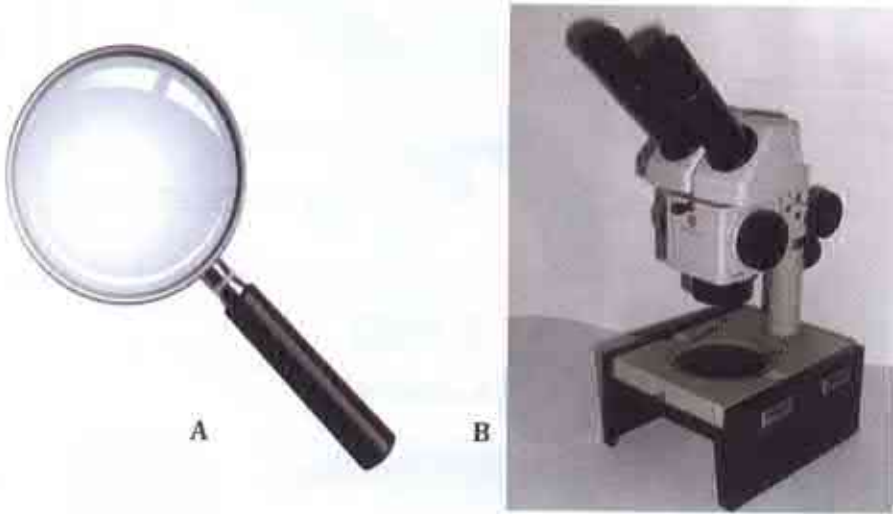


Fig. 1. Optic magnifying apparatus:

A - Hand magnifying glass; **B** - Stereomicroscope МБС - 10



Fig. 2. Optical light microscope Miko

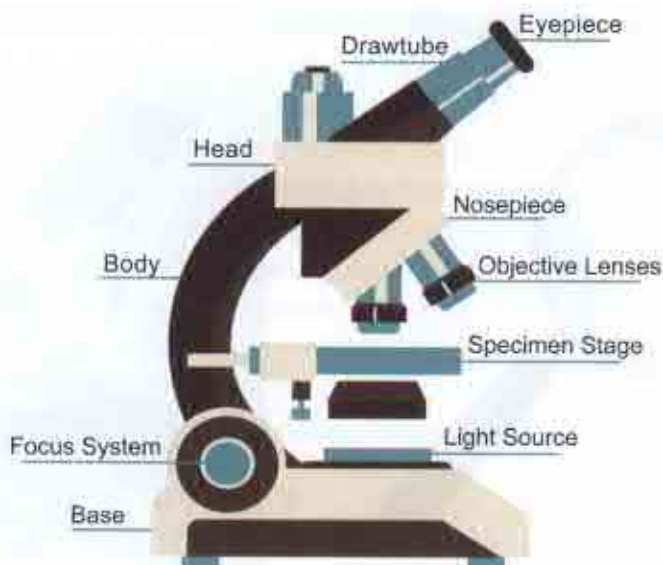


Fig. 3. Optical light microscope Miko (scheme)

2.2. Botanical laboratory tools



Fig. 4. Botanical laboratory tools: **A** – Box with microscopic utensils; **B** – necessary botanic laboratory tools: **a** – lanceolate preparation needle; **b** – pointed preparation needle; **c** – scissors; **d** – tweezers; **e** – scalpel; **f** – spatulate needle

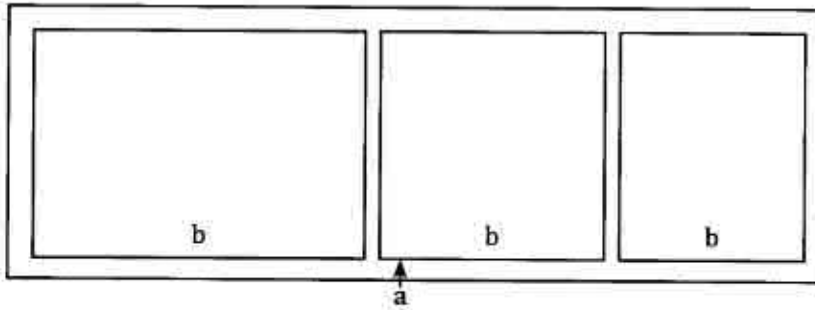


Fig. 5. Micropreparation: a - microscopic glass;
b - covering glasses of different size

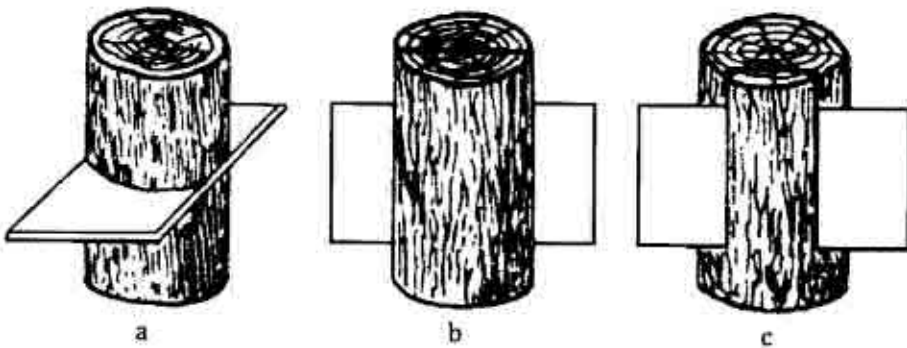


Fig. 6. Direction of sections: a - transversal; b - longitudinal (radial);
c - longitudinal (tangential)

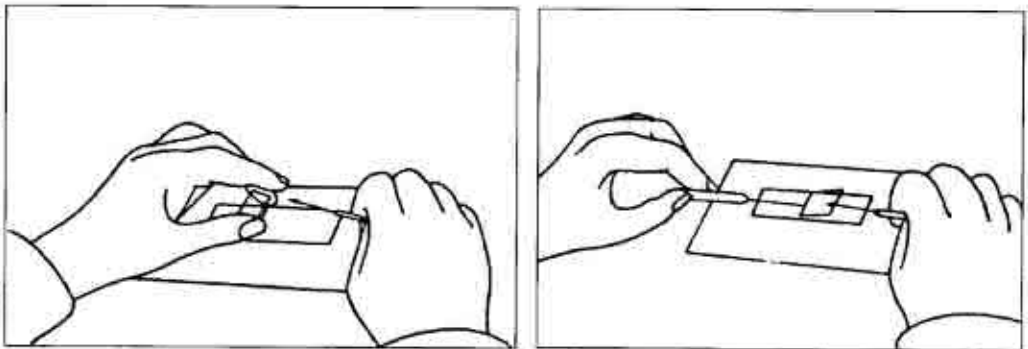


Fig. 7. Hand position in manufacturing of micropreparations

2.2. Reagents for chemical tests

1. **Distilled water.** It is very useful for different procedure (to dilute different chemical reagents, to wash microscopic samples after coloring etc.).

2. **Glycerin dilution.** One volume of glycerin is mixed with two volumes of distilled water. A useful mount for preparations which may be left for some time, as it does not dry up. It has some cleaning action, but is much inferior in this respect to chloral hydrate.

3. **Ethanol.** Different properties are used for preserving material and for hardening. Alcohol acts as a cleaning agent by dissolving oils, resins, chlorophyll, etc. It does not dissolve gums and mucilages.

4. **Solution of chloral hydrate.** This dissolves starch, proteins, chlorophyll, resins and volatile oils, and causes shrunken cells to expand. Chloral hydrate may be used not only for sections but also for whole leaves, flowers, stems etc. It does not dissolve calcium oxalate and is therefore a good reagent for identification of these crystals.

5. **Chloral hydrate with iodine.** It is used cold and causes shrunken cells and starch grains to expand. Iodine stains starch or hemicelluloses.

6. **Solution of sodium.** 3% solution of sodium hydroxide is used as a cleaning agent that dissolves aleuronic, starch, protein grains, etc., causing the swelling of cell walls.

7. **Chlorine-zinc-iodine solution.** The reagent stains cellulose walls blue or violet, lignified and suberized walls yellow or brown, and starch grains blue.

8. **Ether-ethanol.** A defatting agent.

9. **Sudan III solution.** A solution of equal parts of glycerin and alcohol, stains oils and suberized walls, and is useful in the examination of secretory cells and ducts. It colors oils, suberin and cutin in red.

10. **Iodine water.** It gives a blue colour with starch and hemicelluloses.

11. **Methylene blue (CI 52015),** also known as **methylthioninium chloride.** It is used in biology as a stain. Methylene blue with solution of 1% KOH stains lignified cell walls in blue, cellulose cell walls - in violet, suberin - in green and phloem channels - in pink-red.

12. **Toluidine blue.** Toluidine blue with buffer solution pH=7 stains lignified and suberified cell walls and nucleus in blue-greenish, cellulose and pectins - in red-purpurish or red-violet. The staining procedure is rapid and easily performed, thus, toluidine blue is helpful and widely employed for any kind of overview staining.

PRACTICAL WORK nr. 3. Micropreparations

3.1. Types of micropreparations:

Options for preparing specimens are based on microscopy requirements and are limited to:

- Whole mounts, where an entire organism or structure is small enough or thin enough to be placed directly onto a microscope slide (e.g. a small unicellular or multicellular organism or a membrane that can be stretched thinly on a slide).
- Sections, where specimens are supported in some way so that very thin slices can be cut from them, mounted on slides, and stained. Sections are prepared using an instrument called a "microtome" or by cutting blades, biological knife.

There are 2 types of micropreparations used in botany laboratory:

- **permanent or fixed micropreparations** (the specimens are fixed in enclosed substances between the cover and preparation slips); they are prepared by specialist-biologist;
- **temporarily micropreparations**: the specimens are fixed in enclosed substances such water, water and glicerine (1:1), chloral hydrate between the cover and preparation slips; they are prepared by biologists, students (during laboratory work) and can be labeled and stored in a special box for many weeks.

Micropreparations may include different specimens:

- suspension of starch granules, fatty globes, separated plastids e.g.;
- fragments of clarified biological material (leaves, stems, fruits, seeds, cortex) in solution of 3% NaOH or chloral hydrate – superficial preparation;
- slices (sections) obtained by cutting, mounted on slides. According to the direction of cut the sections may be:
 - transversal (cross, perpendicularity on the principal axis) of leaf, root, stem;
 - longitudinal (along the principal axis) of leaf, root, stem;
 - tangential (parallel to the surface) of stem, root, fruit.

3.2. Preparing of micropreparations

Needed materials: glass slide, cover slip (covering glasses), pincers, preparation needles, slices of gauze blotting paper, pipettes, glass rod, scalpels, watch glasses, Petri boxes, bowls with chemical reagents, bowls with distilled water, and different biological materials (samples of leaf, fruit, stem, root), different types of magnifying glasses.

How to make a microscope slide (micropreparation):

- Cut carefully a very thin slice of the specimen using the scalpel – the thinner the slice, the easier it will be to view with your microscope.
- Put one drop of water in the center of a plain glass slide – the water droplet should be larger than the slice of the specimen.
- Set gently the slice of specimen on the top of the drop of water (pincers or preparation needles might be helpful for this).
- If you are not able to cut a thin enough slice of the whole diameter of the specimen, a smaller section will work.
- Take one cover slip and hold it at an angle to the slide so that one edge of it touches the water droplet on the surface of the slide.
- Then, being careful not to move the specimen around, lower the cover slip without trapping any air bubbles beneath it.
- The water should form a seal around the sample. Use the corner of a paper towel to blot up any excess water at the edges of the coverslip.
- Begin with the lowest-power objective (4x or 10x) to view your slide.
- Then switch to a higher power objective (20x or 40x) to see more detail.
- Find the needed structures and analyze carefully. Compare the microscopic view with scheme from methodic instructions.
- Draw schematically the structure in the laboratory album with pencils (simple or color), keep the proportion between structure components and write the correct structure indications.

3.3. Instructions to work with light optical microscope

- Introduction to the Microscope Lab Activity *Miko* refers to tiny, “scope” refers to view or look at.
- Microscopes are tools used to enlarge images of small objects so as they can be studied. The light microscope is an instrument containing two lenses, which magnify, and a variety of knobs to resolve (focus) the picture. As it uses more than one lens, it is sometimes called the compound microscope in addition to being referred to a light microscope. In this laboratory work, we will learn about the proper use and handling of the microscope.
- Basic rules for caring for microscopes, everything on a microscope is unbelievably expensive, so be careful.
- Hold a microscope firmly by the stand, only. Never grab it by the eyepiece holder, for example.

- Hold the plug (not the cable) when unplugging the illuminator. Since bulbs are expensive, and have a limited life, turn the illuminator off when not in use. If used constantly on full power the bulb will overheat and blow. This is not a good idea! Always make sure the stage and lenses are clean before putting the microscope away.

- Never use anything but good quality lens tissue on any optical surface, with appropriate lens cleaner or distilled water; organic solvents may separate or damage the lens elements or coatings.

- Cover the instrument with a dust jacket when not in use. Focus smoothly; don't try to speed through the focusing process or force anything. If it isn't working, DON'T try to fix it unless you really know what you are doing.

SUBJECTS FOR DISCUSSION

1. What is cytology?
2. Necessity of to study cytology for the faculty of Pharmacy.
3. Savety and work rules in pharmaceutical botany laboratory.
4. Principal rules for the record of laboratory work protocol.
5. Type of microscopes.
6. Structure of optic microscope *Miko*.
7. Rules for working with optical microscope.
8. Principal laboratory tools. Technique for working.
9. Principal kinds of micropreparations.
10. Manufacturing technique of micropreparations.
11. Reagents for chemical tests.
12. Technique for applying chemical reagents.

1.2. CELL WALL

Materials and laboratory utensils: pieces of gauze, preparation needle, pieces of filter paper, cutting blades, fragments of pith from the black elderberry stem, pipettes, glass rod, scalpels, preparation glasses, coverslips (covering glasses), watch glasses, preparation needle, Petri boxes, bowls with chemical reagents, bowls with distilled water, and different biological materials (samples of leaf, fruit, stem, root), different types of magnifying glasses, different types of optical microscopes.

PRACTICAL WORK nr. 1. Vegetal cell structure

1.1. Vegetal cell structure of epidermis

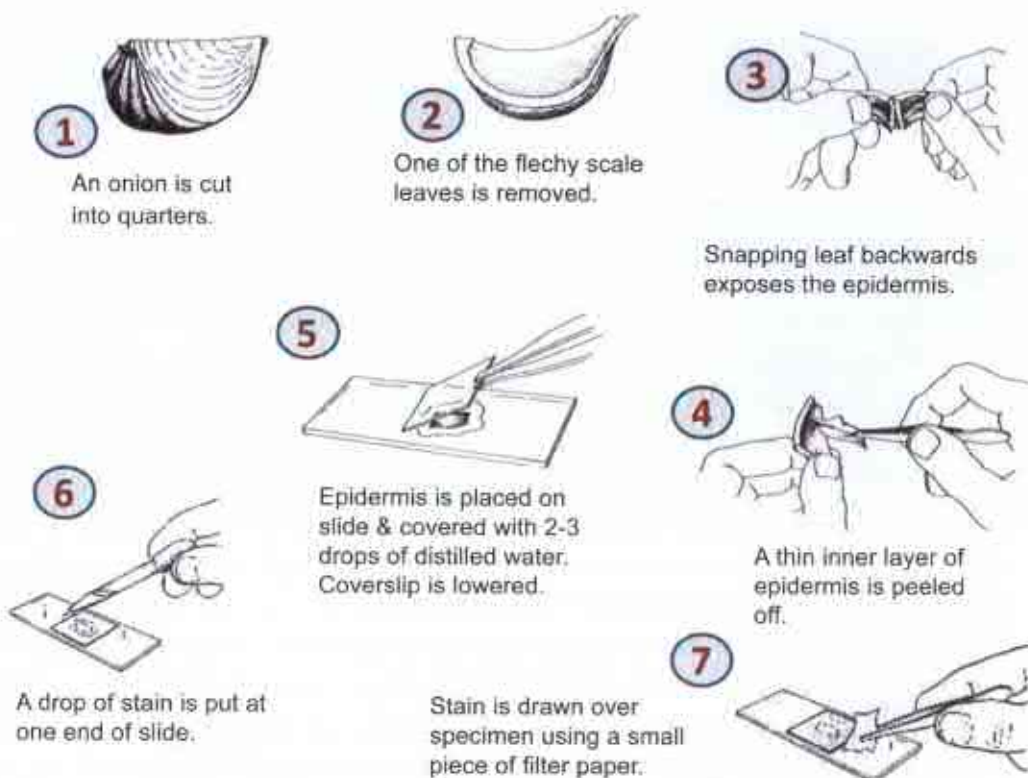


Fig. 8. The technique of temporary micro-preparation preparing
(Epidermis of bulb onion *Allium cepa* fleshy scale)

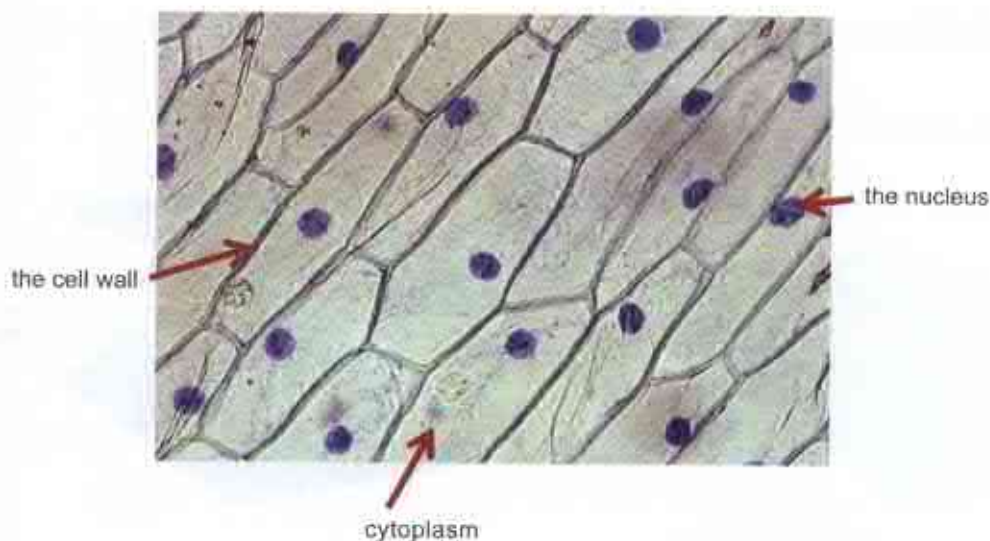
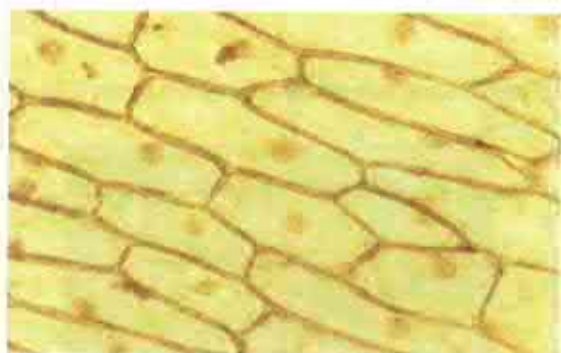
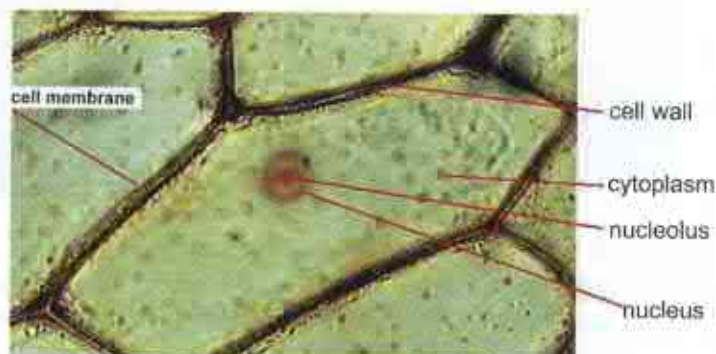


Fig. 9. Epidermis of bulb onion *Allium cepa* fleshy scale



Onion cell epidermis 10x

Fig. 10. Epidermis of bulb onion *Allium cepa* fleshy scale stained with iodine solution (easier to see the structures such as: cell wall, nucleus, cytoplasm)



Onion cell epidermis 40x

PRACTICAL WORK nr. 2. Cell wall

2.1. Scheme of cell wall

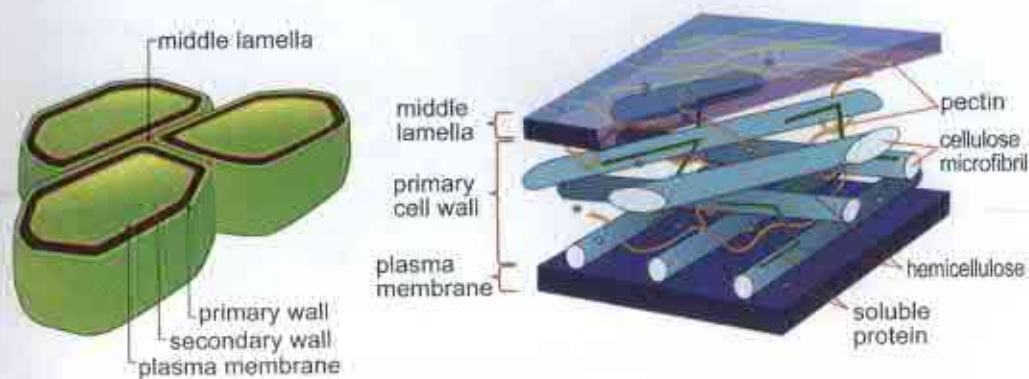


Fig. 11. Scheme of plant cell wall

2.2. Primary cell wall

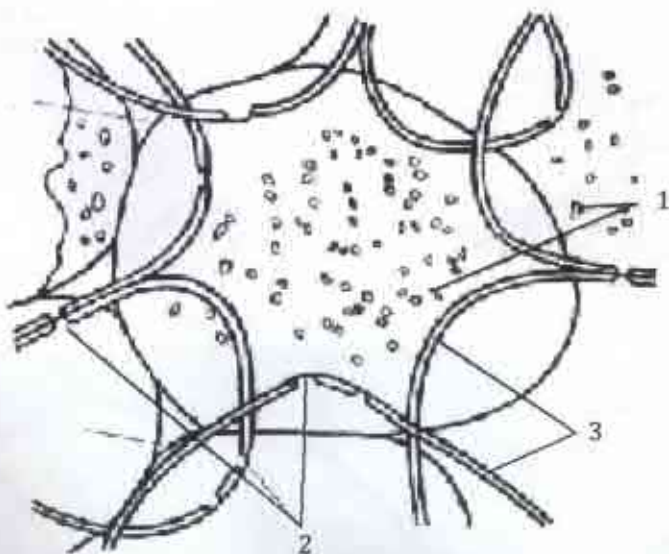


Fig. 12. Cross section of the Elderberry *Sambucus nigra* twig pith:
1 - pore (above view); 2 - pore in cross section; 3 - primary cellulose cell wall

2.3. Primary and secondary cell walls in the Pear fruit

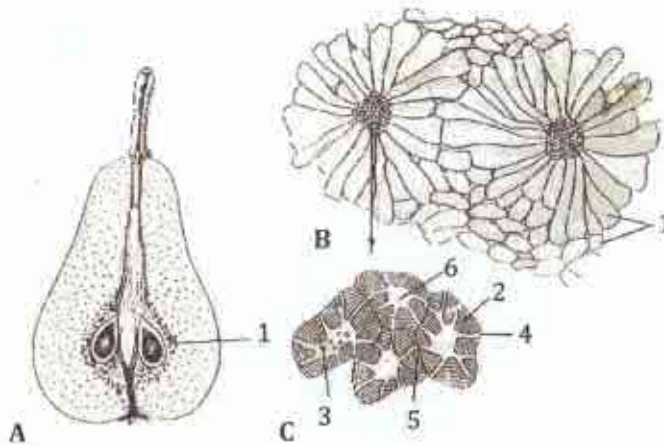


Fig. 13. Section of the Pear *Pyrus communis* fruit: A – longitudinal section of fruit; B – portion of parenchyma fruit, 1 – parenchyma cells with primary cell walls; C – group of stone cells: 2, 5 – secondary lignified cell wall, 3 – pore (above view), 4 – pore (in section), 6 – cavity of cell

2.4. Primary and secondary cell walls in the Black chokeberry fruit



Fig. 14. Section of Black chokeberry *Aronia melanocarpa* fruit (stained by Zn-Cl-I solution): A – radial section of fruit (10x); 1 – parenchymatous cells with primary cell wall, 2 – stone cells with secondary cell wall; B – portion of parenchyma fruit (40x), 3 – cavity of cell, 4 – lignified secondary walls, 5 – pore in section

SUBJECTS FOR DISCUSSION

1. What is cell wall?
2. Functions of the cell wall.
3. Formation of the cell wall.
4. Types of the cell wall.
5. What is the median lamella?
6. Characteristics of the primary cell wall.
7. Characteristics of the secondary cell wall.
8. Chemical composition of the primary and secondary cell walls.
9. Types of secondary cell wall modifications. Role. Examples.
10. Diagnostic role of cell wall modifications.

1.3. PLASTIDS

Botanical materials and laboratory utensils: Different biological materials: *Elodea* leaf; Potato tubers; Bean seeds; Dog rose, Mountain ash, Tomato, and Pepper fruits. Pieces of gauze, preparation needle, pieces of filter paper, cutting blades, fragments of pith from the Black elderberry stem, pipettes, glass rod, scalpels, preparation glasses, coverslips (covering glasses), watch glasses, preparation needle, Petry boxes, bowls with chemical reagents, bowls with distilled water.

PRACTICAL WORK nr. 1. Types of plastids

1.1. Biogenesis of different types of plastids

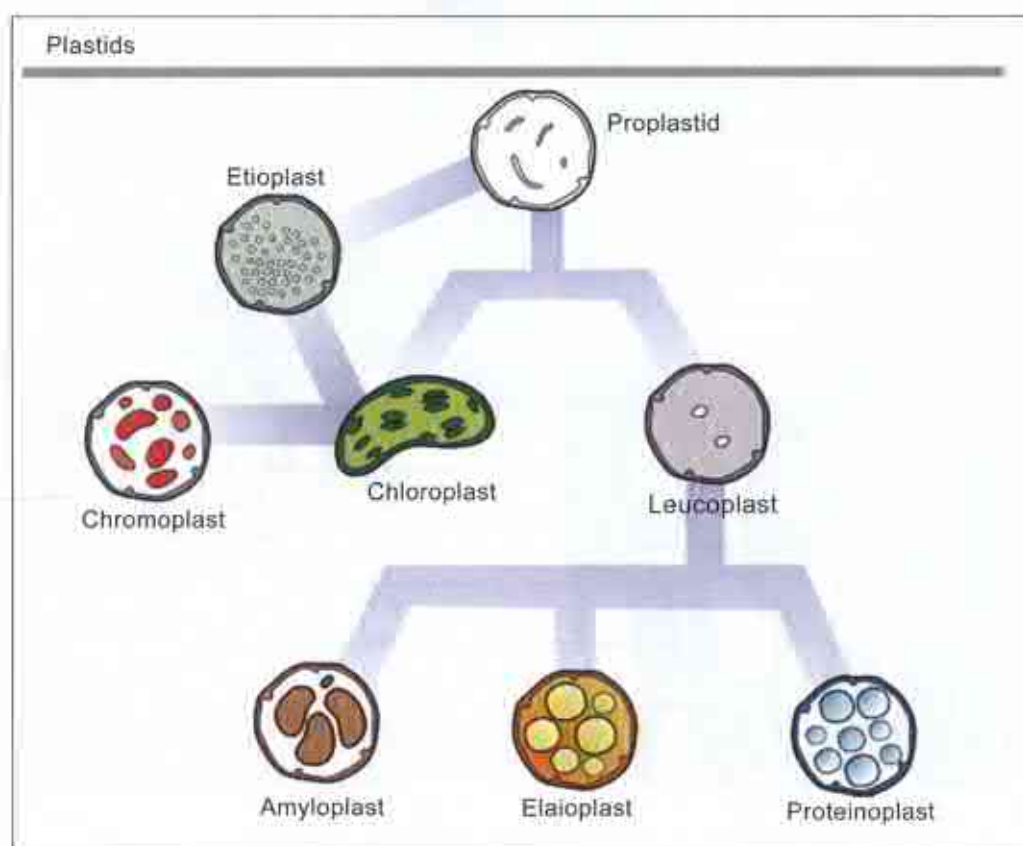


Fig. 15. Biogenesis of different types of plastids

PRACTICAL WORK nr. 2. Chloroplasts

2.1. Chloroplasts in the leaf

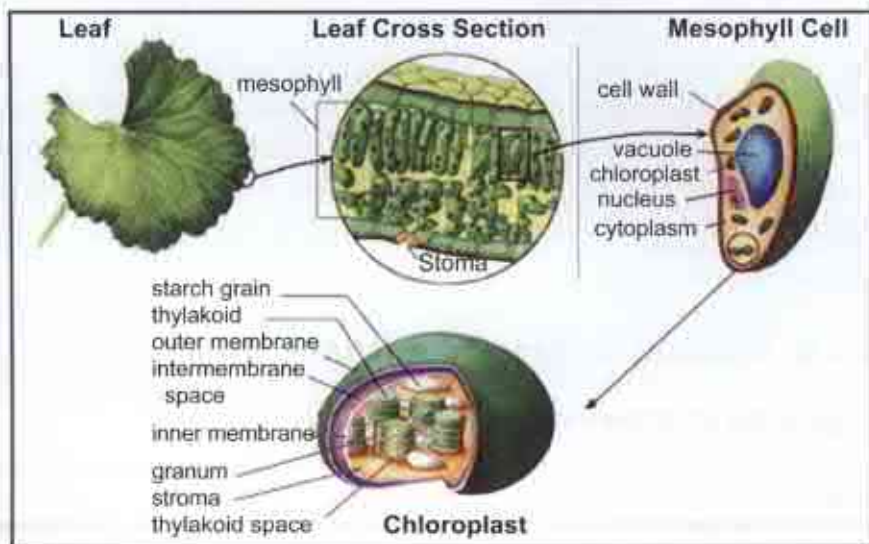


Fig. 16. Chloroplasts in the leaf: leaf-mesophyll-cell-chloroplast

2.2. Chloroplasts in *Elodea* and *Syringa* leaves

You can expect to see the following in a plant cell under a light microscope: cell membrane, chloroplasts, vacuole and cytoplasm.

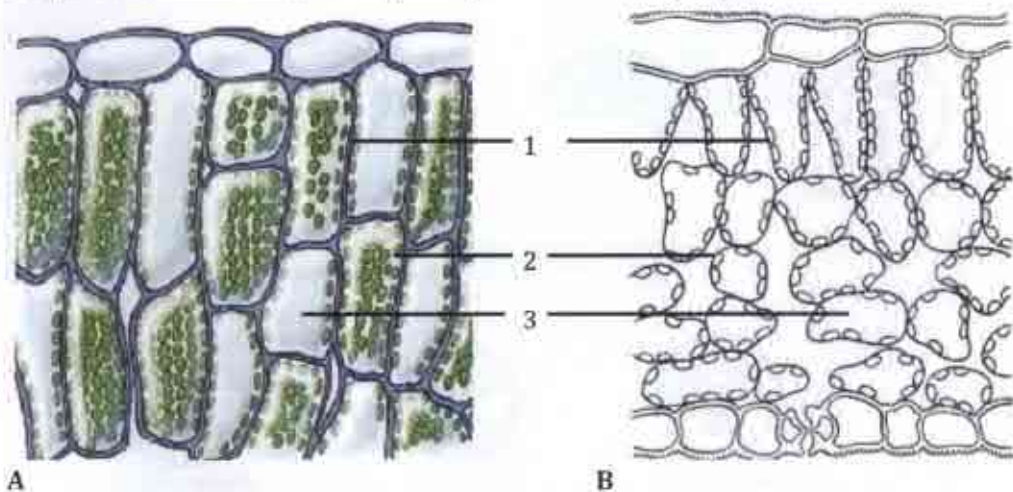


Fig. 17. Chloroplasts in the leaves of species: A - Canadian waterweed *Elodea canadensis*; B - Lilac *Syringa vulgaris*, 1 - cell wall, 2 - chloroplasts, 3 - vacuoles.

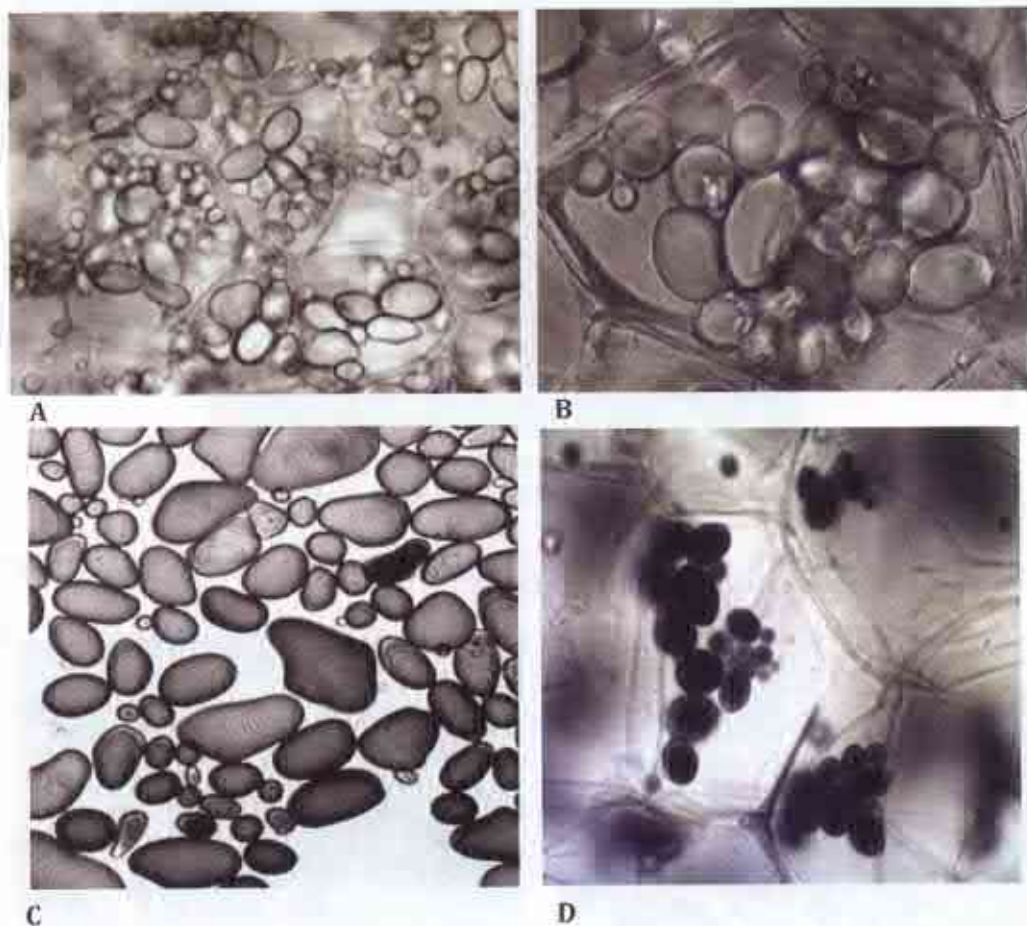
PRACTICAL WORK nr. 3. Leucoplasts**3.1. Amiloplasts in the Potato tuber**

Fig. 18. Amiloplasts in the Potato *Solanum tuberosum* tuber: A (10x), B – cells with amiloplasts 40x); C – separated amiloplasts (40x); D – cells with amiloplasts stained with iodine solution (10x)

3.2. Amiloplasts in the Bean seed

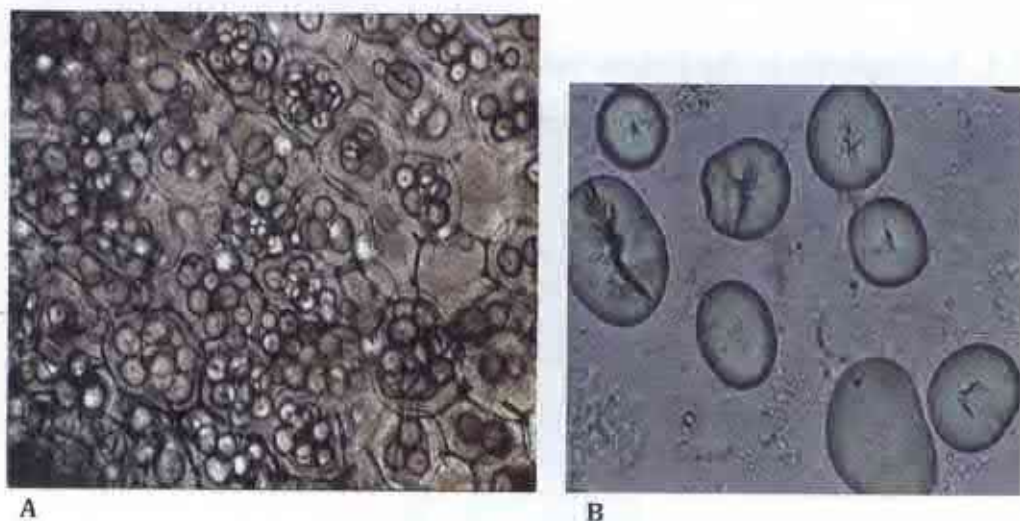


Fig. 19. Amiloplasts in the Bean *Phaseolus vulgare* seed: A - cells with amiloplasts stained with iodine solution (10x); B - separated amiloplasts (40x)

3.3. Elailoplasts in the Avocado fruit

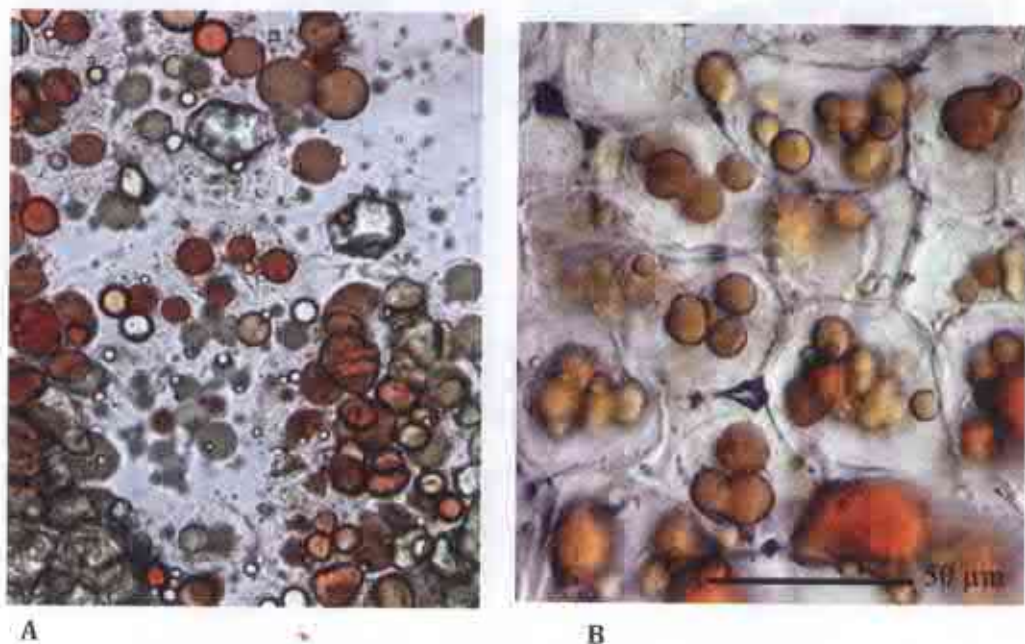


Fig. 20. Elailoplasts stained with Sudan III in the cells of Avocado *Persea americana* fruit: A (10x); B (40x)

3.4. Proteinoplasts (proteoplasts) in the Soybean seed

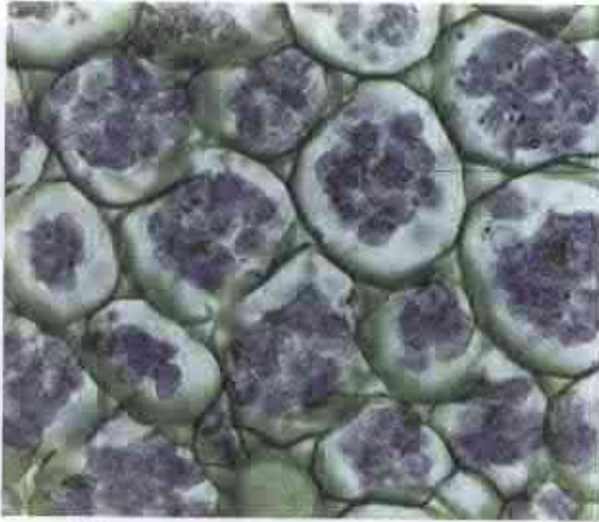


Fig. 21. Proteinoplasts in the cells of Soybean *Glycine max* seed

PRACTICAL WORK nr. 4. Chromoplasts

4.1. Chromoplasts in the Rowan and Hawthorn fruits

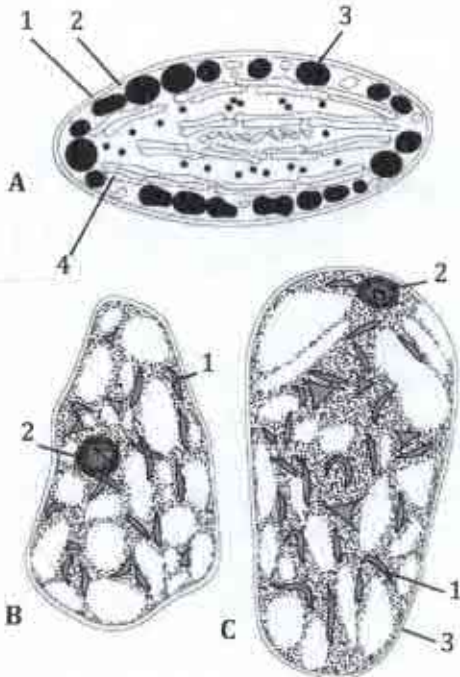


Fig. 22. Structure of chromoplasts: A - Scheme of chromoplast: 1 - outer membrane, 2 - inner membrane, 3 - fatty globules (plastoglobules), 4 - photosynthetic membrane; B - chromoplasts in the cell of Rowan *Sorbus aucuparia* fruit; C - chromoplasts in the cell of Hawthorn *Crataegus monogyna* fruit: 1 - chromoplasts, 2 - nucleus, 3 - cell wall

4.2. Chromoplasts in the Pepper fruits

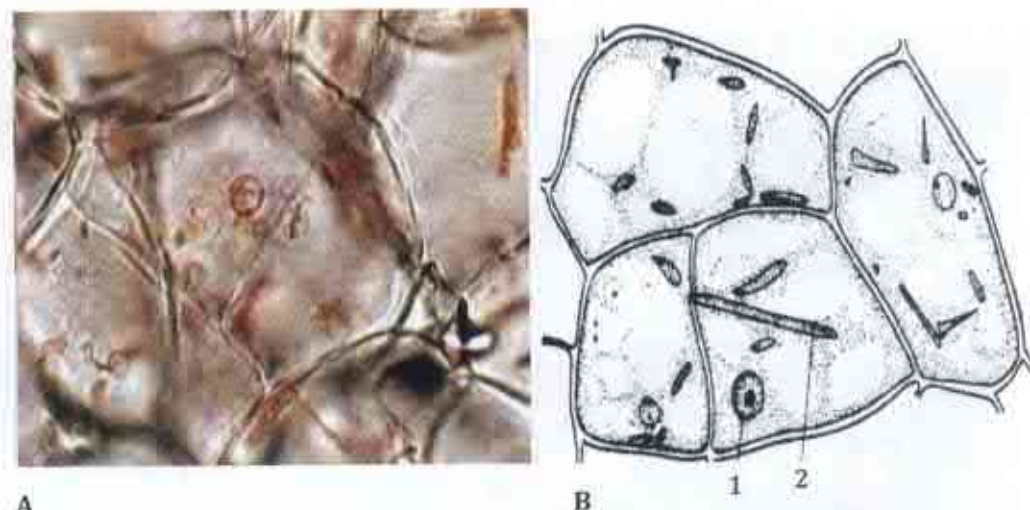


A

B

Fig. 23. Chromoplasts in the cells of Pepper *Capsicum annuum* fruit: A (10x); B (40x)

4.3. Chromoplasts in the Carrot root



A

B

Fig. 24. Chromoplasts in the cells of Carrot *Daucus carota* root:
A – micrograph (40x); B – scheme: 1 – nucleus, 2 – needle-like chromoplasts

PRACTICAL WORK nr. 5. Conversion of one type of plastid to another

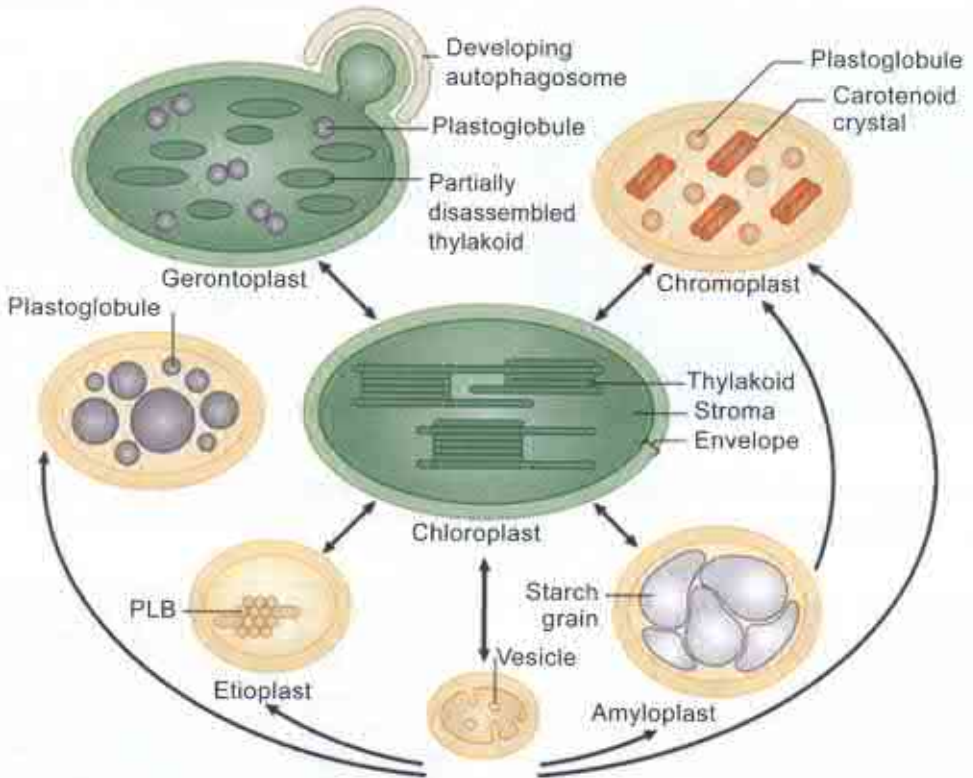


Fig. 25. Scheme of the plastid conversion

SUBJECTS FOR DISCUSSION:

1. Function of plastids.
2. Types of plastids.
3. What is proplastid?
4. What is chloroplast? Function. Location.
5. Ultrastructure of chloroplast.
6. What are plastoglobules, thylakoids, grana, and stroma?
7. What is chromoplast? Ultrastructure, function, location.
8. What is leucoplast? Ultrastructure, function, location.
9. Types of leucoplasts.
10. What is amyloplast? Location. Examples of plants.
11. What is protein (proteoplast)? Location. Examples of plants.
12. What is elaioplast? Location. Examples of plants.
13. What does plastid conversion mean?

1.4. ERGASTIC INCLUSIONS (CELL INCLUSIONS)

PRACTICAL WORK nr. 1. Starch grains

Starch grains are small granules found in cells of leaves, roots, rhizomes, tubers, bulbs, stems, fruits and seeds of plants.

The granules of starch differ:

- by size (about 2µm – rice grains; 5 and 100 µm – potato grains);
- shape (spherical, oval, polyhedral);
- position of hilum (centric, eccentric);
- mode of formation (simple, semicompound, compound).

Special chemical reaction: Iodine solution + starch → deep blue color

1.1. Potato starch grains – *Solani amyllum* (sp. *Solanum tuberosum*, fam. Solanaceae)

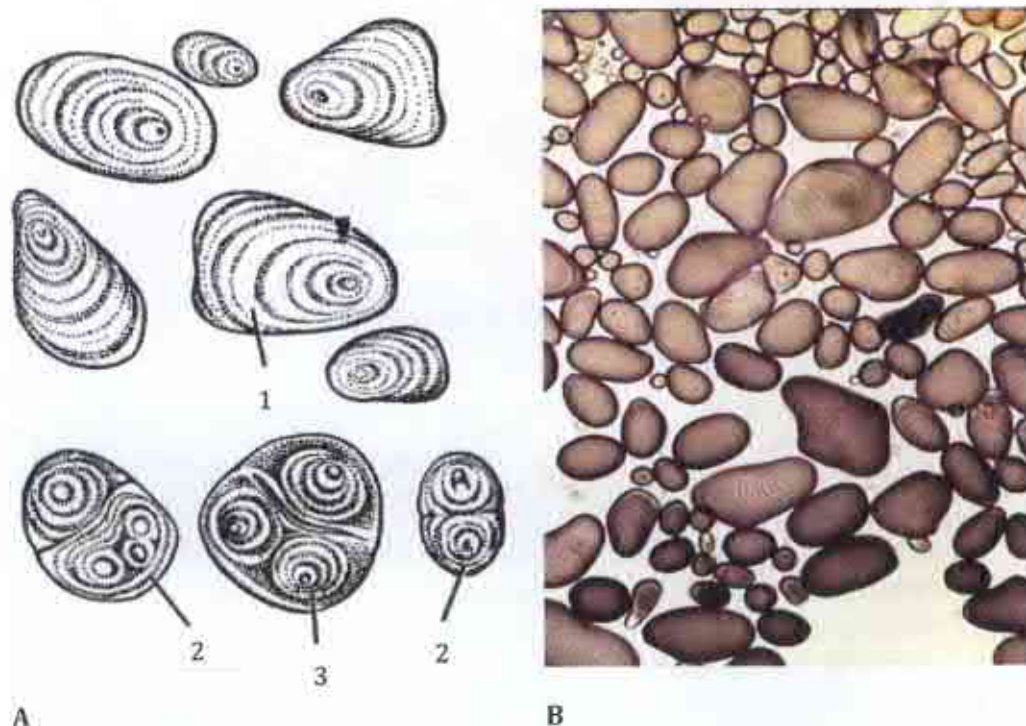
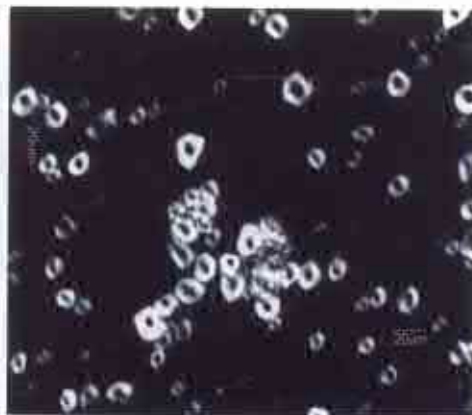
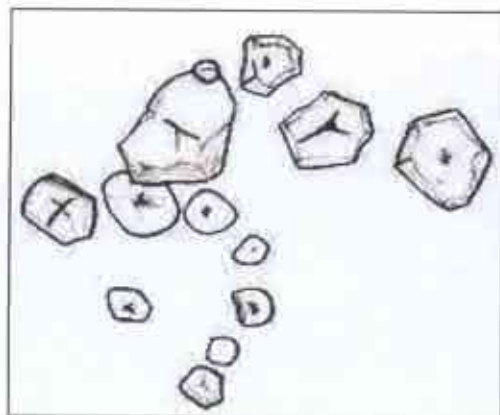


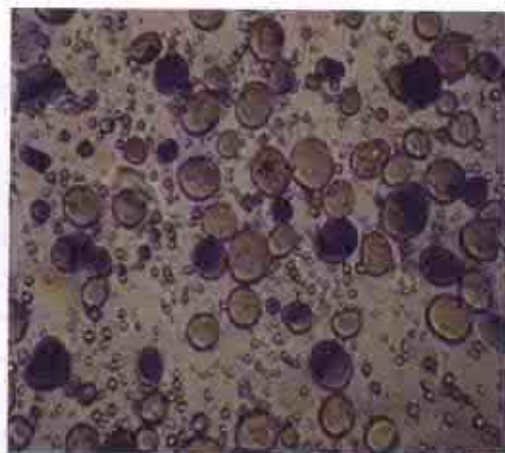
Fig. 26. Potato starch grains: A – scheme: 1 – oval, simple, and eccentric grains, 2, 3 – semicompound, and eccentric grains; B – oval, simple, and eccentric grains under microscope (40x), stained by iodine solution

1.2. Corn starch grains - *Maydis amyllum* (sp. *Zea mays*, fam. Poaceae)

A

B

Fig. 27. Corn starch grains: A - scheme of polyhedral, simple, and centric grains; B - image under microscope of polyhedral, simple, and centric grains (10x)

1.3. Wheat starch grains - *Tritici amyllum* (sp. *Triticum aestivum*, fam. Poaceae)

A

B

Fig. 28. Wheat starch grains (micrographs): A - non-stained, spherical, simple, and centric grains (10x); B - stained (with iodine solution), spherical, simple, and centric grains (40x)

1.4. Rice starch grains - Rice starch *Oryzae amyllum* (sp. *Oryza sativa*, fam. Poaceae)

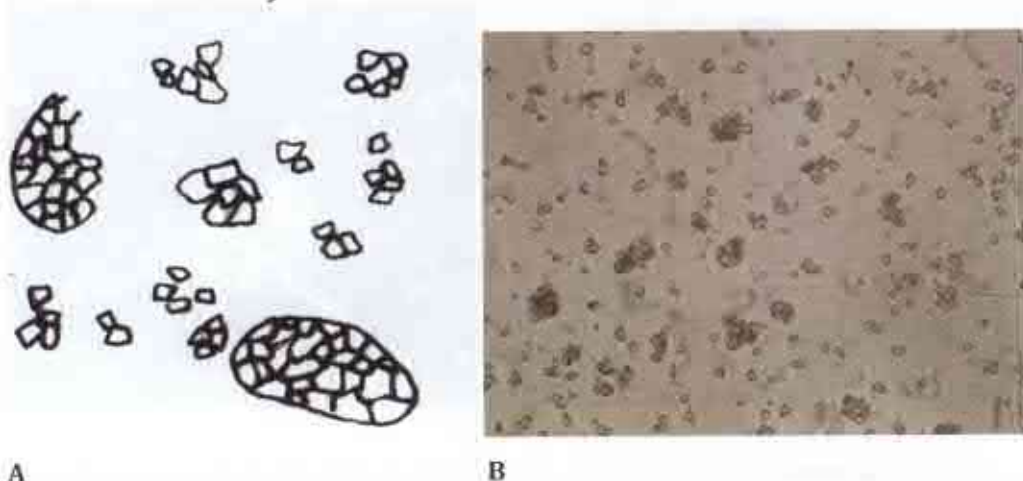


Fig. 29. Rice starch grains: A - polyhedral, compound, and centric grains (scheme); B - image under microscope of polyhedral, compound, and centric grains (10x)

1.5. Bean starch grains - (sp. *Phaseolus vulgaris*, fam. Fabaceae)

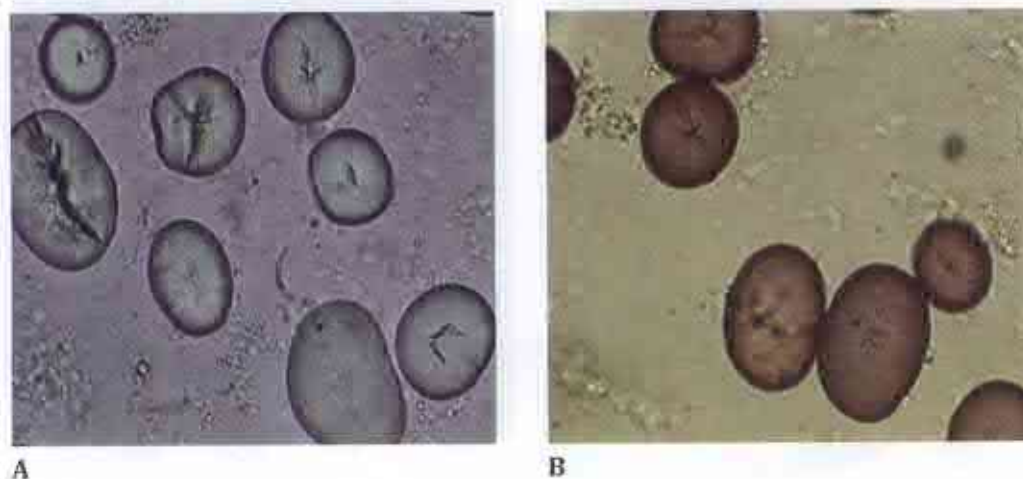


Fig. 30. Bean starch grains (micrographs, 40x): A - oval, simple, and centric grains; B - stained (with iodine solution), oval, simple, and centric grains

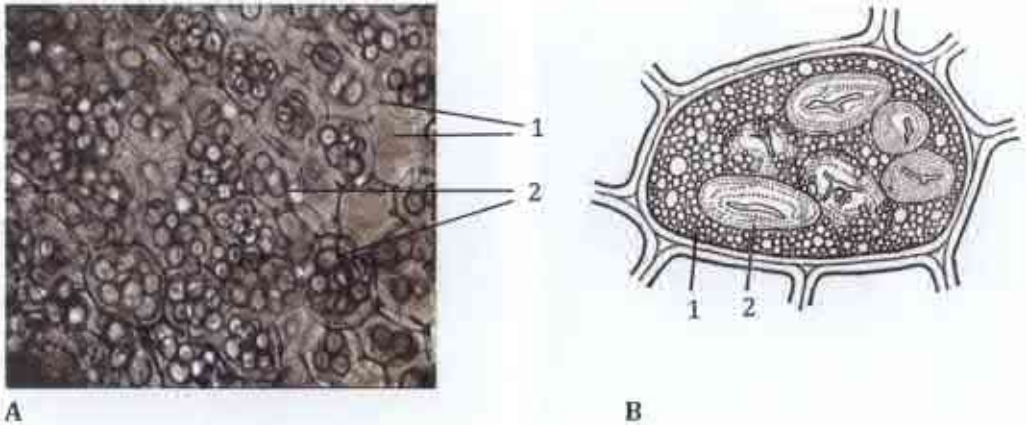
PRACTICAL WORK 2. Aleurone grains**2.1. Aleurone and starch grains in the Bean seed**

Fig. 31. Cells of the Bean *Phaseolus vulgaris* seed: A - cross section (micrograph, 10x); B - scheme of the Bean cell with starch and aleuronic grains: 1 - aleuronic grains, 2 - starch grains (oval and centric with branched hyllum)

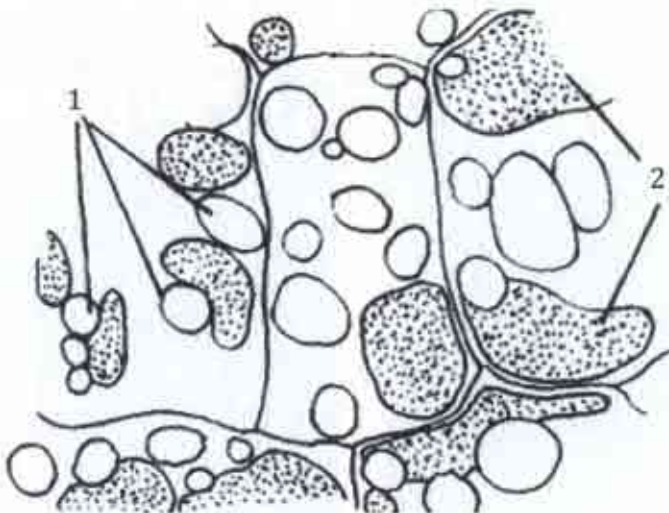
PRACTICAL WORK 3. Fatty oil globules**3.1. Fatty oil globules and aleuronic grains in Persian walnut seed**

Fig. 32. The cells of the Persian walnut *Juglans regia* seed (fam. Juglandaceae): 1 - aleuronic grains; 2 - fatty oil globules

PRACTICAL WORK 4. Latex channel

4.1. Latex channel in the Three-lobed beggarticks plant



Fig. 33. Laticifers (latex channels) in the Three-lobed beggarticks *Bidens tripartita* leaf (family Asteraceae)

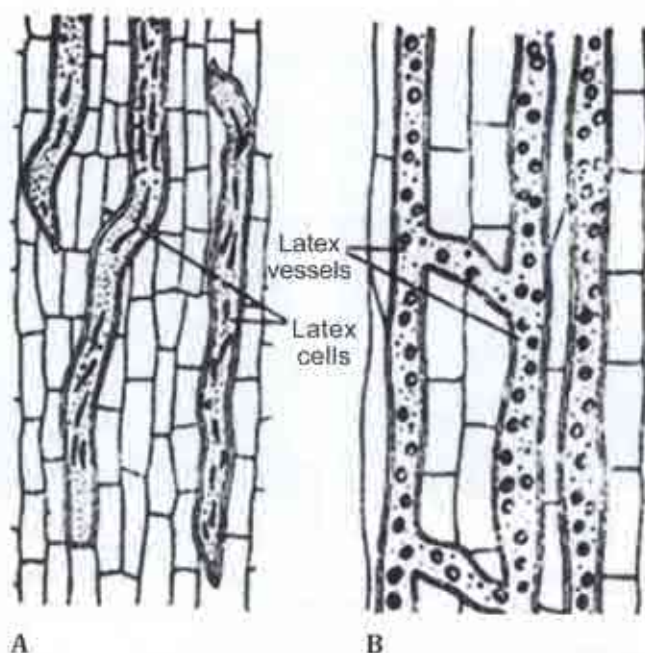


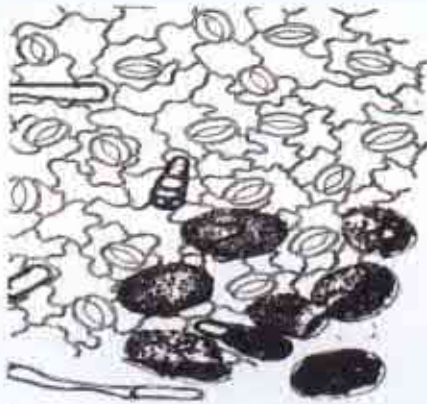
Fig. 34. Laticifers (latex vessels) in longitudinal sections: A - Non-articulated laticifers in the *Euphorbia* stem; B - Articulated in the *Carica* leaf

PRACTICAL WORK 5. Calcium oxalate crystals

Calcium oxalate crystals are of different types:

- ✓ octahedric,
- ✓ prismatic,
- ✓ cubic,
- ✓ needle-like,
- ✓ raphides,
- ✓ druse.

Calcium oxalate crystals represent good microscopic criteria to identify vegetable products and predict medicinal plants.

5.1. Crystalline sand of calcium oxalate

A



B

Fig. 35. Sacs with crystalline sand of calcium oxalate in the leaf of *Belladonna Atropa belladonna*, fam. Solanaceae: A – scheme; B – micrograph (10x)

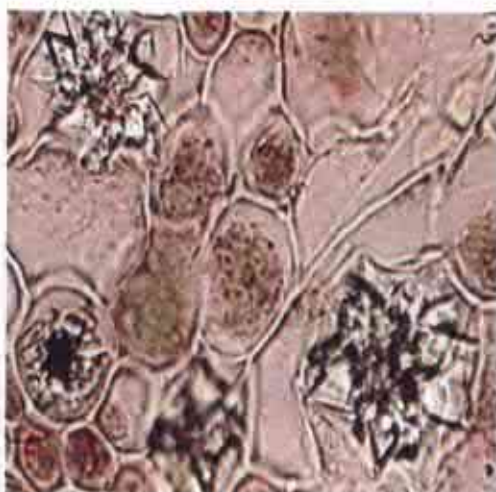
5.2. Calcium oxalate as druse

10x



40x

Fig. 36. Druse of calcium oxalate in the root of Marshmallow *Althaea officinalis*, fam. Malvaceae



A

B

Fig. 37. Druses of calcium oxalate in the leaves of: A – Persian walnut *Juglas regia*, fam. Juglandaceae (40x); B – Common mallow *Malva sylvestris*, fam. Malvaceae (10x)

5.3. Druses and different geometrical forms of calcium oxalate crystals



10x



40x

Fig. 38. Cells with polygonal crystals as a sheath of vascular bundles and with druses in the leaf mesophyll of Silver birch *Betula pendula*, fam. Betulaceae

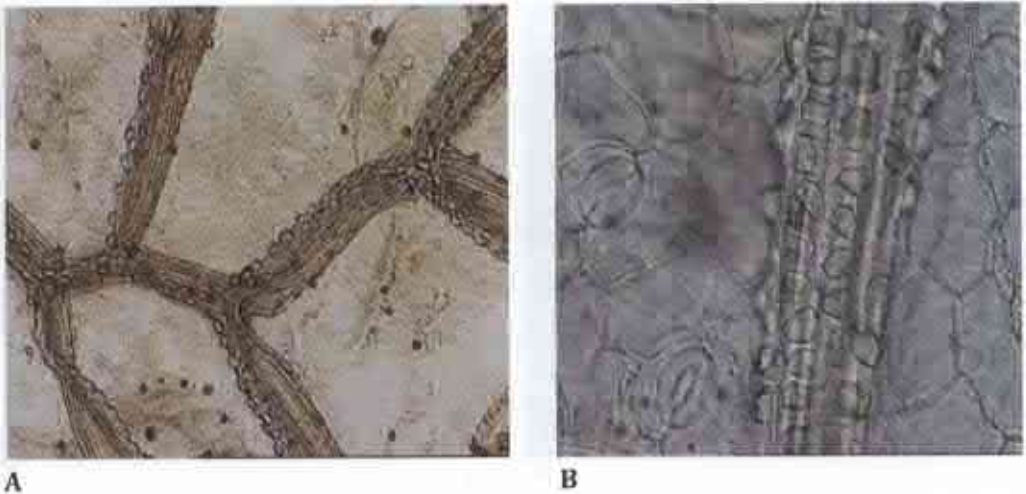


Fig. 39. Superficial leaf preparation: **A** – Cells with diffuse druses and polygonal crystals as a sheath of vascular bundle in the leaf of Silver poplar *Populus alba*, fam. Salicaceae (10x); **B** – Cells with geometrical crystals as a sheath of vascular bundle in the leaf of Indian senna *Cassia acutifolia*, fam. Fabaceae (40x)

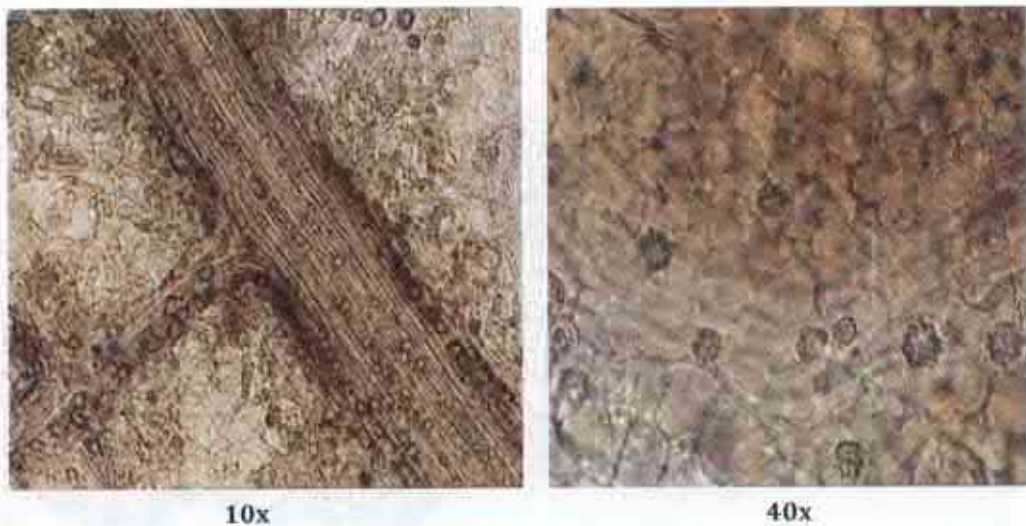


Fig. 40. Cells with polygonal calcium oxalate crystals as a sheath of vascular bundle and with druses of calcium oxalate in the leaf mesophyll of Silver birch *Betula pendula*, fam. Betulaceae

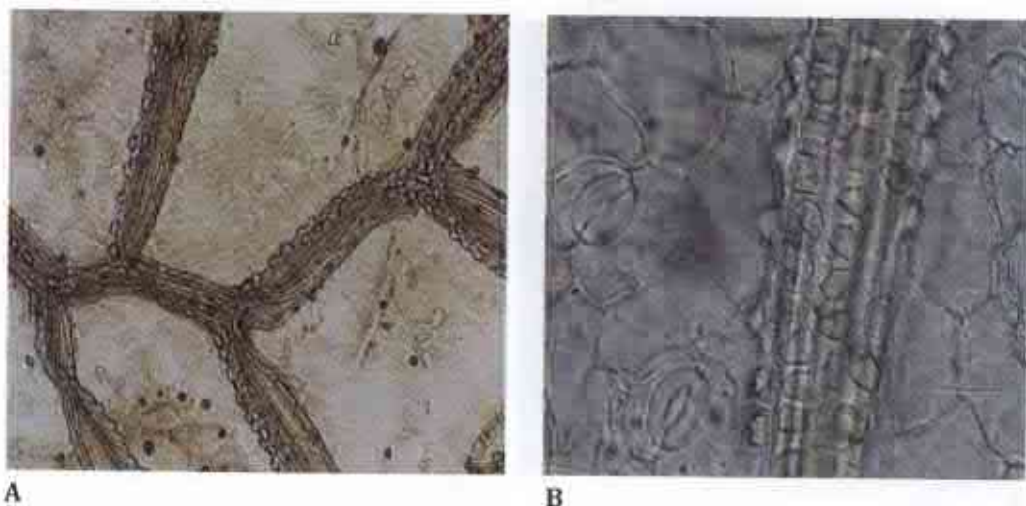


Fig. 41. Cells with calcium oxalate crystals: A – druses and polygonal crystals as a sheath of vascular bundles in the leaf of Silver poplar *Populus alba*, fam. Salicaceae (10x); B – Cells with geometrical calcium oxalate crystals as a sheath of vascular bundles in the leaf of Indian senna *Cassia acutifolia*, fam. Fabaceae (40x)

5.4. Needle-like calcium oxalate crystals and raphides

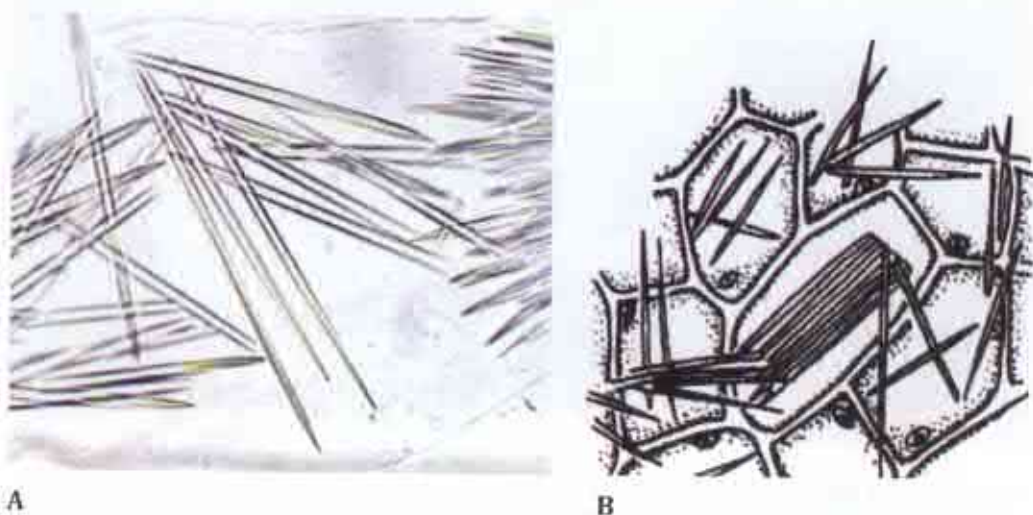


Fig. 42. Needle-like and raphides crystals of calcium oxalate in the Aloe *Aloe vera* leaf, fam. Liliaceae: A – micrograph; B – scheme

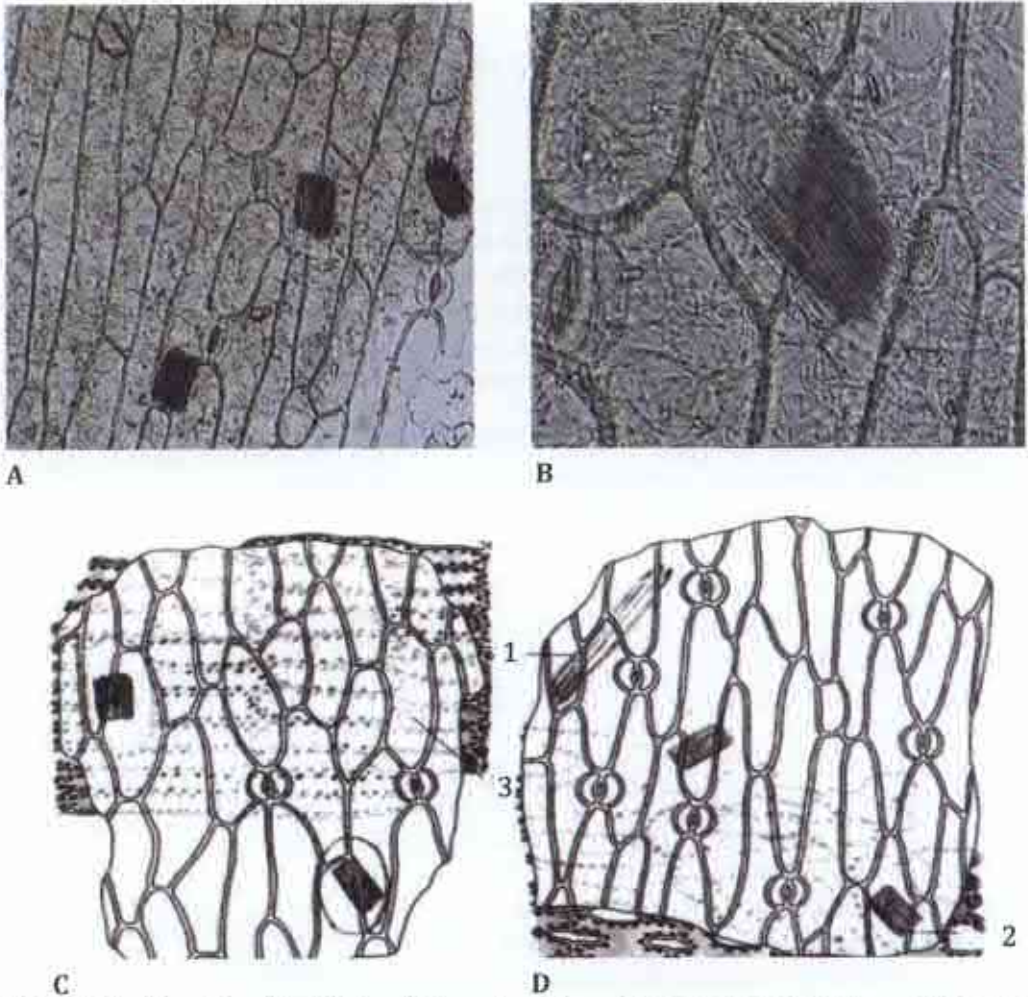


Fig. 43. Epidermis cells of Lily of the valley *Convallaria majalis* leaf, fam. Liliaceae:
 A - micrograph (10x); B - micrograph (40x); C - scheme of upper epidermis;
 D - scheme of lower epidermis: 1 - needle-like crystals, 2 - raphides, 3 - cytoplasm

SUBJECTS FOR DISCUSSION

1. What is ergastic inclusion?
2. Where are ergastic inclusions located?
3. Types of ergastic inclusions according to chemical nature.
4. Characteristics of starch grains (size, mode of formation, shape).
5. Natural sources of starch in pharmaceutical industry.
6. Special chemical reaction to identify starch grains.
7. Characteristics of aleurone grains.
8. Plant organs with a high content of aleurone.

9. Differences between fatty oils and volatile oils.
10. Plant organs as a source of fatty oils.
11. What is latex?
12. Plants with laticifers.
13. Inorganic ergastic inclusions.
14. Types of oxalate crystals in the vacuole.
15. Examples of different types of oxalate crystals in medicinal plants.
16. Biological role of organic ergastic inclusions.
17. Economic role of organic ergastic inclusions.
18. The role of ergastic inclusions in pharmacognostical diagnostic of vegetable drugs and medicinal plants.

SUBJECTS FOR THE TEST ON „VEGETAL CYTOLOGY”

1. Optic component parts of the light microscope.
2. Mechanical parts of the light microscope.
3. Working rules for the optical light microscope.
4. Laboratory apparatus and utensils.
5. Micropreparations, their types, and preparation.
6. Notion of cell.
7. Shapes of vegetal cells.
8. Size of cells.
9. Classification of cells according to their shapes.
10. Living constituents of the vegetal cell.
11. Non-living constituents of the vegetal cell.
12. Special structures of vegetal cells.
13. The structure of eukaryotic cell.
14. The structure of prokaryotic cell.
15. Cell wall. Functions. Types of cell wall.
16. Types of secondary modifications of cell wall.
17. Vacuole. Functions. Vacuole.
18. Ergastic or cell inclusions. Definition. Role.
19. Different types of cell inclusions (starch and aleuronic grains, fatty globules, latex, calcium oxalate crystals).
20. Plastids. Functions. Types of plastids, functions, location.
21. Membrane organelles: endoplasmic reticulum, Golgi body, lysosomes (structure and functions).
22. Double membrane organelles: mitochondria and nuclei (structure and functions).
23. Amembrane organelles – ribosomes (structure and function).
24. Cell division: amitosis, mitosis and meiosis.
25. Cell structures with diagnostic role to identify vegetable products.

TEST SAMPLES

- 1) s.c. Choose the organelle surrounded by tonoplast:
 - a) plastids;
 - b) Golgi body;
 - c) nucleus;
 - d) vacuole;
 - e) endoplasmic reticulum.
- 2) s.c. Choose solid organic ergastic inclusion:
 - a) volatile oils;
 - b) calcium oxalate crystals
 - c) calcium carbonate;
 - d) latex;
 - e) fatty oils.
- 3) s.c. Choose the organelle which is formed from proplastid:
 - a) mitochondrium;
 - b) ribosome;
 - c) vacuole;
 - d) dictyosome;
 - e) plastid.
- 4) s.c. Raphide is characteristic of:
 - a) *Althaea officinalis*;
 - b) *Atropa belladonna*;
 - c) *Convallaria majalis*;
 - d) *Populus nigra*;
 - e) *Senna acutifolia*.
- 5) s.c. Sand calcium oxalate is characteristic of species from the family:
 - a) Liliaceae;
 - b) Fabaceae;
 - c) Rosaceae;
 - d) Solanaceae;
 - e) Asteraceae.
- 6) m.c. Choose the organelles with double membrane:
 - a) plastids;
 - b) endoplasmic reticulum;
 - c) mitochondria;
 - d) nucleus;
 - e) Golgi body.
- 7) m. c. Choose organelles with unitary membrane:
 - a) Mitochondrium;
 - b) Lysosome;
 - c) Vacuole;
 - d) Endoplasmic reticulum;
 - e) Golgi body.
- 8) m. c. The functions of cell wall are:
 - a) protective
 - b) secretory;
 - c) transporting;
 - d) gas change;
 - e) assimilation.
- 9) m.c. Choose the fruits which contain chromoplasts:
 - a) Plum
 - b) Hawthorn;
 - c) Dog rose;
 - d) Mountain ash;
 - e) Tomato.
- 10) m.c. Choose the types of starch grains according to hilum position:
 - a) simple;
 - b) semicompound;
 - c) excentric;
 - d) compound;
 - e) centric.

Chapter 2. VEGETAL HISTOLOGY

2.1. PROTECTIVE TISSUE

PRACTICAL WORK nr. 1. Structure of epidermis

1.1. Epidermis of Monocot plants

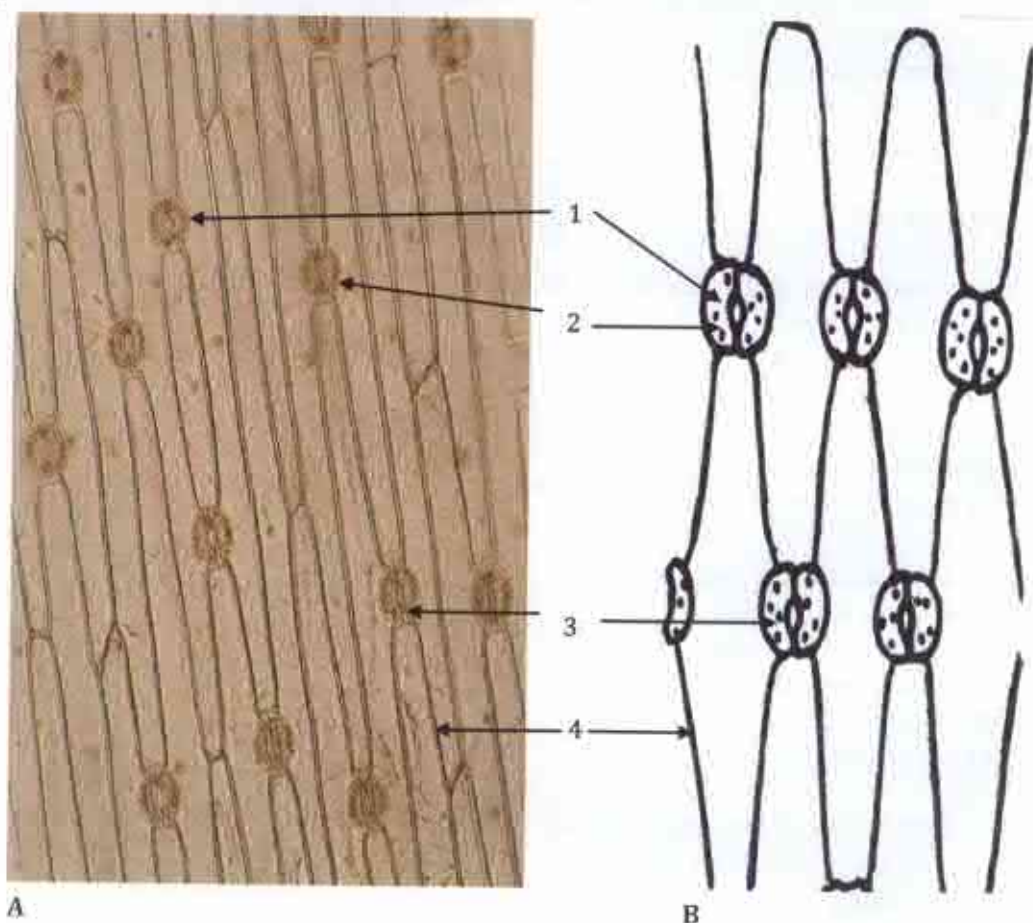


Fig. 44. Epidermis of the Iris *Iris germanica* leaf: A - micrograph (10x); B - scheme:
1 - stomata; 2 - guard cells; 3 - chloroplasts; 4 - straight cell wall

1.2. Epidermis of Dicot plants

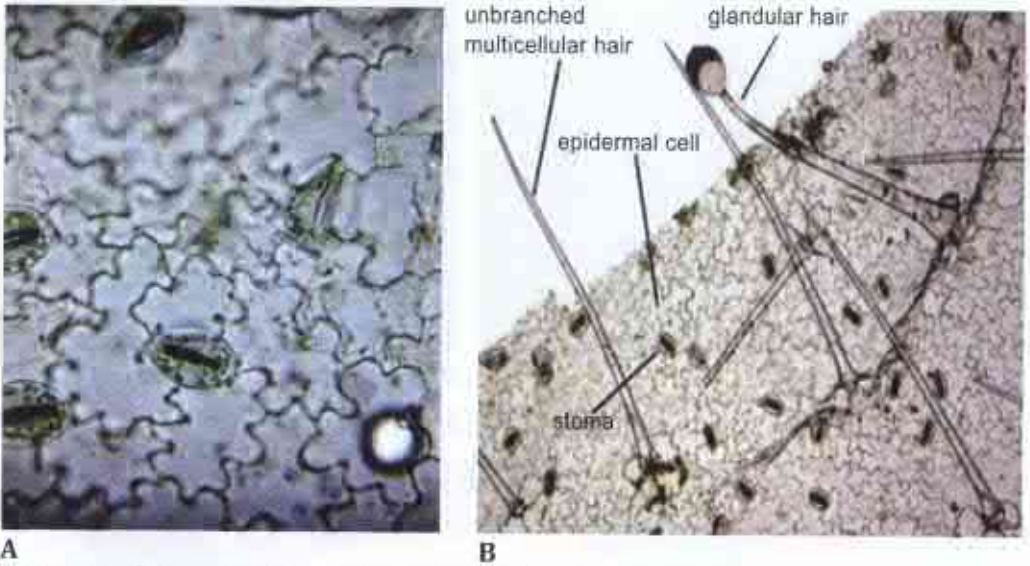


Fig. 45. Epidermis of the *Pelargonium* *Pelargonium zonale* leaf: A (40x); B (10x)

PRACTICAL WORK 2. Types of stomata

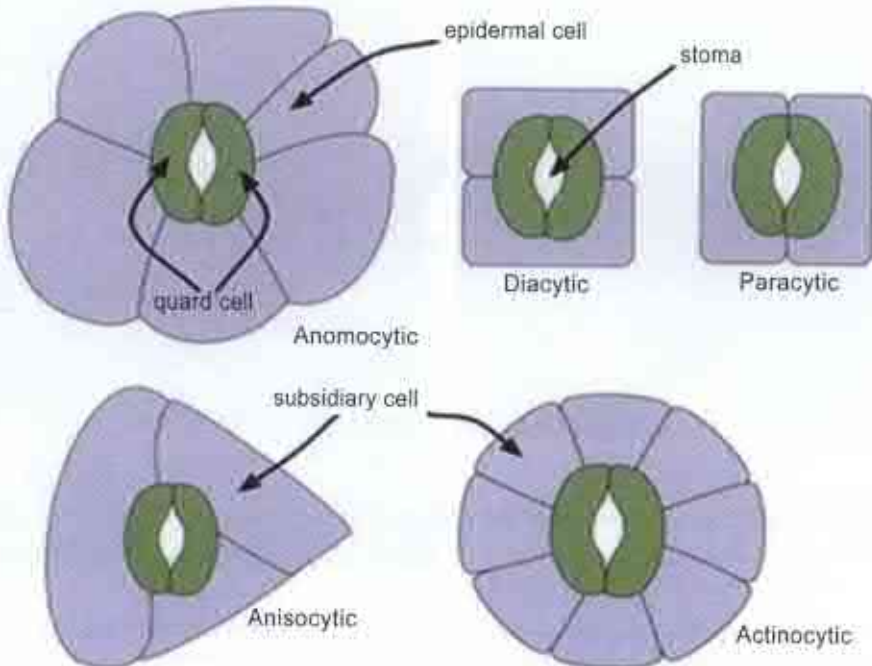


Fig. 46. The most common types of stomata

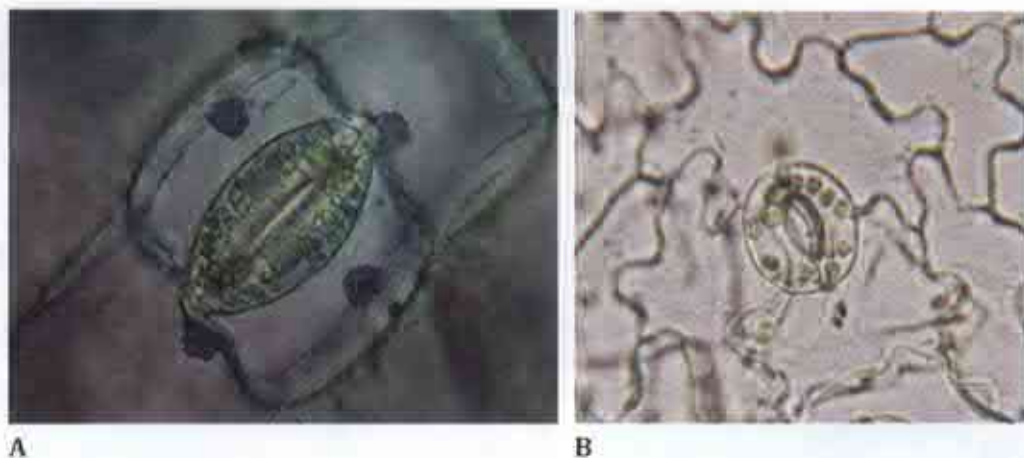


Fig. 47. Different types of stomata: A – paracytic stomata on *Tradescantia* sp. Leaf (60x); B – anisocytic stomata on Shape's pears *Capsella bursa-pastoris* leaf (40x)

PRACTICAL WORK 3. Types of trichomes on some medicinal plants

3.1. Unicellular trichomes

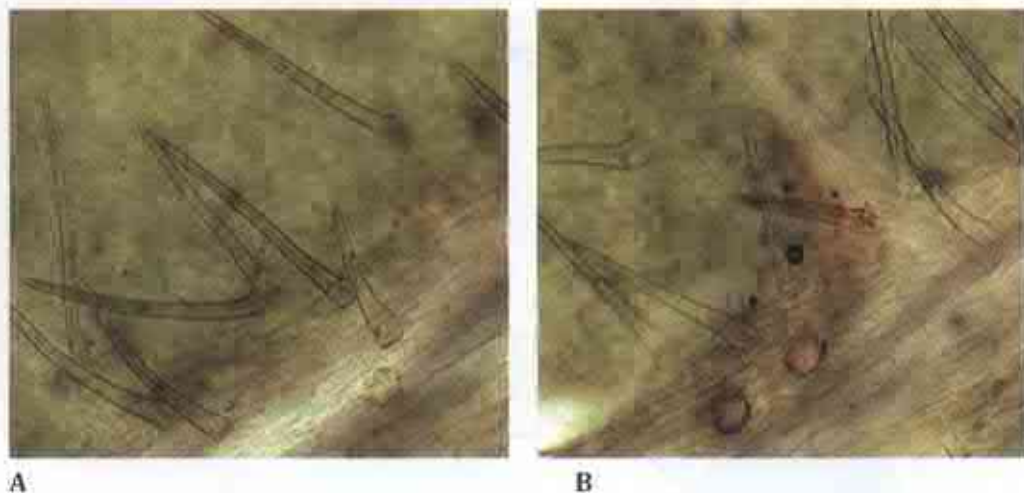
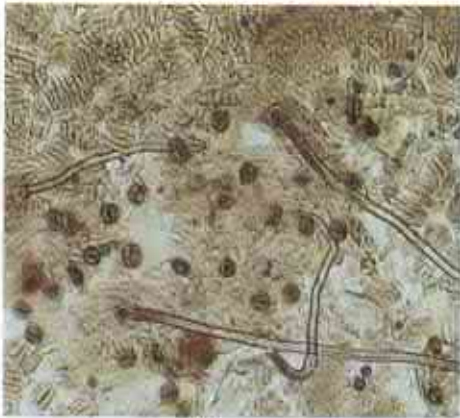


Fig. 48. Unicellular trichomes of the Guelder-rose *Viburnum opulus* leaf (40x)



10x



40x

Fig. 49. Unicellular trichomes of the Black alder *Alnus glutinosa* leaf

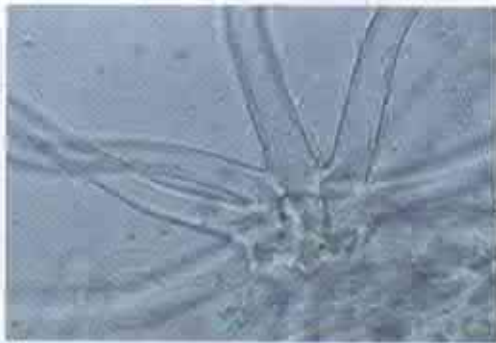
3.2. Unicellular trichomes in a bunch



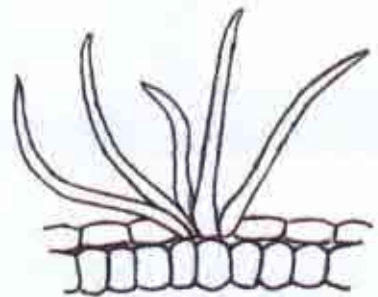
A



B



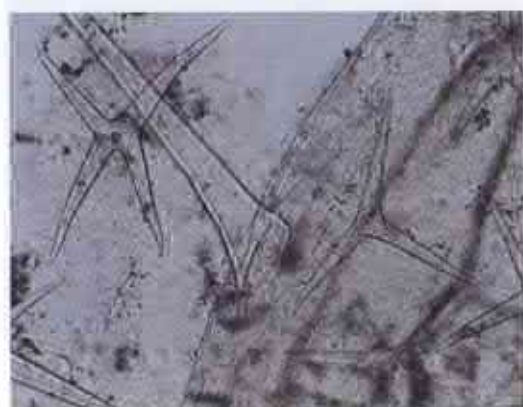
C



D

Fig. 50. Unicellular trichomes in a bunch on the Common mallow *Malva sylvestris* plant: A - on the stem (10x); B - on the leaf (above view, 40x); C - on the leaf (view from side, 40x); D - scheme

3.3. Unicellular, simple and branched trichomes



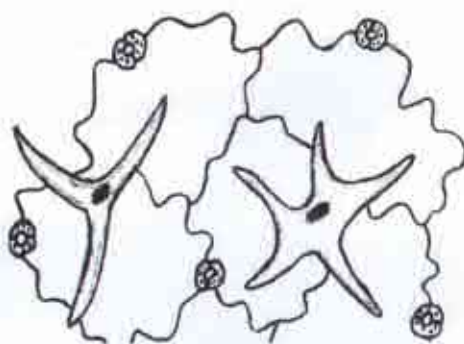
A



B



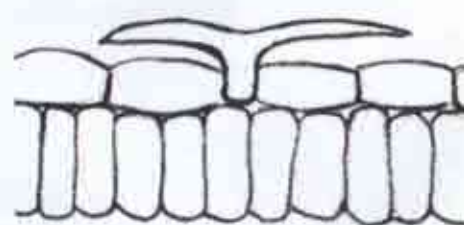
C



D



E



D

Fig. 51. Unicellular trichomes of the Shepherd's purse *Capsella bursa-pastoris* plant: A. – simple, unicellular and 3,4-branched trichomes (40x); B. – unicellular, branched, and stellate (star-like) trichomes (40x); C (40x), D (scheme) – unicellular star-like trichomes with 3- and 4-branches; E, F. (scheme) – T-like trichome

3.4. Multicellular, unbranched trichomes



10x



40x

Fig. 52. Multicellular trichomes on the Tancy *Tanacetum vulgare* leaves



Fig. 53. Multicellular trichomes on the Horse-heal *Inula helenium* leaves (10x)

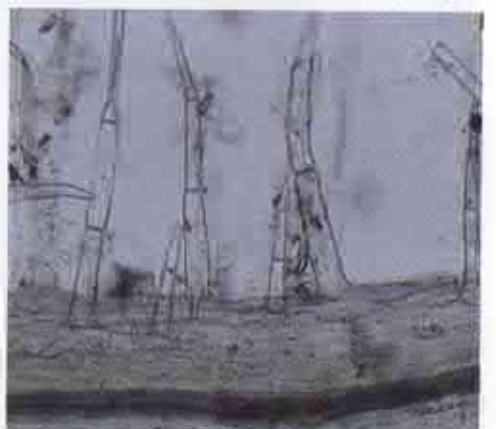
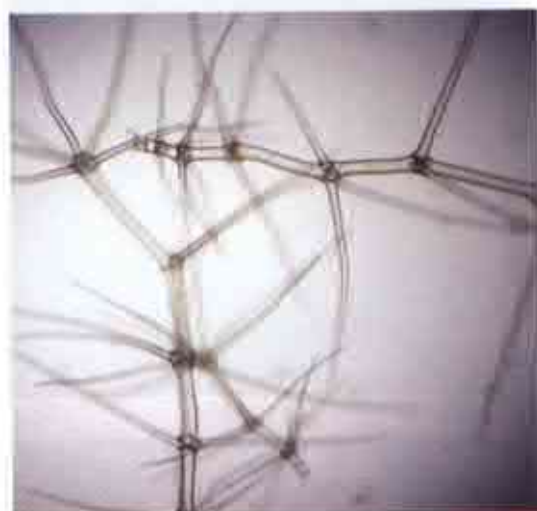


Fig. 54. Multicellular trichomes on the Foxglove *Digitalis purpurea* leaves (40x)

3.5. Multicellular, branched trichomes as a candelabra



A

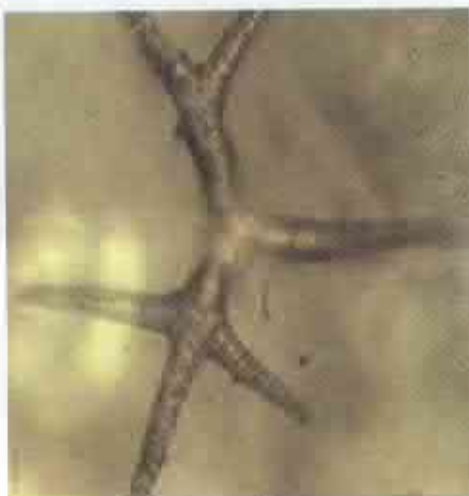


B

*Fig. 55. Multicellular and branched trichomes on the Mullein *Verbascum thapsus* leaves: A - micrograph (40x); B - scheme*



10x



40x

*Fig. 56. Multicellular and branched trichomes on the Lavender *Lavandula vera* leaves*

3.6. Multicellular peltate (star-like) trichomes

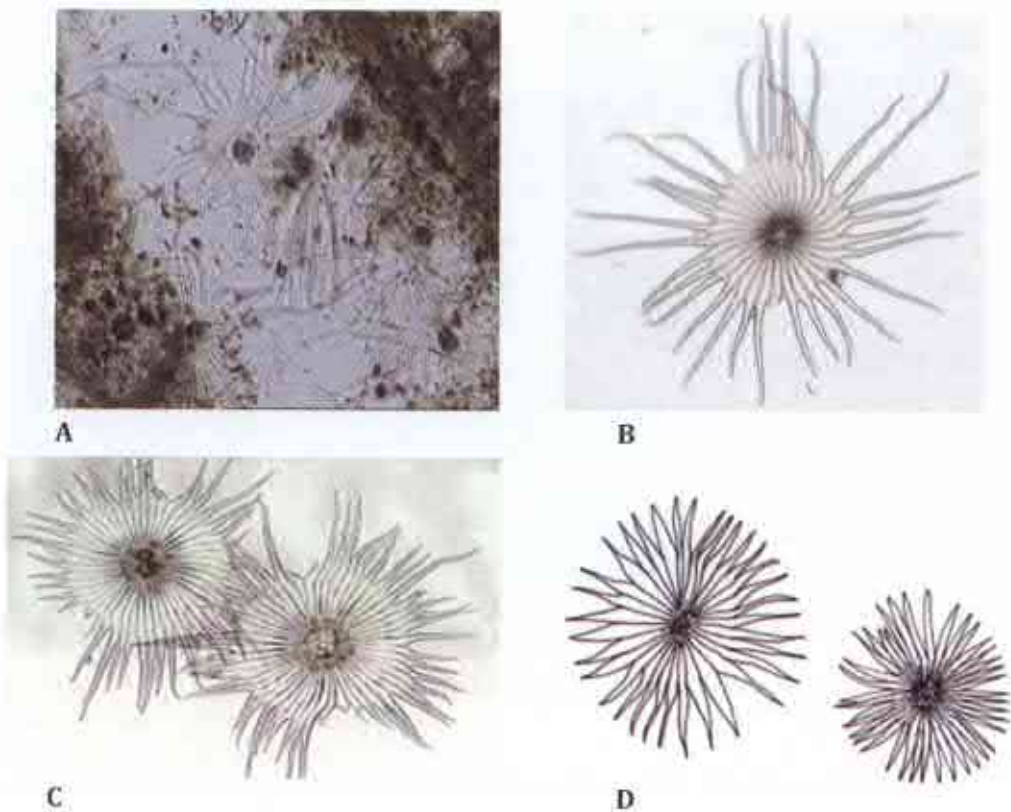


Fig. 57. Multicellular and star-like trichomes on the Sea-buckthorn *Hippophae rhamnoides* leaves: A (10x), B (40x), C (40x) – microscope view; D – scheme

SUBJECTS FOR DISCUSSION:

1. What is tissue?
2. Types of tissues according to their origin.
3. Types of permanent tissues according to their functions.
4. The main characteristics of meristematic tissues.
5. Types of meristematic tissues according to their origin.
6. Types of meristematic tissues according to their location in the plant.
7. Types of protective tissue according to their origin.
8. Types of primary protective tissue.
9. What is epidermis?

10. The main characteristics of epidermis.
11. Special epidermis structures.
12. What is stomata?
13. Structure of stomata.
14. Criteria to determine the type of stomata.
15. Distribution of stomata in Monocot and Dicot plants.
16. What is trichome?
17. Kinds of trichomes according to their functions.
18. Criteria to determine the type of trichome.
19. Examples of different kinds of trichomes in Medicinal plants.
20. What is epiblema?
21. Types of secondary protective tissue.
22. How is periderma formed? What is lenticel?
23. What is rhytidome?
24. The role of periderma and rhytidome.
25. Protective structures with diagnostic role in vegetable product identification.

2.2. GROUND OR FUNDAMENTAL PARENCHYMA (TISSUE)

PRACTICAL WORK nr. 1. Assimilation ground (parenchyma) tissue

1.1. Assimilation parenchyma in the Lilac lamina of leaf

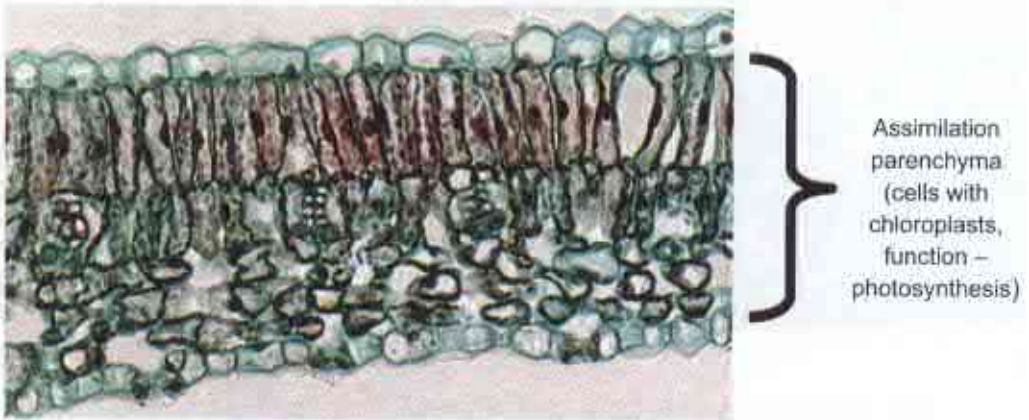


Fig. 58. Cross section of the Lilac *Syringa vulgaris* leaf

1.2. Assimilation parenchyma in the Oleander lamina of leaf

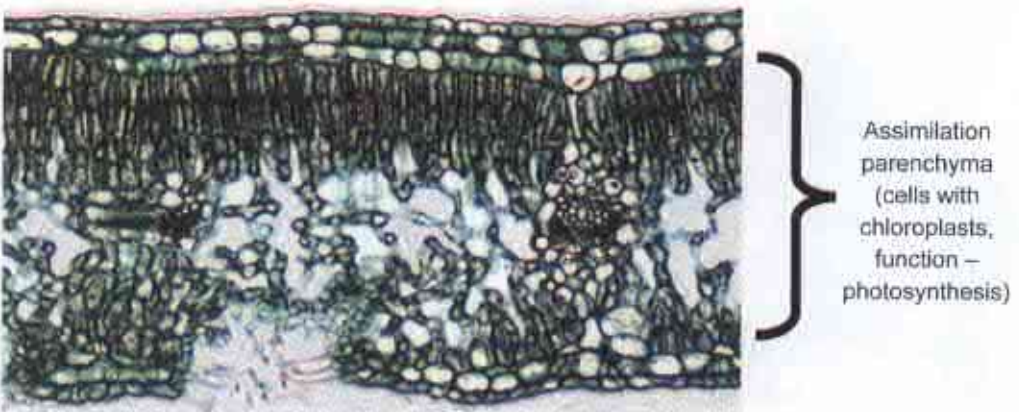


Fig. 59. Cross section of Oleander *Nerium oleander* leaf

PRACTICAL WORK nr. 2. Storage ground (parenchyma) tissue

2.1. Storage parenchyma in the Bean seed

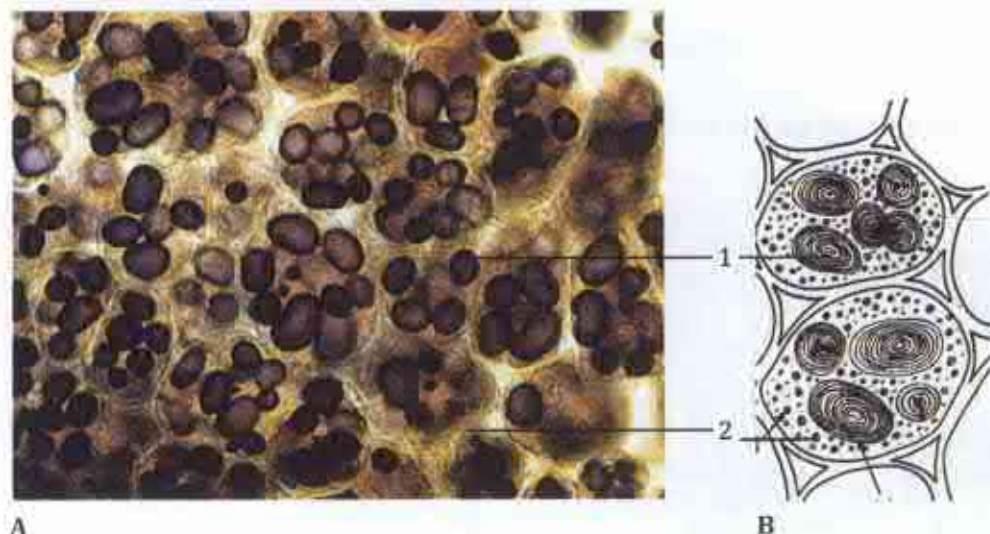


Fig. 60. Storage parenchyma cells of Bean *Phaseolus vulgaris* seed:
A - micrograph, 40x; B - scheme: 1 - starch grains; 2 - aleuronic grains

2.2. Storage parenchyma in the Potato tuber

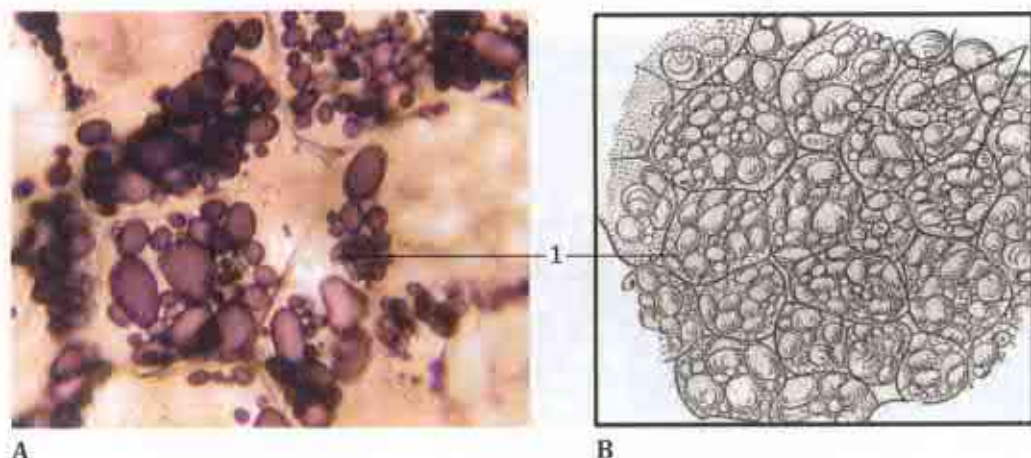
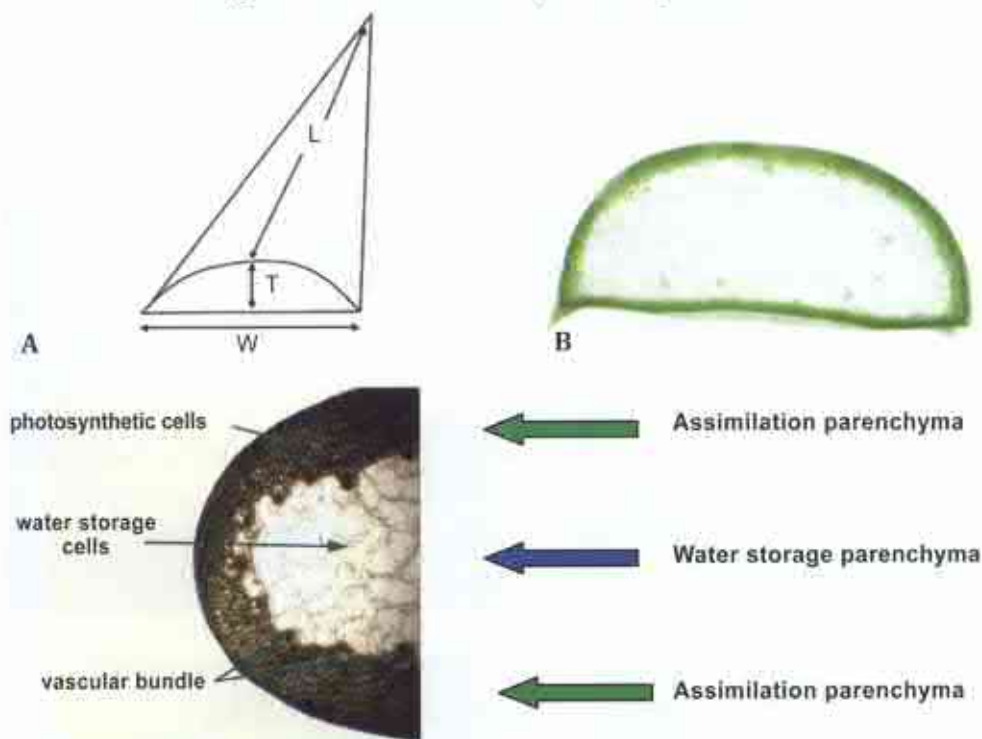


Fig. 61. Storage parenchyma cells of the Potato *Solanum tuberosum* tuber:
A - micrograph (40x); B - (scheme) 1 - starch grains

PRACTICAL WORK nr. 3. Water storage and assimilation parenchyma

3.1. Water storage and assimilation parenchyma in Aloe leaf



C Fig. 62. Aloe *Aloe vera* leaf: A – directions of sections; B – cross section of leaf; C – anatomy structure of the leaf on cross section

PRACTICAL WORK nr. 4. Aerenchyma – air storage parenchyma

4.1. Aerenchyma in the rhizome of Sweet flag

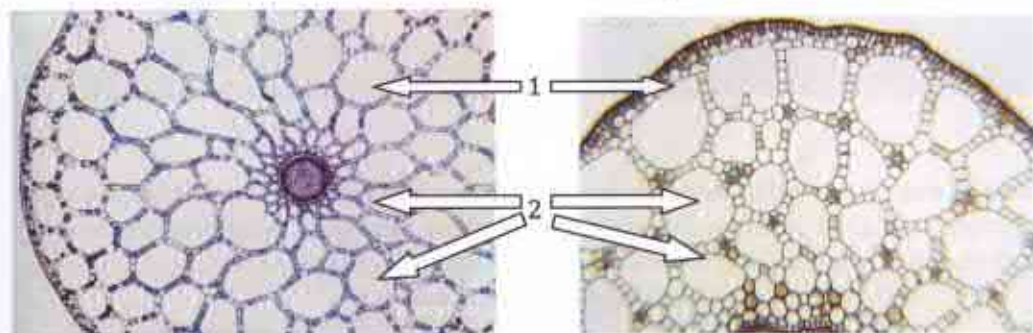


Fig. 63. Cross section of the Sweet flag *Acorus calamus* rhizome: 1 – large intercellular space; 2 – aerenchyma (air system)

SUBJECTS FOR DISCUSSION:

1. What is ground or fundamental parenchyma tissue?
2. Functions of ground parenchyma.
3. Location of ground parenchyma in plant organs.
4. Kinds of ground parenchyma.
5. What is assimilation parenchyma?
6. Location of the assimilation parenchyma in plants.
7. Function of assimilation parenchyma.
8. What is storage parenchyma?
9. Types of storage parenchyma according to chemical nature of storage substances.
10. What is storage parenchyma with nutritive substances? Location. The biological role.
11. Examples of medicinal plants with well developed storage parenchyma with nutritive substances.
12. What is water storage parenchyma? Location. Role.
13. Examples of plants with well developed water storage parenchyma.
14. What is aerenchyma? Location. Role.
15. Examples of plants with well developed water storage parenchyma.

2.3. MECHANICAL AND VASCULAR TISSUES

PRACTICAL WORK nr. 1. Mechanical tissues

1.1. Collenchyma in the White dead nettle stem

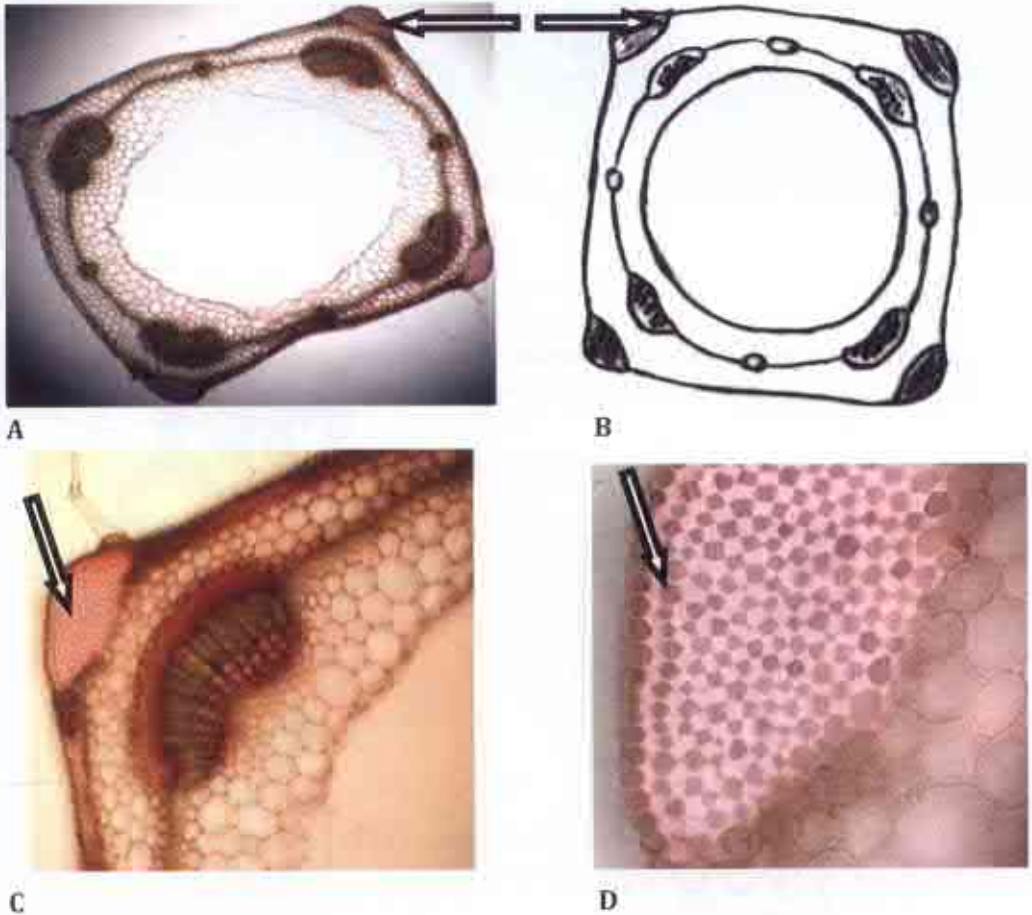
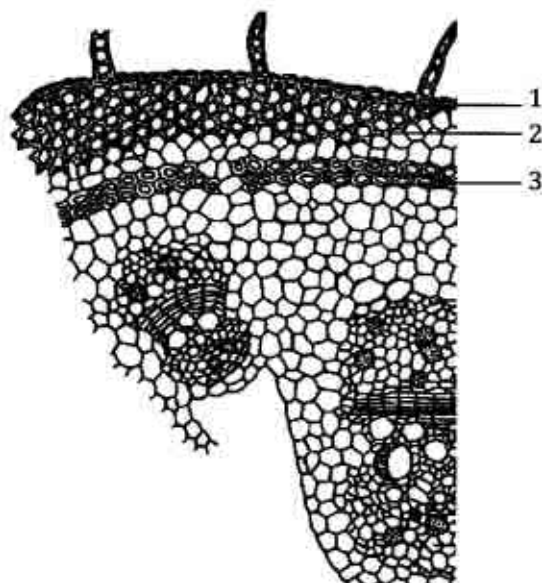


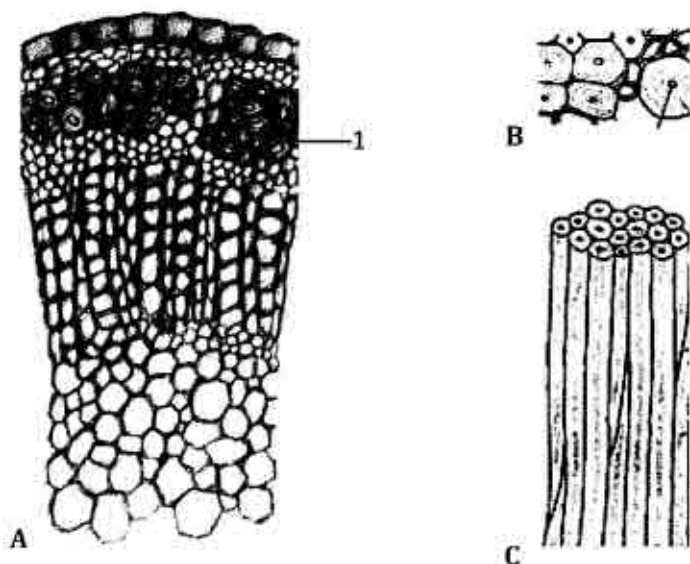
Fig. 64. Angular collenchyma in the corner of square stem of the White dead nettle *Lamium album* plant: A – cross section of the stem (micrograph, 10x); B – scheme; C – collenchyma in the corner of the stem (micrograph 60x); D – angular collenchyma (arrows), (micrograph, 100x)

1.2. Lignified sclerenchyma in the Pumpkin stem



*Fig. 65. Cross section of the Pumpkin *Cucurbita pepo* stem: 1 – epidermis; 2 – colenchyma; 3 – sclerenchyma with lignified cell walls*

1.3. Cellulose sclerenchyma in the Flax stem



*Fig. 66. Stem of Flax *Linum usitatissimum*: A – cross section of the stem, 1 – cellulose sclerenchyma; B – cellulose sclerenchyma in the cross section; C – longitudinal cellulose sclerenchyma (fibres)*

1.4. Sclereids in the Pear fruit

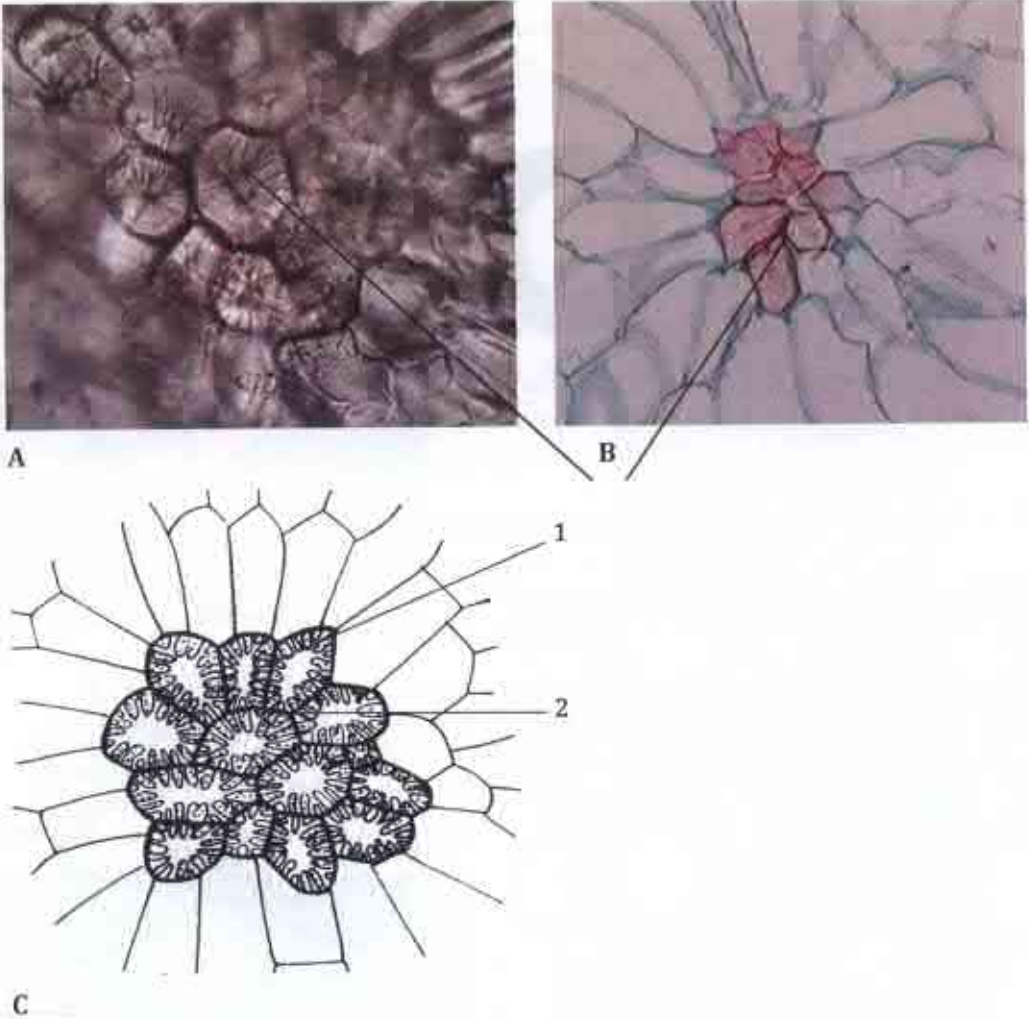


Fig. 67. Sclereids in the Pear *Pirus communis* fruit: **A** – micrograph (40x), **B** – micrograph (10x), **C** – scheme: **1** – group of sclereids; **2** – thickened cell wall

PRACTICAL WORK nr. 2. Types of vascular bundles

2.1. Different types of vascular bundles

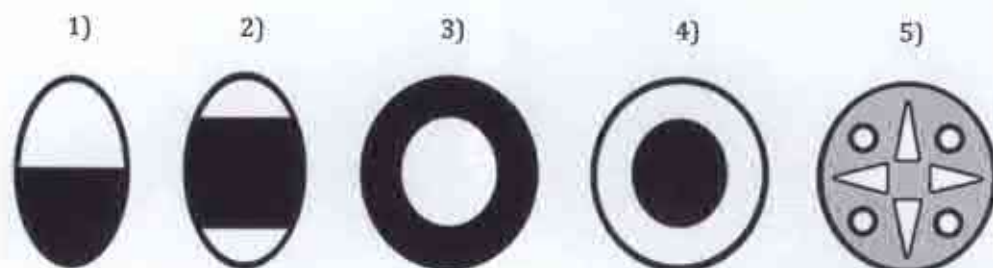
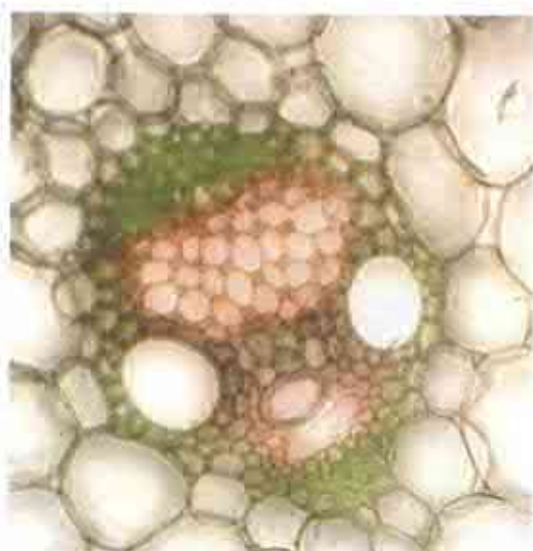
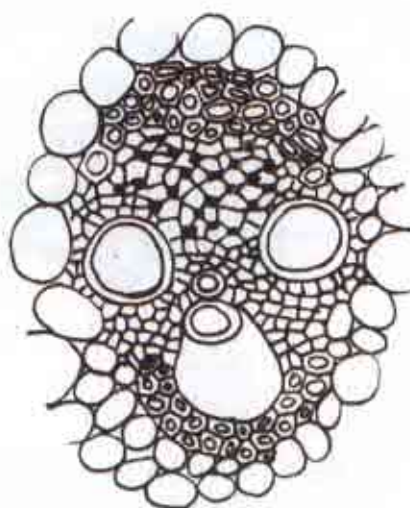


Fig. 68. The scheme of different types of vascular bundles: 1 – collateral, 2 – bicollateral, 3 – concentric leptocentric, 4 – concentric hadrocentric, 5 – radial (for roots)

2.2. Conjoint closed collateral vascular bundle



A



B

Fig. 69. Fragment of cross section of the Corn *Zea mays* stem:

A - micrograph of closed collateral vascular bundle; B - scheme of closed collateral vascular bundle

2.3. Closed collateral and concentric vascular bundles

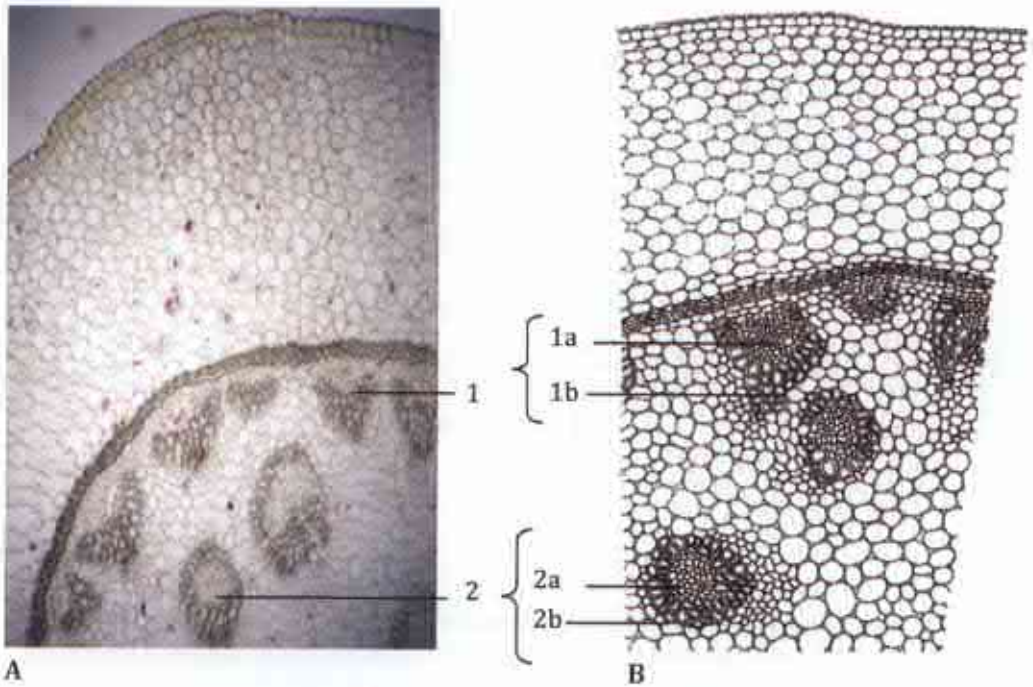


Fig. 70. Cross section of Lily of the Valley *Convallaria mayalis* rhizome:
A – micrograph (40x); **B** – scheme: **1** – collateral vascular bundle, **1a** – phloem,
1b – xylem; **2** – concentric vascular bundle, **2a** – phloem, **2b** – xylem

2.4. Concentric vascular bundle

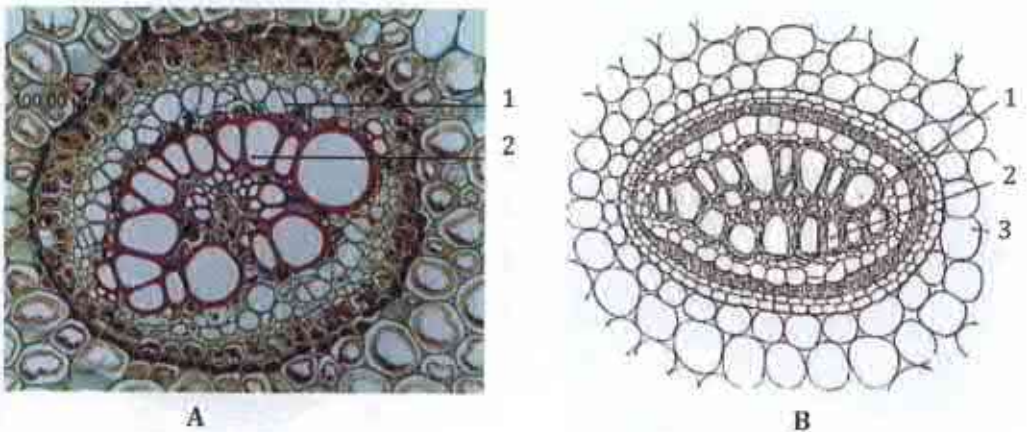


Fig. 71. Cross section of Common fern *Pteridium vulgare* rhizome:
A – micrograph of concentric vascular bundle; **B** – scheme of concentric vascular
 bundle: **1** – phloem, **2** – xylem, **3** – parenchyma

2.5. Open collateral vascular bundle

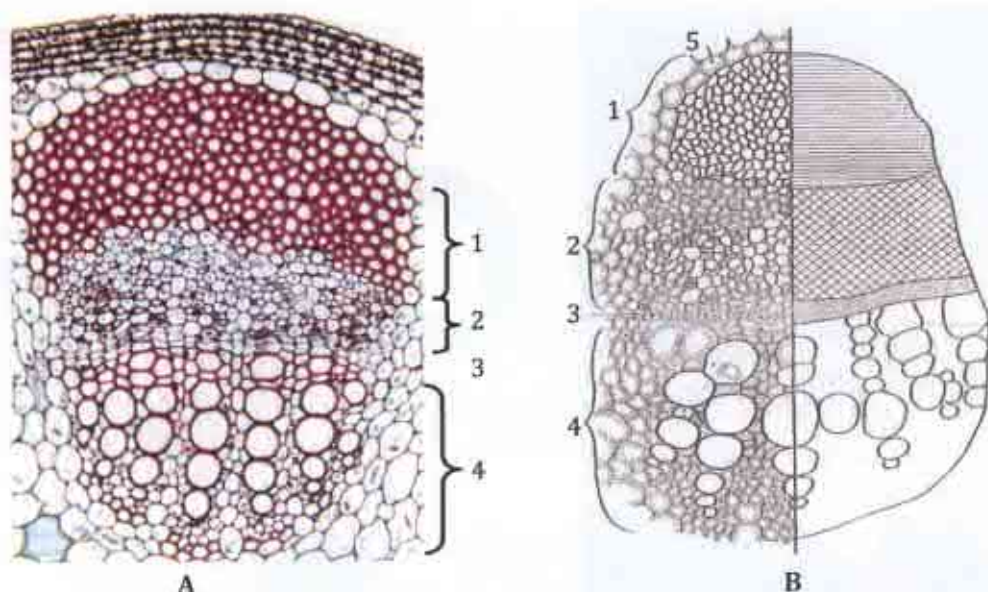


Fig. 72. Open collateral vascular bundles: A – in French marigold *Tagetes patula* stem; B – in Sunflower *Helianthus annuus* stem: 1 – sclerenchyma sheath, 2 – phloem, 3 – cambium (meristematic tissue), 4 – xylem.

2.6. Bicollateral vascular bundle

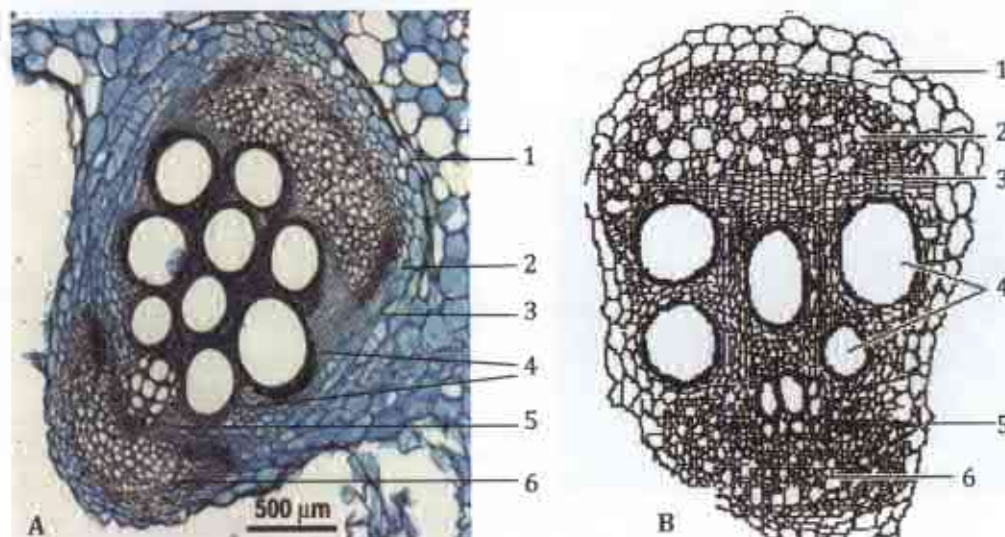


Fig. 73. Bicollateral vascular bundle in the Pumpkin *Cucurbita pepo* stem: A – micrograph; B – scheme: 1 – sclerenchyma sheath, 2 – outer phloem, 3 – cambium, 4 – secondary xylem, 5 – primary xylem, inner phloem

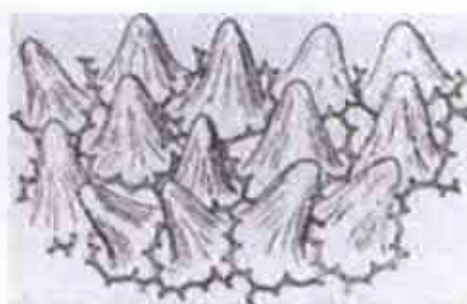
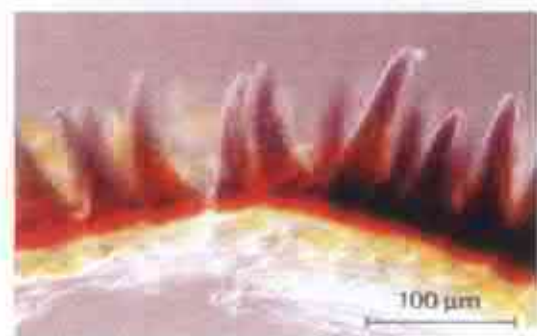
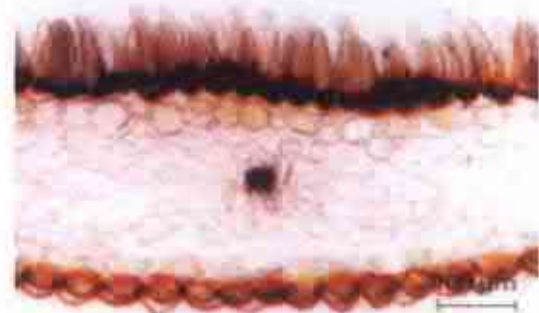
SUBJECTS FOR DISCUSSION:

1. What is mechanical tissue?
2. Functions of mechanical tissue.
3. Types of mechanical tissue.
4. Collenchyma. Characteristics, location.
5. Sclerenchyma. Characteristics, location.
6. Types of sclerenchyma fibers according to their origin and location.
7. Examples of plants as a source of cellulose fibers.
8. What are sclereids?
9. Examples of plant organs with sclereids.
10. Pharmaceutical and economic role of mechanical elements.
11. What is vascular bundle?
12. Phloem. Structure elements (sieve tube and companion cells) and their role.
13. Phloem parenchyma and sclerenchyma.
14. Xylem. Conductive elements (vessels and tracheids) and their role.
15. Xylem parenchyma and sclerenchyma.
16. Types of vascular bundles according to the position of xylem and phloem.
17. What are open and closed vascular bundles?
18. Arrangement of vascular bundles in the stem of Monocot plant.
19. Arrangement of vascular bundles in the stem of Dicot plants.
20. Mechanical and vascular structure with diagnostic role in vegetable drugs identification.

2.4. SECRETORY TISSUE

PRACTICAL WORK nr. 1. External structures of secretory tissue

1.1. Secretory papillae

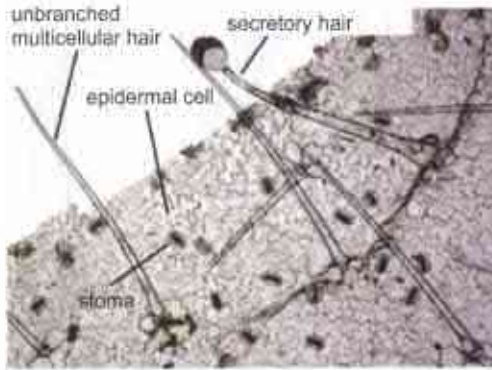


A

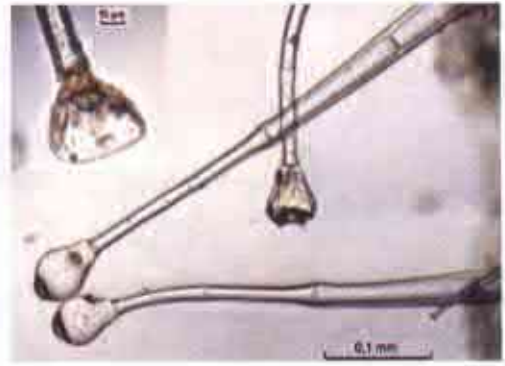
B

Fig. 74. Secretory papillae: A - on the Violet petals of *Viola wittrochiana* (scanning micrograph); B - the scheme of secretory papillae

1.2. Secretory hairs



A



B



C



D

Fig. 75. Leaf of Horse-shoe pelargonium *Pelargonium zonale* plant: A - epidermis with secretory hair; B - secretory hairs; C - comparative scheme of protective and secretory hairs; D - Horse-shoe pelargonium plant.

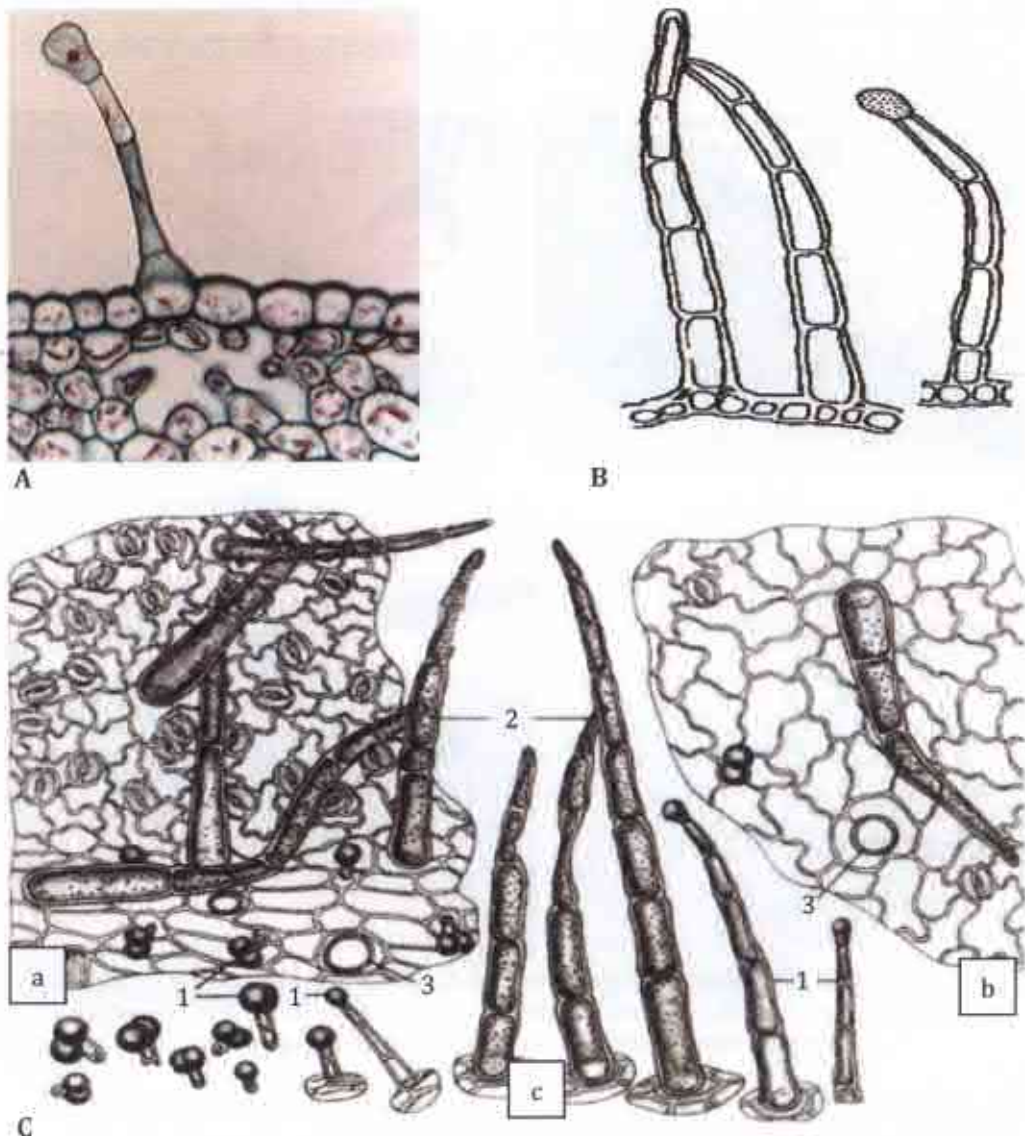


Fig. 76. Leaf of Fox glove *Digitalis purpurea* plant: **A** – epidermis with secretory hair; **B** – comparative scheme of protective and secretory hairs; **C** – **a** – upper epidermis; **b** – lower epidermis: **1** – secretory hairs with 1 or 2-celled head and 1 – 3-cells stalk, **2** – multicellular protective hairs, **3** – place of hair; **c**. **1** – secretory hairs with 1-cell head and multicellular stalk

1.3. Glandular hair

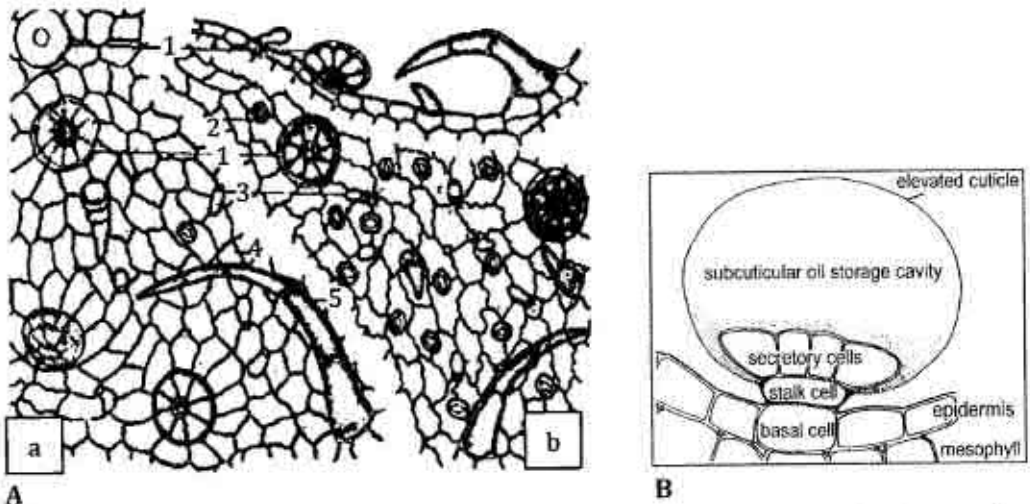


Fig. 77. Leaf of Mint *Mentha piperita* plant: A.a. - upper epidermis; A.b. - lower epidermis: 1 - glandular hair with 8-cell head, 2 - stomata, 3 - short secretory hair, 4 - epidermal cell, 5 - protective multicellular hair. B. - scheme of the glandular hair with 8-cell head

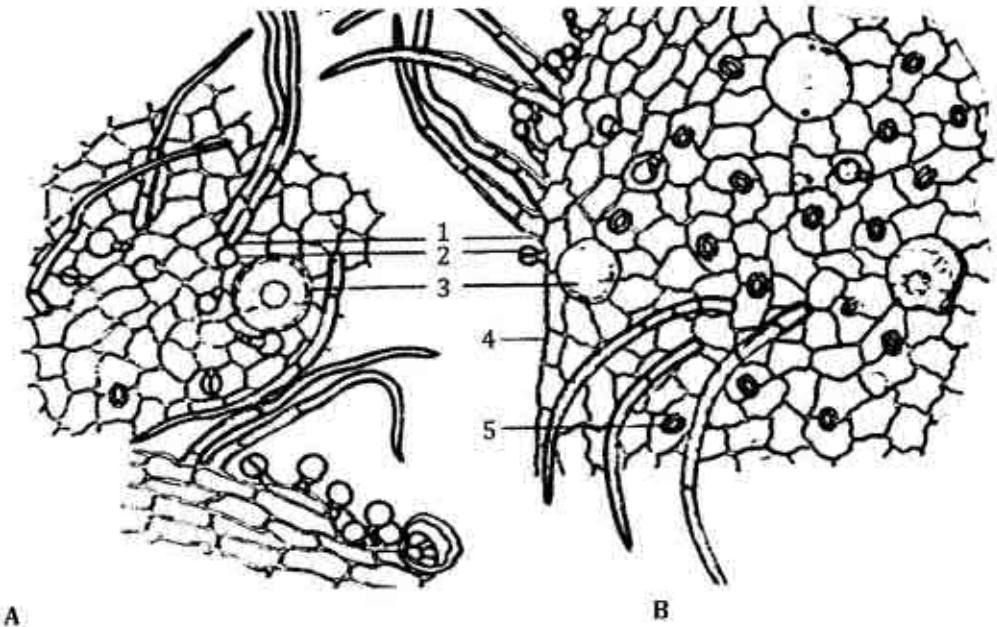


Fig. 78. Leaf of Sage *Salvia officinalis* plant: A - upper epidermis; B - lower epidermis: 1 - protective multicellular hair, 2 - secretory hairs with 1-2-cell head and 1-4 cell stalk, 3 - glandular hair with 8-cell head, 4 - epidermal cell, 5 - stomata

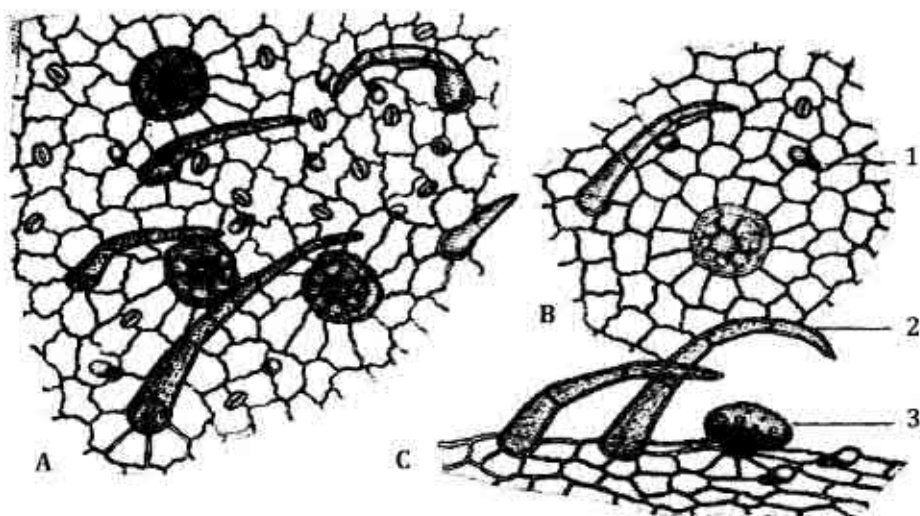


Fig. 79. Leaf of the Oregano *Origanum vulgare* plant: A - upper epidermis; B - lower epidermis: 1 - secretory hair; C - 2 - protective multicellular hairs, 3 - glandular hair with 8-cells head

1.4. Glands

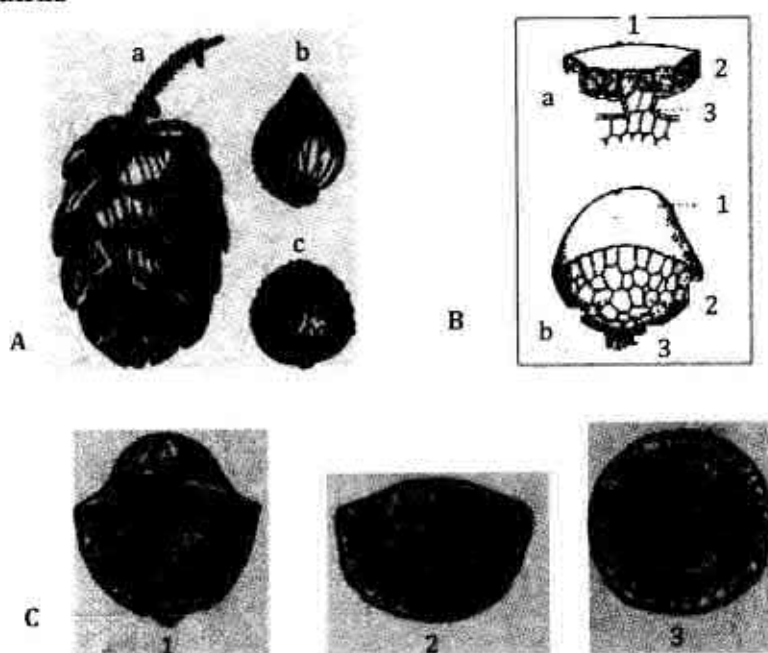
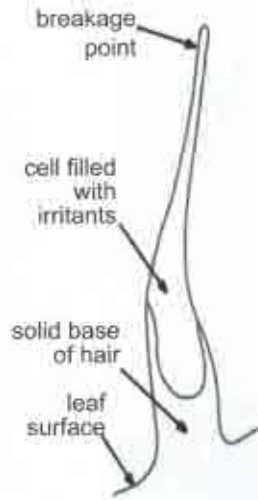


Fig. 80. Glands on the cone scales of the Hops *Humulus lupulus*: A.a - cone, b - scale, c - scale with glands; B.a, B.b - scheme of the gland: a.1 - cuticle, 2 - secretory cells, 3 - stalk; C - structure of gland: 1 - side view, 2 - upper view without cuticle, 3 - upper view with cuticle

1.5. Stinging hair



A



B



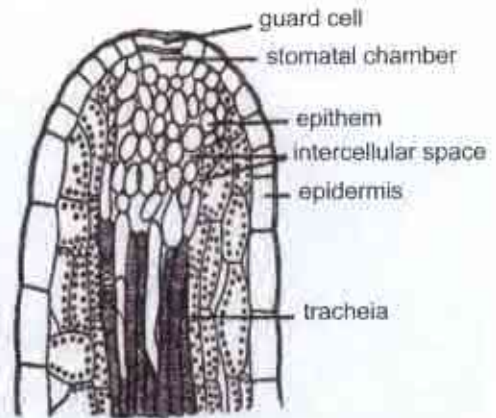
C

Fig. 81. Stinging hairs of the Nettle *Urtica dioica* plant: A – leaf surface with stinging hair; B – structure scheme of the stinging hair; C – the apex of stinging hair with thick cuticle

1.6. Hydathode



A



B

Fig. 82. Hydathodes: A – Strawberry *Fragaria vesca* leaf with hydathodes and process of guttation; B – scheme of the leaf tip with hydathode

1.7. Digestive hair (digestive gland)

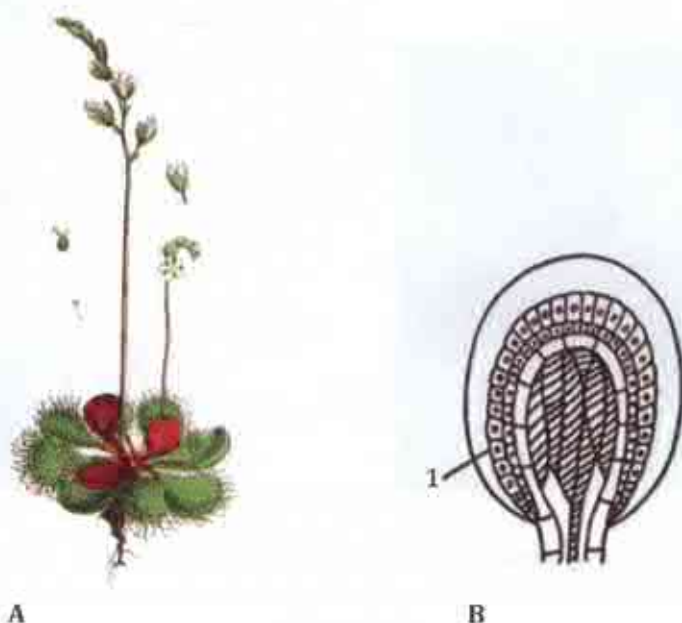


Fig. 83. Digestive hairs: A - Leaves of the *Drosera rotundifolia* plant with digestive hair; B - scheme of the digestive hair: 1 - secretory cells of digestive hair

PRACTICAL WORK nr. 2. Internal structures of secretory tissue

1.1. Idioblasts

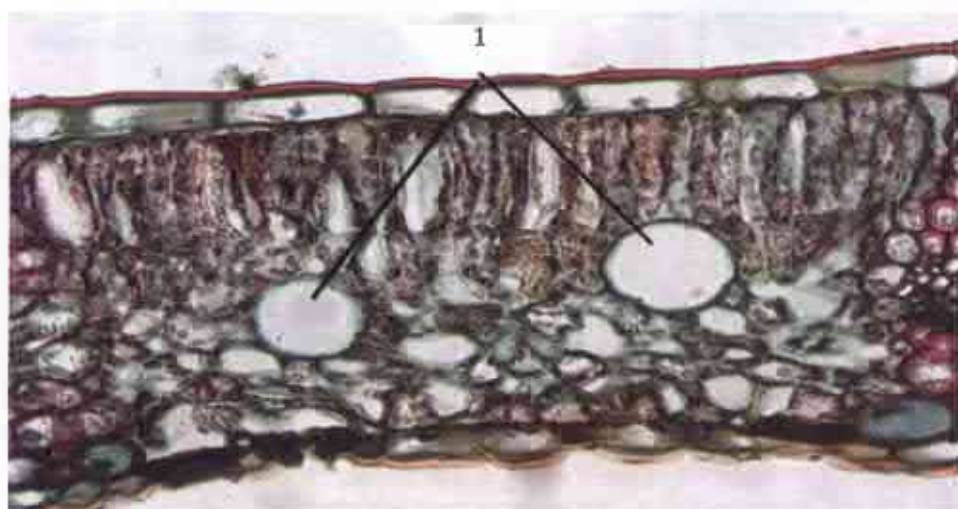
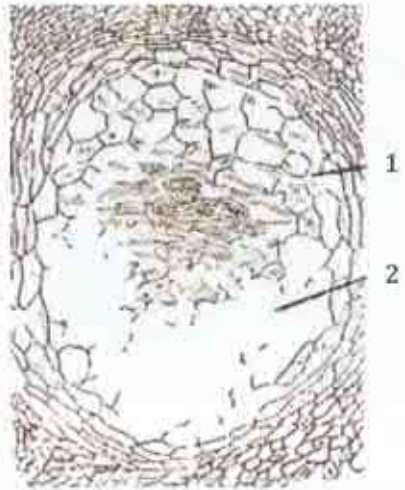


Fig. 84. Cross section of the Bay laurel *Laurus nobilis* plant: 1 - idioblasts with volatile oils

1.2. Lysigenous cavities



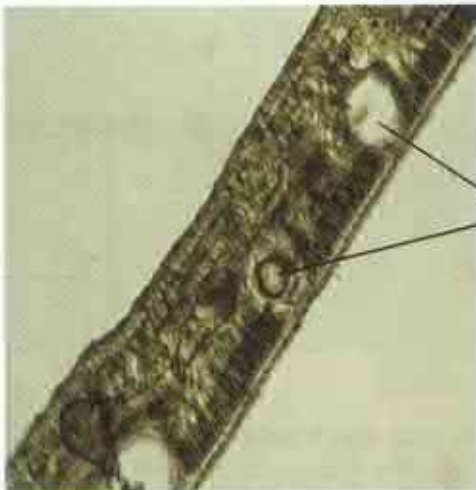
A



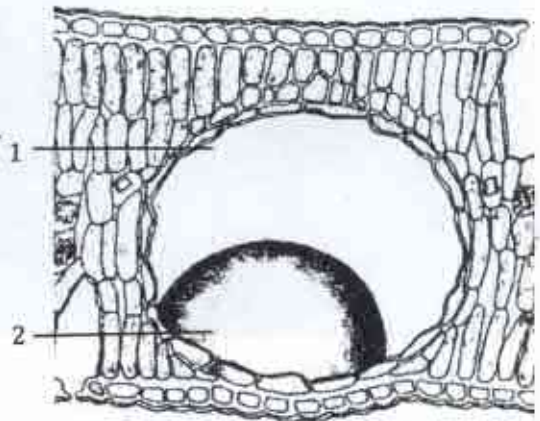
B

Fig. 85. Cross section of the Lemon *Citrus limon* fruit: **A** – lysigenous cavity (micrograph, 40x); **B** – scheme: 1 – cells in destruction process, 2 – cavity

1.3. Schysogenous cavities



A



B

Fig. 86. Cross section of the Blue gum *Eucalyptus globules* leaf: **A** – micrograph (20x); **B** – scheme: 1 – schysogenous cavity; 2 – drop of volatile oils

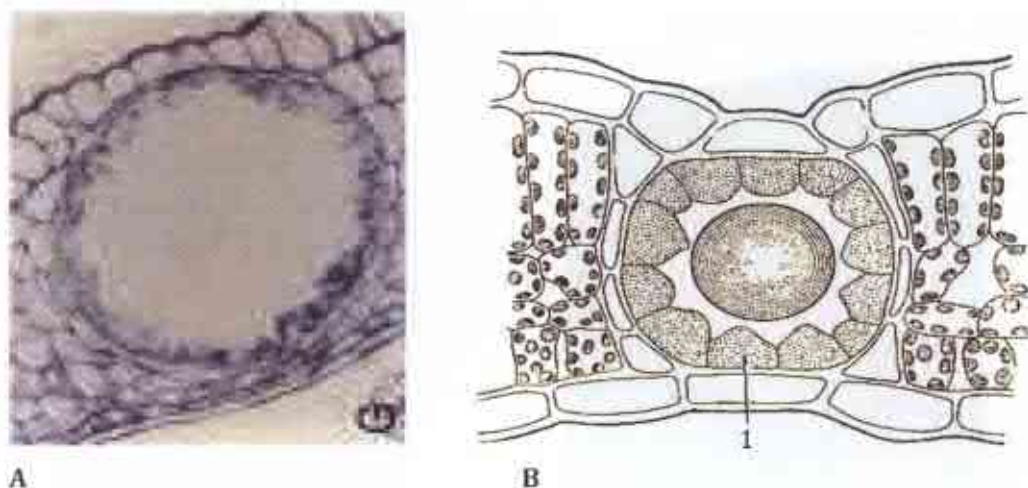


Fig. 87. Cross section of the Perforate St John's-wort *Hypericum perforatum* leaf: A – micrograph; B – scheme: 1 – secretory cells of schysogenous cavity

1.4. Resin ducts

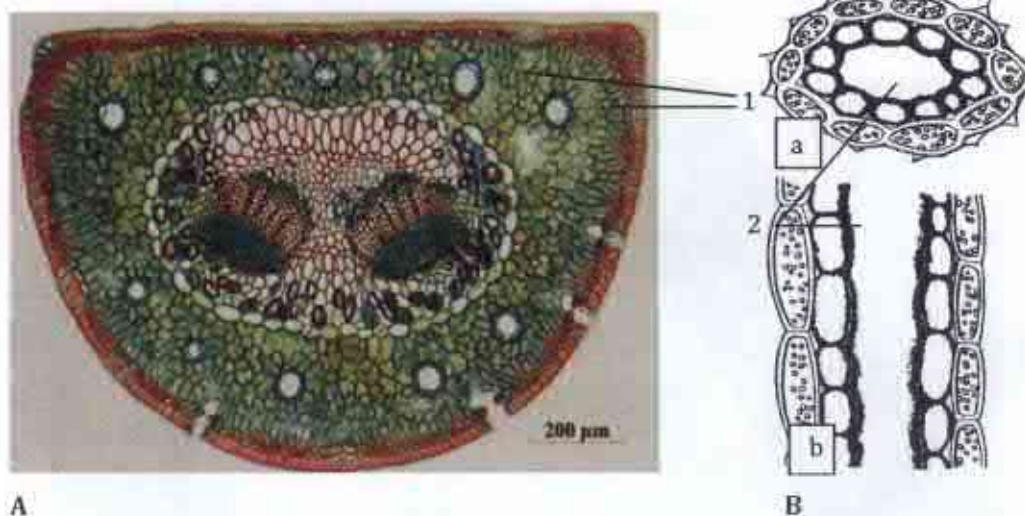
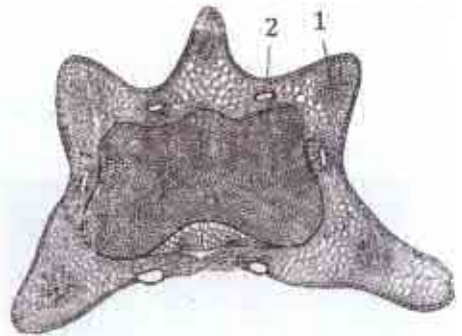


Fig. 88. Leaf of the Pine *Pinus nigra*: A – cross section of the leaf: 1 – resin ducts (as schysogenous cavity on cross section); B.a. – scheme of resin duct on cross section; B.b. – scheme of resin duct in longitudinal section: 2 – cavity of duct

1.5. Secretory channels



A



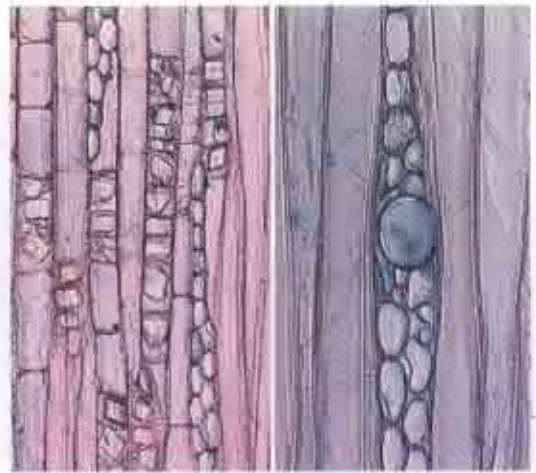
B

Fig. 89. Fruits of the Fennel *Foeniculum vulgare* plant: A – fruits (achenes); B – cross section of fruit: 1 – vascular bundle, 2 – secretory channel

1.6. Laticifers (latex channels)



A



B

Fig. 90. Articulated laticifers in the Poppy *Papaver somniferum* plant: A – incised capsule with exudated latex; B – articulated laticifers in longitudinal section

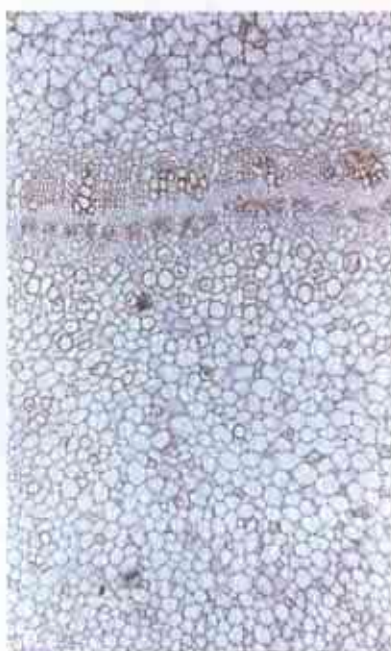


A

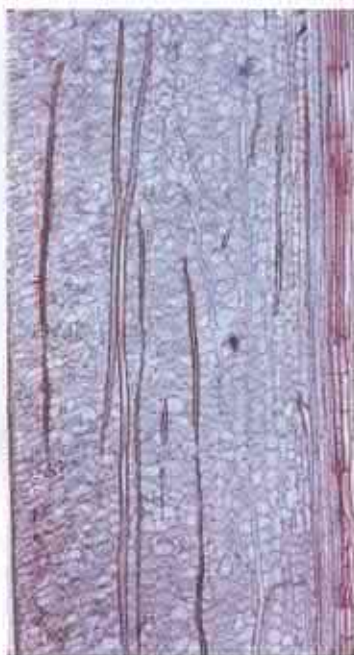


B

Fig. 91. Articulated laticifers in the Great celadine *Chelidonium majus* plant:
A – broken stem with latex; B – articulated laticifers in longitudinal section of the stem



A



B

Fig. 92. Non-articulated laticifers in the *Euphorbia* stem:
A – Cross section of the stem; B – longitudinal section of the stem

SUBJECTS FOR DISCUSSION:

1. Characteristics of secretory tissue.
2. Type of external secretory structure.
3. What is glandular hair? Types, location. Example of organ herbs.
4. What is secretory hair? Types, location. Example of organ herbs which develop secretory hairs.
5. What is gland? Location and role. Example of organ herbs which develop glands.
6. What is nectarine? Location and role. Example of organ herbs which develop glandular hairs.
7. What is hydathode? Location and role. Example of organ herbs which develop hydathode.
8. Types of internal secretory structure.
9. What is idioblast? Types, location. Example.
10. What is secretory lysigenous cavity? Location. Example of organ herbs which develop secretory lysigenous cavity.
11. What is secretory schysigenous cavity? Location. Example of organ herbs.
12. What is secretory channel? Location. Example of medicinal plants.
13. What is resin duct? Location. Example of medicinal plants.
14. What is laticifer channel? Location. Example of medicinal plants.
15. The pharmaceutical role of secretory structures.
16. The main criteria of secretory tissue to identify vegetable products.

SUBJECTS FOR TEST ON "VEGETAL HISTOLOGY"

1. What is tissue?
2. Types of tissues according their origin.
3. Types of permanent tissues according to their functions.
4. The main characteristics of meristematic tissues.
5. Types of meristematic tissues according to their origin.
6. Types of meristematic tissues according to their location in plants.
7. Types of protective tissue according to their origin.
8. Types of primary protective tissue.
9. What is epidermis?
10. The main characteristics of epidermis.
11. Special epidermis structures.
12. What are stomata?

13. The structure of stomata.
14. Criteria to determine the type of stomata.
15. Distribution of stomata in Monocot and Dicot plants.
16. What is trichome?
17. Kinds of trichomes according to their functions.
18. The criteria to determine the type of trichome.
19. Examples of different kinds of trichomes in Medicinal plants.
20. What is epiblema?
21. Types of secondary protective tissue.
22. How periderma is formed? What is lenticel?
23. What is rhytidome?
24. The role of periderma and rhytidome.
25. The protective structures with diagnostic role in vegetable drug identification.
26. What is ground or fundamental parenchyma tissue?
27. Functions of ground parenchyma.
28. Location of ground parenchyma in the plant organs.
29. Kinds of ground parenchyma.
30. What is assimilation parenchyma?
31. Location of the assimilation parenchyma in plants.
32. Function of assimilation parenchyma.
33. What is storage parenchyma?
34. The types of storage parenchyma according to chemical nature of storage substances.
35. What is storage parenchyma with nutritive substances?
36. Location. The biological role.
37. Examples of medicinal plants with well developed storage parenchyma with nutritive substances.
38. What is water storage parenchyma? Location. Role.
39. Examples of plants with well developed water storage parenchyma.
40. What is aerenchyma? Location. Role.
41. Examples of plants with well developed water storage parenchyma.
42. What is mechanical tissue?
43. Functions of mechanical tissue.
44. Types of mechanical tissue.
45. Collenchyma. Characteristics, location.
46. Sclerenchyma. Characteristics, location.
47. Types of sclerenchyma fibers according to their origin and location.
48. Examples of plants as source of cellulose fibers.

49. What are sclereids?
50. Examples of plant organs with sclereids.
51. The pharmaceutical and economic role of mechanical elements.
52. What is vascular bundle?
53. Phloem. Structure elements (sieve tube and companion cells) and their role.
54. Phloem parenchyma and sclerenchyma.
55. Xylem. Conductive elements (vessels and tracheids) and their role.
56. Xylem parenchyma and sclerenchyma.
57. Types of vascular bundles according position of xylem and phloem.
58. What are open and closed vascular bundles?
59. Arrangement of vascular bundles in the stem of monocot plant.
60. Arrangement of vascular bundles in the stem of dicot plants.
61. Mechanical and vascular structures with diagnostic role in vegetable product identification.
62. Characteristics of secretory tissue.
63. Types of external secretory structure.
64. What is glandular hair? Types, location. Example of organ herbs.
65. What is secretory hair? Types, location. Example of organ herbs which develop secretory hair.
66. What is gland? Location and role. Example of organ herbs which develop glands.
67. What is nectarine? Location and role. Example of organ herbs which develop glandular hairs.
68. What is hydathode? Location and role. Example of organ herbs which develop hydathode.
69. Type of internal secretory structure.
70. What is idioblast? Types, location. Example.
71. What is secretory lysigenous cavity? Location. Example of organ herbs which develop secretory lysigenous cavity.
72. What is secretory schysigenous cavity? Location. Example of organ herbs.
73. What is secretory channel? Location. Example of medicinal plants.
74. What is resin duct? Location. Example of medicinal plants.
75. What is laticifer channel? Location. Example of medicinal plants.
76. The pharmaceutical role of secretory structures.
77. The main criteria of secretory tissue to identify vegetable products.

TEST SAMPLES

- 1) s.c. Choose the principal function of stomata:
 a) protective;
 b) storage;
 c) reproductive;
 d) gas change;
 e) supporting.
- 2) s.c. Epiblema (rizoderma) covers:
 a) leaves;
 b) roots
 c) stems;
 d) petals;
 e) fruits.
- 3) s.c. Secretory channels are characteristics of species from the family:
 a) Aspergillaceae;
 b) Araceae;
 c) Araliaceae;
 d) Apocynaceae;
 e) Apiaceae.
- 4) s.c. Choose the species of plant which develop laticifers:
 a) *Althaea officinalis*;
 b) *Cucurbita pepo*;
 c) *Convallaria majalis*;
 d) *Taraxacum officinale*;
 e) *Solanum tuberosum*.
- 5) m.c. According to their functions the tissues may be:
 a) mechanical;
 b) assimilation;
 c) conductive;
 d) secretory;
 e) internal.
- 6) m.c. Choose the protective tissues:
 a) epiderma;
 b) rizoderma;
 c) sclerenchyma;
 d) periderma;
 e) rithydom.
- 7) m. c. Choose the special epidemal structures:
 a) stone cells;
 b) stomata;
 c) trichomes;
 d) glands;
 e) secretory hairs.
- 8) m. c. Vascular cambium generates:
 a) secondary xylem;
 b) primary xylem;
 c) phelloderma;
 d) secondary phloem;
 e) fellema.
- 9) m.c. Select the types of mechanical tissue:
 a) chlorenchyma;
 b) colenchyma;
 c) xylem sclerenchyma;
 d) phloem sclerenchyma;
 e) sclereids.
- 10) m.c. Choose the types of intenal secretory structure:
 a) laticifers;
 b) secretory chanals;
 c) gland hairs;
 d) idioblasts;
 e) nectarines.

Chapter 3. ORGANOGRAPHY

3.1. MORPHOLOGY AND ANATOMY OF THE ROOT

PRACTICAL WORK nr. 1. Morphology of the root

1.1. Types of roots according to their origin

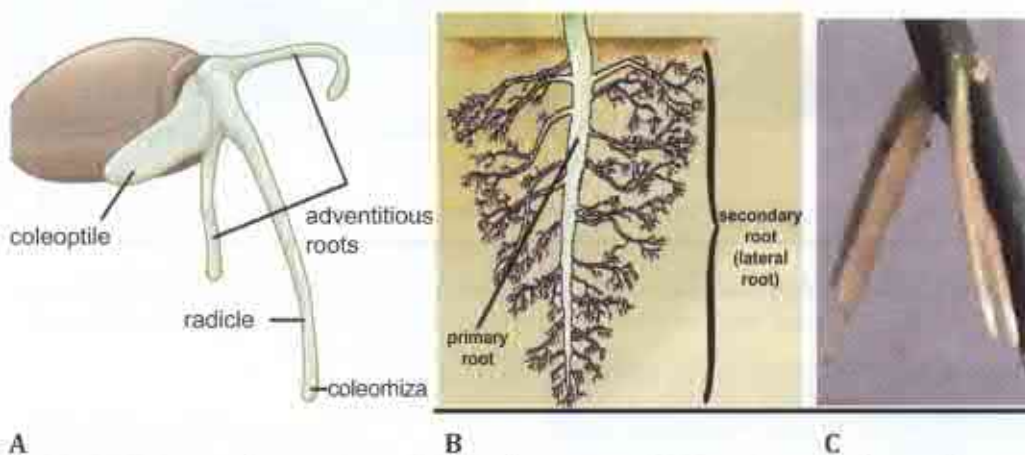


Fig. 93. Types of roots: A – radicle (embryonic root); B – primary and secondary (lateral) roots; C – adventitious roots

1.2. Types of root systems

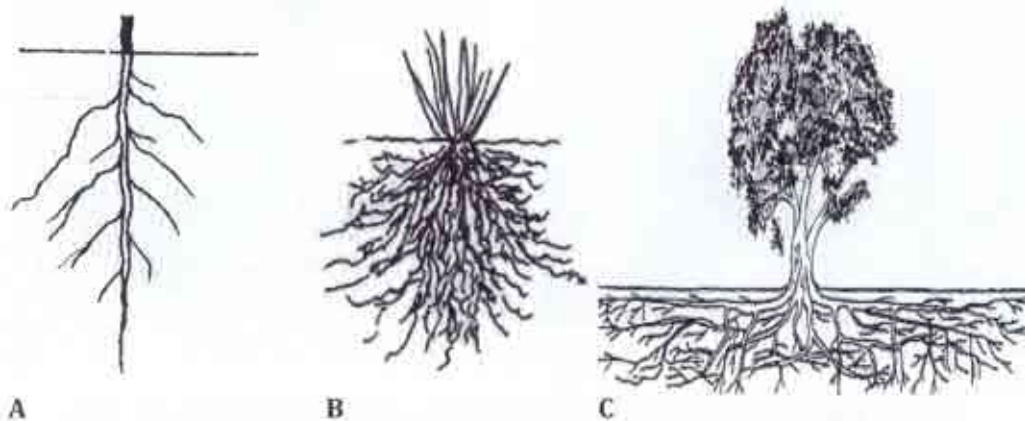


Fig. 94. Types of root systems: A – tap root system; B – fibrous root system; C – branched root system

1.3. Modified roots

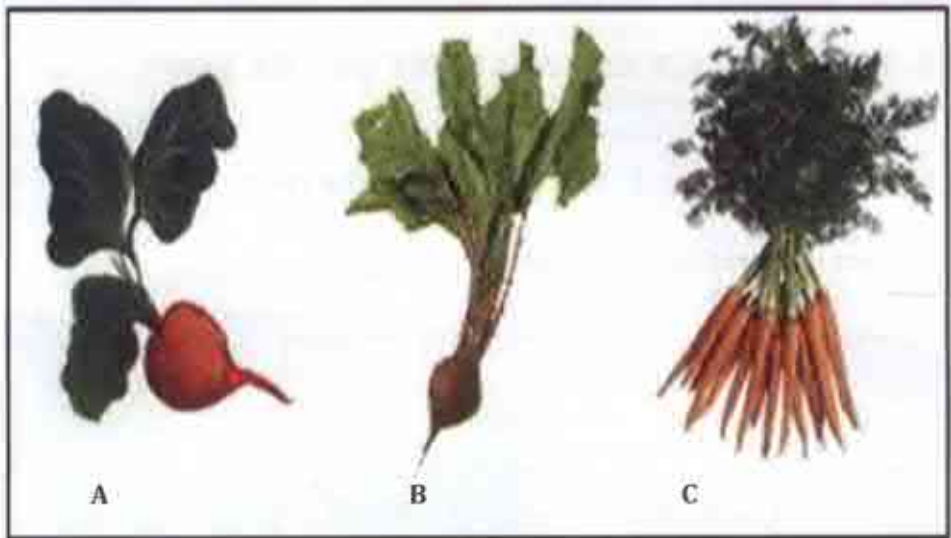


Fig. 95. Tuberous (enlarged) roots: A – spherical tuberous root of Radish *Raphanus sativus*; B – spherical tuberous root of Beet *Beta vulgaris*; C – conical tuberous root of cultivated Carrot *Daucus carota*, var. *sativa*

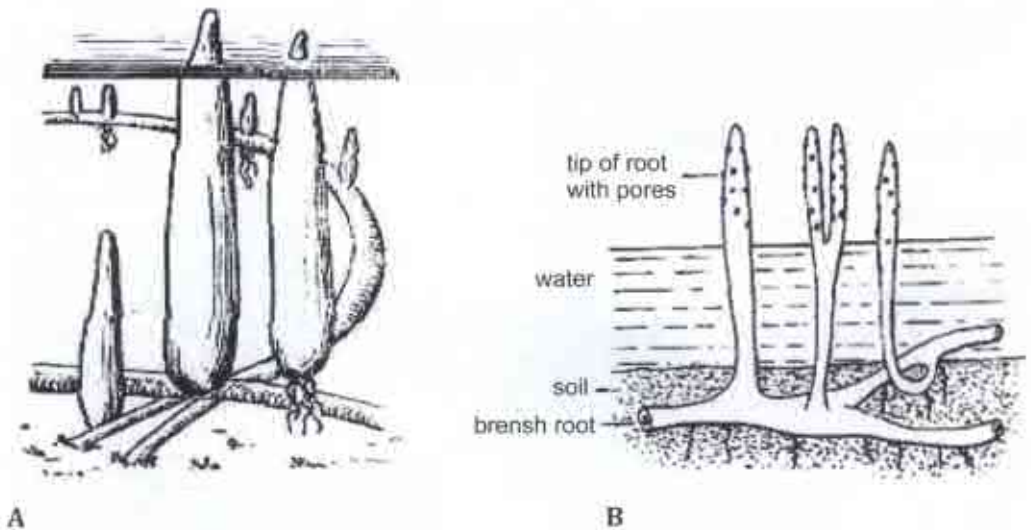
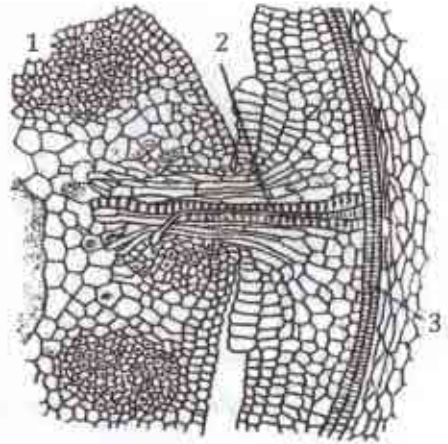


Fig. 96. Breathing roots (pneumatophores) with pores on the top of bog plant roots: A – *Jussiaea peruviana*; B – *Avicena sp.*



A



B

Fig. 97. Haustorium root (sucking root): A – parasitic Dodder plant *Cuscuta epiphytum*; B – scheme between host root and parasitic plant: 1 – host root; 2 – sucking root; 3 – conductive tissue of parasitic plant



A



B

Fig. 98. Symbiotic roots: A – root of Oak *Quercus robur* with fungal hyphae; B – nodules with nitrogen-fixed bacteria on roots of Alfalfa plant *Medicago sp.*



Fig. 99. Aerial assimilation root of Orchid species



A



B

Fig. 100. Aerial roots: A - aerial fixed roots of ivy *Hedera helix* plant;
B - aerial prop (supporting) roots of tropical trees.

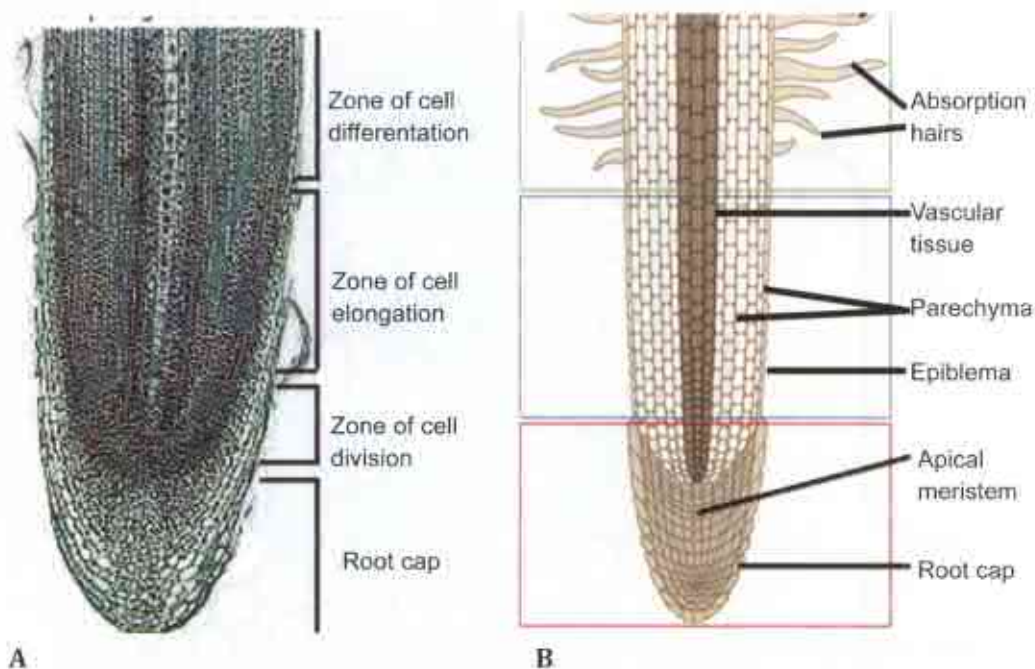
PRACTICAL WORK nr. 2. Anatomical zones of the root

Fig. 101. Anatomical zones of the root: A – micrograph; B – scheme

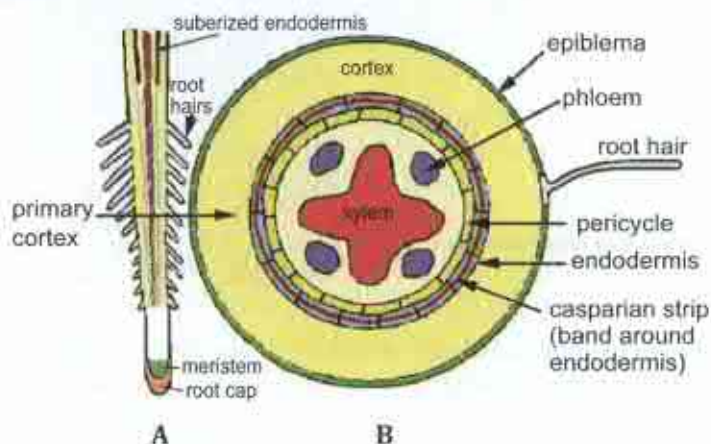
PRACTICAL WORK nr. 3. Anatomy of the root**3.1. Primary anatomy structure of the root (Monocot plant)**

Fig. 102. Scheme of the primary anatomical structure of the root: A – on longitudinal section; B – on cross section

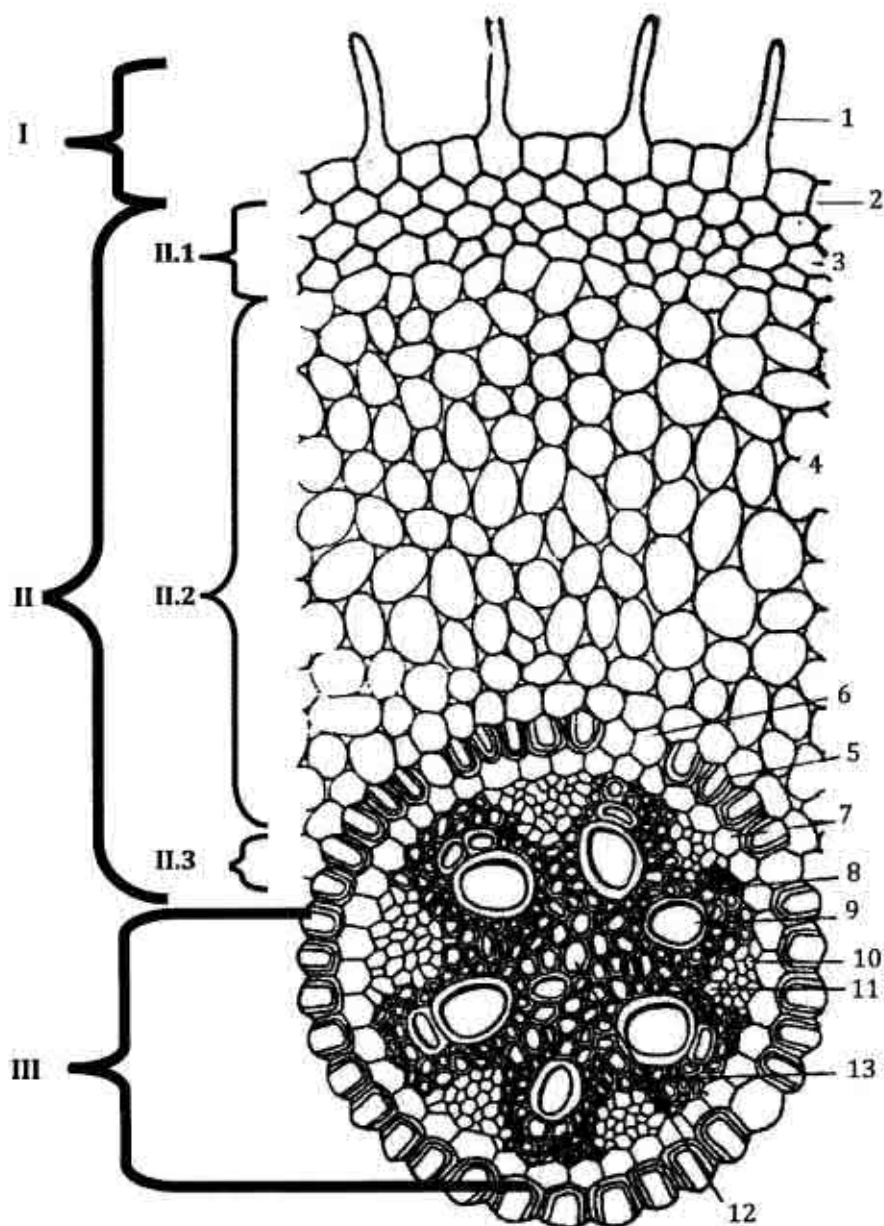


Fig. 103. Scheme of primary anatomy structure of the Iris *Iris germanica* root.

Zones: I – epiblema; II – cortex (II.1 – exo-, II.2 – meso-, II.3 – endodermis);
 III – central cylinder (stele): 1 – absorption hairs, 2 – epiblema, 3 collenchyma,
 4 – storage parenchyma, 5 – Caspary cell, 6 – endodermis, 7 – pericycle,
 8 – protoxylem, 9 – metaxylem, 10-11 – phloem, 12 – pith, 13 – sclerenchyma

3.2. Secondary anatomy structure of the root (Dicot plant)

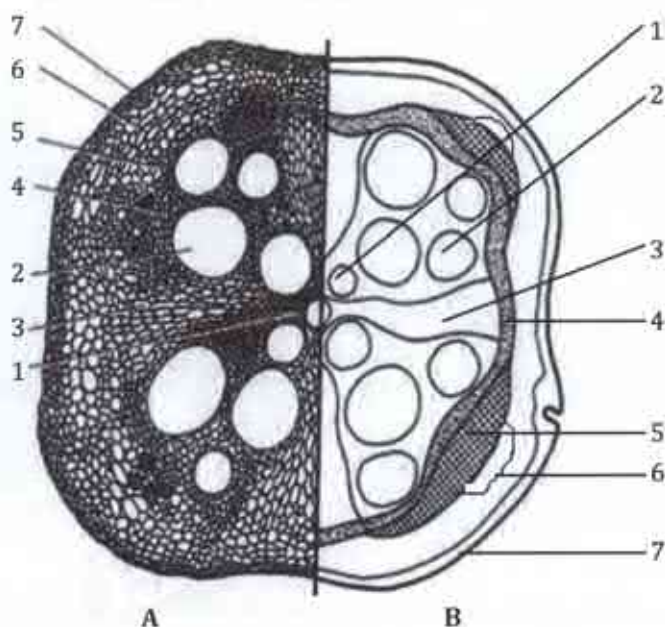


Fig. 104. Secondary anatomy structure of the Pumpkin *Cucurbita pepo* root:
 A – micrograph, B – scheme: 1 – primary xylem, 2 – secondary xylem,
 3 – medullar parenchymatocal ray, 4 – vascular cambium, 5 – secondary phloem,
 6 – primary phloem, 7 – periderma

SUBJECTS FOR DISCUSSION:

1. Vegetative organs of the plant.
2. Functions of the root (primary and secondary).
3. Types of roots according to their origin.
4. What are primary, secondary and adventitious roots?
5. Types of roots systems. Examples of plants.
6. What is modified root?
7. Types of modified roots. Examples of plants.
8. What is primary growth of roots?
9. Primary anatomy structure of the root.
10. What is secondary growth of roots?
11. Secondary anatomy structure of the root.
12. Roots as a source of medicines. Examples of medicinal plants (Latin name of plant species, family and vegetable products, chemical compounds, usage).

3.2. MORPHOLOGY AND ANATOMY OF THE STEM

PRACTICAL WORK nr. 1. Morphology of the stem

1.1. Morphology of the stem

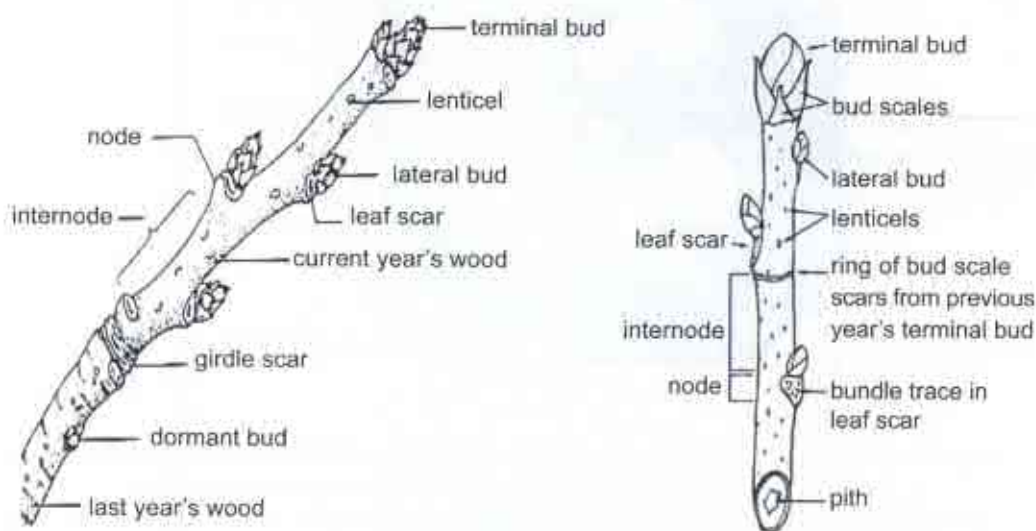


Fig. 105. Morphology of the stem

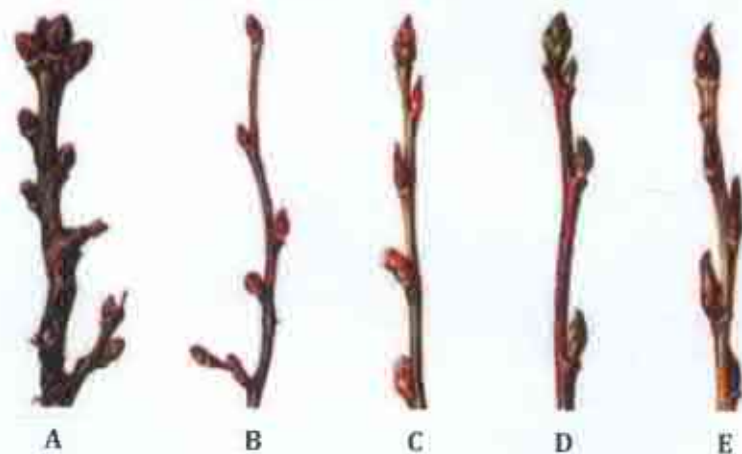


Fig. 106. Twigs of different woody plants: A – Oak *Quercus robur*; B – Lime *Tilia cordata*; C – European aspen *Populus tremula*; D – Mountain ash *Sorbus aucuparia*; E – Black poplar *Populus nigra*

1.2. Types and arrangement of buds

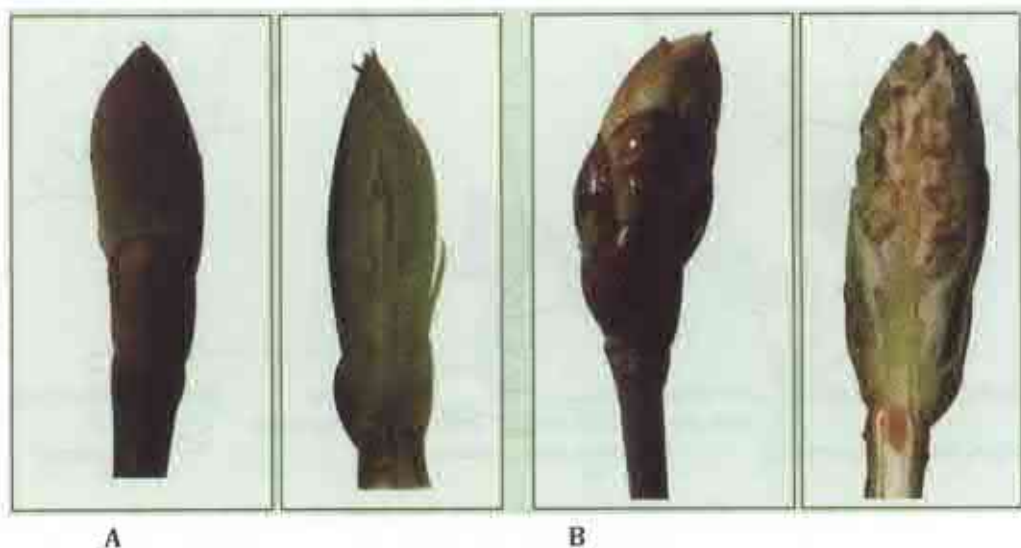


Fig. 107. Types of buds: A – vegetative bud of Lilac *Syringa vulgaris* plant;
B – reproductive bud of Horse chestnut *Aesculus hippocastanum* plant



Fig. 108. Bud arrangement: A – alternate (1 bud at a node);
B – opposite (2 buds at a node); C – whorled (3 and more buds at a node)

1.3. Stem branching

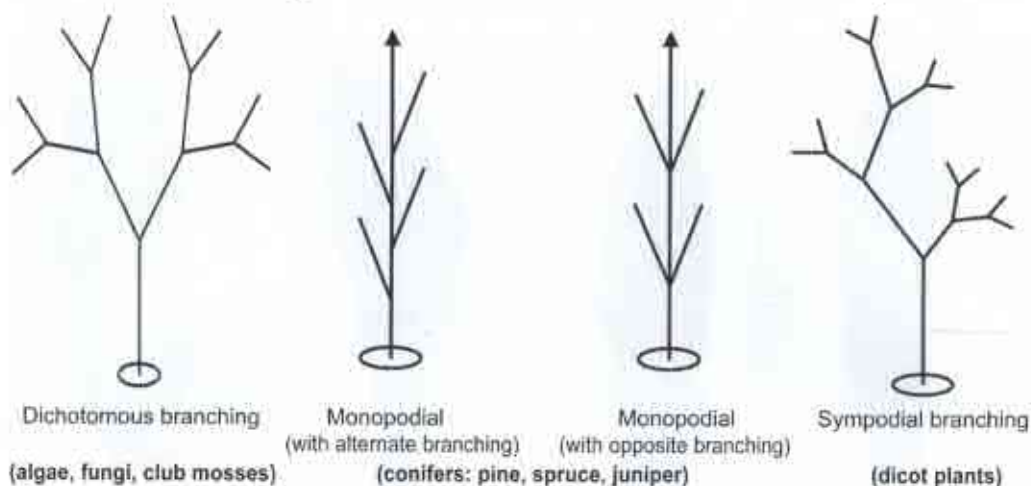


Fig. 109. Types of stem branching

1.4. Configuration of the stem in cross section

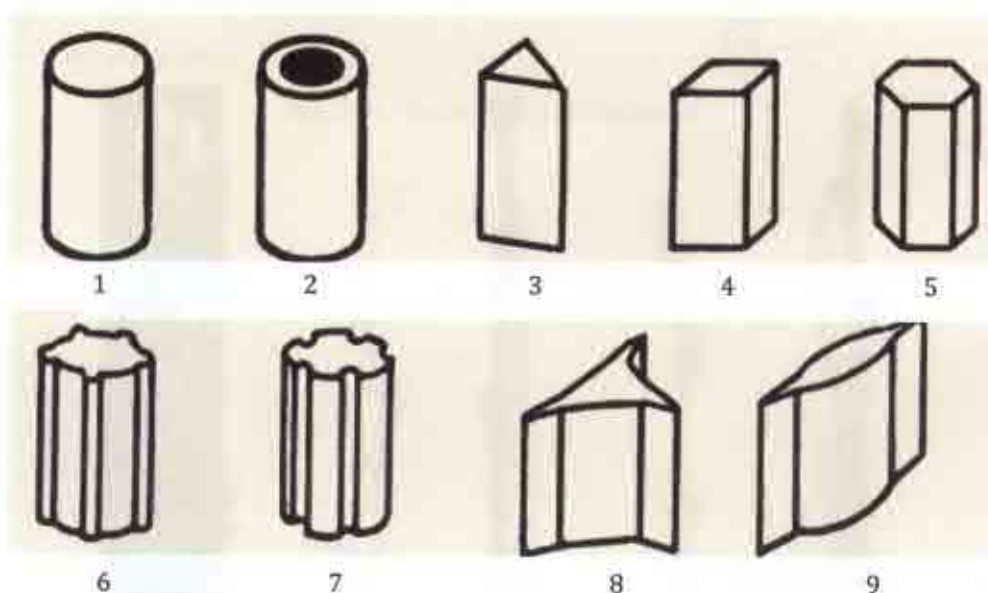


Fig. 110. Configuration of the stem in cross section: 1 - rounded (spherical), 2 - spherical hollow, 3 - triangular, 4 - square, 5 - polygonal, 6,7 - costate, 8 - triangular-winged, 9 - flattened and winged

1.5. Types of stems according to their position



Fig. 111. Types of stem according their to position: A - erect (most plants); B - creeping stem (Strawberry *Fragaria vesca* plant); C - climbing by means of tendrils (Purple passionflower *Passiflora incarnata* plant); D - voluble (Field bindweed *Convolvulus arvensis* plant)

2.2. Underground stem modifications

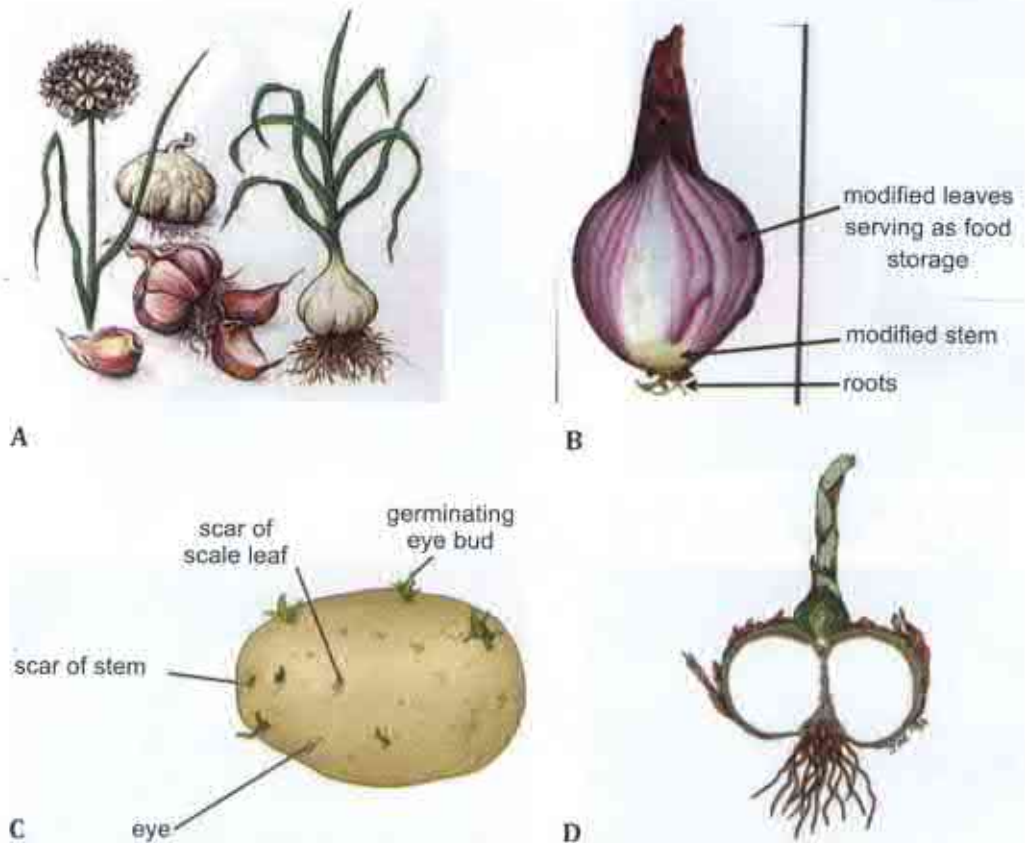


Fig. 114. Stem modifications: A – bulbs of Garlic *Allium sativus* plant;
B – bulb of Onion *Allium cepa* plant; C – tuber of Potato *Solanum tuberosum* plant;
D – tuber-bulb of Saffron crocus *Crocus sativus* plant

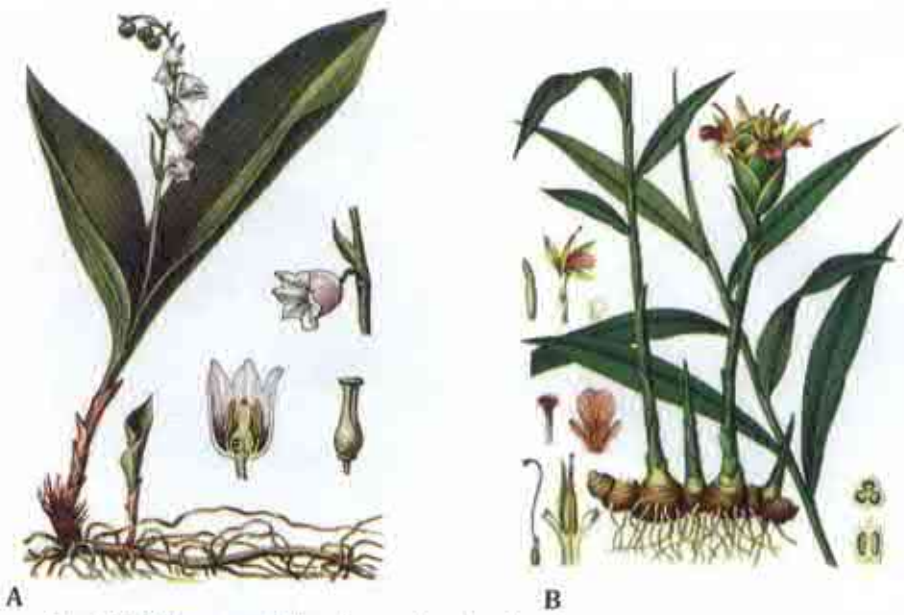


Fig. 115. Stem modifications: A – slender rhizome of Lily of the valley *Convallaria majalis* plant; B – thick rhizome of Ginger *Zingiber officinale* plant

PRACTICAL WORK nr. 3. Anatomy of the stem

3.1. Primary anatomy structure of the stem (Monocot plant)

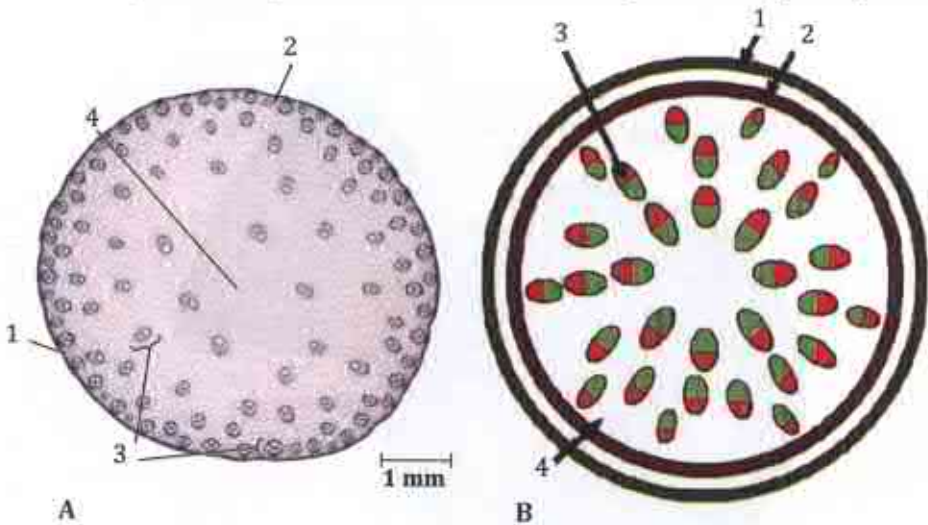


Fig. 116. Cross section of Corn *Zea mays* stem: A – primary anatomy structure of Corn stem (micrograph); B – scheme of primary anatomy structure: 1 – epidermis; 2 – lignified sclerenchyma; 3 – scattered collateral closed vascular bundles; 4 – ground parenchyma

3.2. Secondary structure of the stem (Dicot herbaceous plant)

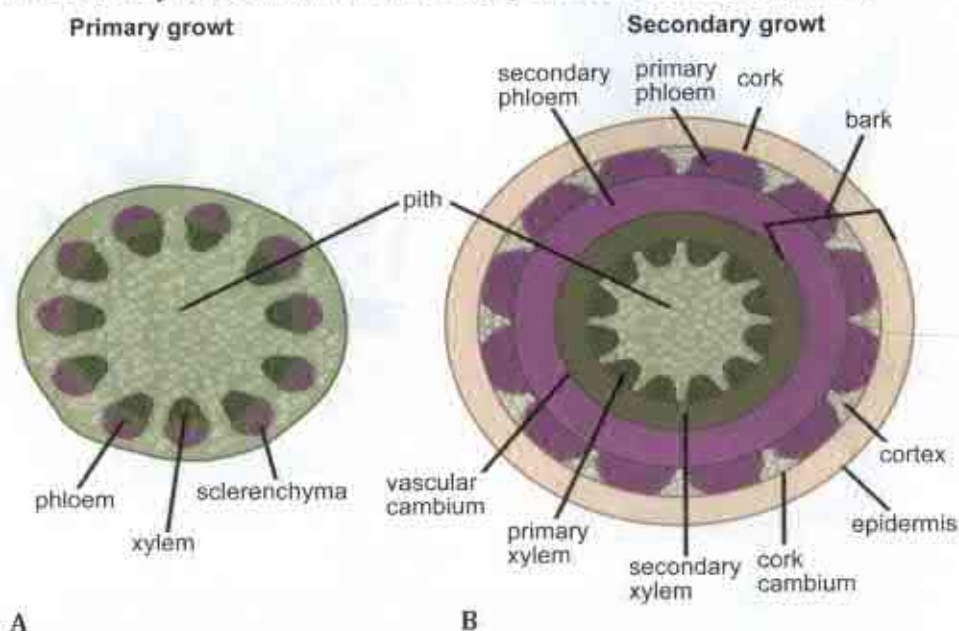


Fig. 117. Scheme of anatomy structure in the Dicot plant: **A** – primary anatomy structure; **B** – secondary anatomy structure

3.3. Secondary structure of the stem (Dicot woody plant)

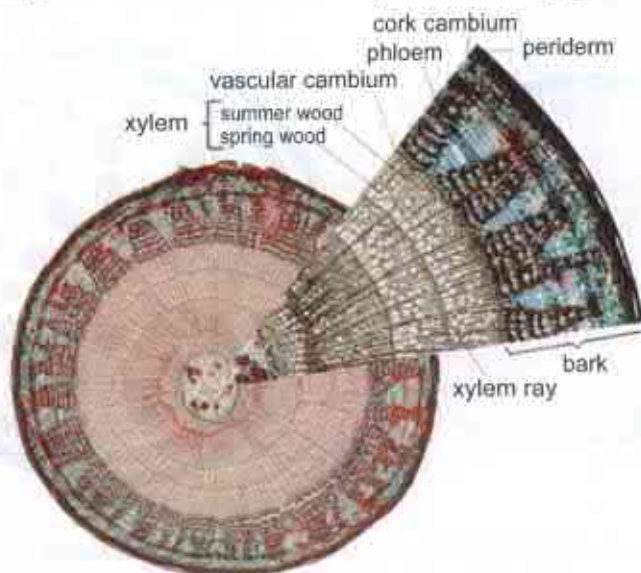


Fig. 118. Cross section of the 3-year-old woody stem

SUBJECTS FOR DISCUSSION:

1. Functions of the stem (primary and secondary).
2. Morphology of the twig.
3. Types of buds.
4. Arrangement of buds on a twig.
5. Types of stem according to their position.
6. Shapes of stem in cross section.
7. Types of stem branching. Examples.
8. Types of aboveground stem modifications. Examples.
9. Types of underground stem modifications. Examples.
10. What is primary growth of stem?
11. Primary anatomy structure of the stem.
12. What is secondary growth of stem?
13. Secondary anatomy structure of the stem.
14. Examples of vegetable products derived from the stem: *Gemmae, Turiones, Herba, Cortex.*

3.3. MORPHOLOGY AND ANATOMY OF THE LEAF

PRACTICAL WORK nr. 1. Morphology of the leaf

1.1. Morphology of the simple and compound leaves

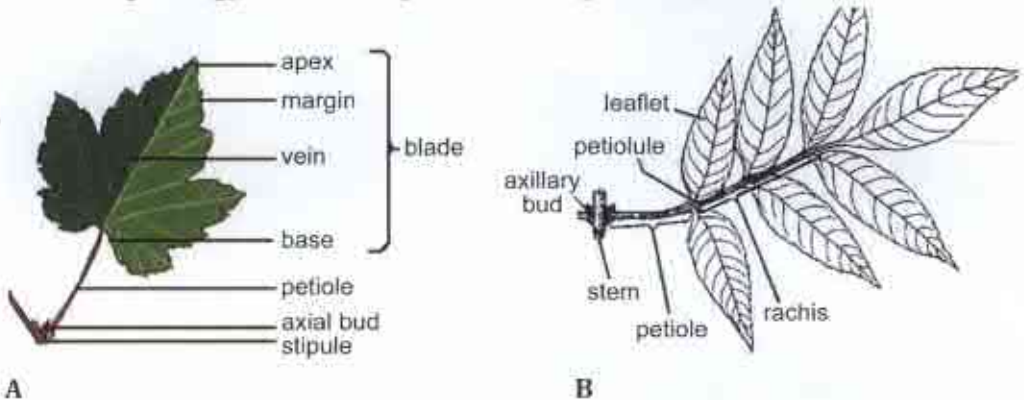


Fig. 119. Morphology of the leaves: A – simple; B – compound

1.2. Types of the simple leaves



Fig. 120. Types of the simple leaves

1.3. Venation of the leaf

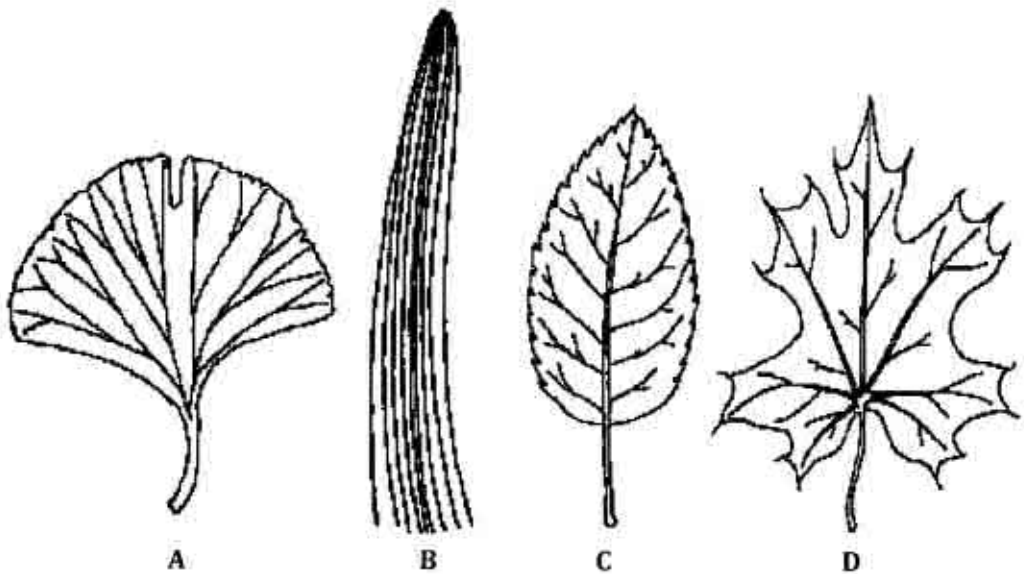


Fig. 121. Types of venation (nervation): A - dichotomous; B - parallel; C - pinnate; D - palmate

1.4. Shape of leaf apex

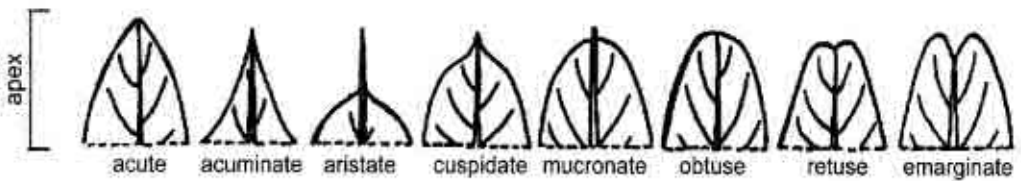


Fig. 122. Types of leaf apex

1.5. Shape of leaf base

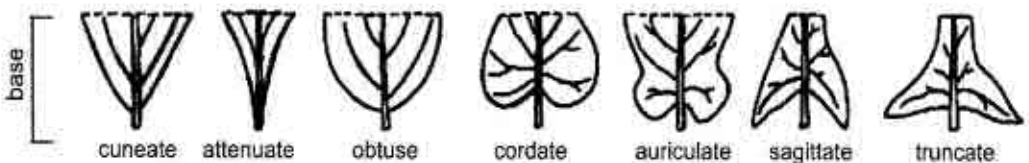


Fig. 123. Types of the leaf base

1.6. Shape of the leaf lamina



Fig. 124. Shapes of the leaf lamina

1.7. Leaf margin with small incisions

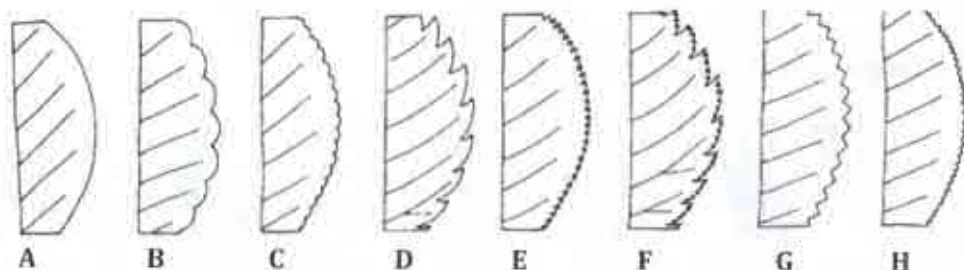


Fig. 125. Shapes of the leaf lamina with small incisions: A - entire; B - crenate; C - crenulate; D - serrate; E - serrulate; F - doubly serrate; G - dentate; H - denticulate

1.8. Leaf margin with deep incisions










LOBED LEAF (1/4 from half of lamina)	PARTED LEAF (3/4 from half lamina)	SECTATED LEAF (until midrib)
 Three-lobed	 Three-parted	 Three-sectated
 Palmate-lobed	 Palmate-parted	 Palmate-sectated
 Pinnate-lobed	 Pinnate-parted	 Pinnate-sectated

Fig. 126. Types of the leaf margin with deep incisions

1.9. Compound leaves

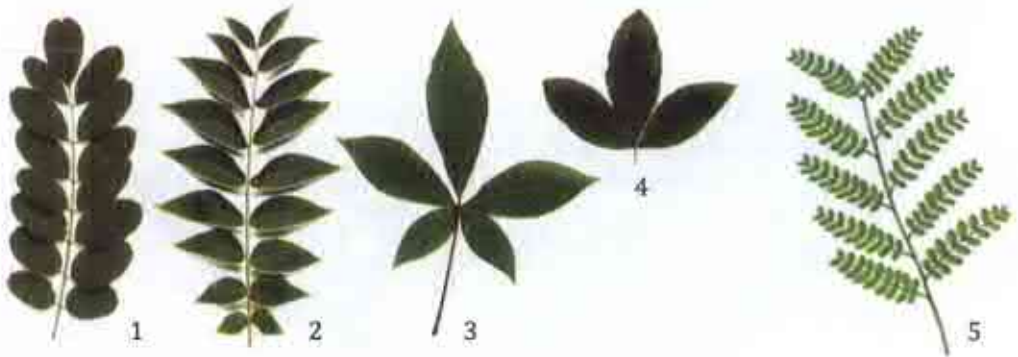


Fig. 127. Types of the compound leaves: 1 – imparipinnate; 2 – paripinnate; 3 – palmate (digitate); 4 – trifoliate; 5 – double-pinnate

1.10. Leaf arrangement

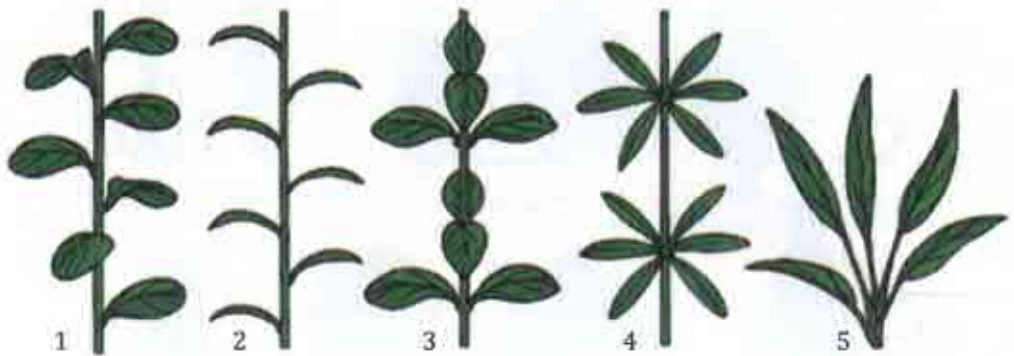


Fig. 128. Types of leaf arrangement: 1, 2 – alternate; 3 – opposite; 4 – whorled; 5 – in basal rosette

1.11. Leaf modifications

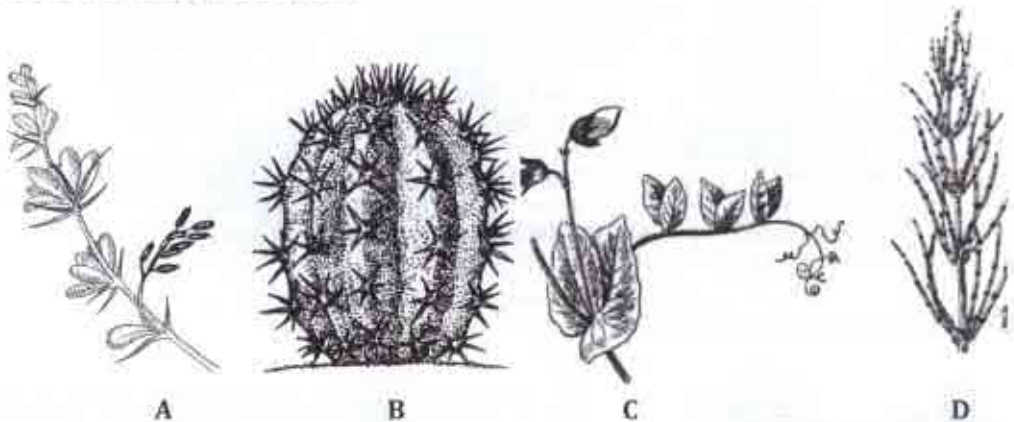
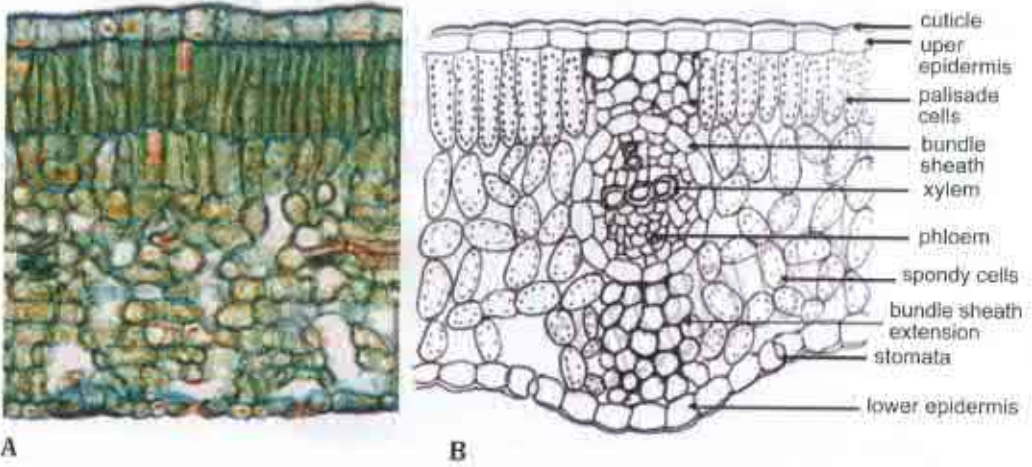


Fig. 129. Leaf modifications: A – leaf modified into spine (g. *Berberis*); B – leaf modified into spine (Cacti); C – apical leaflet in tendrils (g. *Pisum*); D – reduced leaf in scale (g. *Equisetum*)

PRACTICAL WORK nr. 2. Anatomy of the leaf

2.1. Anatomy structure of the Camellia leaf (Angiosperms)



**Fig. 130. Cross section of the Camellia *Camellia chinensis* leaf:
A - micrograph; B - scheme of anatomy structure**

2.2. Anatomy structure of the Pine leaf (Gymnosperms)



A

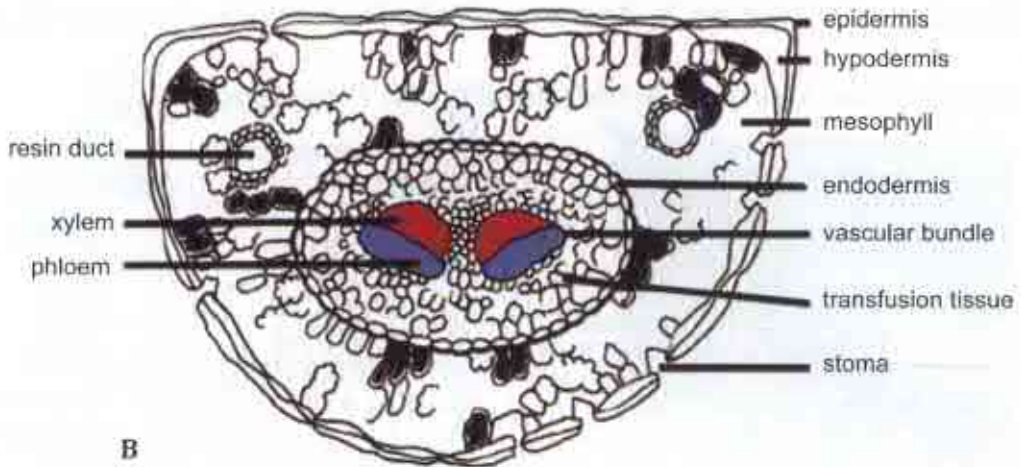


Fig. 131. Cross section of the Pine *Pinus sylvestris* leaf: A – micrograph; B – scheme of anatomy structure

SUBJECTS FOR DISCUSSION:

1. Functions of the leaf (primary and secondary).
2. Morphology of the leaf.
3. Petiolate and sessile leaves. Examples.
4. Types of compound leaves. Examples.
5. Types of venation. Examples.
6. Shapes of the leaf apex. Examples.
7. Shapes of the leaf base. Examples.
8. Leaf margins with small incisions. Examples.
9. Leaf margins with deep incisions. Examples.
10. Shapes of the leaf lamina (blade). Examples.
11. Shapes of the petiole. Examples.
12. Types of leaf arrangement.
13. Types of leaf modifications. Examples.
14. Anatomical structure of the leaf.
15. Types of anatomical structure of the leaf.
16. Types of the leaf according stomata location.
17. Leaf as a source of medicines. Examples of medicinal plants.

3.3. MORPHOLOGY OF THE FLOWER. INFLORESCENCES

PRACTICAL WORK nr. 1. Morphology of the flower

1.1. Flower structure

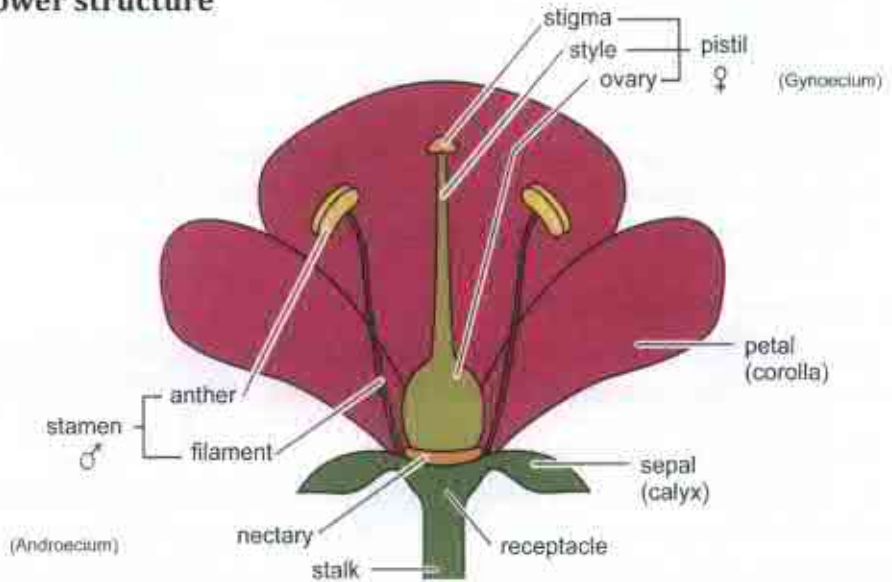
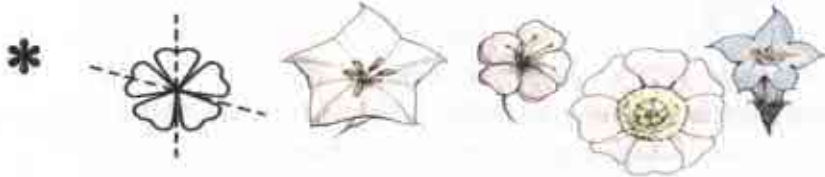


Fig. 132. Basic flower structure

1.2. Symmetry of the corolla

Actinomorphic flowers



Zigomorphic flowers

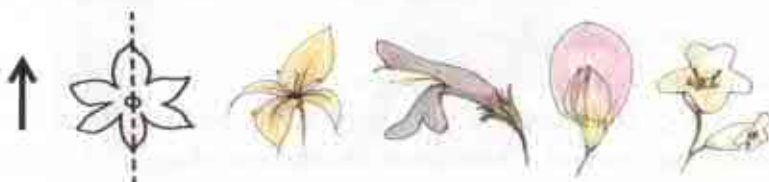


Fig. 133. Symmetry of the corolla

1.3. Shape of calyx (Ca)

Working with dried or fixed botanical materials and herbaria find and analyze different types of calyx shape.

1. **Campanulate:** Bell-shaped, e.g., g. *Althaea*.
2. **Stellate:** Star-like, e.g., g. *Capsicum*, *Solanum*.
3. **Cupulate:** Cup-like, e.g., g. *Gossypium*.
4. **Urceolate:** Urn-shaped, e.g., g. *Hyoscyamus*.
5. **Infundibuliform:** Funnel-shaped, e.g., sp. *Atropa belladonna*.
6. **Tubular:** Tube-like, e.g., g. *Datura*.
7. **Bilabiate:** Calyx forms two lips, e.g., g. *Ocimum*.
8. **Pappus:** Calyx is modified into hairs e.g., g. *Taraxacum* (fam. Asteraceae).
9. **Spinous:** Calyx with spines, e.g., g. *Trapa*.

1.4. Shape of the corolla (Co)

Working with dried or fixed botanical materials and herbaria, find and analyze different types of corolla shape (fig. 134).

Shapes of actinomorphic (*) corolla

1. **Tubular:** Five united petals form a cylindrical tubular structure, e.g., disc florets of some species from fam. Asteraceae (e.g. Sunflower *Helianthus annuus*, Chamomile *Matricaria chamomilla*, and Marigold *Calendula officinalis*).

2. **Long-tubular:** Petals are fused and form a long tubular corolla, e.g., g. *Datura*, *Nicotiana*.

3. **Companulate:** It is a bell-shaped corolla, e.g., g. *Atropa*, *Convallaria*.

4. **Rotate:** Short tubular corolla with spread out lobes appearing like a wheel e.g., g. *Petunia*, *Convolvulus*.

5. **Urceolate:** e.g. g. *Arctostaphylos*.

6. **Stelate (star-like):** e.g., g. *Lycopersicon*, *Capsicum*

4. **Infundibuliform (long-tubular):** The petals are fused and form a long tubular-funnel corolla, e.g., g. *Datura*, *Nicotiana*.

7. **Hypocrateriform:** It is a salver-shaped corolla. It is provided with an elongated narrow tube having lobes at the top placed at right angles, e.g., g. *Vinca*.

Shapes of zygomorphic (↑) corolla

1. **Ligulate:** Corolla with a short tube which is drawn out into a tongue-shaped structure e.g., ray florets of some species from fam. Asteraceae (e.g. Sunflower *Helianthus annuus*, Chamomile *Matricaria chamomilla*, and Marigold *Calendula officinalis*).

2. **Bilabiate:** An irregular Co is united, in such a way that it appears 2 lipped. It is the characteristic Co of species from fam. Lamiaceae, e.g., *Salvia officinalis*, *Lamium album*.

3. **Papilionate:** An irregular Co is like a butterfly, e.g., fam. Fabaceae.

4. **Spurate:** An irregular Co with spur. e.g., g. *Consolida*, *Linaria*.



(rotate, wheel-shaped)



(campanulate, bell-shaped)



(urceolate, urn-shaped)



(salverform, hypocrateriform)



(funneliform)



(tubular)



(ligulate, tongue-shaped)



(bilabiate)



(personate)



(star-tubular)



(papilionaceous)

Fig. 134. Shapes of the flower corolla

1.5. Morphology of androecium (A)

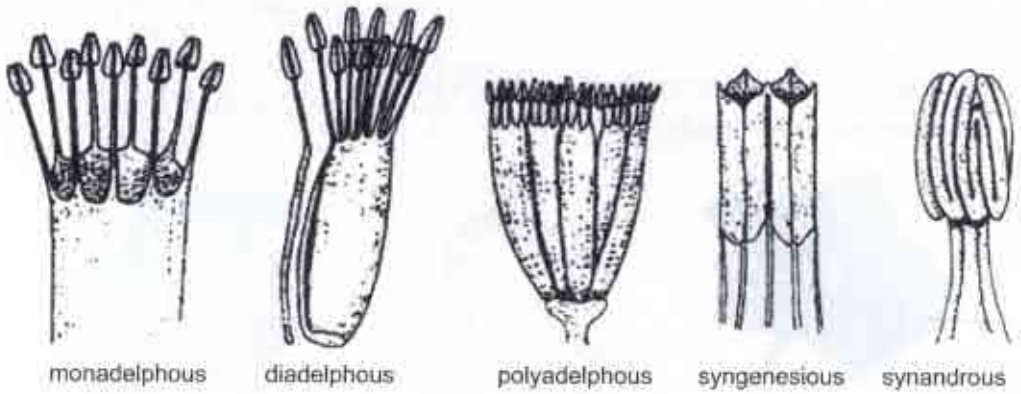


Fig. 135. Types of fused androecium

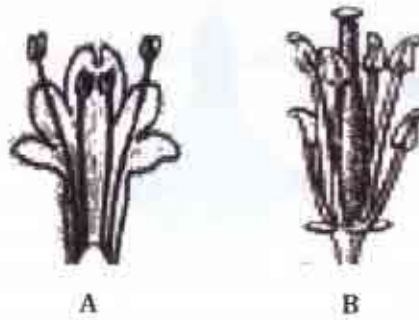


Fig. 136. Types of free androecium: A - didynamous; B - tetradynamous

1.6. Morphology of gynoecium (G)

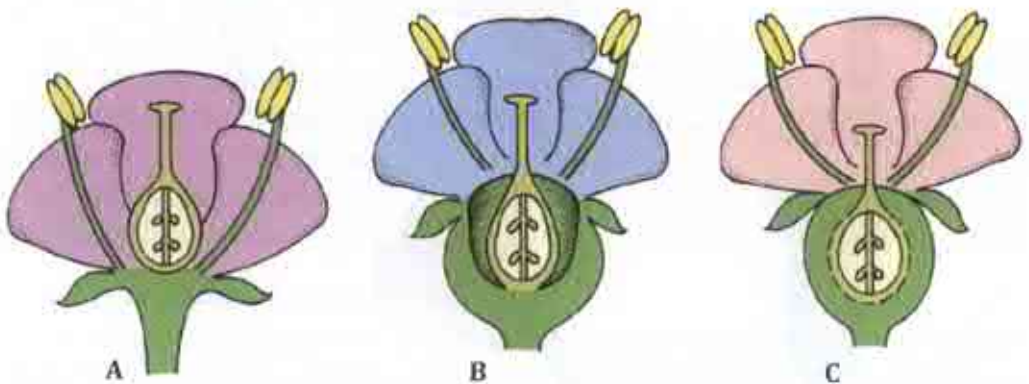


Fig. 137. Types of flowers according to the position of the gynoecium ovary:
A - hypogynous; B - perigynous; C - epigynous

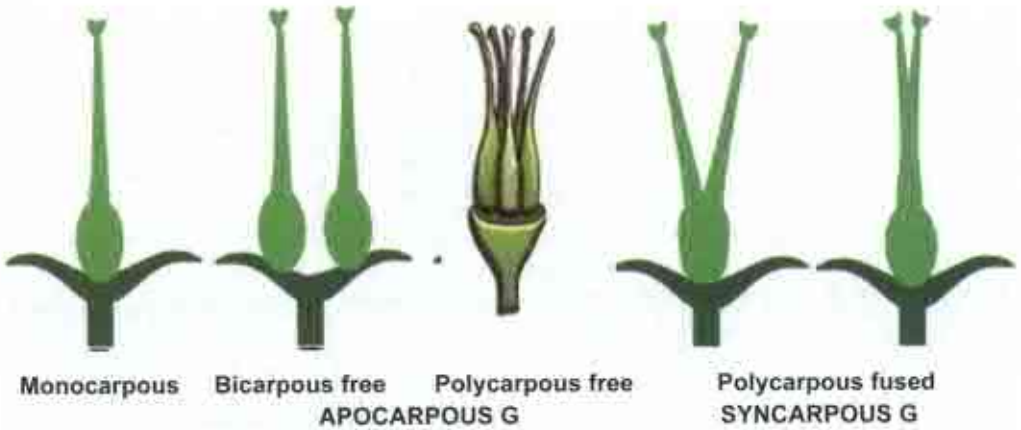


Fig. 138. Types of gynoecium according to the degree of carpel fusion

PRACTICAL WORK nr. 2. Inflorescences

2.1. Types of inflorescences

Working with dried or fixed botanical materials and herbaria, find and analyze different types of inflorescences (fig. 139).

Simple racemous:

- spike
- raceme
- corymb
- umbel
- spadix
- catkin
- calatidium (head)

Compound racemous:

- compound umbel
- compound spike
- compound corymb
- compound calatidium
- compound raceme
- panicle
- (compound raceme + raceme or spikes)
- raceme + umbels
- corymb + calatidium

Cymose inflorescences:

- monochasial
- dichasial
- pleiochasial

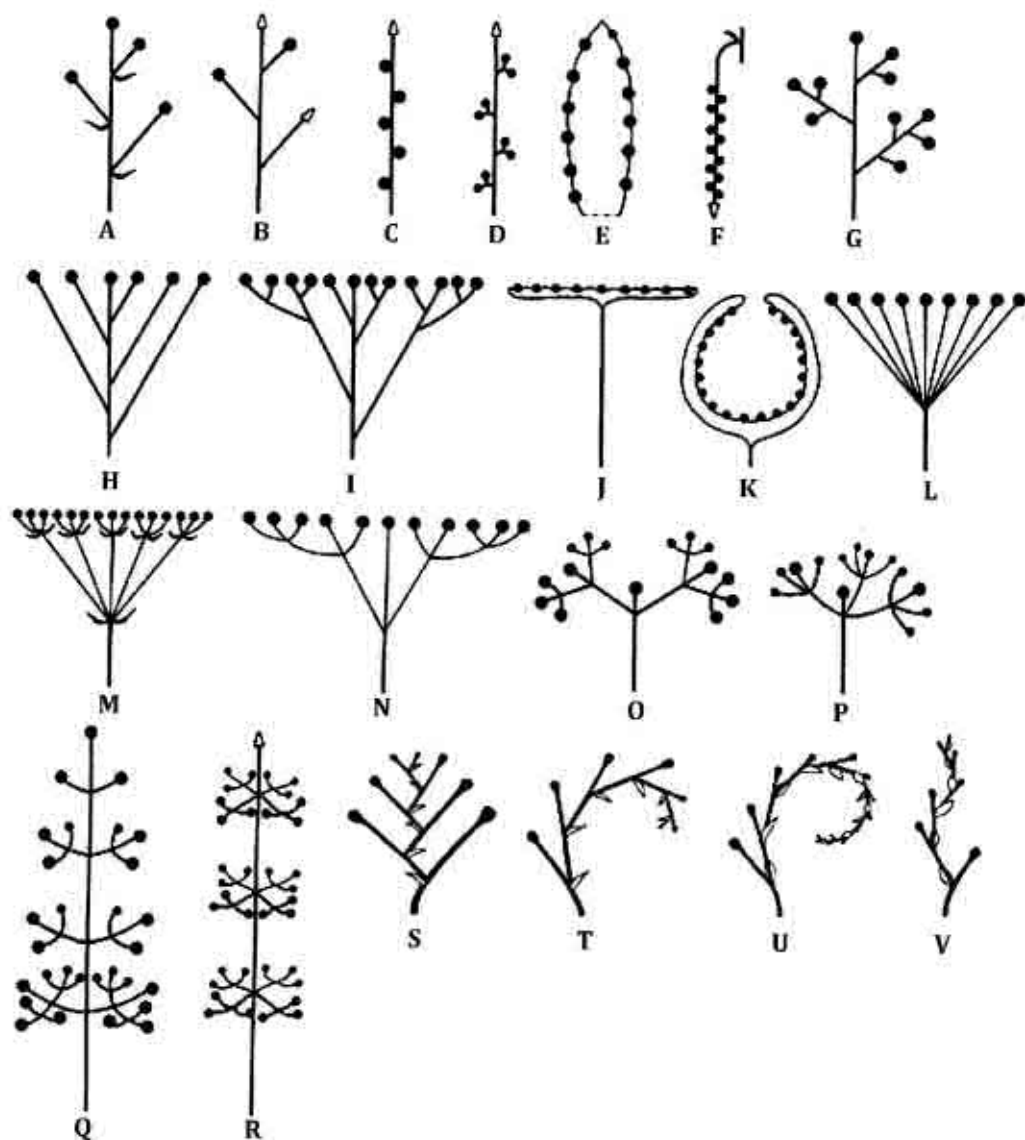


Fig. 139. Types of inflorescences: A, B – raceme; C, D – spike; E – spadix; F – catkin; G – panicle; H – corymb; I – compound corymb; J – calatidium; K – hypanthodium; L – simple umbel; M, N – compound umbel; O – dichasial cyme; P – pleiochasial cyme; Q – thryse; R – verticillaster; S-V – monochasial cymes (S – rhipidium; T – drepanium; U – cincinnus; V – bostryx)

SUBJECTS FOR DISCUSSION:

1. Functions of the flower.
2. Basic structure of the complete flower.
3. What is calyx, corolla, peryanth, androecium, gynoecium?
4. Symmetry of the flower.
5. Types of calyx according to the degree of fusion.
6. Shapes of the calyx.
7. Types of the corolla according to the degree of fusion.
8. The shape of actinomorphic and zygomorphic flowers.
9. Morphology of stamen.
10. Types of androecious. Examples.
11. Morphology of the pistil. Examples.
12. Types of gynoecious. Examples.
13. Flower sex. Examples.
14. Flower symbols. Examples.
15. Flower formula. Examples.
16. What is inflorescence?
17. Characteristics of racemous and cymose inflorescences.
18. Types of simple racemous inflorescences. Examples.
19. Types of compound racemous inflorescences. Examples.
20. Types of simple cymose inflorescences. Examples.
21. The biological role of flowers and inflorescences.
22. Flower as a source of medicines. Examples.

3.5. MORPHOLOGY AND ANATOMY OF THE FRUIT AND SEED

PRACTICAL WORK nr. 1. Morphology of the fruit

1.1. Morphology of the fruit

Analyze the morphology of fruits on dried or fixed botanical materials and herbaria using the complex of criteria:

1. **Shape:** rounded, conical, ovate, elongated, pyramidal, irregular;
2. **Size:** from some millimeters to a meter;
3. **Symmetry:** non-symmetrical and symmetrical: monosymmetrical, bisymmetrical, polysymmetrical (radial);
4. **Colour:** uni-, bi- and polychromatic: lines, spots, geometrical, diffuse;
5. **Aspect of surface:** shiny, matt, sticky, spiny, hairy.
6. **Opening:** dehiscent and non-dehiscent

1.2. Classification of fruits

Principal classification criteria of fruit classification:

1. **mode of formation** (type of gynoecium that formed the fruit – apocarpous or syncarpous; superior, inferior or semi-inferior; ovary from one flower or from one inflorescence; ovary and other flower elements);
2. **consistence** of mature pericarp;
3. **number** of seeds;
4. **opening** of pericarp and others.



Fig. 140. Scheme of fruit classification

1.3. Types of fruits

Analyze different types of fruits on dried or fixed vegetable drugs and herbaria according to the following categories:

SIMPLE FRUITS (fig. 141, 142)

Simple, dry, polyspermous, dehiscent fruits:

- **follicle** (fam. Ranunculaceae, Rosaceae);
- **pod or legume** (fam. Fabaceae);
- **siliqua and silicle** (fam. Brassicaceae);
- **different types of capsules: poricidal capsule** (fam. Papaveraceae), **operculate capsule** (pyxis) (g. *Hyoscyamus*), **septicidal capsule** (g. *Gossypium*), **septifragal capsule** (g. *Datura*); **valvular capsule** (g. *Colchicum*).

Simple, dry, polyspermous, indehiscent fruits:

- **strangulated siliqua** (g. *Raphanus*);
- **lomentous or strangulated legume** (g. *Arachis, Sophora*).

Simple, dry, monospermous, indehiscent:

- **nut:** acorn (g. *Quercus*); nut in involucre (g. *Coryllus*); nut in spiny husks (g. *Fagus*);
- **nutlet:** spherical (fam. Tiliaceae); angular nutlet (fam. Polygonaceae); 4-nutlets (fam. Lamiaceae);
- **achene** without or with pappus (fam. Asteraceae); Caryopsis or grain (fam. Poaceae);
- **samara:** unisamara (g. *Fraxinus*), bisamara (fam. Aceraceae).

Simple, fleshy (succulent), indehiscent fruits:

- **berry:** (g. *Solanum, Vaccinium, Capsicum*);
- **hesperidium:** (fam. Rutaceae);
- **drupe:** (s/fam. Prunoideae – g. *Prunus*).

Simple, fleshy (succulent), dehiscent fruits:

- **flashy capsule** (fam. Hyppocastanaceae, Juglandaceae).

AGGREGATE FRUITS

- **Polyachene** (g. *Adonis*);
- **Schizocarp** (polyachene) (fam. Malvaceae); biachene (fam. Apiaceae);
- **Polynutlet** (g. *Fragaria*);
- **Three-follicle** (g. *Aconitum*), **polyfollicle** (g. *Heleborus, Paeonia*);
- **Polydrupe** (g. *Rubus*).

PSEUDOFRUIT (FALSE FRUIT)

- **Pseudoberry** (g. *Juniperus*);
- **Berry fused with calyx** (g. *Atropa*);
- **Pseudodrupe** (g. *Ginkgo*);
- **Pomme** (s/fam. Maloideae, g. *Malus*, *Pyrus*, *Cydonia*, *Aronia*);
- **Hips** (s/fam. Rosoideae, g. *Rosa*);
- **Melonide or pepos** (fam. Cucurbitaceae, g. *Cucurbita*, *Cucumis*).

COMPOUND OR MULTIPLE FRUITS

- **Glomerule** (fam. Chenopodiaceae);
- **Sycony** (g. *Ficus*);
- **Spadix** (g. *Zea*);
- **Multiple druplet** (g. *Morus*).



pod
of prea



silique
of crucifer



follicle
of larkspur



capsule
of jimson weed



caryopsis
of corn



achene
of sunflower



samara
of maple



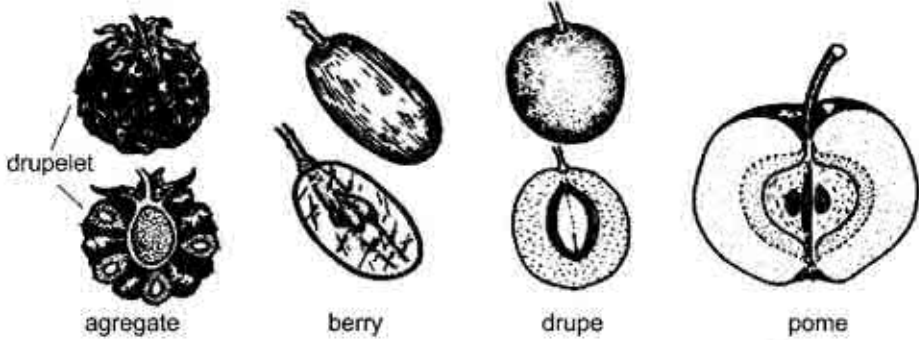
schizocarp
of carrot



nut
of oak

Fig. 141. Types of simple dry fruits

FLESHY



DRY

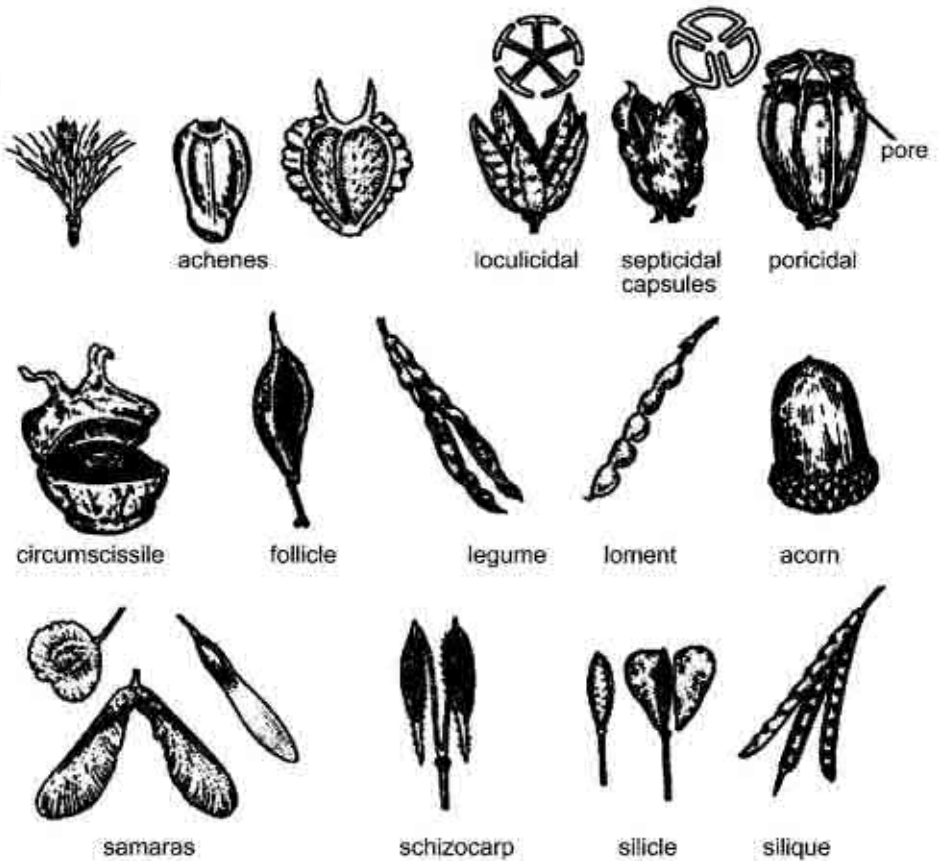


Fig. 142. Some types of fleshy and dry fruits

PRACTICAL WORK nr. 2. Anatomy of the fruit

2.1. Anatomy of some fleshy fruits

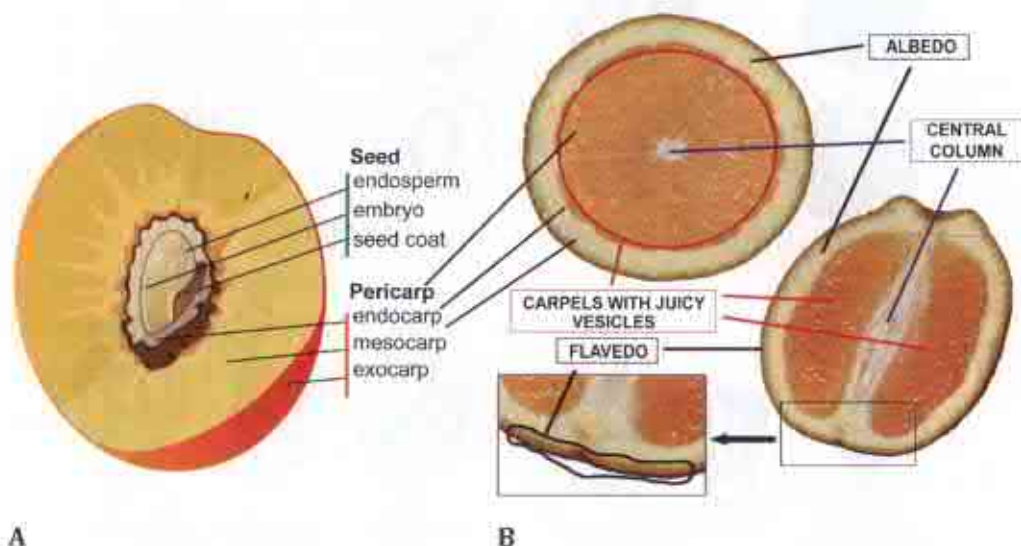


Fig. 143. Anatomy of fruit: A – anatomy of the Peach *Prunus persica* drupe;
B – anatomy of the Lemon *Citrus limon* hesperidium

PRACTICAL WORK nr. 3. Morphology and anatomy of the seed

3.1. Morphology of the seed

Analyze the morphology of seeds on dried or fixed vegetable materials and herbaria using the complex of criteria such:

1. **shape:** rounded, conical, ovate, elongated, elliptical, lenticular, pyramidal;
2. **size:** from mm to cm;
3. **colour:** uni-, bi- and polychromatic (lines, spots, geometrical forms);
4. **aspect of seed surface:** shiny, matt, sticky, spiny, hairy.
5. **chemical nature of storage substances:** starchy or amylogenous; fatty (rich in oils); protein; fibrous (rich in cellulose fibers).

3.2. Anatomy of the seed

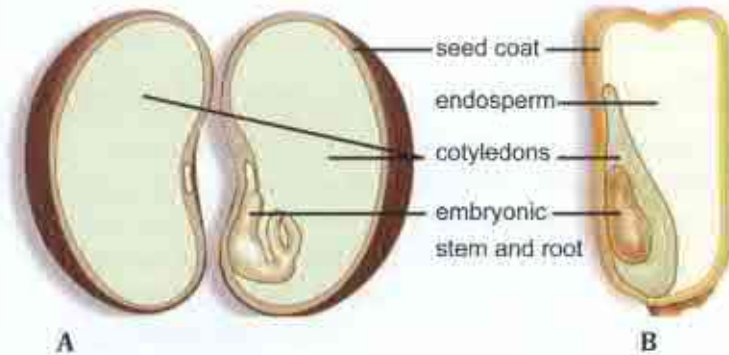


Fig. 144. Anatomy of the seeds: A – Bean *Phaseolus vulgaris*; B – Corn *Zea mays*

SUBJECTS FOR DISCUSSION:

1. Functions of the fruit.
2. Morphology of fruit.
3. Criteria for fruit classification.
4. What do simple, aggregate, multiple or compound, and false fruits mean?
5. Simple, dry, polyspermous, dehiscent fruits.
6. Differences of follicle, pod, silique, silicle, and different types of capsules. Examples of medicinal plants.
7. Simple, dry, monospermous indehiscent fruits.
8. Differences of achene, caryopsis, nut, nutlet, samara and bisamara. Examples of medicinal plants.
9. Simple, dry, polyspermous, indehiscent fruits.
10. What are lomentous legume and silique? Examples.
11. Simple, fleshy (succulent), indehiscent and dehiscent fruits.
12. Characteristics of berry, drupe, hesperidium and fleshy capsule. Examples of medicinal plants.
13. Examples of false fruits of medicinal plants.
14. Example of aggregate fruits of medicinal plants.
15. Example of compound fruits of medicinal plants.
16. Fruits as a source of medicines. Examples of medicinal plants.
17. Morphology of the seed. Examples of medicinal plants.
18. Anatomy of the Dicot seed.
19. Anatomy of the Monocot seed.
20. Fruits and seeds as a source of healthy nutrition. Examples.

21. The biological role of fruits and seeds.
22. Ways of fruit and seed dissemination.
23. Seeds as a source of medicines. Examples of medicinal plants.

SUBJECTS FOR THE TEST ON „ORGANOGRAPHY“

1. Vegetative and reproductive organs.
2. **Root. Primary and secondary functions.**
3. Types of roots according to their origin.
4. What are primary, secondary and adventitious roots?
5. Types of roots systems. Examples of plants.
6. Types of aerial modified roots. Examples of plants.
7. Types of underground modified roots. Examples of plants.
8. Primary anatomical structure of the root.
9. What is secondary growth of the root?
10. **Stem. Primary and secondary functions.**
11. Morphology of the twig.
12. Types of buds and bud arrangement on the twig.
13. Types of stems according to their position.
14. Shapes of stem in cross section.
15. Types of stem branching. Examples.
16. Types of aboveground stem modifications. Examples.
17. Types of underground stem modifications. Examples.
18. Primary anatomical structure of the stem.
19. Secondary anatomical structure of the stem.
20. **Leaf. Primary and secondary functions.**
21. Morphology of the leaf.
22. Petiolate and sessile leaves.
23. Types of compound leaves.
24. Types of venation.
25. Shapes of the leaf apex.
26. Shapes of the leaf base.
27. Leaf margins with small incisions.
28. Leaf margins with deep incisions.
29. Shapes of the leaf lamina.
30. Types of leaf modifications. Examples.
31. Types of anatomy leaf structure.
32. Types of leaf according to the stomata position.
33. **Flower. Functions.**
34. Basic structure of complete flowers.

35. What are calyx, corolla, peryanth, androceous, gynoecium?
36. Symmetry of the flower.
37. Types of calyx according to the degree of fusion.
38. Shapes of the calyx.
39. Types of the corolla according degree of fusion.
40. The shape of actinomorphic and zygomorphic flowers.
41. Morphology of the stamen.
42. Types of the androecium.
43. Morphology of the pistil.
44. Types of gynoecium.
45. **What is inflorescence?**
46. Types of simple racemous inflorescences.
47. Types of compound racemous inflorescences.
48. Types of simple cymose inflorescences.
49. The biological role of the flower and inflorescence.
50. **Fruit. Functions.**
51. Morphology of the fruit.
52. What do simple, aggregate, multiple or compound, and false fruits mean?
53. Simple, dry, polyspermous, dehiscent fruits.
54. Differences of follicle, pod, silique, silicle, and different types of capsules. Examples of medicinal plants.
55. Simple, dry, monospermous indehiscent fruits.
56. Differences of achene, caryopsis, nut, nutlet, samara and bisamara. Examples of medicinal plants.
57. Simple, dry, polyspermous, indehiscent fruits.
58. What are lomentous legume and silique? Examples.
59. Simple, fleshy (succulent), indehiscent and dehiscent fruits.
60. Characteristics of berry, drupe, hesperidium and fleshy capsule. Examples of medicinal plants.
61. Examples of false fruits in medicinal plants.
62. Examples of aggregate fruits in medicinal plants.
63. Examples of compound fruits in medicinal plants.
64. **Seed. Functions.**
65. Morphology of the seed. Examples of medicinal plants.
66. Anatomy of the Dicot seed and Monocot seeds.
67. Fruits and seeds as a source of healthy diet. Examples.
68. Seeds as a source of medicines. Examples of medicinal plants.
69. Biological role of fruits and seeds.
70. Ways of fruit and seed dissemination.

TEST SAMPLES

- 1) s.c. Choose the organ which is covered with the epiblema:
 - a) stem;
 - b) twig;
 - c) root;
 - d) flower;
 - e) fruit.

- 2) m.c. Choose the species that are a source of vegetable product *Radices*:
 - a) *Matricaria chamomilla*;
 - b) *Daucus carota*, var. *carota*
 - c) *Taraxacum officinale*;
 - d) *Papaver somniferum*;
 - e) *Solanum tuberosum*.

- 3) m.c. Choose the types of modified underground stem:
 - a) tuber;
 - b) rhizome;
 - c) tuberous root;
 - d) tendril;
 - e) bulb.

- 4) m.c. The types of leaf venation are:
 - a) parallel;
 - b) pinnate;
 - c) serrate;
 - d) dichotomous;
 - e) palmate.

- 5) m.c. The types of compound leaves are:
 - a) palmate;
 - b) three-foliolate;
 - c) paripinnate;
 - d) imparipinnate;
 - e) three-sected.

- 6) s.c. Choose the type of dry, monospermous fruit:
 - a) hesperidium;
 - b) drupe;
 - c) legume;
 - d) achene;
 - e) follicle.

- 7) m. c. The shapes of zygomorphic flower corolla are:
 - a) bilabiate;
 - b) ligulate;
 - c) campanulate;
 - d) rotate;
 - e) personate.

- 8) m. c. The shapes of actinomorphic flower corolla are:
 - a) lanceolate;
 - b) funnelform;
 - c) tubular;
 - d) rotate;
 - e) campanulate.

- 9) s.c. Choose the type of inflorescence specific for fam. Asteraceae:
 - a) raceme;
 - b) umbel;
 - c) corymb;
 - d) calatidium;
 - e) spadix.

- 10) m.c. Choose the characteristics of the berry fruit:
 - a) dry;
 - b) fleshy;
 - c) monospermous;
 - d) polyspermous;
 - e) specific for fam. Fabaceae.

3.6. MORPHOLOGICAL ANALYSIS OF HERBORIZED PLANTS

PRACTICAL WORK nr. 1. Morphological description of flowering plants

Working with atlases, schemes, images and herbaria describe the morphology of some species of herbaceous and woody plants (using the proposed plan).

PLAN OF PLANT DESCRIPTION ON MORPHO-ANATOMICAL CLUES

In order to identify a plant it is necessary to make a morphological analysis, and if it is necessary to carry out an anatomical study, too. We propose a schematic plan of plant description, based on morphological clues of vegetative and reproductive organs. This scheme of plant description may serve as a support for morpho-anatomical description and identification of species of flowering plants of division *Magnoliophyta*.

A. VITAL FORMS OF THE PLANT

Woody plants:

- tree;
- shrub;
- subshrub;
- woody vine.

Herbaceous plants:

- annual;
- biannual;
- perennial.

B. VEGETATIVE ORGANS:

1. Root

- **Types of roots according to their origin** (principal, secondary, adventitious);
- **Types of root systems:** tap root, fibrous, branched;
- **Types of root modifications** (methamorphosis): contractile, fixed aerial, prop or stilt, tuberous, nodules with N-fixed bacteria, haustoria, mycorrhiza, assimilatory roots, respiratory (pneumatophoria), with buds.

2. Stem

- **Types of stem branching:** unbranching and branching (dichotomical, pseudodichotomical, monopodial, simpodial);
- **Types of stems according space orientation (position):** orthotropic stem (erect, nutant, climbers) and plagiotropic (trailer, prostrate, creeper);
- **Full stem or with lacuna;**
- **Surface of the stem:** shiny, matt, hairy, steaky, costate, rough, smooth;
- **Degree of pubescence:** glabrous, glabrescent, pubescent;
- **Colour of the stem:** uni-, bi- or polychromatic (in the last 2 cases – mode of colour alternating: spots, longitudinal or transversal lines, diffuse, mosaic);
- **Presence or absence** of lenticels, its colour and mode of distribution;
- **Stem shape in section:** cylindrical, oval, compressed, costate, triangular, square, winged;
- **Mode of bud arrangement** on a twig: alternate (spiralate), opposite, whorled;
- **Length of internodes:** long, middle, short, very short (to 0.5 cm);
- **Type of aboveground stem modifications:** thorn, tendrill, giant bud, succulent or assimilation stems, cladode, phylloclade;
- **Type of aboveground stem modificatins:** rhizome (horizontal, vertical, oblique; short and wide, long and slender), bulb, tuber, tuber-bulb.

3. Leaf

- **Petiolate** (short or long), **sessile** (amplexicaul, perfoliate, decurrent);
- **Presence or absent of foliar annexes:** stipules, sheath, ligule, ochrea;
- **Types of venation:** univein, dichotomical, parallel, curbate (ovate), pennate, palmate;
- **Mode of arrangement on the twig:** alternate (hellicoidal), opposite, whorled, basal rosette;
- **Type of modified leaf:** spine, tendrill, phyllode, reduced leaf – scale-like or cataphylls;
- **Presence or absence of:** anisophylly, heterophylly, leaf mosaic.

Simple leaves

- **Shape of the petiole:** cylindrical, compressed, dilated, auriculate;
- **Shape of the leaf-blade (lamina):** elliptical ovate, oval, obovate, spherical, lanceolate, ovate-lanceolate, thre-ungular, diamondal, re-

niform, deltoid, cordate, hastate, spatulate, linear, oblong, sagittate, cylindrical, oblique;

- **Base of the lamina:** rotunded, cordate, sagittate, hastate, reniform, cuneate, dilated, asymmetric, auriculate, obtuse, attenuate;
- **Apex of the lamina:** acute, acuminate, rotunded, obtuse, mucronate, cuspidate, emarginate, mucronate, aristate, retuse;
- **Entire lamina margin:** smooth, rough, ciliate, curled, folded;
- **Leaf margin with small incisions:** entire, dentate, denticulate, serrate (doubly-serrate), crenate (doubly crenate), sinuate, serrulate, crenulate ;
- **Leaf margin with deep incisions:** three-, palmate-, pinnate- (lobed, parted, sected);
- **Lamina with irregular margin:** runcinate, lirate;
- **Surface of the lamina:** shiny, matt, pubescent (glabrescent, pubescent, hispid, woolly, rough, smooth, sticky, glandulous);
- **Consistency of the lamina:** succulent, fleshy, leather, woody;
- **Venation of the lamina:** uni-vein, dichotomous; parallel; pinnately; palmately, ovate;
- **Colour of the lamina:** uni-, bi-, polychromatic (longitudial or horizontal lines, spots, geometrical forms, diffuse).

Compound leaves

- **Types of compound leaves:** trifoliate, palmate (digitate) compound, pinnate compound (bipinnate compound);
- **The shape of the margin, apex, base and the shape of the leaflet** of compound leaves is determined by such a method as lamina of simple leaves.

C. REPRODUCTIVE ORGANS

1. Flower

- Sessile or pedunculate;
- Complete or incomplete;
- Symmetry (actinomorphic, zigomorphic, asymmetrical).

Receptacle

- Form: flat, concave, convex.

Perianth

- **Type of perianth:** double, simple (sepaloid or petaloid), absent - naked flower;
- **Arrangement of flower elements:** spirocyclic (helicoidal), semicyclic (cycles and helicoidal), whorled (cycles);

- **Number of circles:** mono-, di-, three-, four-, penta-, hexacircles;
- **Number of elements in a circle:** mono-, di-, three-, tetra-, penta- and poly.

Calyx

- **Dialisepalous** (free sepals)
- **Gamosepalous** (fused sepals) with different degree: at the base, $\frac{1}{2}$; $\frac{2}{3}$; $\frac{3}{4}$ from calyx length, total length;
- **Shape:** tubular, infundibuliform, stelate, urceolate, bulbing, campanulate, cupulate, spinous, modified in pappus;
- **Number** of sepals;
- **Colour** (uni-, bi- or polychromatic) and aspect of surface (matt, shiny, pubescent, glabrous, spiny).

Corolla

- **Dialipetalous** (free petals);
- **Gamopetalous** (fused petals) with different degree: at the base, $\frac{1}{2}$; $\frac{2}{3}$; $\frac{3}{4}$ from calyx length, total length;
- **Shape of gamopetalous, actinomorphic corolla:** tubular, urceolate, campanulate, rotate, fennel-like, hipocrateriform, star-like;
- **Shape of gamopetalous, zygomorphic corolla:** bilabiate (two-lipped), personate, ligulate, spurate;
- **Number of petals** (3, 4, 5 and their multiple) **and their shape:** orbiculate, ovate, ovate-lanceolate, lanceolate, emarginate;
- **Colour of petals** (uni-, bi- or polychromatic; stained, striped, mottled;)
- **Petal modifications into:** nectariferous petals, nectariferous cones, nectariferous spur;

Androceous (A)

- **Number of stamens** (monomerous A, dimerous A, polymerous A);
- **Degree of fusion:** dialistemous A, gamostemous A (monodelphous, didelphous, polyadelphous, syngenesious, syandrous);
- **Presence or absence of staminoids.**

Gineceous (G)

- **Number of carpels:** monocarpous, bicarpous, tricarpous, pentacarpous, polycarpous;
- **Degree of fusion:** apocarpous or syncarpous G;
- **Ovary position:** superior (hypogenous), semiinferior (perigenous), inferior (epigenous);

Types of flowers according to the sex: bisexual, unisexual (female or male), asexual (sterile);

Types of plants according to the flower distribution: plants with bisexual flowers, monoecious (unisexual female and male flowers on the same plant), dioecious (unisexual female and male flowers on different plants), polygamous (bisexual and unisexual flowers on the same or on different plants), polygamous-trioecious (bisexual and unisexual flowers on different plants or in different combinations).

Flower formula

Flower diagram

Inflorescences

- **Racemose (monopodial) simple:** raceme, spike, catkin, spadix, corymb, umbel, capitulum, calatidium;
- **Cimose simple:** monochasial (drepanium, ripidium, bostryx, cincinnus), dichasial, pleiochasial;
- **Compound homogenous:** compounds spike, compound raceme, compound umbel (with or without involucre), compound corymb, compound calatidium;
- **Compound heterogenous:** panicle (compound raceme with spikelets), corymb with calatidium, umbel with spike, dichasial with catkins, raceme with umbels, raceme with calatidium.

4. Fruits

Simple

- **Dry, indehiscent:** nut, nut in involucre, nutlet, achene, acorn, samara (uni-, bisamara), caryopsis, lomenta;
- **Dry, dehiscent:** folicle, legume (pod), silicule, silique, capsule (poricidal, dentate, valvular, operculate (pyxis), loculicidal, septifragal);
- **Succulent indehiscent:** berry, drupe, hesperidium;

Aggregate fruits

- 3-folicle, polyfolicle, polydrupe, diachene, polyachene, schizocarp, 4-nutlets, polynutlet.

Compound or multiple

- Multiple druplet, sycony, glomerule, spadix.

False (pseudo)

- Pseudoberry, pseudodrupe, pomme, melonide (pepos), hips.

5. Seed

- **Shape:** rounded, conical, ovate, elongated, elliptical, lenticular, pyramidal, spindle;
- **Size:** from mm to cm;
- **Colour:** uni-, bi- and polychromatic (lines, spots, geometrical forms);
- **Aspect of seed surface:** shiny, matt, sticky, spiny, velvety, hairy.
- **Presence or absent** of seed annexes: aril, ariloid, carunculous, strophilous;
- **Number of cotyledons and degree** of development;
- **Presence or absence of endosperm;**
- **Presence or absence persperm;**
- **Chemical type of endosperm:** amylogenous, fatty, aleuronic.

Chapter 4. VEGETAL SYSTEMATICS

LOWER ORGANISMS – THALLOBIONTA

4.1. MORPHOLOGY OF THE ALGAE

Material and tools: herberia, dried and fixed botanical materials, atlases, drawings, charts, schemes, hand glasses, preparation needles, pincers, Petry boxes, samples of living specimens (if necessary and when available)

Note: These materials and tools will be required for each laboratory work of chapter IV. Each student records the protocol in album. Each analysed species is depicted schematically with simple pencil, and is colored properly. Special morphological characteristics of species are marked. Below the drawing the correct Latin name of species and taxonomy is written. It is well to mention that the species is toxic and if the species is spontaneous or cultivated.

PRACTICAL WORK nr. 1. Blue-green algae

1.1. Morphology of the Spirulina

sp. Spirulina platensis L., syn. *Arthrospira platensis* L.

common name - spirulina

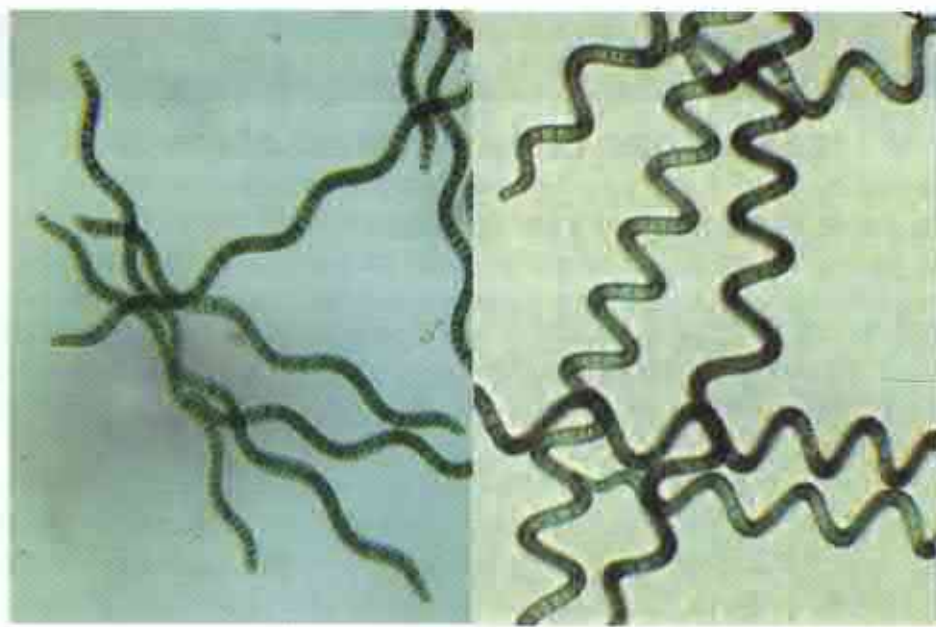
Fam. Oscillatoriaceae

Div. Cyanophyta

Blue-green (it contains chlorophylls and phycocyanins), prokaryotic, microscopic (60-90 μm), multicellular, filamentous algae, which can be floating (because they contain gas vacuole) and take helical structure in liquid media (fig. 145).

It is an autotrophic and fresh-water organism, but prefers salt water (30g/l) and pH 8-12.

Spirulina contains about 70% of proteins, a lot of essential amino acids, vitamins (B group, A, C, D, E, K), minerals (Fe, Mg, F, I, Se, Ge, Zn), dietary fibers, sugars, and fatty oils.



A

B

Fig. 145. Morphology of the sp. *Spirulina platensis*: A – filamentous algae;
B – helicoidally algae

PRACTICAL WORK nr. 2. Green algae

2.1. Unicellular non-mobile algae

Sp. *Chlorella vulgaris* L., common name – Chlorella

Fam. Chlorellaceae

Div. Chlorophyta

It is green (it contains chlorophylls and carotenoids), eukaryotic, microscopic, unicellular and non-mobile (fig. 146). The chromatophore has a disc-like shape.

It is an autotrophic and fresh-water organism, but can grow also on moist soils, tree bark and on damp walls. Alga is characterized by a high photosynthetic capacity.

Chlorella is now used as an adjunct supplement during radiation treatment of cancer. Its abundance of chlorophyll is known to protect the body against ultraviolet radiation.

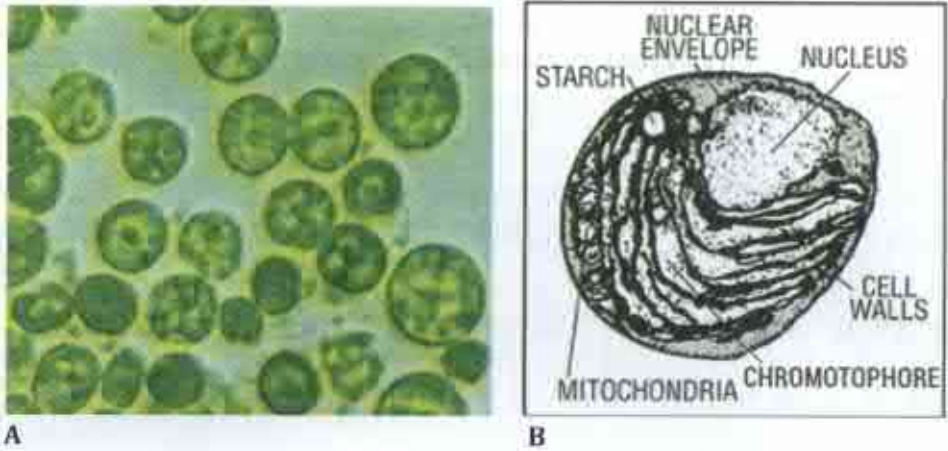


Fig. 146. Morphology of the sp. *Chlorella vulgaris*: A - population of algae; B - structure of *Chlorella* cell

2.2. Unicellular mobile algae

sp. *Dunaliella salina* (Dunal), common name - *Dunaliella*

Fam. Dunaliellaceae

Div. *Chlorophyta*

It is green, unicellular, mobile alga because it develops 2 flagella (fig. 147). It is autotrophic and prefers water with high salt concentration. *D. salina* has adapted to survive in high salinity environments by accumulating glycerol to balance osmotic pressure. *D. salina* is also adapted to solar radiation using carotene to protect against ionizing energy.

D. salina is perfect biotechnological producer to produce β -carotene and glycerol.

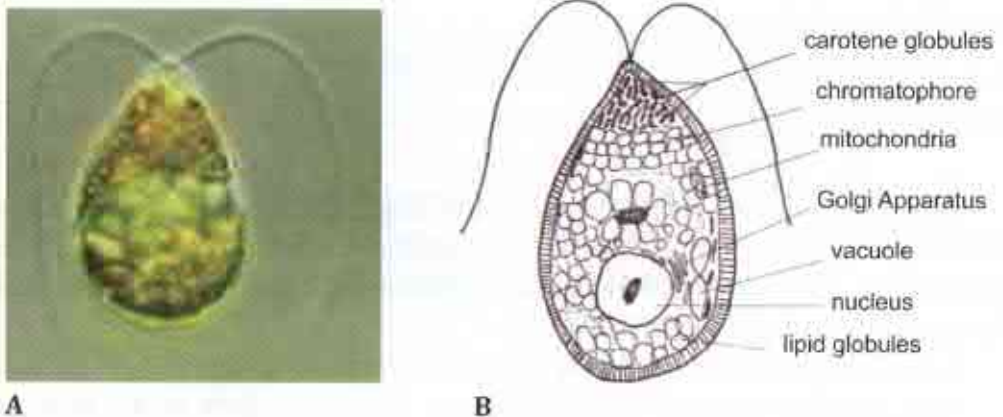


Fig. 147. Morphology of the sp. *Dunaliella salina*: A - micrograph; B - scheme structure

2.3. Multicellular fresh-water algae

Sp. Spirogyra elongata (Vaucher), common name – Water silk

Fam. Zygnemaceae

Div. Chlorophyta

It is green, multicellular, filamentous alga, consisting of a chain of cells with nucleus, vacuole and helicoidall chromatophore (fig. 148). It prefers fresh-water.

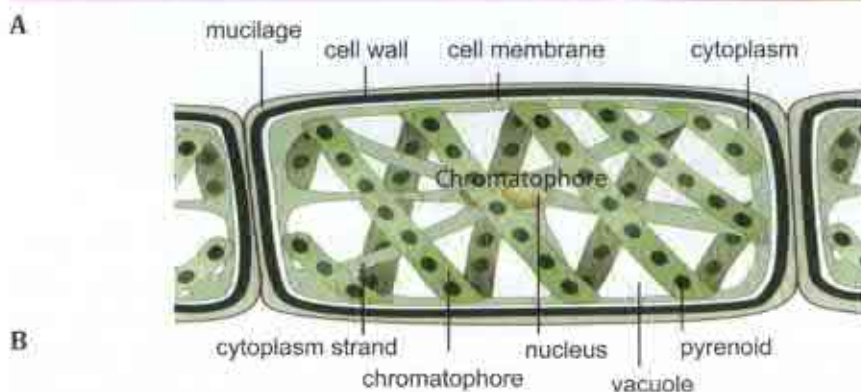


Fig. 148. Morphology of the sp. *Spirogyra elongata*: A – micrograph; B – scheme structure

2.4. Multicellular marine algae

Sp. Ulva lactuca L., common name – See lettuce

Fam. Ulvaceae

Div. Chlorophyta

It is a multicellular thallus consisting of large lamellar with wave margins, called phylloid (fig. 149). The lamellar phylloid is two-cell thick, soft and translucent, and usually grows attached, without a stipe, to rocks or other algae by a small disc-shaped holdfast.

It prefers salt water and forms benthos in seas and oceans.

Alga contains dietary fibers, mucilage, vitamin C, fatty acids, proteins, minerals.

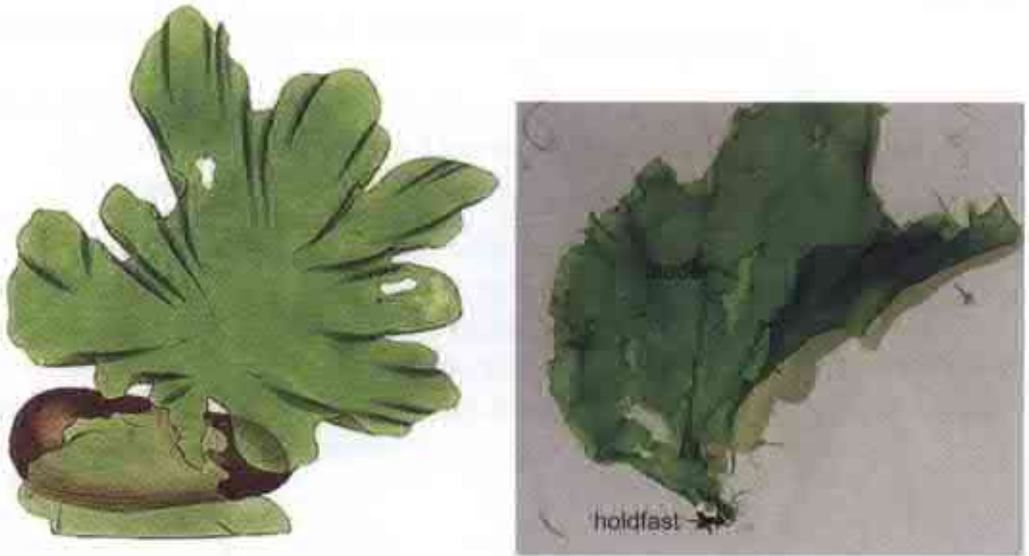


Fig. 149. Morphology of the Sea lettuce sp. *Ulva lactuca*

PRACTICAL WORK nr. 3. Brown algae

3.1. Multicellular marine algae

Sp. *Laminaria saccharina* L. (syn. *Saccharina latissima* L.),
common name – Sea belt

Fam. Laminariaceae

Div. Phaeophyta

It is of yellowish-brown colour with a long narrow, undivided phylloid (blade) that can grow to 5 meters long and 20 centimeters wide, elongated narrow stipe (caulloid) and fixed to the rock by a claw-like holdfast (rhizoid) (fig. 150).

It prefers salt water and forms benthos in cold deep seas and oceans.

Alga contains alginic acids, laminarine, mannitol, phucoin, iodine, proteins, lipids, dietary fibers, minerals (Fe, Zn, Cu, K, S, Na, Ca, Mg).

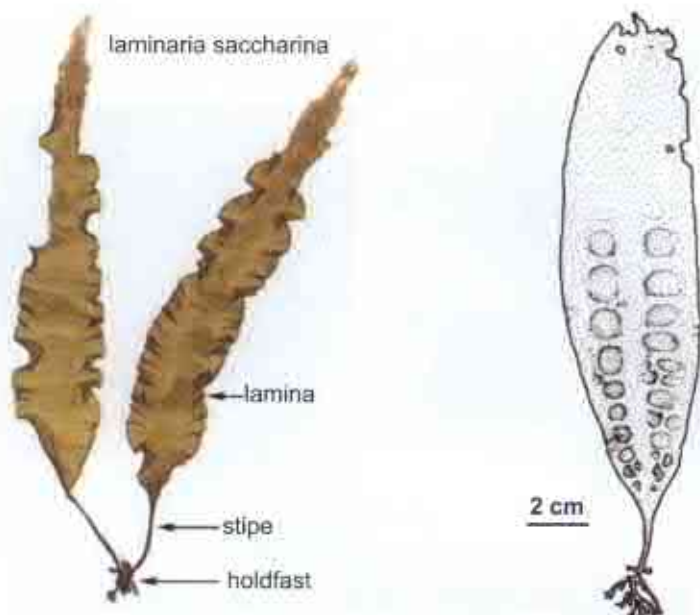


Fig. 150. Morphology of the Sea belt sp. *Laminaria saccharina* alga

Sp. *Fucus vesiculosus* L., common name – Bladder wrack

Fam. Fucaceae

Div. Phaeophyta

The thallus consists of dichotomous divided phylloides is stipe-like due to abrasion of the tissue lateral to the midrib and it is attached to the rock by a holdfast. Phylloides contain air bulbs (fig. 151).

The algae contain mucilage, and iodine.



Fig. 151. Morphology of the Bladder wrack sp. *Fucus vesiculosus* alga

PRACTICAL WORK nr. 4. Red algae

4.1. Multicellular marine algae

Sp. *Porphyra leucosticta* Thuret, common name - Porphyra
div. *Rhodophyta*

It is an alga of pink-red colour with lamellar foliose blade (phylloid), short stipe (cauloide) and fixed to the rock by a claw-like holdfast (rhizoid) (fig. 152).

It prefers salt water and forms benthos in seas and oceans.

The alga contains agar-agar, mucilage, Br and I, lipids, dietary fibers, and minerals (Fe, Zn, Cu, K, S, Na, Ca, Mg). It may be cultivated as an edible alga.

Other species: *P. variegata* (fig. 152).

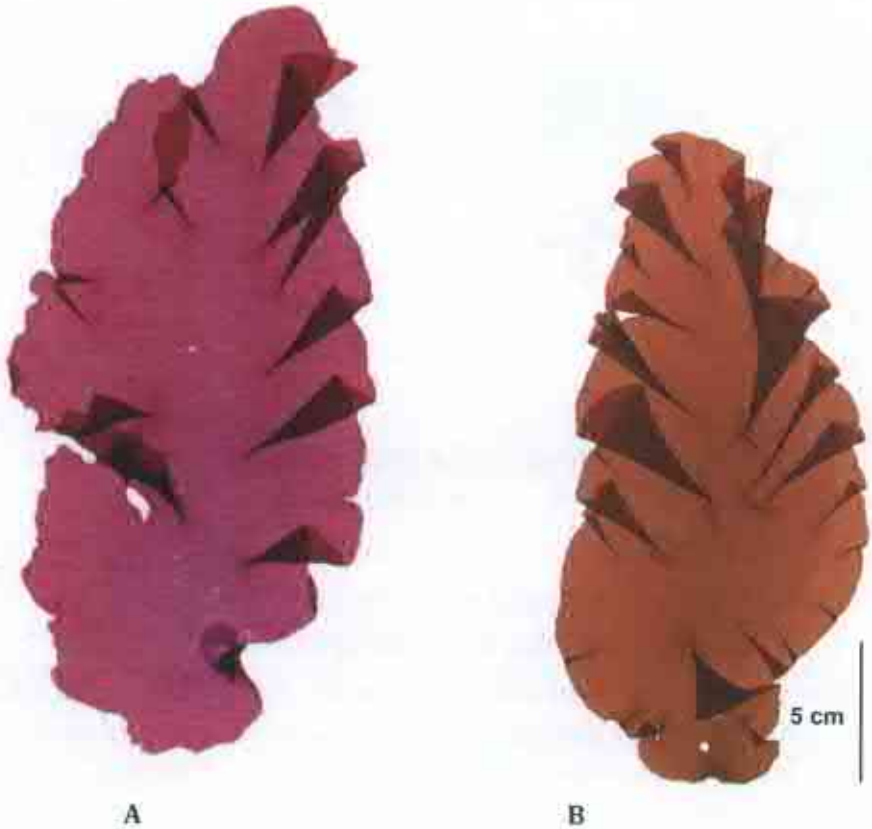


Fig. 152. Morphology of the species of g. *Porphyra*: A - *P. leucosticta*;
B - *P. variegata*

Sp. *Condrus crispus* (L.) Stackh., common name -

Irish moss or Carrageen moss

Fam. Rhodophyceae

Div. Rhodophyta

It is a red alga (contains chlorophylls, carotenoids and phycoerythrin - red pigments). Large thallus, fixed on rocks by rhizoids, develops a narrow stipe with a 4-5 dichotomous branching phylloid in a fan-like manner (fig. 153).

It prefers salt, cold water and forms benthos in the seas and oceans.

Alga contains agar-agar, carrageen, mucilage, lipids, dietary fibers, I, Br and other minerals.

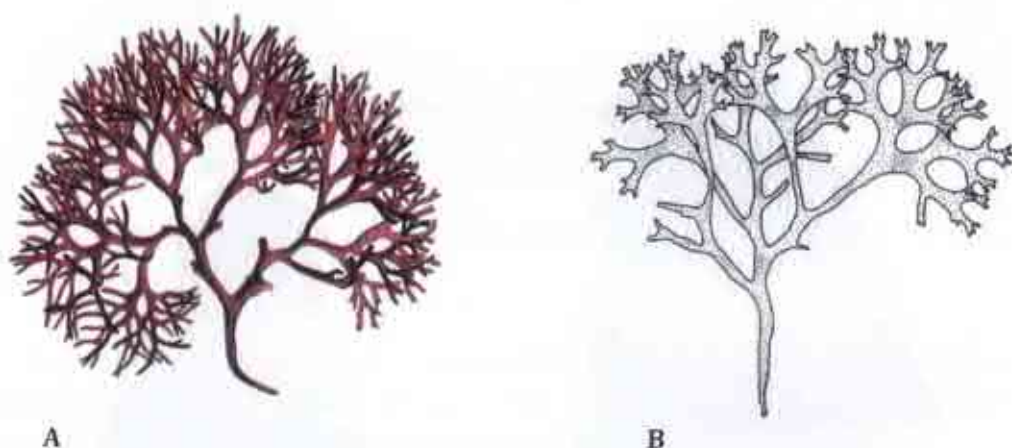


Fig. 153. Morphology of the Irish moss *Chondrus crispus*:

A - picture; B - scheme

INDIVIDUAL PRACTICAL WORK CHARACTERISTICS OF SOME SPECIES OF ALGAE

Analyze morphology of the following species: *Spirulina platensis*, *Chlorella vulgaris*, *Dunaliella salina*, *Spyrogyra elongata*, *Laminaria saccharina*, *Porphyra leucosticta*, and *Condrus crispus*, working with herbaria, drawings, schemes, atlases, algal literature, use the theoretical knowledge and fill in table 1 (below).

Table 1

Characteristics of some species of algae

Nr.	Species	Division (Filum)	Ecology	Morphology of thallus	Pigments	Role
1.	<i>Spirulina platensis</i>	<i>Cyanophyta</i>	Salt water (30g/l), pH 8-12	Multicellular thallus, helicoidal, about 60-90 μm in length. Prokariotic cells.	Chlorophylls, phycocyanins	Pharmaceutical and as a dietary product. It contains: proteins, free amino acids, vitamins, macro- and microelements.

SUBJECTS FOR DISCUSSION:

1. What is systematics?
2. What is taxonomy?
3. Principal taxons.
4. What is characteristic of species, genus, family, order, division, regnum?
5. What is the binominal nomenclature?
6. What is Carl Linneus? The role in botany.
7. What is the *Thallobionta*?
8. Characteristics of *Thallobionta*.
9. Ecology.
10. What is the thallus?
11. Structure organization of the thallus.
12. Reproduction.
13. Characteristics of the Blue-green algae div. *Cyanophyta*.
14. Description of sp. *Spirulina platensis*.
15. Characteristics of div. *Chlorophyta*.
16. Morphology of representative species from div. *Chlorophyta*.
17. Characteristics of div. *Phaeophyta*.
18. Morphology of representative species from div. *Phaeophyta*.
19. Characteristics of div. *Rhodophyta*.
20. Morphology of representative species from div. *Rhodophyta*.
21. The ecological and economic role of algae.
22. The pharmaceutical value of algae. Examples.

4.2. MORPHOLOGY OF THE FUNGI AND LICHENS

PRACTICAL WORK nr. 1. Saprophytic fungi

1.1. Morphology of acellular fungi

sp. *Mucor mucedo* (L.) Fres., common name - White mould

fam. Mucoraceae

div. *Mycophyta*

They are saprophytic fungi, microscopic with acellular (one big cell with a lot of nucleus) hyphae of mycelium. Mycelium is like a cottony mass. Ascendant hyphae are called sporangiophores and arise from the mycelium. At the tip of this the spherical head - the sporangium with a lot of black spores is developed (fig. 154).

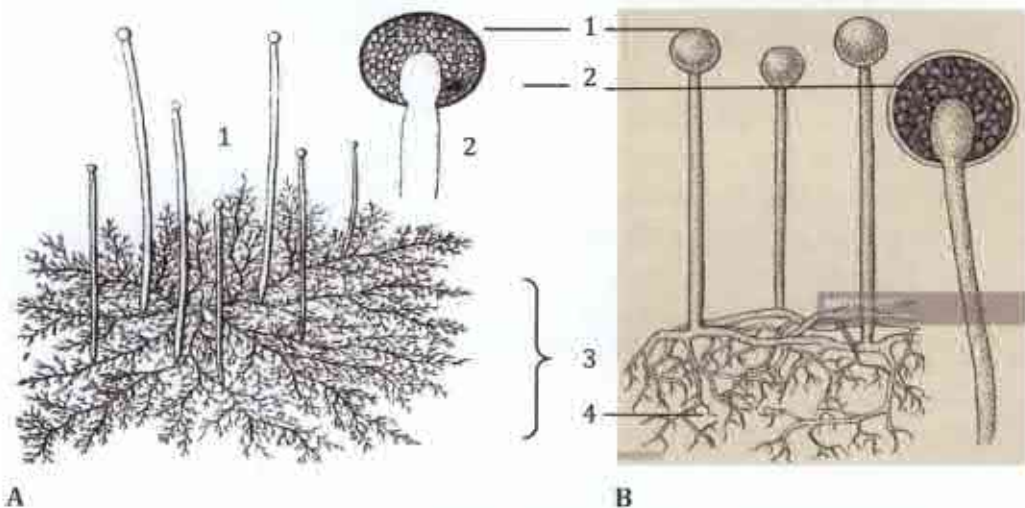


Fig. 154. White mould *Mucor mucedo* fungi: **A** - population of White mould; **B** - scheme of White mould mycelium: **1** - entire sporangia, **2** - section through sporangium with spores, **3** - mycelium, **4** - acellular branching hyphae

1.2. Morphology of the unicellular fungi

sp. *Saccharomyces cerevisiae* Meyen ex E. C. Hansen,

common name - Baker's Yeast

fam. Saccharomycetaceae

div. *Mycophyta*

Baker's Yeast consists of a single cell, which represents the whole body. Each cell is colourless, oval or almost spherical with a well-distinct cell-wall and contains a single nucleus, vacuoles, dense cytoplasm, rich in ribosomes, granules of glycogen, and globules of fatty and a lot of enzymes.

Reproduction: mostly vegetative - by budding and sometimes sexual - by fusion (fig.155).

Baker's Yeast is a perfect biotechnological producent to produce vitamins group B, enzymes, aminoacids, proteins, fatty and minerals. It has a medicinal value, being rich in vitamins and enzymes. Yeasts have a variety of economic uses: for fermentation processes, such as the manufacture of beer from barley grains, wine and juices from grapes, industrial alcohol from different kinds of cereals and potato; in making bread.

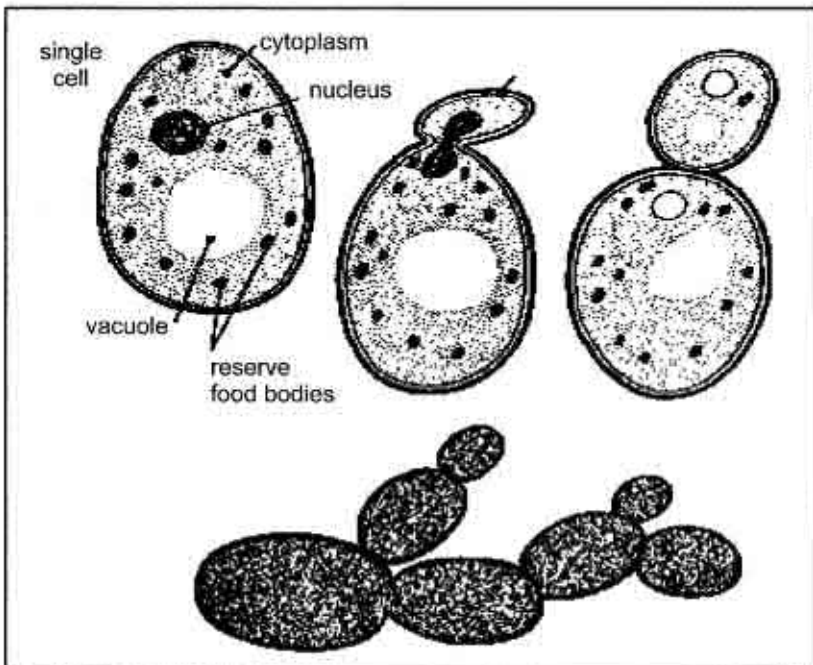


Fig. 155. Cell structure and vegetative reproduction of yeast
Saccharomyces cerevisiae

1.3. Morphology of the multicellular fungi

sp. *Aspergillus oryzae* (Ahlb.) E. Cohn, common name - Green mould

sp. *Penicillium notatum* L., syn. *Penicillium chrysogenum* L.,

common name - Blue-green mould

fam. Aspergillaceae

div. *Mycophyta*

These species are filamentous fungi, usually saprophytes on alimentary products. Mycelium consists of septate hyphae with dichotomous branching (fig. 3,4).

Aspergillus oryzae - develops ascendant hyphae with unicellular conidiophore and radial conidia (fig. 156). It is a good biotechnological producent to produce vitamins, enzymes, organic acids, aminoacids, proteins, fatty and minerals.

Penicillium notatum - develops ascendant hyphae with multicellular conidiopore of brush-like structure (fig.157). Blue-green moulds serve a good source of penicillins (antibiotics).

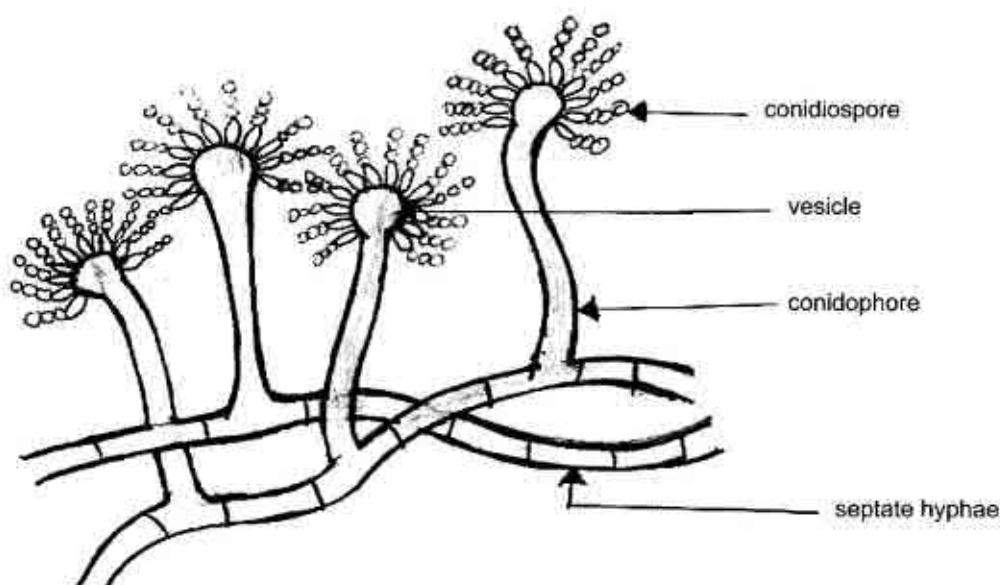


Fig. 156. Mycelium structure of the Blue mould *Aspergillus oryzae*

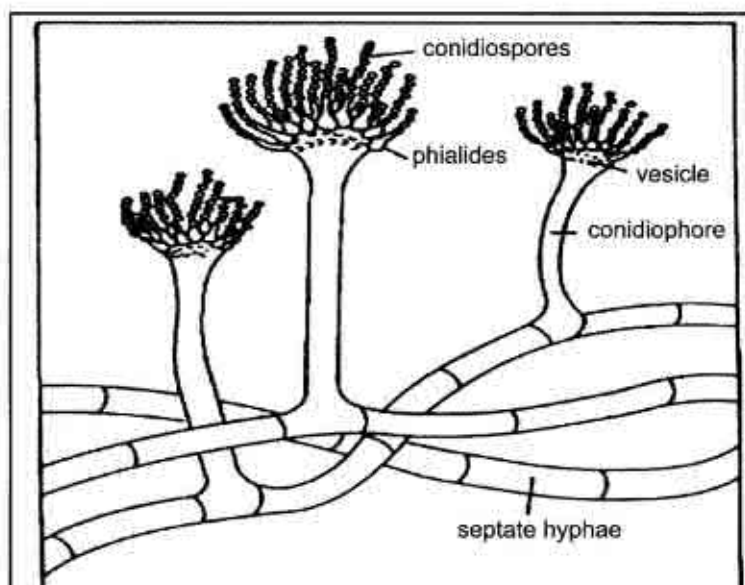


Fig. 157. Mycelium structure of the Blue-green mould *Penicillium notatum*

PRACTICAL WORK nr. 2. Parasitic fungi

2.1. Morphology of the Ergot fungus

sp. *Claviceps purpurea* (Fiers.) Tulasne, common name – Ergot fungus,
fam. Clavicipitaceae
div. *Mycophyta*

Ergot fungus is a parasitic fungus on grass plants, especially on Rye plant. The spores of ergot fungus attack the ovary flower. Instead of grass grain the sclerotium develops (fig. 158). The sclerotium represents a vegetative elongated body, pointed at the ends, hard, rough of violet-black color, and inside it is yellow (fig. 159).

The sclerotia are vegetable product. They are a source of alkaloids with sedative and hypotensive effects. The vegetable product is very toxic!

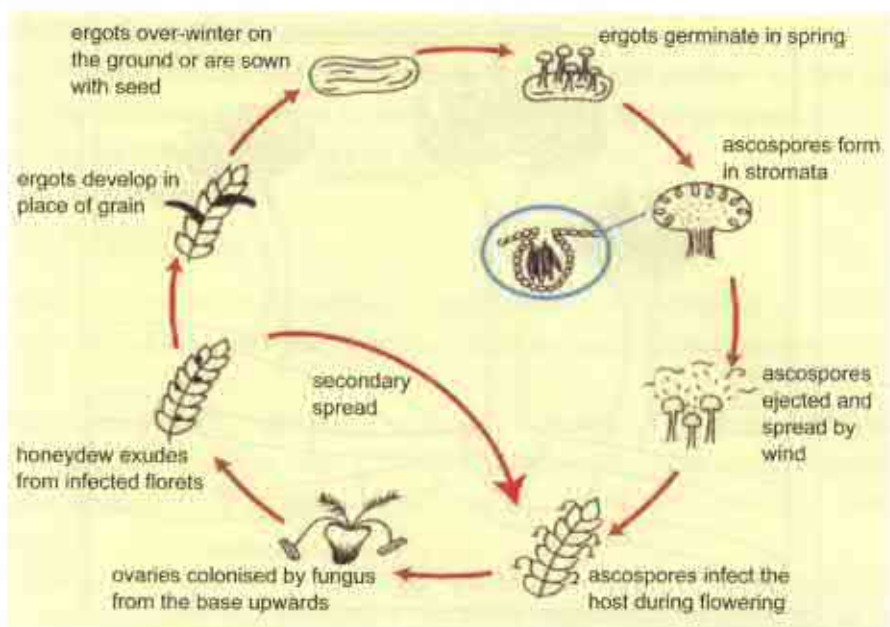


Fig. 158. The life cycle of Ergot fungus sp. Claviceps purpurea



Fig. 159. Sclerotia of the Ergot fungus sp. Claviceps purpurea

2.2. Morphology of Chaga mushroom

sp. *Fungus betulinus* L. (*Inonotus obliquus*), common name -
Chaga mushroom

fam. Hymenomycetaceae

div. *Mycophyta*

Chaga mushroom is a parasitic fungus on Birch and other trees. In cracks of the Birch cork stem the spores form a crustose, rough, black body, consisting of compact hyphae (fig. 160).

The Chaga mushroom body contains minerals (Mn, P, K), and polyphenols. It is considered a good anticancer remedy.



Fig. 160. Morphology of the Chaga mushroom *Fungus betulinus* on Birch tree

PRACTICAL WORK nr. 3. Lichens

3.1. Structure and morphology of the lichens

Lichens are symbiotic organisms, consisting of unicellular green or blue-green algae and fungal hyphae (fig. 161). The algae photosynthesize and produce organic substances as nutrition for fungal hyphae. Fungal hyphae absorb water and form a perfect aquatic media for algae. There are three morphological types of lichens: crustose, foliose and fruticose (fig. 162).

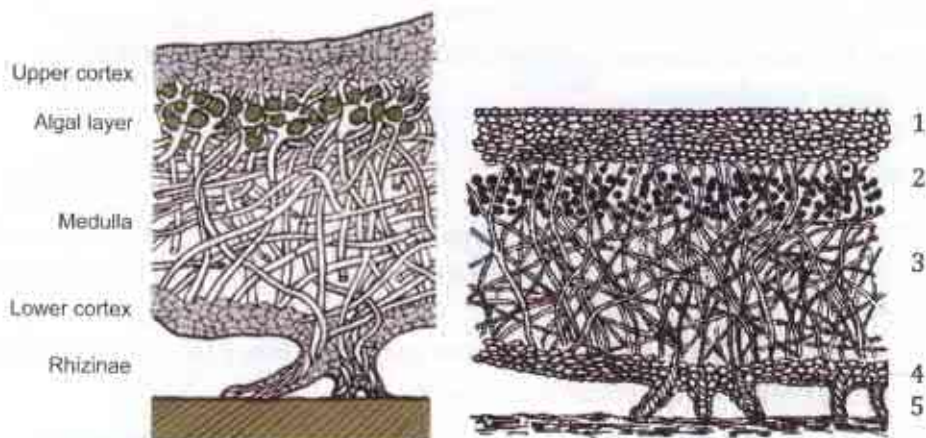


Fig. 161. Cross section through lichen thallus: 1 - upper protective surface, 2 - layer of green algae, 3 - layer of hyphae, 4 - lower protective surface, 5 - rhizinae

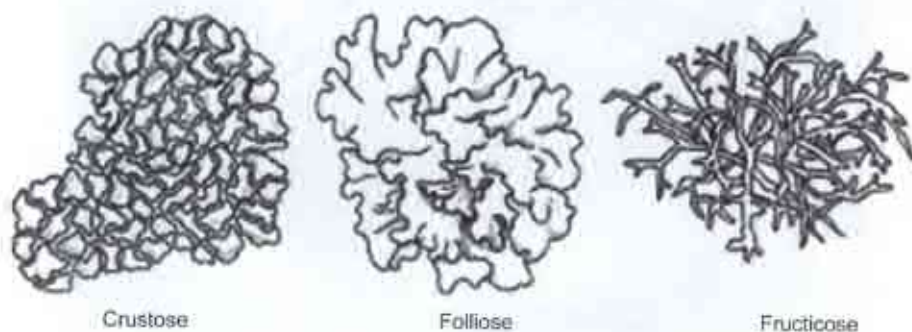


Fig. 162. Morphological types of lichens

INDIVIDUAL PRACTICAL WORK MUSHROOMS FROM CL. *BASIDIOMYCETES*

Analyze the morphology of the some edible (5 species) and toxic (5 species) mushrooms from the families Agaricaceae, Boletaceae, Amanitaceae working with herbaria, drawings, schemes, atlases, literature of mycology.

SUBJECTS FOR DISCUSSION:

1. What is mycology?
2. Mode of nutrition of fungi.
3. Ecology.
4. Morphology of the fungal thallus.
5. The levels of structure organization of the hyphae.
6. Classification of the fungi.
7. Characteristics of fam. Mucoraceae and sp. *Mucor mucedo*.
8. Characteristics of fam. Saccharomycetaceae: sp. *Saccharomyces cerevisiae*.
9. Characteristics of fam. Aspergillaceae: sp. *Aspergillus oryzae*, *Penicillium notatum*.
10. Characteristics of fam. Clavicipitaceae and sp. *Claviceps purpurea*.
11. Characteristics of fam. Hymenomytaceae and sp. *Fungus betulinus* (*Inonotus obliquus*).
12. Pharmaceutical role of the fungi. Examples.
13. Morphology of mushrooms. Examples of edible and toxic mushrooms.
14. Benefits and risks of fungi.
15. What is the symbiotic organism – lichen?
16. Structure of the of lichen thallus.
17. Morphological types of lichens.
18. Biological, ecological and pharmaceutical values of the lichens. Examples.

HIGHER PLANTS - CORMOBIONTA

HIGHER SPORE PLANTS

4.3. MORPHOLOGY OF SOME SPECIES FROM THE HIGHER SPORE PLANTS

PRACTICAL WORK nr. 1. Morphology of the non-vascular higher spore plants

1.1. Morphology of the Peat moss

sp. *Sphagnum acutifolium* Ehrh, common name - Peat moss
 fam. Sphagnaceae
 div. Bryophyta

The stems are erect and the base is permanent by decaying. The leaves are green, minute and crowded. They are one cell thick and lack midrib with two types of cells: 1) pored, large and non-living cells; 2) green, small cells with chloroplasts, living. Rounded and pored capsules are developed on the top of the stem (fig.162).

Peat moss prefers bogs, mountain forests.

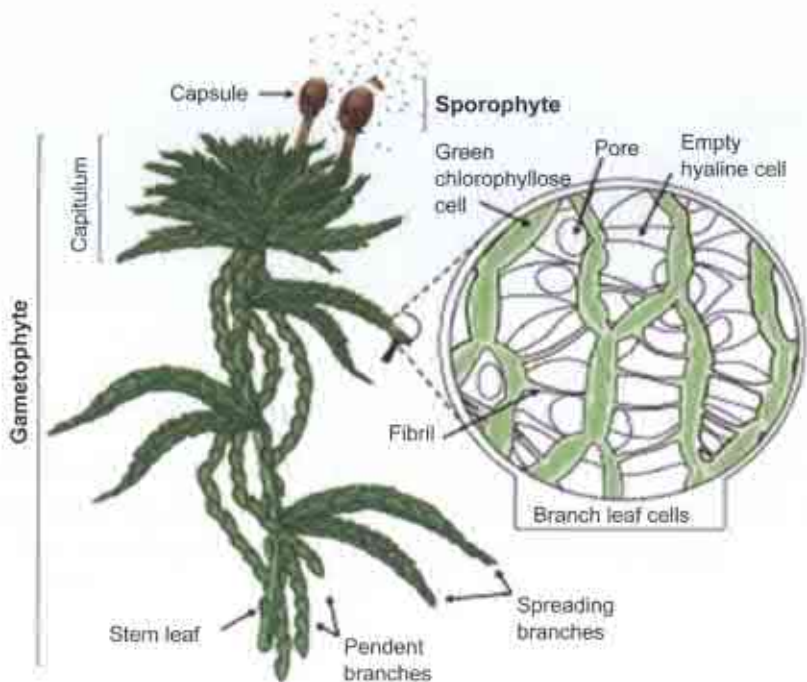


Fig. 162. Morphology of the sp. *Sphagnum acutifolium*

PRACTICAL WORK nr. 2. Morphology of the vascular higher spore plants

2.1. Morphology of the Club moss plant

sp. *Lycopodium clavatum* L., common name – Wolf's-foot club moss
 fam. Lycopodiaceae
 div. Lycopodiophyta

It is a perennial plant with dichotomous branching, creeping stem (5-12 m long), adventitious roots, and small leaves with elongated apex. At the top of ascendant shoot the spore spikes develop with sporangia. In sporangium a lot of yellow, tetrad spores develop (fig. 163).

The plants prefer coniferous forests and mountain conditions.

Vegetable product: *Lycopodium herba* and *L.sporae*

Other species: *L. selago* L.



Fig. 163. Morphology of the Wolf's-foot club moss sp. *Lycopodium clavatum*

2.2. Morphology of the Horsetail plant

sp. *Equisetum arvense* L., common name – Horsetail

fam. Equisetaceae

div. *Equisetophyta*

It is a perennial plant with rhizome, which develops two types of stem: 1) articulate, non-branched with strobillum at the tip, brown, hollow, spring – fertile stem; 2) articulate, green, hollow, summer – sterile stem. The leaves are reduced, and scale-like (fig. 164).

These plants prefer moist, sandy soils. The plant is toxic.

Vegetable product: *Equiseti herba* (sterile stems)

Other species: *E. palustre* L., *E. sylvatica* L., *E. maximum* Lam.

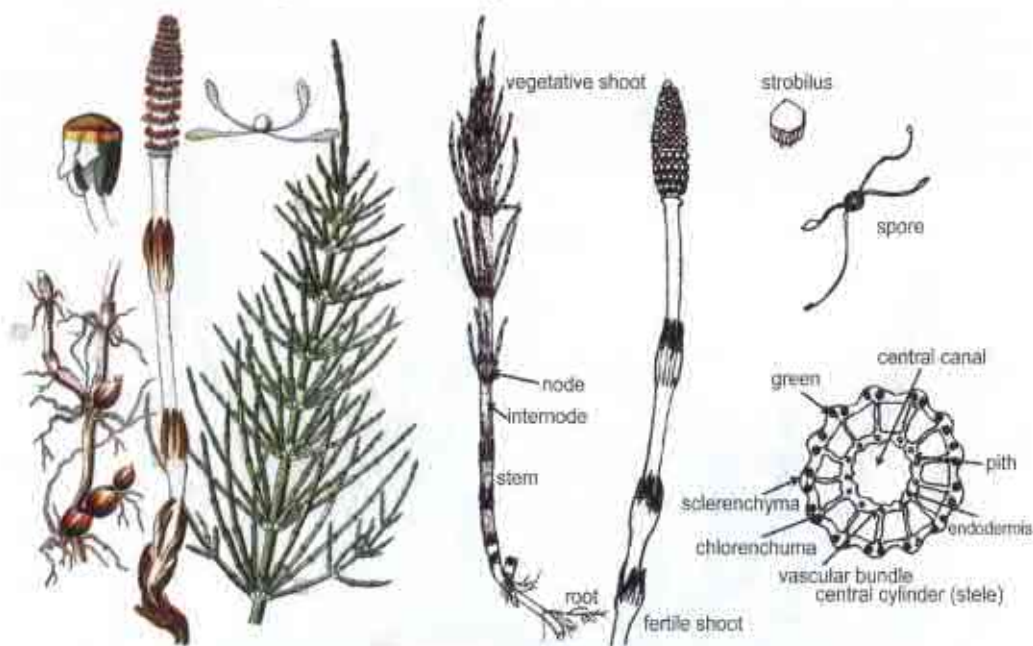


Fig. 164. Morphology of the Horsetail sp. *Equisetum arvense*

2.3. Morphology of the Male fern plant

sp. *Dryopteris filix-mas* (L.) Schott., common name – Male fern

fam. Polypodiaceae

div. *Polypodiophyta*

It is a perennial plant, with underground, oblique rhizome, outside it is covered with old stipe bases and inside it is of yellow-greenish colour. The rhizome gives rise to a cluster of large, simple, double pinnate-sected leaves

with strong stipe and brown sori in 2 rows along the veins on the lower surface. Inside of the sori the spherical sporangia develop (fig. 165).

The plants prefer moist, shaded places. Plant is toxic.

Vegetable product: *Filicis maris rhizomata*

Other species: *Athyrium filix-femina* (L.) Roth, *Polypodium vulgare* L.



Fig. 165. Morphology of the Male fern sp. Dryopteris filix-mas plant

SUBJECTS FOR DISCUSSION:

1. What is a non-vascular higher spore plant? Characteristics.
2. Fil. *Bryophyta*: general characteristics, ecology, species, morphological description of the Peat moss, usage of mosses.
3. What are vascular higher spore plants? Characteristics.
4. Fil. *Lycopodiophyta*, fam. Lycopodiaceae: general characteristics, ecology, species, morphological description of the Clubmoss, usage of Clubmoss.
5. Fil. *Equisetophyta*, fam. Equisetaceae: general characteristics, ecology, species, morphological description of the Horsetail, usage of Horsetail.
4. Fil. *Pteridophyta*, fam. Aspleniaceae: general characteristics, ecology, species, morphological description of the Male fern, usage of Male fern.

GYMNOSPERMS – NAKED SEED PLANTS
div. *PINOPHYTA* (*GYMNOSPERMATOPHYTA*)

**4.4. MORPHOLOGY OF SOME SPECIES
OF THE GYMNASPERMS**

**PRACTICAL WORK nr. 1. Morphology of the Ginkgo plant,
cl. *Ginkgopsida***

sp. *Ginkgo biloba* L., common name - Ginkgo or Maidenhair tree
fam. Ginkgoaceae
div. *Pinophyta*

It is a deciduous and dioecious tree (male and female plants). Its leaves are simple, petiolate, and fan-shaped (2-lobed) with dichotomous venation. The fruit is false – pseudodrupe (fig. 166). It is native to China and Japan. It is known as an ornamental and medicinal plant.

Vegetable product: *Ginkgo folia*



Fig. 166. Morphology of the Ginkgo or Maidenhair tree sp. *Ginkgo biloba*:
1 - simple leaf, petiolate, with dichotomous venation; 2 - pseudodrupe; 3 - female shoot;
4 - male shoot; 5 - male pollen cones

PRACTICAL WORK nr. 2. Morphology of some species of cl. *Pinopsida*

2.1. Morphology of the Pine plant

sp. *Pinus sylvestris* L., common name – Silver pine

fam. Pinaceae

div. Pinophyta

Silver pine is an evergreen and monoecious tree. The leaves are simple, needle-like with univein, two leaves in the bundle and with spiral arrangement on the shoot. The male (pollen) cones are yellow, small in the clusters, but a young female (ovulate) cone is green, and a mature one is woody-brownish with winged seeds (fig. 167).

It prefers mountains and cold regions.

Vegetable product: *Pini folia*, *P. turiones*

Other species: *P. montana* Miller.

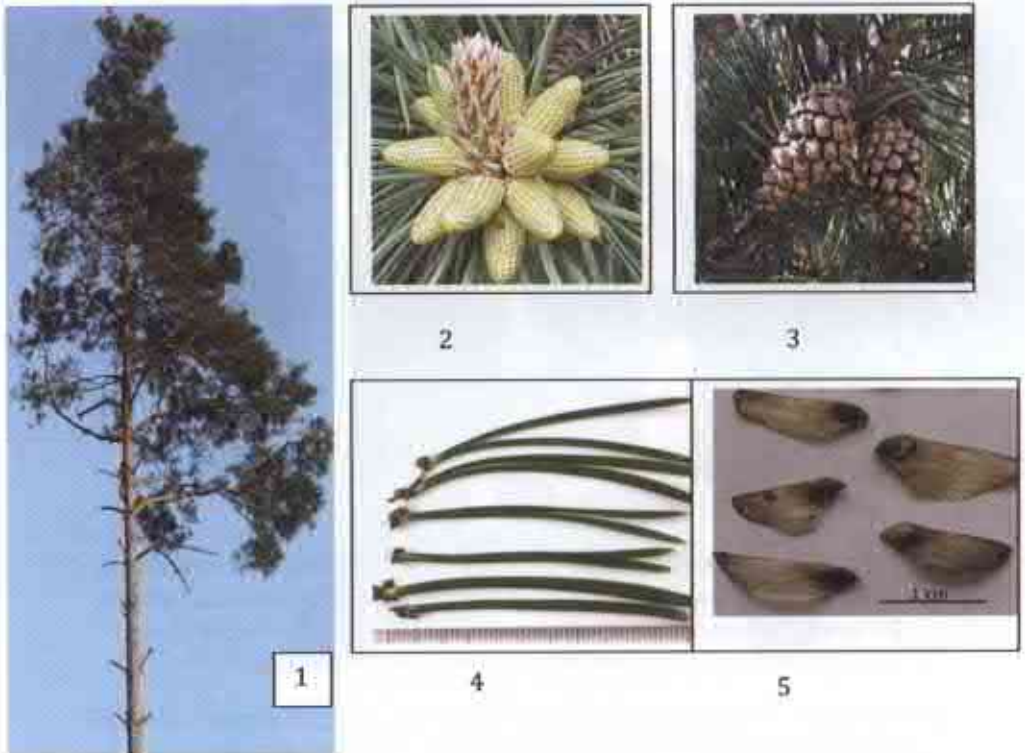


Fig. 167. Morphology of the Silver pine *Pinus sylvestris* plant:

1 - pine tree; 2 - cluster of male cones; 3 - female cones; 4 - leaves; 5 - winged seeds

2.2. Morphology of the Spruce plant

sp. *Picea abies* (L.), syn. *Picea excelsa* (Lam.) common name –

Common spruce

fam. Pinaceae

div. Pinophyta

It is an evergreen and monoecious tree. Its leaves are simple, needle-like, univein, square with pointed apex, one by one in spiral arrangement on the shoot. Male (pollen) cones are yellow, small and in clusters; young female (ovulate) cones are small, erect, and of pink-reddish color, but mature ones are woody brownish, and pendent (fig. 168).

It prefers mountains and cold regions.

Vegetable product: *Picea folia*



Fig. 168. Morphology of the Common spruce *Picea abies* plant:
1 – shoot with square needle-like, pointed leaves with spiral arrangement;
2 – young female cones; 3 – shoot with pendent woody female cones

2.3. Morphology of the Fir plant

sp. *Abies alba* Mill., common name – Silver fir

fam. Pinaceae

div. *Pinophyta*

It is an evergreen and monoecious tree. Its leaves are simple, needle-like, univein, flattened with 2 white lines (stomata) on the lower surface. The leaves have pennate arrangement on the shoot. Male (pollen) cones are yellow, small, and in clusters; young female (ovulate) cones are small, green, erect; mature ones are woody, brownish, and erect. The cone scales fall and only erect axis remains (fig. 169).

Silver fir grows mostly in the cold climate (high altitudes and in the hills and cold regions).

Vegetable product: *Abieti cortex*



Fig. 169. Morphology of the Silver fir *Abies alba* plant: 1 – winged seed; 2 – young female cones; 3 – scale of female cone; 4 – male mature cones; 5 – axis of mature female cone; 6 – needle-like leaf with two white lines; 7 – mature woody female cone; 8 – male mature cone

2.4. Morphology of the European larch plant

sp. *Larix decidua* Mill., syn. *L. europaea* DC,

common name – European larch

fam. Pinaceae

div. *Pinophyta*

It is a deciduous and monoecious tree. Its leaves are simple, needle-like, univein, 15-20 leaves in a bunch with spiral arrangement on the shoot. The leaves fall in the autumn. Male (pollen) cones are yellow, small and in clusters; young female (ovulate) cones are small, pink-violet, but mature ones become woody and brownish (fig. 170).

European larch prefers mountains and cold regions.



Fig. 170. Morphology of the European larch *Larix decidua* plant:

- 1 – needle-like in the brunch; 2 – mature woody female cones; 3 – winged seed;
4 – young female cone; 5 – axis male cones

2.5. Morphology of the Common Juniper plant

sp. *Juniperus communis* L., common name - Common juniper

fam. Cupressaceae

div. *Pinophyta*

It is a dioecious, pyramidal shrub or small tree. Its leaves are simple, needle-like, mucronate (base - flattened, apex - pointed) There are 3 leaves in the whole with spiral arrangement on the shoot. Male (pollen) cones are yellow and small. On female plants a false fruit - pseudoberry of dark blue-violet colour, fleshy and with 3 seeds develops (fig. 171).

It prefers mountains and cold regions. The plant is toxic.

Vegetable product: *Juniperi fructus*



Fig. 171. Morphology of the Common juniper *Juniperus communis* plant:

A - shoot of female plant with pseudoberries; B - shoot of male plant with small pollen cones; 1 - rounded, fleshy pseudoberry

2.6. Morphology of the Savin juniper plant

sp. *Juniperus sabina* L., common name - Savin juniper plant

fam. Cupressaceae

div. *Pinophyta*

It is a dioecious shrub. It prefers open mountain places (fig. 172). The plant is toxic.



A

B

Fig. 172. Morphology of the Savin juniper *Juniperus sabina* plant:
A – shrub; B – female shoots with pseudoberry

2.7. Morphology of the Oriental biota plant

sp. Thuja orientalis L., common name – Oriental biota

or Eastern white-cedar or Tree of life

fam. Cupressaceae

div. *Pinophyta*

It is a tree or shrub with a pyramidal crone. Its leaves are scale-like (fig. 173) and toxic.



Fig. 173. Morphology of Eastern white-cedar *Thuja orientalis* plant:

1 – shoot with female mature cones; 2 – arrangement of the scale-like leaves on the shoot;
3 – winged seed; 4 – tree with cones

2.8. Morphology of the Common yew plant

sp. *Taxus baccata* L., common name – Common yew

fam. Taxaceae

div. Pinophyta

It is a dioecious, shrub or tree. Its leaves are simple, needle-like, flattened with a rounded apex, and pinnate arrangement on the twig. They are dark green on the upper surface and green-yellowish on the lower surface. Male (pollen) cones are yellow and small on male plants. On female plants a red, false fruit – pseudoberry develops (fig. 174). The pseudofruit represents a single seed surrounded by fleshy, red covering, called arilloid.

Common yew prefers mountains and cold regions. All organs of the plant are toxic, excluding the fleshy and red arilloid.



A



B

Fig. 174. Morphology the of Common yew *Taxus baccata* plant: A – shoot of male plant with pollen cones; B – shoot of female plant with berry-like fruits

PRACTICAL WORK nr. 3. Morphology of the Joint-pine plant, cl. *Gnetopsida*

sp. *Ephedra distachya* L., common name – Joint-pine plant or
Sea Grape

fam. Ephedraceae

div. Pinophyta

It is a dioecious shrub or tree. The stems are articulate and green with scale-like leaves at the nodes. Male plants develop pollen cones, and female ones ovulate cones with fleshy red bracts (fig. 175).

The plants prefer dry soils in warm regions. The plant is toxic.

Vegetable product: *Ephedrae herba*

Other species: *E. equisetina* Bge.



A



B

Fig. 175. Morphology of the Joint-pine plant *Ephedra dystachya* plant: A – shoot of male plant with pollen cones; B – shoot of female plant with ovulate cones

SUBJECTS FOR DISCUSSION:

1. What is naked seed plant?
2. General characteristics of Gymnosperms:
 - branching;
 - morphology of the leaf;
 - morphology of male and female cones.
3. Distribution and ecology of Gymnosperms.
4. Classification of the Gymnosperms.
5. Fil. *Cycadopsida*. Morphology of *Cycas revoluta*.
6. Fil. *Ginkgopsida*. Fam. Ginkgoaceae. Characteristics.
7. Morphology and distribution of Ginkgo plant.
8. Fil. *Pinophyta*. Characteristics.
9. Fam. Pinaceae.
 - Morphology of Siver pine tree.
 - Morphology of Silver fir plant.

- Morphology of Common spruce tree.
 - Morphology of Larch plant.
10. Fam. Cupressaceae:
- Morphology of Common juniper.
 - Morphology of Savin juniper.
 - Morphology of oriental biota (life tree).
11. Fam. Taxaceae
- Morphology of Common yew plant.
12. Fil Gnetopsida. Characteristics.
13. Fam. Ephedraceae
- Morphology of Joint-pine plant or Sea Grape plant.
14. Ecological and economic role of the Gymnosperms.
15. Species of Gymnosperms with pharmaceutical value.

TEST SAMPLES

- 1) m.c. Choose the unicellular green algae:
- a) *Spirulina platensis*;
 - b) *Dunalliella salina*;
 - c) *Chlorella vulgaris*;
 - d) *Ulva lactuca*;
 - e) *Laminaria saccharina*.
- 2) m.c. Choose the multicellular, saprophytic fungi:
- a) *Claviceps purpurea*;
 - b) *Saccharomuce cerevisae*;
 - c) *Aspergillus oryzae*;
 - d) *Penicillium notatum*;
 - e) *Fungus betulinus*.
- 3) m.c. Choose the characteristics of fungi:
- a) thallus is called mucellium;
 - b) lack of plastids;
 - c) photosynthesis;
 - d) heterotrophic;
 - e) autotrophic.
- 4) m.c. Choose the higher spore species of plants:
- a) *Juniperus communis*;
 - b) *Equisetum arvense*;
 - c) *Lycopodium clavatum*;
 - d) *Sphagnum acutifolium*;
 - e) *Ephedra dystachia*.
- 5) m.c. Choose the characteristics of naked seed plants:
- a) herbaceous plants;
 - b) woody plants;
 - c) evergreen, needle-like leaves;
 - d) with resins ducts;
 - e) monopodial branching.
- 6) m.c. Choose the dioecious species:
- a) *Ginkgo biloba*;
 - b) *Ephedra dystachia*;
 - c) *Juniperus communis*;
 - d) *Taxus baccata*;
 - e) *Pinus silvestris*.

- 7) m. c.** Choose the characteristics of the Horsetail plant:
- a)** perennial, herbaceous;
 - b)** develops 2 type of stems;
 - c)** leaves are fan-like;
 - d)** stem is articulated, and hollow;
 - e)** leaves are reduced, and scale-like.
- 8) s. c.** Choose the species which develop a false darck-violet berry:
- a)** *Pinus silvestris*;
 - b)** *Ginkgo biloba*;
 - c)** *Juniperus communis*;
 - d)** *Ephedra dystachia*;
 - e)** *Taxus baccata*.
- 9) s.c.** Sclerotium is specific for:
- a)** *Saccharomuce cerevisae*;
 - b)** *Claviceps purpurea*;
 - c)** *Fungus betulinus*.
 - d)** *Aspergillus oryzae*;
 - e)** *Penicillium notatum*;
- 10) m.c.** Choose the characteristics of Male fern plant:
- a)** oblique rhizome;
 - b)** large double compound leaves;
 - c)** large double pinnate-sected simple leaves;
 - d)** leaves with sporangia;
 - e)** perennial plant.

FLOWERING PLANTS**div. MAGNOLIOPHYTA (ANGYOSPERMATOPHYTA)****DICOTYLEDONS – cl. MAGNOLIOPSIDA****(selected families)**

Material and tools: Herbaria, dried and fixed botanical materials, atlases, drawings, charts, schemes, hand glasses, preparation needles, pincers, Petry boxes, samples of living specimens (if necessary and when available).

These materials and tools will be required for each laboratory work while studying the theme Flowering plants. Each student records the protocol in the album. Each analysed species is depicted schematically with a simple pencil, and is colored properly. Special morphological characteristics of species are specified. Below the drawing must be the correct Latin name of species and taxonomy must be written. It is well to mention if the species is toxic and if the species is spontaneous or cultivated.

**4.5. MORPHOLOGY OF SOME SPECIES
FROM THE FAMILIES: SCHISANDRACEAE,
NYMPHAEACEAE, RANUNCULACEAE,
BERBERIDACEAE, PAPAVERACEAE**

**PRACTICAL WORK nr. 1. Morphology of the Schisandra plant,
fam. Schisandraceae**

**sp. *Schisandra chinensis* (Turz.) Baill.,
common name – Schisandra or “Five-flavor berry”**

It is a deciduous and dioecious woody vine about 10-15 m in length. Its leaves are simple, shiny, petiolate, ovate-elliptical and with serrate margin. White-pink and waxed flowers (1-3) are axillary. The fruits are red, rounded berries on an elongated receptacle (fig. 176).

It is native to forests of Northern China and the Russian Far East. The vines are cultivated as ornamental and berry-producing plants.

Vegetable products: *Schisandrae cortex*, *S. folia*, *S. fructus*, *S. semina*.

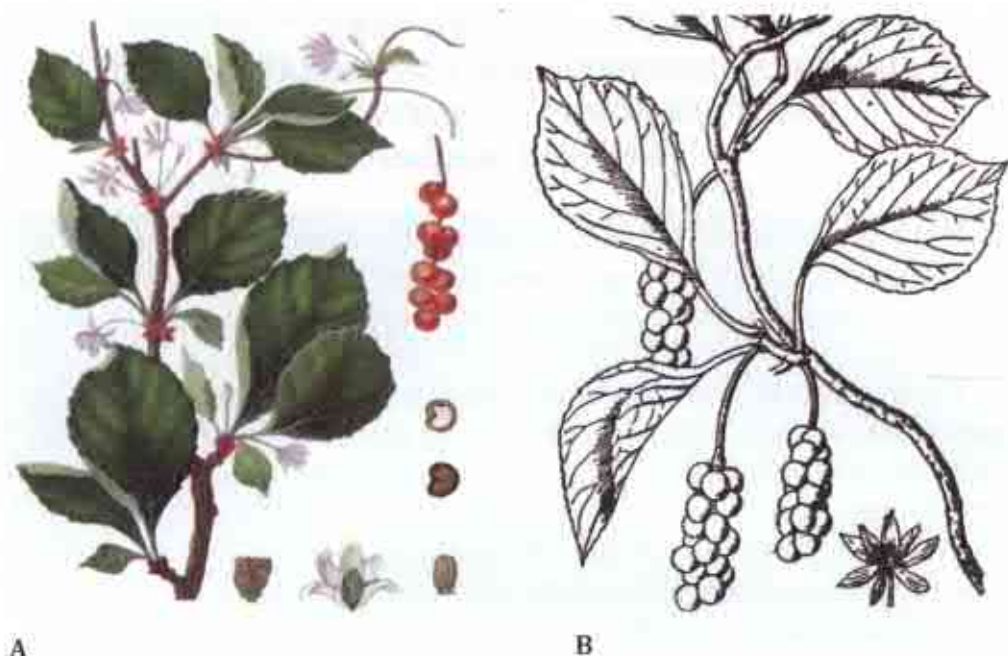


Fig. 176. Morphology of the Schisandra *Schisandra chinensis* plant:
A – picture; B – drawing

PRACTICAL WORK nr. 2. Morphology of the Yellow pond (water) lily plant, fam. Nymphaeaceae

sp. *Nuphar lutea* L., common name – Yellow pond (water) lily plant

It is an aquatic and perennial plant. The plants develop a horizontal and yellow rhizome with brown scars – traces of a leaf petiole. The rhizome gives rise to two types of simple leaves: 1) thin, submersed leaves and 2) large, floating, and leathery leaves. The flower is yellow with a long pedicel over water. The fruit is a capsule (fig.177). Rhizomes and leaves develop aerenchyma.

It grows in stagnant fresh water of ponds and rivers. The plant is toxic.

Vegetable product: *Nupharis rhizomata*

Other species: *Nymphaea alba* L.

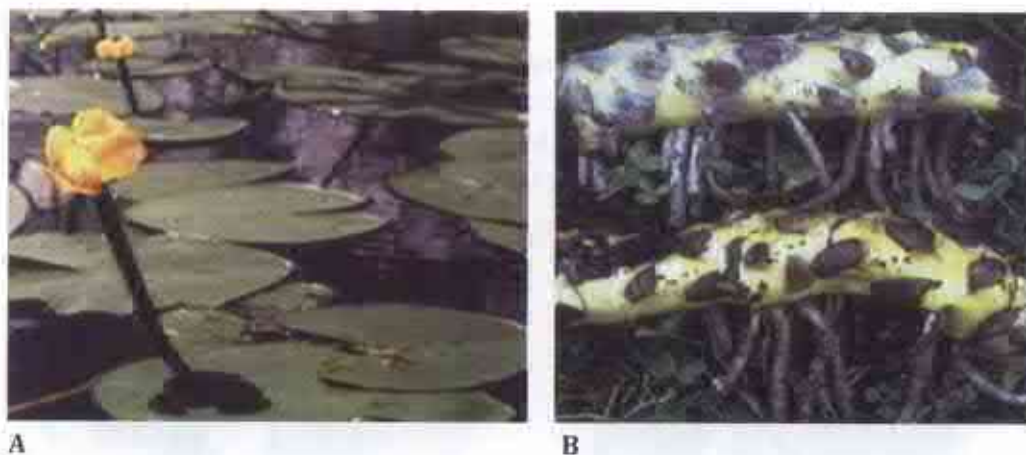


Fig. 177. Morphology of the Yellow pond (water) lily *Nuphar lutea* plant: A – plant with flower and floating leaf; B – rhizome with brown scars and adventitious roots

PRACTICAL WORK nr. 3. Morphology of some species from fam. Ranunculaceae

3.1. Morphology of the Fig buttercup plant

sp. *Ranunculus ficaria* L., syn. *Ficaria verna*,

common name – Fig buttercup plant or Lesser celandine

It is a perenneial herbaceous plant, growing to a height of 20-30 cm. Its leaves are simple, long-petiolated and entire usually in the basal rosette. The flowers are long pedunculated with yellow, shiny petals. Fruit is polynut (fig. 178).

It is native to Europe, temperate Eurasia and America. The plant prefers moist soil and wet places, semi-shade position.

3.2. Morphology of the Meadow buttercup plant

sp. *Ranunculus acris* L., common name – Meadow buttercup

It is a perennial, herbaceous plant, and growing to a height of 60-80 cm. Its leaves are simple and palmate-sected. The flowers are long pedunculated, yellow with five shiny petals and a lot of stamens. Friut is polynut (fig. 178).

It is common in Europe and temperate Eurasia. It prefers moist soil and wet places. The plant is toxic.



A



B

Fig. 178. Morphology of the species: A – Fig buttercup *Ranunculus ficaria* plant; B – Meadow buttercup *R. acris*

3.3. Morphology of the Spring pheasant's eye plant

sp. *Adonis vernalis* L., common name – Spring pheasant's eye

It is a perennial herbaceous plant and with erect rhizome. The plants develop two types of leaves: brown scale-like leaves and simple sected, thread-like ones. The flower is solitary, yellow and large. The fruit is a polynut (consists of a lot of nutlets) (fig. 179).

It is found in dry meadows and steppes in Eurasia. The plants prefer shiny open fields. It is cultivated as an ornamental and medicinal plant. The plant is poisonous.

Vegetable product: *Adonidis vernalis herba*

Other species: *A. aestivalis* L., *A. annua* L. (syn. *A. autumnalis* L.)

3.4. Morphology of the Aconite plant

sp. *Aconitum napellus* Rap., common name – Aconite

It is a perennial, herbaceous plant, and growing to a height of 1.5-2.0 m, with two underground tubers. The leaves are simple, petiolated, alternate and palmate- sected. The flowers are of dark purple to bluish-purple colour. They

are zygomorphic and helmet-shaped. Each flower consists of 5 unequal tepals (the upper tepal is helmet-shaped). The flowers are united in a compound racemous inflorescence. The fruit is three-follicle (fig. 179).

The plant is native to Asia, Europe and North America. It prefers a moist soil in sunny or semi-shady places. The plant is very toxic.

Vegetable product: *Aconiti tuber*



Fig. 179. Morphology of the species: A – *Adonis vernalis*; B – *Aconitum napellus*

3.5. Morphology of the Forking Larkspruce plant

sp. Delphinium consolida L., syn. Consolida regalis Gray,
common name – Forking Larkspruce

It is an annual and herbaceous plant. The leaf is simple, sected, and thread-like. The flowers are zygomorphic with spruce-like corolla, grouped in small and rare racemes. The fruit is a follicle (fig. 180).

The plants are native to all Europe. The plants grow everywhere in open fields, along roads and cultivated lands. The plant is toxic.

Vegetable product: *Consolidae herba*

3.6. Morphology of the Black caraway plant

sp. *Nigella sativa* L., common name – Black caraway or Black cumin

It is an annual and herbaceous plant. The leaf is simple, sected, and thread-like. The flowers are solitary and actinomorphic. The black caraway fruit is a large and inflated capsule composed of three-seven united follicles (polyfollicle), each containing numerous seeds which are used as a spice (fig. 180).

It is native to South and South-West Asia. The plants prefer the full sun and dryish soils. They are potentially toxic plants.

Vegetable product: *Nigellae semina*



Fig. 180. Morphology of the species: A – *Delphinium consolida*; B – *Nigella sativa*

3.7. Morphology of the Helebores plant

sp. *Helleborus purpurascens* Waldst. et Kit., common name – Helebores

It is a perennial, herbaceous plant with strong rhizome. The leaf is simple, palmate-sected with a serrate margin. The flowers are solitary, actinomorphic with 5 purplish sepals, petals modified in nectarines, infinity of stamens and free pistils. The fruit is a polyfollicle (fig. 181).

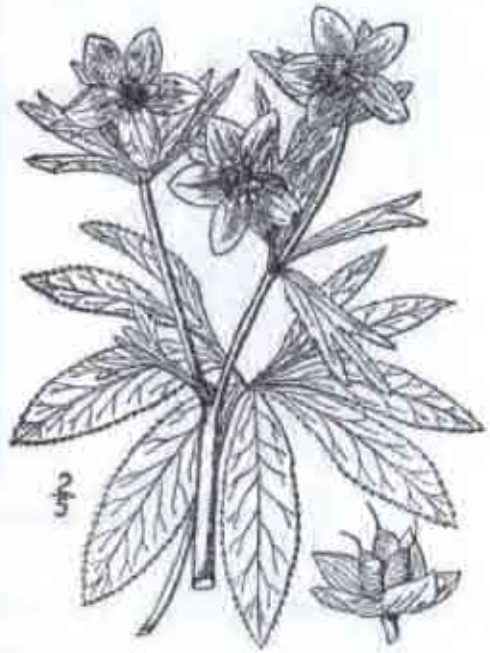
Its native center is Europe and Asia. Helebores plants prefer to grow in rich, well-drained soil in dappled shade.

Vegetable product: *Hellebori rhizomata*

Other species: *H. caucasicus* A. Braun, syn. *H. orientalis* Lam.



A



B

Fig. 181. Morphology of the Helebores *Helleborus purpurascens* plant:
A - picture; B - drawing

PRACTICAL WORK nr. 4. Morphology of the Common barberry plant from fam. Berberidaceae

sp. *Berberis vulgaris* L., common name – Common barberry

It is a shrub with 2 types of leaves; 1) simple, ovate leaves with serrate margin and 2) leaves modified in thorns. Yellow, actinomorphic flowers are united in pendant racemes. Its fruit is a red and elongated berry (fig. 182).

The shrub is native to central and southern Europe, North-West Africa and Western Asia; it is also naturalised in Northern Europe and North America. The plants prefer forest edges in temperate zones. It is cultivated as an ornamental and fruit plant.

Vegetable product: *Berberidis folia*, *B. fructus*, *B. cortex*



Fig. 182. Morphology of the Common barberry *Berberis vulgaris* plant

PRACTICAL WORK nr. 5. Morphology of some species from fam. Papaveraceae

1.1. Morphology of the Opium poppy plant

sp. *Papaver somniferum* L., common name – Opium poppy

It is a herbaceous annual plant growing to a height of 90-120 cm. Its leaves are alternate, simple, sessile, amplexicauline, ovate with irregular serrate margin and waxy surface. The flower is solitary, actinomorphic (2 green sepals, 4 colored petals, a lot of free stamens and fused carpels). The fruit is an ovate, poricidal capsule (fig. 183). The plant develops laticifers with white latex.

It is native to temperate and cold regions of Eurasia, Africa and North America. It is a cultivated plant. The plant is toxic.

Vegetable product: *Papaveris immaturi fructus* (*Papaveris capita*)

1.2. Morphology of the Yellow hornpoppy plant

sp. *Glaucium flavum* L., common name – Yellow hornpoppy

It is a perennial herbaceous plant with rhizome. Its leaves are simple, alternate, pinnate-parted and with crenate margin. The flower is yellow, solitary. The fruit is an elongated (silique) capsule. All plant organs are perforated by laticifers with orange latex (fig. 8).

It is native to Northern Africa, Macronesia, temperate zones in Western Asia and the Caucasus, as well as Europe. Nowadays it is cultivated as a medicinal and ornamental plant. It prefers sunny location with moist soil. The plant is toxic.

Vegetable product: *Glaucii flavi herba*



Fig. 183. Morphology of the species: A – *Papaver somniferum*; B – *Glaucium flavum*

1.3. Morphology of the Great celandine plant

sp. *Chelidonium majus* L., common name – Great celandine

It is a perennial herbaceous plant with strong rhizome. The leaves are simple, alternate, and pinnate-sected with a crenate margin. The flowers are yellow in umbel inflorescences. The fruit is an elongated (silique) capsule. All plant organs are perforated by laticifers with orange latex (fig. 184).

It is native to Europe and Western Asia and is spread widely in North America. It prefers shady and moist places. The plant is toxic.

Vegetable product: *Chelidonii herba*

1.4. Morphology of the Plume poppy plant

sp. *Macleya microcarpa* (Maxim), common name – Plume poppy

It is a perennial herbaceous plant with rhizome, growing to a height of 2.5 m. Its leaf is simple, alternate, petiolate, palmate-lobed and it is green-greyish, especially on the lower side. Its small yellowish buff flowers are united in compound raceme. The fruit is a small capsule. All plant organs are perforated by laticifers with orange latex (fig. 184).

Plume poppy originates from the regions of Central China. Nowadays it is cultivated as an ornamental and medicinal plant. It prefers moist places with sunny or semi-shaded positions.

Vegetable product: *Macleya* herba



Fig. 184. Morphology of the species:

A - *Chelidonium majus*; B - *Macleya microcarpa*

SUBJECTS FOR DISCUSSION:

1. What is a flowering plant? General characteristics of Angiosperms.
2. Distribution and ecology of flowering plants.
3. Classification of the Angiosperms. Characteristics of Dicot and Monocot classes.
4. General characteristics of fam. Schisandraceae. Morphology of the Schisandra plant.
5. General characteristics of fam. Nymphaeaceae. Morphology of the Water lily plant.
6. General characteristics of fam. Ranunculaceae. Morphology of the Fig bittercup, Spring pheasant's eye, Aconite, Larcspruce, Black caraway, Hellebore plants.
7. General characteristics of fam. Berberidaceae. Morphology of the Barberry plant.
8. General characteristics of fam. Papaveraceae. Morphology of the Opium poppy, Yellow hornpoppy, Great celendine, Plume poppy plants.
9. Pharmaceutical value of plant species.
10. Economic role of the described plant species.

4.6. MORPHOLOGY OF SOME SPECIES FROM THE FAMILIES: URTICACEAE, CANNABACEAE, FAGACEAE, BETULACEAE, POLYGONACEAE

PRACTICAL WORK nr. 1. Morphology of the Stinging nettle plant of fam. Urticaceae

sp. *Urtica dioica* L., common name – Stinging nettle

It is a herbaceous, dioecious plant, and growing to a height of 0.8-1.0 m. Its leaves are opposite, simple, petiolate, ovate and with serrate margin. The flowers are reduced, greenish in axillary inflorescences on the top of the stems. The fruit is a nutlet (fig. 185). The leaves and stems are coated with stinging hairs.

It is native to Europe, Asia, Northern Africa, and Western North America, and is spread elsewhere. The plants prefer ruderal places and ravines.

Vegetable product: *Urticae folia*, *U. herba*



Fig. 185. Morphology of the Stinging nettle *Urtica dioica* plant:
 A – female plant; B – simple, cordate leaves; C – serrate margin, upper surface;
 D – serrate margin, lower surface; E – male plant

PRACTICAL WORK nr. 2. Morphology of some species of fam. Cannabaceae

2.1. Morphology of the Hemp plant

sp. *Cannabis sativa* L., common name - Hemp

It is a herbaceous, annual and dioecious plant. Its leaves are opposite, simple, petiolate, palmate-sected, with a serrate margin. The flowers are small, green, united in axillary cymose. The fruit is a small, dry nutlet (fig. 186).

It is native to Central Asia, and is cultivated in Asia, Europe, and America as an important economic plant (cellulose, textile fibers, and oils) for a long time. The plants prefer a warm and humid climate.

Vegetable product: *Cannabidis herba*

Other species: *C. ruderalis* Janisch

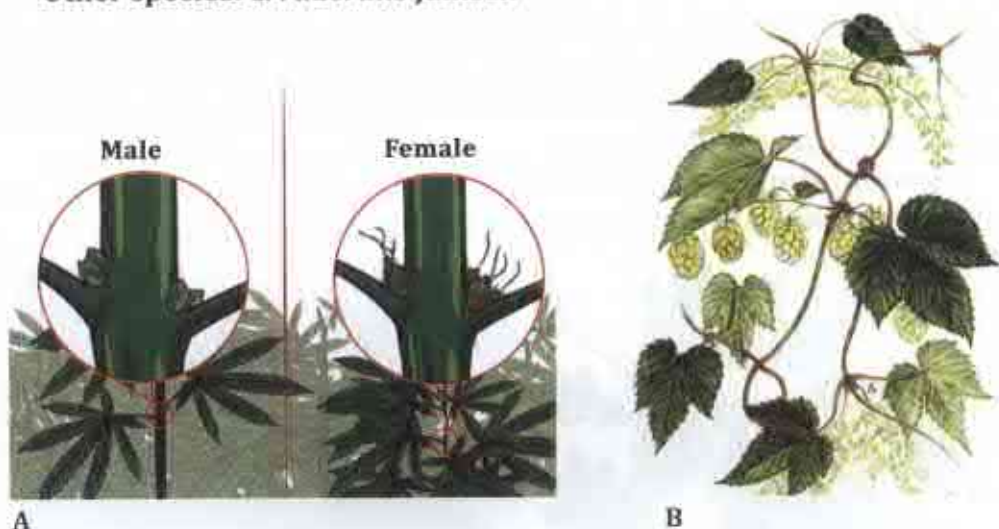


Fig. 186. Morphology of the species: A - *Cannabis sativa*; B - *Humulus lupulus*

2.2. Morphology of the Hop plant

sp. *Humulus lupulus* L., common name - Hop

It is a herbaceous, and dioecious wine. In the spring hop shoots grow very rapidly from rhizomes and climb on the supports (trees, shrubs). Its leaves are opposite, simple, petiolate from palmate-lobed to entire, ovate, and with a serrate margin. Female flowers are grouped in cone-like inflorescences on the separate shoots. On male shoots small, reduced, and greenish flowers are grouped in axillary spikes. The fruit is a nutlet (fig. 186).

The hop is native to temperate regions of the Northern Hemisphere. The plants prefer moist places. Female plants, which produce cones, are used in brewing beer, and are often propagated vegetatively and grow in the absence of male plants.

Vegetable product: *Lupuli strobili*

PRACTICAL WORK nr. 3. Morphology of the Oak tree of fam. Fagaceae

sp. *Quercus robur* L., common name - Pedunculate oak or English oak

It is a tall, deciduous, monoecious and long-living tree. Its leaf is simple, very short-stalked, nearly sessile, alternate, pennate lobed. The flower is small, greenish united in racemose inflorescences. The fruit is an elongated nut in a woody cup, called acorn (fig. 187).

It is native to most of Europe, West of the Caucasus. The tree is widely cultivated in temperate regions. A number of cultivars are grown in gardens and parks and in arboreta and botanical gardens. It prefers moist or wet soil and can tolerate drought.

Vegetable product: *Quercus cortex*

Other species: *Q. petraea* (Matt.) Liebl. (fig. 187)



**Fig. 187. Morphology of the Oak species: A - *Quercus robur* (syn. *Q. pedunculata*);
B - *Q. petraea* (syn. *Q. sessiliflora*)**

PRACTICAL WORK nr. 4. Morphology of some species of fam. Betulaceae

4.1. Morphology of the Silver birch tree

sp. *Betula pendula* Roth., syn. *B. alba* L., *B. verrucosa* Ehrh., *B. pubescens* Ehrh., common name - Silver birch

It is a deciduous, monoecious and tall tree (15-30 m). The roots develop mychoryza. The leaves are simple, alternate, and triangular or diamond in shape, with 2-3 serrate margins. The young leaves are sticky with resins. Unisexual flowers are small, green, united in catkins. Some shoots are long and bear male catkins at the tip, while others are short and bear female catkins. Immature male catkins are present during the winter but female catkins develop in the spring. The fruits are small and 3-samara, ripe in late summer on pendulous, cylindrical female catkins of 2 to 4 cm and are spread widely by the wind (fig. 188). The foliage is a pale to medium green and turns yellow early in the autumn before the leaves fall.

It is native to Europe and some parts of Asia. The trees prefer moist soil, tolerate wet and cold climate.

Vegetable product: *Betulae folia*, *B. succus*, *B. gemmae*



Fig. 188. Morphology of the Birch *Betula pendula* tree

4.2. Morphology of the Black alder tree

sp. *Alnus glutinosa* (L.) Gaerth., common name – Black alder

It is a deciduous, monoecious and tall tree (20-25 m). The leaves are simple, ovate-elliptical, with emarginated apex and irregular serrate margin. The leaves, when young, are gummy, and develop into leathery, dark green. Unisexual flowers are in catkin inflorescences. Female inflorescences turn in woody cones (fig. 190). Fruits are formed in autumn, initially as green, cone-like woody catkins about 2 cm long. These ripen to brown and contain many small winged nutlets.

The plant is native to Eurasia and the Northern part of Africa. The trees prefer a sunny to half-shady position on moist and wet soil.

Vegetable product: *Alni glutinosae fructus*

4.3. Morphology of the Grey alder tree

sp. *Alnus incana* (L.) Moench, common name – Grey alder

It is a tall tree, growing to a height 20 m. Its leaves are simple, matte, ovate with acute apex, the upper surface is green, the lower surface – grayish. Unisexual flowers are in catkin inflorescences. Female inflorescences turn in ovate woody cones with small winged fruits (fig. 190).

The plants range widely across the cooler parts of the Northern Hemisphere and grow best in sunny place. It is tolerant of a wide range of soils, though it prefers a heavy soil and damp places.



A



B

Fig. 190. Morphology of the species: A – *Alnus glutinosa*; B – *Alnus incana*

PRACTICAL WORK nr. 5. Morphology of some species of fam. Polygonaceae

5.1. Morphology of the Smartweed plant

sp. *Polygonum hydropiper* L., common name - Smartweed

It is an annual and herbaceous plant with tap root system. Its stem is with enlarged nodes. The leaf is simple, lanceolate, and entire. The flowers are white-pinkish in racemose spike. The fruit is a nutlet (fig. 191).

It is a widespread plant, found in Australia, New Zealand, temperate Asia, Europe, and North America. The plants grow everywhere, on moist roadsides and arable ground.

Vegetable product: *Polygoni hydropiperis herba*

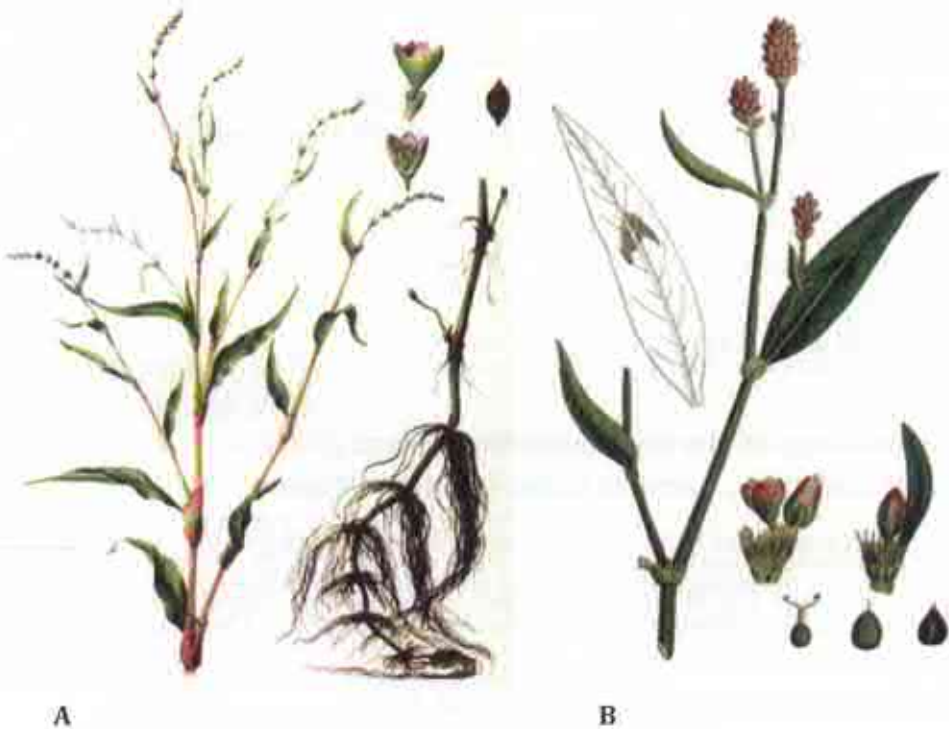


Fig. 191. Morphology of species:
A - *Polygonum hydropiper*; B - *P. persicaria*

5.2. Morphology of the Spotted ladysthumb plant

sp. *P. persicaria* L., syn. *P. maculosa* L.,
common name – Spotted ladysthumb

It is an annual and herbaceous plant with strong tap root system. The stem is reddish with enlarged nodes. The leaf is simple, lanceolate, and entire with violet "V" spot in the middle part of the blade. Its flowers are pinkish in racemose spike. The fruit is a nutlet (fig. 191).

It is native to Europe and Asia. The plants grow everywhere, on moist roadsides and arable ground.

Vegetable product: *Polygoni persicariae herba*

5.3. Morphology of the Common knotgrass plant

sp. *P. aviculare* L., common name – Common knotgrass

It is an annual and herbaceous plant with tap root system. Its stem is branched with enlarged nodes. The leaf is simple, ovate, entire, and sessile. Pinkish and small flowers are axillary. The fruit is a nutlet (fig. 192).

It is widespread across many countries in temperate regions, apparently native to Eurasia and North America, naturalized in temperate parts of the Southern Hemisphere.

The plants grow everywhere, usually on the roadsides.

Vegetable product: *Polygoni avicularis herba*

5.4. Morphology of the Common bistort plant

sp. *P. bistorta* L., common name – Common bistort

It is a perennial and herbaceous plant with bistort rhizome (S-shaped). Its lower leaves are petiolate, simple, ovate-lanceolate and entire, the upper leaves are sessile. Reddish flowers are grouped in dense spikes. The fruit is a nutlet (fig. 192).

It is native to Europe and North and West Asia.

The plants prefer moist places.

Vegetable product: *Bistortae rhizomata*



Fig. 192. Morphology of the species: A - *Polygonum aviculare*; B - *P. bistorta*

5.5. Morphology of the Asiatic dock plant

sp. *Rumex confertus* Willd, common name - Asiatic dock

It is a perennial and herbaceous plant. The rhizome is brownish outside and inside it is yellowish. The leaf is simple, petiolate, triangular and elongated with rough surface. Its flowers are grouped in compound racemose spike. The fruit is a nutlet (fig. 193).

The plants grow mainly in the Northern Hemisphere and is spread almost everywhere. The plants prefer sunny places.

Vegetable product: *Rumicis radices*

Other species: *R. acetosa* L. (syn. *Acetosa fontano-paludosa* (Kalela) Holub.), *R. acetosella* L., (syn. *Acetosella vulgaris* (W.D.J. Koch) Fourr.)

5.6. Morphology of the Chinese rhubarb plant

sp. *Rheum palmatum* L. var. *tanguticum* Maxim., common name - Chinese rhubarb

It is a perennial herbaceous shrub-like plant with a strong multicapitate rhizome. Its leaf is simple, large, and palmate-lobed. The reddish flowers are grouped in compound spikouse racemes. The fruit is a triangular nutlet (fig. 193).

Chinese rhubarb is native to China and Tibet. It is cultivated in Asia and Europe. It prefers moist soil and semi-shade places.

Vegetable product: *Rhei radices*



Fig. 193. Morphology of the species: A – *Rumex confertus*; B – *Rheum palmatum*

5.8. Morphology of Burchwheat plant

sp. *Fagopyrum esculentum* Moench., syn. *F. sagittatum* Gilib.,
Polygonum fagopyrum L., common name – Burchwheat

It is an annual monoecious and herbaceous plant with strong tap root system. Its leaf is simple, triangular or arrow-shaped. The white-pinkish flowers, male and female on the same plant, are grouped in terminal or axillary clusters (spikose raceme). The flowers are pollinated by bees. The fruit is a three-sided nutlet (fig. 194).

Its native center is Asia. Nowadays it is cultivated as a crop plant. The plants prefer sunny, dry to moist soils.

Vegetable product: *Fagopyri herba*



Fig. 194. Morphology of the Burchwheat *Fagopyrum esculentum* plant

SUBJECTS FOR DISCUSSION:

1. General characteristics of fam. Urticaceae.
2. Morphology of the Stinging nettle plant.
3. General characteristics of fam. Cannabaceae.
4. Morphology of the Hemp and Hop plants.
5. General characteristics of fam. Fagaceae.
6. Morphology of the Oak plant.
7. General characteristics of fam. Betulaceae.
8. Morphology of the White birch, White and Black elders plants.
9. General characteristics of fam. Polygonaceae.
10. Morphology of the Smartweed, Spotted ladythumb, Common knotgrass, Common bistort, Asiatic dock, Chinese rhubarb, and Burchwheat plants.
11. Pharmaceutical value of plant species.
12. Economic role of the described plant species.

**4.7. MORPHOLOGY OF SOME SPECIES
FROM THE FAMILIES:
THEACEAE, VIOLACEAE, PASSIFLORACEAE,
CUCURBITACEAE, BRASSICACEAE, SALICACEAE**

**PRACTICAL WORK nr. 1. Morphology of the Tea tree,
fam. Theaceae**

sp. *Thea sinensis* L., syn. *Camellia sinensis* L., common name - Tea tree

It is a tree or shrub, and growing to a height of 8-10m. Its leaf is evergreen, simple, leathery, alternate, and ovate with serrate margin. The flowers are white and axillary. The fruit is a capsule (fig. 195).

Tea tree is spread in subtropic zones of Asia (from the Himalaya mountains to Japan). The Tea tree prefers fertile soil, moderately moist, slightly acidic, and sunny places at mountain altitude. It is cultivated in India, Cylon, China, Georgia and South of Russia.

Vegetable product: *Theae folia*

Other species: *Camellia japonica* L., common name - Japanese camellia



A



B

Fig. 195. Morphology of the *Thea Thea sinensis* plant: A - picture; B - drawing

PRACTICAL WORK nr. 2. Morphology of some species from the fam. *Violaceae*

2.1. Morphology of the Heartsease plant

sp. *Viola tricolor* L., common name – Heartsease

It is an annual and herbaceous plant with tap root system. Its leaf is simple, petiolate, and ovate, with crenate margin and a pair of parted stipules. The solitary flowers are zygomorphic with petals of different color, usually white or yellow, purplish, or blue (fig. 196). They are hermaphrodite and self-fertile, pollinated by bees. Its fruit is a capsule.

It is a common European wild plant and is usually cultivated as a medicinal and ornamental plant.

Vegetable product: *Violae tricoloris herba*

2.2. Morphology of Sweet violet plant

sp. *Viola odorata* L., common name – Sweet violet

It is a herbaceous, perennial plant with stolons. Its leaf is simple with crenate margin in the basal rosette. The flower is solitary, usually blue-violet. The fruit is a capsule (fig. 196).

It is native to Europe and Asia. It is common in relatively moist and semi-shaded places. It is an ornamental plant.



Fig. 196. Morphology of the species: A – *Viola tricolor*; B – *V. odorata*

PRACTICAL WORK nr. 3. Morphology of the Purple passion flower plant, fam. Passifloraceae

sp. *Passiflora incarnata* L., common name – Purple passion flower

It is a herbaceous vine with tendrils (modified stem). Its leaves are simple, alternate, 3-parted with crenate margin. The flower is actinomorphic, large, solitary and of special structure with filamentous corona (coronule) between the corolla and androecium. The fruit is a large, purple berry (fig. 197).

It is spread in South America, Eastern Asia, Southern Asia and New Guinea. It prefers sunny places, sandy or medium heavy soils and well-drained soil.

Vegetable product: *Passiflorae incarnatae herba*

Other species: *Passiflora coerulea* L.



A

B

Fig. 197. Morphology of the Purple passion flower *Passiflora incarnata*:
A – morphology of the plant; B – morphology of the flower

PRACTICAL WORK nr. 4. Morphology of some species from the fam. Cucurbitaceae

4.1. Morphology of the Pumpkin plant

sp. *Cucurbita pepo* L., common name – Pumpkin

It is an annual herbaceous plant with tendrils (modified shoot). The leaves are simple, large, petiolate, alternate, and hairy with sinuate margins. The flowers are yellow, large, axillary and actinomorphic. The fruit is berry-like – pepo or melonide (fig. 198).

It is widely spread geographically, but the centre of origin is Mexico. It is largely cultivated. It prefers moist soil and tolerates nutritionally poor soil. The full sun is required for its maximum production.

Vegetable product: *Cucurbitae semina*

4.2. Morphology of the Water melon plant

sp. *Cytrullus lanatus* (Thunb.) Matsum. et Nakai,
common name - Water melon

It is an annual herbaceous plant with tendrils (modified shoot). Its leaves are simple, large, petiolate, and alternate, with sected blade. The flowers are yellow, large, axillary and actinomorphic. The fruit is a berry-like pepo or melonide (fig. 198).

The wild Watermelon is widely distributed in Africa and Asia, but it originates from Southern Africa. Nowadays it is a popular crop that can grow in any climate that has warm summer, and are the best suited to those climates that have long hot summers.

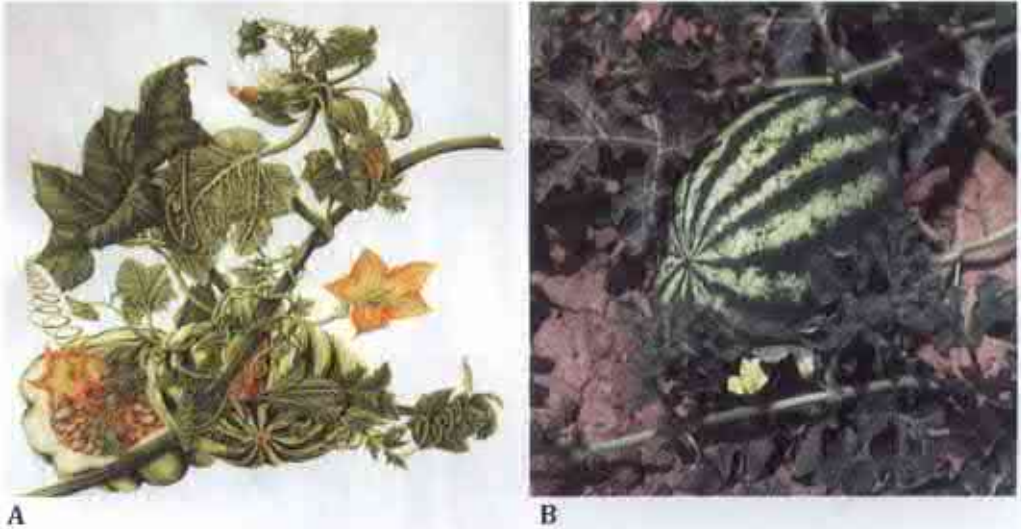


Fig. 198. Morphology of the species: A - *Cucurbita pepo*; B - *Cytrullus lanatus*

4.3. Morphology of the Cucumber plant

sp. *Cucumis sativus* L., common name - Cucumber

It is an annual herbaceous plant with tendrils (modified shoot). Its leaves are simple, large, petiolate, alternate and with sinuate margin. The flowers are yellow, large, axillary and actinomorphic. The fruit is a berry-like elongated pepo or melonide (fig. 199).

Cucumber originated in India, where a great many varieties are available. Nowadays, it is largely cultivated in Europe, Asia, Africa and America as a vegetable.

Other species: *C. melo* L.

4.4. Morphology of the White bryony plant

sp. *Bryonia alba* L., common name – White bryony

It is a perennial herbaceous, monoecious vine with curling tendrils (modified shoot). It has strong and enlarged root. The leaves are simple, large, palmate lobed. The flowers are white-greenish in racemose inflorescences. The fruit is a black berry (fig. 199).

White bryony is native to Europe and Northern Iran.

It prefers moist soil, especially in winter and spring and semi-shaded gardens. The plant is toxic.



A



B

Fig. 199. Morphology of the species: A – *Cucumis sativus*; B – *Bryonia alba*

PRACTICAL WORK nr. 5. Morphology of some species from the fam. Brassicaceae

5.1. Morphology of the Black mustard plant

sp. *Brassica nigra* Koch. (syn. *Sinapis nigra* Koch.),
common name – Black mustard

It is an annual, herbaceous plant, growing to a height of 1.0-1.5 m. It has a tap root system. Its basal leaves are simple, lyrate (deeply lobed, but with an enlarged terminal lobe and smaller lateral lobes), the stem leaves are alternate,

the upper leaves on flowering stems are narrow and oblong. The yellow, four-parted and cross-shaped flowers occur in many racemes. The fruit is a square siliqua along the stem, the seeds are brown (fig. 200).

It originated in the Middle East and is now widely cultivated as a primary source of mustard seeds used in making a condiment sauce, table mustard.

Vegetable product: *Sinapis semina*



Fig. 200. Morphology of the species: A - *Brassica nigra*; B - *B. alba*

5.2. Morphology of the White mustard plant

sp. *Brassica alba* L. (syn. *Sinapis alba* L.), common name - White mustard

It is an annual, herbaceous plant, growing to a height of 40-90 cm with strong tap root system. The stem is branched. The leaf is simple, pinnate sected with serrate margin. The flowers are shiny-yellow in racemes. The fruit is a strangulated siliqua, hairy, perpendicularly to the stem. The seeds are large and yellow (fig. 200).

Grown for its seeds, mustard, as fodder crop, it is now widespread worldwide, although it probably originated in the Mediterranean region.

Vegetable product: *Sinapis semina*

5.3. Morphology of the Garden cabbage

sp. *Brassia oleracea* L., var. *capitata* L., common name -
Garden cabbage or Heading cabbage

It is a biannual, herbaceous plant. In the first year it develops the tap root system, simple leaves and enlarged, giant vegetative buds, which form dense-leaved heads. In the second year – the flowering stem with yellow flowers in racemes. The fruit is a silique (fig. 201).

It is difficult to trace the exact history of Cabbage, it originated from wild types growing on the European coasts of the Atlantic Ocean and the Mediterranean sea. The domestication of cabbage coincides with the development of human culture and civilization in ancient Egypt and the Roman Empire.



A



B

Fig. 201. Morphology of the Garden cabbage *Brassica oleracea*, var. *capitata*:

A – I year (modified vegetative bud); B – II year (flowering plant)

Other varieties of cabbage (fig. 202):

botrytis – Broccoli and cauliflower;

gemmifera – Brussels sprouts;

sabauda – Savoy cabbage;

gongylodes – Kohlrabi.



A



B



C



D

Fig. 202. Morphology of different varietales of Cabbage *Brassica oleracea*:
 A – Broccoli *Botrytis*; B – Brussels sprouts *gemmifera*; C – savoy cabbage *sabauda*;
 D – Kohlrabi *gongyloides*

5.4. Morphology of the Shepherd's-purse plant

sp. Capsella bursa-pastoris (L.) Medic., common name –
 Shepherd's-purse

It is an annual, herbaceous plant with tap root system. Its lower leaves are simple, pinnate sected (runcinate) in basal rosette; the stem leaves are simple, sessile, entire and arrowed. The flowers are white, type 4 and united in a raceme. The fruit is a silicula (fig. 203).

It is native to Eastern Europe and Asia Minor, but it was naturalized and is considered a common weed in many parts of the world, especially in colder climates. The plant prefers dry and semi-moist soil and sunny places.

Vegetable product: *Bursae herba*



Fig. 203. Morphology of the species: A – *Capsella bursa-pastoris*;
B – *Armoracia rusticana*

5.5. Morphology of the Horseradish plant

sp. *Armoracia rusticana* G. Gaertn., B. Mey. Scherb,
syn. *Cochlearia armoracia* L., common name – Horseradish

It is a perennial, herbaceous plant with enlarged root. The lower leaves are simple, large, ovate-elliptical with a crenate margin, the stem leaves are also simple, but lanceolate and sessile. The flowers are white, type 4 in compound raceme. The fruit is silique (fig. 203).

The plant is native to Southeastern Europe and Western Asia. It is now popular around the world and is cultivated for its large, white, tapered root with hardly any aroma, which irritates the mucous membrane of the nose and eyes.

Vegetable product: *Armoracie radices*

PRACTICAL WORK nr. 6. Morphology of some species from fam. Salicaceae

6.1. Morphology of the Black poplar plant sp. *Populus nigra* L., common name - Black poplar

It is a medium to large-sized deciduous tree, reaching 20–30 m, and rarely 40 m tall with a narrow columnar crown. Their leaves are diamond-shaped to triangular, 5–8 cm long and 6–8 cm broad, green on both surfaces and shiny. The species is dioecious – male and female flowers are on different plants. The flowers are unated in catkin inflorescences. The fruit is a capsule with many hairy seeds (fig. 204).

Black poplar has a large distribution area throughout Europe and is also found in Northern Africa and Central and West Asia. Trees are characterized by rapid growth and are able to quickly colonize open areas.

Black poplar prefers to grow in full sun on well-drained, acid, neutral or alkaline soils. They tolerate wet soil but can also grow well under drought, losing leaves early in very dry summers.

Vegetable product: *Populi gemmae*

Other species: *P. alba* L. – Silver poplar, *P. tremula* L. – Common aspen (fig. 205)



Fig. 204. Morphology of the Black poplar *Populus nigra* plant



Fig. 205. Morphology of the species: A - *Populus alba*; B - *P. tremula*.

6.2. Morphology of the White willow plant sp. *Salix alba* L., common name - White willow

It is a medium-sized to large deciduous tree growing up to 10-30 m tall, with a trunk up to 1 m diameter and an irregular, often-leaning crown. The leaves are simple, lanceolate, covering of very fine, silky white hairs, in particular on the underside.

The flowers are produced in catkins in early spring, and pollinated by insects. It is dioecious, with male and female catkins on separate trees; the male catkins are 4-5 cm long, the female catkins 3-4 cm long at pollination, lengthening as the fruit matures. When mature in midsummer, the female catkins comprise numerous small (4 mm) capsules, each containing numerous minute seeds embedded in white down, which aids wind dispersal (fig. 206).

White willow has a large distribution area throughout Europe and is also found in Northern Africa and Central and West Asia. It prefers to grow in full sun on well-drained, acid, neutral or alkaline soils, but needs wet soil, and near water.

Other species: *Salix caprea* L. - Goat willow (fig. 206)



Fig. 206. Morphology of the species: A – *Salix alba*; B – *S. caprea*

SUBJECTS FOR DISCUSSION:

1. General characteristics of fam. Theaceae.
2. Morphology of the Tea plant.
3. General characteristics of fam. Passifloraceae.
4. Morphology of the Passion flower.
5. General characteristics of fam. Violaceae.
6. Morphology of the Heartsease plant.
7. General characteristics of fam. Cucurbitaceae.
8. Morphology of the Pumpkin, Water melo, Cucumber and Bryony plants.
9. General characteristics of fam. Brassicaceae.
10. Morphology of the Black and White mustard, Cabbage, Shepherd's-purse, Horseradish plants.
11. General characteristics of fam. Salicaceae.
12. Morphology of the Black poplar and White willow plants.
13. Pharmaceutical value of plant species.
14. Economic role of the described plant species.

4.8. MORPHOLOGY OF SOME SPECIES FROM THE FAMILIES: ERICACEAE, PRIMULACEAE, TILIACEAE, MALVACEAE, HYPERICACEAE, ROSACEAE

PRACTICAL WORK nr. 1. Morphology of some species from the fam. Ericaceae

1.1. Morphology of the Bilberry plant

sp. *Vaccinium mirtyllus* L., common name – Bilberry

It is a low bush, growing to a height of 30-70 cm. The stem is branched. Its leaf is simple, alternate, and ovate with serrate margin. The flowers are urceolate, white-pinkish, and axillary. The fruit is a dark-violet berry (fig. 207).

It is a berry-producing plant.

Bilberries are found in acidic, nutrient-poor soils throughout the temperate and subarctic regions of the world.

It can grow in semi-shade (light woodland) places. It prefers moist and acid, bog soils.

Vegetable product: *Mirtylli folia*

1.2. Morphology of the Mountain cranberry plant

sp. *Vaccinium vitis-idaea* L., common name – Mountain cranberry

It is a low bush with creeping rhizome, growing to height 25-35 cm. Its leaves are evergreen, simple, ovate or obovate, leathery, with brown spots on the lower surface. The lamina apex is rounded or emarginated. The flowers are white-pinkish, urceolate in terminal pendent with racemes. The fruit is a red, rounded berry (fig. 207).

It is a berry-producing plant.

The bush is native to boreal forest and Arctic tundra throughout the Northern Hemisphere from Eurasia to North America.

The plants prefers wet, boggy soils and sunny or a partly sunny places.

Vegetable product: *Vitis idaeae folia*

Other species: *Vaccinium uliginosum* L., common name – Bog bilberry

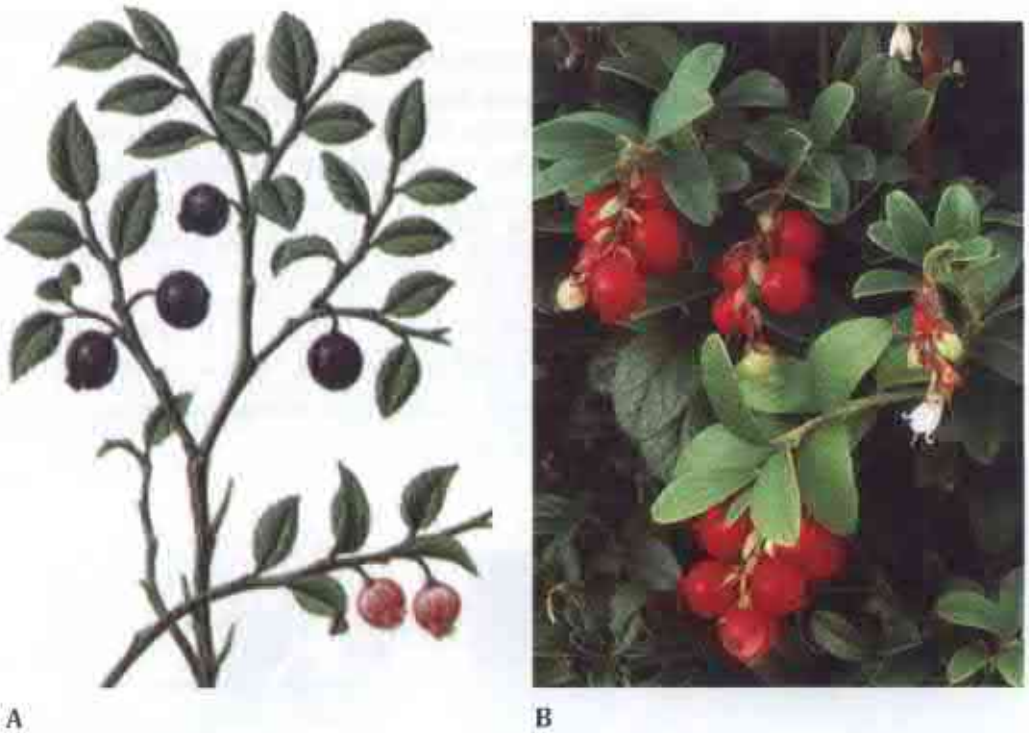


Fig. 207. Morphology of the species: A – *Vaccinium myrtillus*;
B – *V. vitis-idaea*

1.3. Morphology of the Common bearberry

sp. *Arctostaphylos uva-ursi* (L.) Spreng, common name –
Common bearberry

It is a low bush, growing to a height of 25-80 cm with creeping stem. Bearberry is long-living, but it grows very slowly. The leaves are simple, narrow-obovate, and leathery, with entire margin. The leaf apex is rounded and the base is cuneate. The flowers are white-pinkish, urceolate in terminal, pendent racemes. The fruit is a red, rounded berry (fig. 208). It is a berry-producing plant.

The plant prefers moist, well-drained soil and can grow in nutritionally poor soil. The suitable pH: acid, neutral and basic (alkaline) soils and can grow in very acid soils. It can grow in full shade (deep woodland) semi-shade (light woodland) or no shade places.

Vegetable product: *Uvae-ursi folia*

1.4. Morphology of the Wild rosemary plant

sp. *Ledum palustre* L., syn. *Rhododendron tomentosum* Harmaja,
 common name - Wild rosemary or Northern Labrador tea

It is an evergreen subshrub, growing to a height of 25-40 cm. The leaves are simple, linear, leathery, with entire margin. The flowers are white in umbel inflorescences. The fruit is a small capsule that changes from greenish-red to red or brown and splits open to expose the seeds (fig. 208).

The distribution of Northern Labrador tea is restricted to the northern hemisphere. It is suitable for acid soils and can grow in very acid soils. It can grow in full shade (deep woodland) semi-shade (light woodland) or no shade. It prefers moist or wet soil. The plant is toxic.



Fig. 208. Morphology of the species: A - *Arctostaphylos uva-ursi*;
 B - *Ledum palustre*

PRACTICAL WORK nr. 2. Morphology of the Cowslip plant from the fam. Primulaceae

**sp. *Primula veris* L., syn. *Primula officinalis* (L.) Hill.,
common name – Cowslip**

It is a perennial herbaceous plant with erect short rhizome. The leaves in the basal rosette are simple, ovate and crenate margin with winged petiole. Its yellow flowers are campanulate in umbel inflorescences and bloom early in the spring. The fruit is a dry dentate capsule (fig. 209).

The species is native to most of the temperate zones of Europe and Asia. Cowslip likes moist and wet soil in sunny or partially shaded places.

Vegetable product: *Primulae folia*



Fig. 209. Morphology of the Cowslip *Primula veris* plant

PRACTICAL WORK nr. 3. Morphology of some species from the fam. Tiliaceae

3.1. Morphology of the Large-leaved lime plant

sp. *Tilia platyphyllos* Scop., common name – Large-leaved lime

It is a deciduous tree, growing to a height of 30-45 m. Its leaf is simple, alternate, cordate, with acuminate apex and serrate margin. There are gray hairs at the base of veins of the lower leaf surface. It has actinomorphic flowers

in cymose inflorescences with a bract on the principal axis. The fruit is a nutlet, and 5-costate (fig. 210).

It is native to much of Europe, including Southwestern Great Britain, growing on lime-rich soils.

Vegetable product: *Tiliae flores*

3.2. Morphology of the Small-leaved lime plant

sp. *Tilia cordata* Mill., common name – Small-leaved Lime

It is a deciduous tree, growing to a height of 20-40 m. Its leaf is simple, alternate, cordate, with acuminate apex and serrate margin. There are grey hairs on the lower leaf surface with brownish hairs in the axils of the veins. It has actinomorphic flowers in cymose inflorescences with a bract on the principal axis. The fruit is a nutlet (fig. 210).

It is native to much of Europe, from Britain to central Russia, and Southern and Central Spain, Italy, Greece, Bulgaria, Romania, Turkey, the Caucasus, and Western Asia.

Vegetable product: *Tiliae flores*

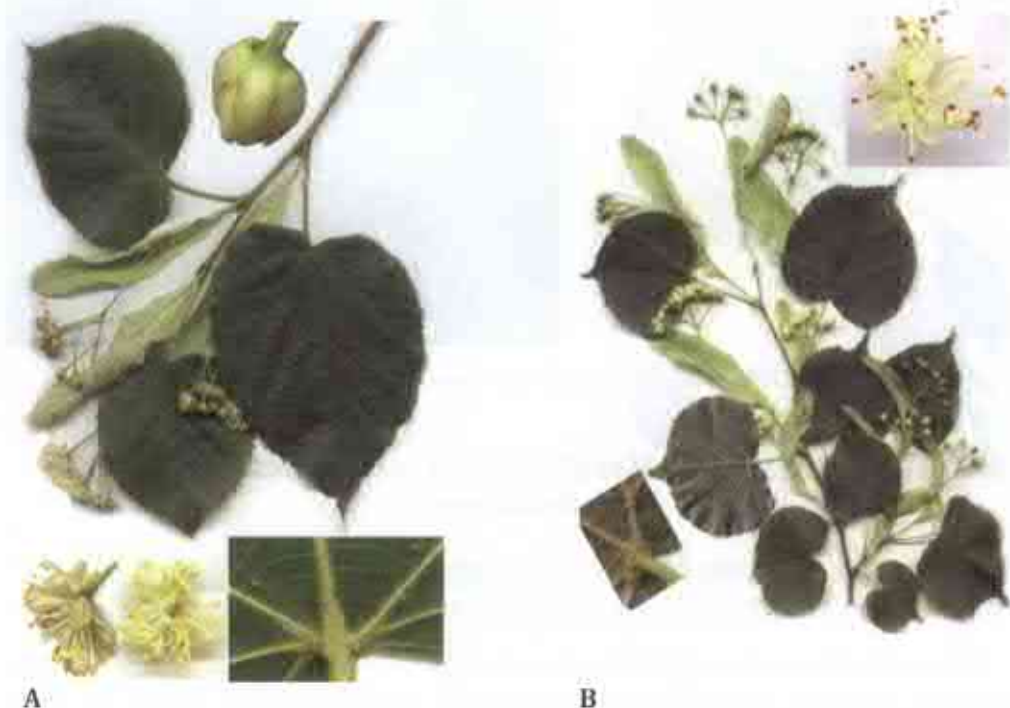


Fig. 210. Morphology of the species: A – *Tilia platyphyllos*; B – *T. cordata*

PRACTICAL WORK nr. 4. Morphology of some species from the fam. Malvaceae

4.1. Morphology of the Marshmallow plant

sp. *Althaea officinalis* L., common name - Marshmallow

It is a perennial herbaceous plant with enlarged and branched root. Its leaves are simple, large, petiolate, alternate, hairy, 5-lobed with serrate margins. The flowers with double calyx are pink, large, axillary and actinomorphic. The fruit is a schizocarp with 15-20 mericarps (fig. 211).

It is common to Europe, Western Asia, and North Africa. It prefers sunny, open places. Usually it is cultivated as a medicinal and ornamental plant.

Vegetable product: *Athaeae radices et folia*

4.2. Morphology of the Mallow plant

sp. *Malva sylvestris* L., common name - Common Mallow or Silver Mallow

It is a herbaceous plant with branched stem, growing to a height of 30-100 cm. Its leaves are simple, petiolate, 5-lobed with a crenate margin. The flowers are pink with violet veins, large, axillary and actinomorphic. Its fruit is a schizocarp (fig. 211).

It is native to Western Europe, North Africa and Asia. It grows freely in fields, hedgerows and in fallow fields.

Vegetable product: *Malvae herba*



A



B

Fig. 211. Morphology of the species: A - *Althaea officinalis*; B - *Malva sylvestris*

4.3. Morphology of the Cotton plant

sp. *Gossypium barbadense* L., common name – Cotton

It is a perennial, herbaceous plant, growing to a height of 50-120 cm with resin secretory cavities. The stem is branched. The leaves are simple, large, petiolate, alternate, 3-5-lobed. The flowers are large and actinomorphic. Its fruit is a dry capsule with hairy seeds (fig. 212).

It originates from tropical South America (probably Peru). It is cultivated for extra-long staple fibers – longer than 34 mm, which are associated with high quality products. The Cotton plant requires the full sun, high humidity and rainfall.

Medicinal product: *Gossypium depuratum*

4.4. Morphology of the Levant Cotton plant

sp. *G. herbaceum* L., common name – Levant Cotton

This species (fig. 209) is possibly native to South Africa and reached Asia and America in early prehistoric times. It is cultivated in Asia and Africa. It was possibly grown in South-East Asia, e.g. in Indonesia and Cambodia.



Fig. 212. Morphology of the species: A – *Gossypium barbadense*; B – *G. herbaceum*

PRACTICAL WORK nr. 5. Morphology of St. John's wort plant from the fam. Hypericaceae

sp. Hypericum perforatum L., common name – St. John's wort

It is a perennial, herbaceous plant, growing to a height of 0.5-0.7 m., branched at the tips, winged and lignified stem at the base. The leaf is simple, ovate, opposite with white and dark spots. The flowers are yellow with brown spots on the petals, in dichasial inflorescences. The fruit is a nutlet (fig. 213).

It is native to some parts of Europe and Asia, but spread to temperate regions worldwide as a cosmopolitan invasive weed. In pastures St John's wort acts as both a toxic and invasive weed.

Vegetable product: *Hyperici herba*



A



B

Fig. 213. Morphology of the sp. Hypericum perforatum: A – plant; B – leaf with white and dark spots

PRACTICAL WORK nr. 4. Morphology of some species from the fam. Rosaceae

4.1. Morphology of the Dog rose plant

sp. *Rosa canina* L., common name – Dog rose

It is a shrub. Its stem develops curved thorns. The leaves are imparipennate compound, large, alternate with a pair of stipules. The leaflets are oval with fine serrate margin. The flowers are white-pinkish, large and actinomorphic. The fruit is false – hips with hairy achene (fig. 214).

Dog rose is native to Europe, northwest Africa, and western Asia. Dog rose is one of the most cultivated and economically valued species in many countries. In forest habitats it prefers sunny and warm places.

Vegetable product: *Rosae fructus*

Other species: *R. damascena* Mill., *R. cinnamomea* L., *R. gallica* L.,
R. centifolia L.



Fig. 214. Morphology of the species: A – *Rosa canina*; B – *Rubus idaeus*

4.2. Morphology of the Raspberry plant

sp. *Rubus idaeus* L., common name – Raspberry

It is a shrub, growing to a height of 1.5 m. The leaves are large, alternate and imparipennate compound. The lower surface is white. The flowers are white, united in short racemes. The fruit (multiple) is polydrupe, consisting of numerous drupelets around the central core (fig. 214).

It is native to Europe and northern Asia and is commonly cultivated in other temperate regions. As a wild plant, *R. idaeus* grows typically in forests. It can grow in semi-shade (light woodland) or in open places. It prefers moist soil.

It is a berry- producing plant.

Vegetable product: *Rubi idaei fructus*

4.3. Morphology of the European Dewberry plant

sp. *Rubus caesius* L., common name – European Dewberry or Blackberry

It is a climbing woody vine with thorns. The leaves are imparipennate compound, the leaflets are ovate with serrate margin. The flowers are white. Its fruit is polydrupe (fig. 215).

It is widely distributed across much of Europe and Asia, from Ireland and Portugal to Far East. *R. caesius* most often inhabits areas with rocky, basic soil and light shade. It is often found in forest margins, coppices, rocky broadleaf woods and waterside thickets. It is cultivated as a berry-fruit plant.

Other species: *R. fruticosus* L.

4.4. Morphology of the Wild strawberry plant

sp. *Fragaria vesca* L., common name – Wild strawberry

It is a perennial herbaceous plant with aboveground stolon (for vegetative reproduction). The leaves are tree-foliolate compound with serrate margin in the basal rosette. The flowers are white. The fruit is polynut (fig. 215).

It grows naturally throughout much of the Northern Hemisphere, and produces edible fruits. The typical habitat is along roadsides, hillsides, stone- and gravel-laid paths and roads, meadows, young woodlands, forest. The plants can often be found where they do not get sufficient light to form fruit. In the southern part of its range, it can grow only in shady areas; further to the North it tolerates more sun. It is tolerant of a variety of moisture levels (except very wet or dry conditions).

Vegetable product: *Fragariae fructus et folia*



Fig. 215. Morphology of the species: A – *Rubus caesius*;
B – *Fragaria vesca*

4.5. Morphology of the Common tormentil plant

sp. *Potentilla erecta* (L.) Raeusch., syn. *P. tormentilla* (L.) Neck,
common name – Common tormentil

It is a perennial, herbaceous plant with erect rhizome. Its leaves are 3-sected with 2 large stipules and serrate margin. The flowers are yellow, type 4 or 5, growing at the tip of a long stalk. The fruit is polyachene (fig. 216).

It grows wild predominantly in Scandinavia, Europe, and Western Asia. It prefers mostly acid soils in a wide variety of habitats, such as mountains, heaths, meadows, sandy soils and open fields.

Vegetable product: *Tormentillae rhizomata*

Other species: *P. argentea* L. (fig. 216), *P. anserina* L. (fig. 217)

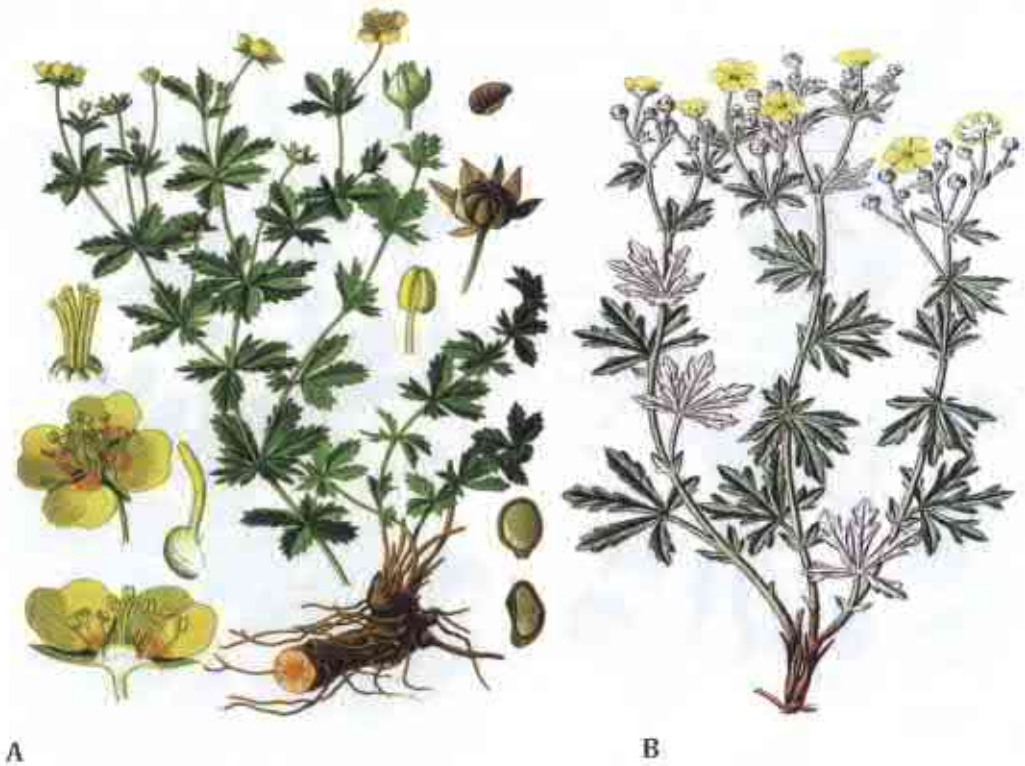


Fig. 216. Morphology of the species: A - *Potentilla erecta*;
B - *P. argentea*

4.6. Morphology of the Agrimony plant

sp. *Agrimonia eupatoria* L., common name - Agrimony

It is a perennial and herbaceous plant. The leaves are imparipennate-compound (one pair of small leaflets alternate with other pair of large leaflets). The flowers are yellow, type 5 in spike inflorescence. The fruit is polyachene with burs (fig. 217). These attach to passing grazing animals such as cattle, sheep and deer and are spread over a large area.

It is native to the temperate regions of the Northern Hemisphere. It can grow in semi-shade (light woodland) or in open places. It prefers dry or moist soil.

Vegetable product: *Agrimoniae herba*



Fig. 217. Morphology of species: A – *Potentilla anserina*;
B – *Agrimonia eupatoria*

4.7. Morphology of the Great burnet plant

sp. *Sanguisorba officinalis* L., common name – Great burnet

It is a perennial, herbaceous plant with thick, horizontal rhizome, growing to a height of 1 m. The leaves are imparipinnate compound, the leaflet is ovate with serrate margin. The flowers are red, united in terminal dense spike. The fruit is an achene (fig. 218).

It is native throughout cooler regions of the Northern Hemisphere in Europe, Northern Asia, and Northern North America. It occurs in grasslands, growing well on grassy banks. Great burnet prefers to grow in a sunny part and moist soils.

Vegetable product: *Sanguisorbae rhizomata*

4.8. Morphology of the Wood avens plant

sp. Geum urbanum L., common name - Wood avens

It is a perennial, herbaceous plant with cylindrical and dark brown rhizome. The leaves are simple, 3-parted or 3-sected with large stipules in basal rosette and on the stem. The flowers are yellow, axillary. The fruit is polyachene with curved, lignified styles (fig. 218).

It grows in shady places (such as woodland edges and near hedgerows) in Europe and the Middle East.

Vegetable product: *Gei rhizomata cum radicibus*



Fig. 218. Morphology of the species: A - *Sanguisorba officinalis*;
B - *Geum urbanum*

4.9. Morphology of the Rowan tree

sp. Sorbus aucuparia L., common name - Rowan or mountain-ash

It is a deciduous tree or shrub. The leaves are imparipennate compound of leaflets with serrate margin. White or small yellowish flowers are grouped in a compound corymb inflorescence. The fruit is a small orange or red pomme (fig. 219).

It is native to most of Europe and parts of Asia, as well as northern Africa. The Rowan can grow in semi-shade (light woodland) or in open places and prefers moist soil. It can tolerate atmospheric pollution.

Vegetable product: *Sorbi fructus*

4.10. Morphology of the Hawthorn plant

sp. *Crataegus monogyna* L., common name - Hawthorn

It is a shrub or small tree growing to a height of 5-14 m, with a dense crown and modified twig in thorn. The leaves are simple, pennate-parted or pennate-lobed. The upper surface of the leaf is dark green above and paler underneath. White, 5-type flowers are grouped in compound corymb. The fruit is an oval, small, dark-red pomme (fig. 219).

It is native to Northern Europe and prefers well-drained soils and needs sunny forestry places.

Vegetable product: *Crataegi fructus et flores*



A



B

Fig. 219. Morphology of the species: A - *Sorbus aucuparia*;
B - *Crataegus monogyna*

4.11. Morphology of the Black chokeberry plant sp. *Aronia melanocarpa* (Michx.) Elliot, common name – Black chokeberry

It is a deciduous shrub with spherical, dense crown. The leaves are simple, alternate, ovate-elliptical with serrate margin. Its white flowers are grouped in a corymb inflorescence. The fruit is a violet-black, small, rounded pomme (fig. 220).

It is native to Eastern North America and is most commonly found in wet woods and swamps.

The plants are suitable for acid, neutral and basic (alkaline) soils. It can grow in semi-shade (light woodland) or open places. It prefers dry or moist soil. It is cultivated as a fruit-producing and ornamental plant.

Vegetable product: *Aroniae fructus*



A



B

Fig. 220. Morphology of the species: A – *Aronia melanocarpa*; B – *Cydonia oblonga*

4.12. Morphology of the Quince plant sp. *Cydonia oblonga* L., common name – Quince

It is a deciduous tree with simple, oblong, alternate, hairy leaves. The flowers are white and solitary. The fruit is yellow, aromatic pomme (fig. 220). An immature fruit is green with dense grey-white pubescence, late in autumn the

fruit changes color to yellow with hard, strongly perfumed flesh. It is a fruit-producing plant.

Quince is native to rocky slopes and woodland margins in South-West Asia, Armenia, Turkey and Iran. It is a hardy, drought-tolerant shrub which adapts to many soils of low to medium pH. It tolerates both shade and sun.

INDIVIDUAL PRACTICAL WORK
ANALYZE AND DETERMINE THE MORPHOLOGY
OF THE FOLLOWING SPECIES:

Pyrus communis L., common name - Pear tree (fig. 221)

Malus domestica (L.) Borkh, common name - Apple tree (fig. 221)



A



B

*Fig. 221. Morphology of the species: A - *Pyrus communis*; B - *Malus domestica**

Prunus amigdalus L. (*Amygdalus communis* L.), common name - Almond tree (fig. 222);

P. persica (L.) Batsch (*Persica vulgaris* L.), common name - Peach tree (fig. 222);

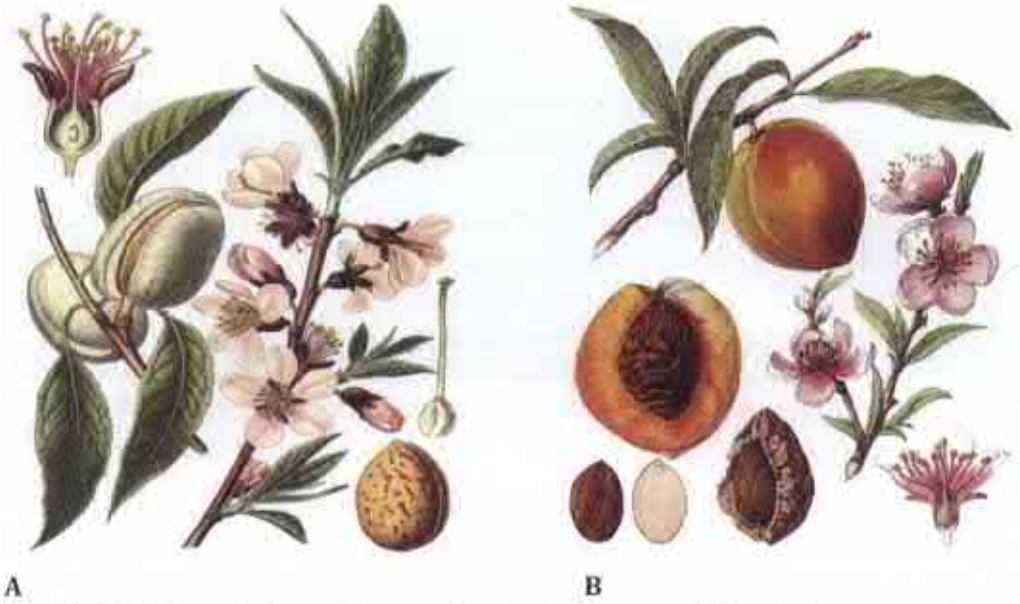


Fig. 222. Morphology of the species: A - *Prunus amygdalus*; B - *Prunus persica*

P. domestica L., common name - Plum tree (fig. 223);

P. avium L. (*Cerasus avium* (L.) Moench.), common name - Cherry tree (fig. 223).



Fig. 223. Morphology of the species: A - *Prunus domestica*; B - *P. avium*

SUBJECTS FOR DISCUSSION:

1. Morphological and ecological characteristics of the families: ERICACEAE, PRIMULACEAE, TILIACEAE, MALVACEAE, HYPERICACEAE, ROSACEAE.
2. Latin and common names of each described species from each family, their morphological characteristics, distribution and ecology.
3. Economical and pharmaceutical usage of the species.

4.9. MORPHOLOGY OF SOME SPECIES FROM THE FAMILIES: FABACEAE, RUTACEAE, MYRTACEAE, ANACARDIACEAE, HIPPOCASTANACEAE

PRACTICAL WORK nr. 1. Morphology of some species from the fam. Fabaceae

1.1. Morphology of the Japanese pagoda tree

sp. *Sophora japonica* L., common name - Japanese pagoda tree
or Chinese pagoda tree

It is a deciduous large tree, growing to a height of 20-25 m. The leaves are imparipennate compound, and ovate-lanceolate leaflets with entire margin. The papilionoid flowers are yellow, zygomorphic, grouped in erect compound racemes. The fruit is a lomentous pod (fig. 224).

This tree is native to eastern Asia, especially China and Japan. The plant grows in a well-drained moderately fertile soil and full sun.

It tolerates poor soils, atmospheric pollution, and heat, once established, drought. Usually, it is cultivated as an ornamental tree.

Vegetable product: *Sophorae japonicae alabastra*

1.2. Morphology of the Sophora plant

sp. *Sophora pachycarpa* C.A.May., common name - Sophora

It is a deciduous subshrub, growing to a height of 35-55 cm. The leaf is imparipennate compound with small, elliptical, entire leaflets. The papilionoid flower is yellow, zygomorphic in erect axillary racemes. The fruit is a rough, dark-brown pod (fig. 224).

It grows mainly in Central Asia and prefers dry soils and full sunny places. The plant is toxic.

Vegetable product: *Sophorae pachycarpae herba*



Fig. 224. Morphology of the species: A - *Sophora japonica*, B - *S.pachycarpa*

1.3. Morphology of the Yellow melilot plant

sp. *Melilotus officinalis* (L.) Lam., common name - Yellow melilot or yellow sweet clover

It is a herbaceous, growing to a height of 90-150 cm and it can be an annual or biennial plant. The plants have large taproots and tend to grow in groups. Its costate stem is branching. The leaf is a trifoliolate-compound. The leaflet has a dentate margin. The flowers are yellow in axillary spike inflorescences. The fruit is a rounded pod with 1-2 seeds (fig. 225). The plants have a characteristic sweet odor.

It is native to Eurasia and is introduced in North America, Africa and Australia as a forage crop. It can be found in open fields, and it grows in full or partial sunlight. It is an invasive species in areas where it was introduced, especially in open grasslands and woodlands.

The plant can be toxic for animals and humans.

Vegetable product: *Meliloti herba*

1.4. Morphology of the Common liquorice plant

sp. *Glycyrrhiza glabra* L., common name – Common liquorice

It is a deciduous subshrub, growing to a height of 100-150 cm with creeping rhizome (length – 1-2 m). The stem is lignified at the base. The leaf is imparipinnate-compound with ovate leaflets, secretory hairs on the lower surface, that why it is sticky. The papilionoid flowers are pinkish in erect, axillary racemes. The fruit is a lomentous, brown pod with prominent seeds (fig. 225), 1-3 cm long and 4-5 mm wide. Each pod contains 2-5 brown-blackish seeds.

It is native to Eurasia, northern Africa and western Asia. The plants prefer dry, open land and damp soil near streams, often soils with high nitrogen content.

In Russia, Spain and the Middle East it is cultivated as a crop plant for its rhizomes containing the compound glycyrrhizin, which is 50 times sweeter than sugar.

Vegetable product: *Glycyrrhizae glabrae radices*.



Fig. 225. Morphology of the species: A – *Melilotus officinalis*;
B – *Glycyrrhiza glabra*

1.5. Morphology of the Spiny Rest-harrow
 sp. *Ononis spinosa* L., syn. *O. vulgaris* L.,
 common name – Spiny Rest-harrow

It is a deciduous subshrub, growing to a height of 40-50 cm. The stem is lignified at the base, branching with thorns (modified shoots). The leaves are trifoliolate-compound, ovate with dentate leaflets with secretory hairs on the both surfaces. The papilionoid flowers are pinkish with red veins, axillary along of the stem. The fruit is a rounded pod (fig. 226).

It is found throughout much of Europe but it occurs seldom in the North of Scotland. It prefers dry or moist, well-drained soil and can grow in nutritionally poor soil. The suitable pH is acid, neutral and basic (alkaline) soils and it can grow in very alkaline soils. It likes sun and cannot grow in the shade.



**Fig. 226. Morphology of species: A – *Ononis spinosa*;
 B – *Arachis hypogaea***

1.6. Morphology of the Peanut or ground peanut plant

sp. *Arachis hypogaea* L., common name - Peanut or ground peanut

It is a herbaceous plant, growing to a height of 30-40 cm. It has a tap root system. The stem is branching. The leaves are paripennate-compound, with entire, ovate leaflets. Its flowers are solitary, on a long pedicel. The flower gynophores (internode between androecium and gynoecium) grow quickly after fertilization and penetrate the soil. The fruits are rough, strangulate pods developed in the soil (fig. 226).

It is native to South America and is adapted to semi-arid and semi-humid conditions. Peanut is cultivated as a major food crop species of global importance.

It grows on the sandy soils, of the types ranging from loamy sands to sandy clay loams, with good drainage and pH range is 5.5-6.5.

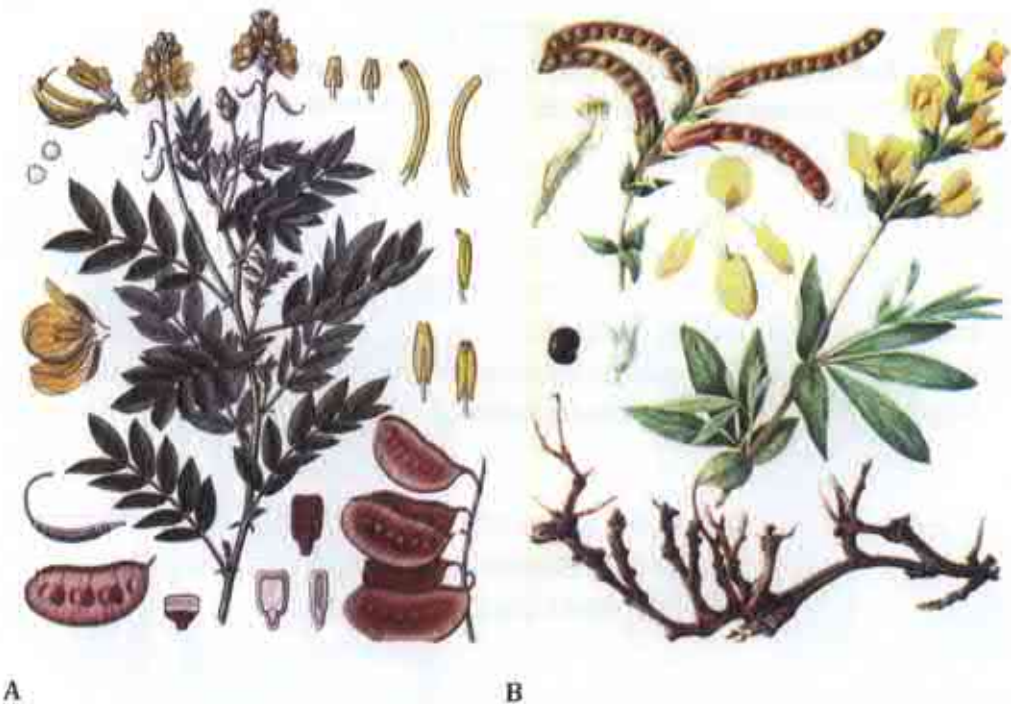


Fig. 227. Morphology of the species: A - *Cassia acutifolia*;

B - *Thermopsis lanceolata*

1.7. Morphology of the Indian senna plant

sp. *Cassia acutifolia* Delile, syn. *Senna acutifolia* L.,
common name - Indian senna

It is a deciduous subshrub growing to a height of 100 cm. Its stem is lignified at the base and branching. The leaves are paripennate-compound. The leaflet is entire and ovate with acute apex. Flowers are yellow in axillary raceme. The fruit is flattened pod (fig. 227).

It is native to Egypt and Sudan. The plants can be grown in drier warm temperate to tropical zones. The plants prefer a deep, well-drained, moderately fertile sandy loam and a position in the full sun.

Vegetable product: *Sennae folia et fructus*

Other species: *C. angustifolia* L., syn. *Senna angustifolia* L.

1.8. Morphology of the Carolina lupine plant

sp. *Thermopsis lanceolata* (L.) Link., common name -
Carolina lupine or False lupine

It is a perennial, herbaceous plant, growing to a height of 30-40 cm. The creeping rhizome develops a lot of erect, hairy, costate stems. The leaves are trifoliolate-compound with 2 big laceolate stipules. Its papilionoid flowers are yellow united in a terminal spike. The fruits are curbate pods (fig. 227).

It is native to temperate North America and East Asia. The plants prefer sunny and moist soil. The plants can tolerate drought. The plant is toxic.

Vegetable product: *Thermopsidis herba*

INDIVIDUAL PRACTICAL WORK ANALYZE AND DETERMINE THE MORPHOLOGY OF THE FOLLOWING SPECIES:

Phaseolus vulgaris L., common name - Bean (fig. 228)

Glycine max (L.) Merr., common name - Soybean (fig. 228)



A



B

Fig. 228. Morphology of the species: A – *Pisum sativum* L., common name – Pea (fig. 229)

***Pisum sativum* L., common name – Pea (fig. 229)**

***Robinia pseudoacacia* L., common name – Black locust (fig. 229)**



A



B

Fig. 229. Morphology of the species: A – *Pisum sativum*; B – *Robinia pseudoacacia*

PRACTICAL WORK nr. 2. Morphology of some species of fam. Rutaceae

2.1. Morphology of the Common rue plant

sp. *Ruta graveolens* L., common name – Common rue or Herb-of-grace

It is a perennial herbaceous plant, growing to a height of 70-80 cm. The stem is lignified at the base. The leaves are pinnate-sected, at the base of stem they are petiolate, at the tip – sessile. The flowers are yellow in corymb inflorescences. The fruit is a capsule (fig. 230).

It is native to the Balkan Peninsula. It is easily grown in moderately fertile, dry and medium moisture, well-drained soils in the full sun. The plant is very toxic.

Vegetable product: *Rutae herba*

2.2. Morphology of the Lemon tree

sp. *Citrus limon* (L.) Burm., common name – Lemon tree

It is an evergreen shrub or tree with thorns, cultivated in the tropics and subtropics. The leaves are simple, ovate-elliptical, and leathery, with winged petiole. The flowers are white and star-like. The fruit is a hesperidium (fig. 230).

The Lemon tree originates from Asia (likely India and Pakistan). Now it is grown commercially worldwide in tropical, semi-tropical and warm temperate countries, including the Mediterranean region for the fruit.



Fig. 230. Morphology of the species: **A** – *Ruta graveolens*; **B** – *Citrus limon*

INDIVIDUAL PRACTICAL WORK
ANALYZE AND DETERMINE THE MORPHOLOGY
OF THE FOLLOWING SPECIES:

Citrus reticulata L., common name - Mandarin tree (fig. 231).

Citrus paradisi Macfad, common name - Grapefruits tree (fig. 231).



A

B

Fig. 231. Morphology of the species: A - Citrus reticulata; B - C. paradisi

**PRACTICAL WORK nr. 3. Morphology of some species from
 fam. Myrtaceae**

3.1. Morphology of the Tasmanian blue gum plant

— *sp. Eucalyptus globulus* Labill., common name - Tasmanian blue gum

It is an evergreen tree specific for the Australian flora, growing to a height of 100-145 m. It is characterized by heterofillia: on young shoots the leaves are ovate, opposite and thin; on old shoots the leaves are simple, leathery, lanceolate-falcate, sessile and alternate. Actinomorphic flowers are solitary. The fruit is quadrangular capsule (fig. 232).

It is native to Australia. There are naturalized non-native specimens in Spain and Portugal, and other parts of southern Europe including Cyprus, Southern Africa, New Zealand, Western United States (California), Hawaii, and the Caucasus (Western Georgia).

The Tasmanian blue gum is a thirsty plant. The main argument against planting it is its high consumption of ground water and it can dry up water sources such as rivers and springs. It cannot grow in the shade. It prefers dry moist or wet soil and can tolerate drought.

Vegetable product: *Eucalypti folia*

Other species: *E. viminalis* L., *E. cinerea* F.Muell.

3.2. Morphology of the Common myrtle or true myrtle

sp. *Myrtus communis* L.,

common name – Common myrtle or True myrtle

It is an evergreen shrub. Its leaf is simple, ovate, leathery, shiny, and aromatic. The flowers are solitary, white and attractive. The fruit is a berry (fig. 232).

It is native to Southern Europe, North Africa, Western Asia, and the Indian Subcontinent, and is also cultivated.

Common myrtle prefers well drained soil, moist soil and the full sun. It is cultivated as an aromatic plant.

Vegetable product: *Myrtili folia*



A



B

Fig. 232. Morphology of the species: A – *Eucalyptus globulus*; B – *Myrtus communis*

PRACTICAL WORK nr. 4. Morphology of some species from the fam. Anacardiaceae

4.1. Morphology of the European smoke tree

sp. *Cotinus coggygria* Scop., common name – European smoke tree

It is a deciduous shrub or tall tree. The leaves are simple, alternate, ovate or oblong, in autumn they become reddish or pinkish. The flowers may be bisexual or sterile in compound erect racemes. The fruit is a small drupe (fig. 233).

It is native to a large area of Southern Europe, Central Asia, in the Himalayas and in Northern China. The plant grows on dry soil and sunny places. It is commonly grown as an ornamental plant.

Vegetable product: *Cotini coggygriae folia*

4.2. Morphology of the Tanners Sumac

sp. *Rhus coriaria* L., common name – Tanners Sumac

It is a deciduous shrub or small tree. The leaves are compound with 4-10 pairs of leaflets and winged rachis. The leaflets are ovate with a serrate margin. The flowers are small in conical panicle. The fruit is small, brown-reddish, hairy (fig. 233).

It is a native to the mild Mediterranean climates of Southern Europe and Western Asia. Tanners sumac cannot grow in the shade. It prefers dry or moist soil.

Vegetable product: *Rhus coriariae folia*



A



B

Fig. 233. Morphology of the species: A – *Cotinus coggygria*; B – *Rhus coriaria*

PRACTICAL WORK nr. 5. Morphology of the Horse-chestnut plant, fam. Hippocastanaceae

5.1. Morphology of the Horse-chestnut tree

sp. *Aesculus hippocastanum* L., common name - Horse-chestnut

It is a deciduous tree, growing to a height of 20-25 m. The leaves are palmate-compound, the leaflets are obovate with serrate margin and acuminate apex. The flowers are united in erect, pyramidal, compound racemes. The fruit is a succulent capsule with fleshy thorns (fig. 234).

It is native to Greece and the central Balkan Peninsula and is planted across Europe as an ornamental plant. It prefers sunny areas with little competition and moderate moisture.

Vegetable product: *Hippocastani semina*



Fig. 234. Morphology of the sp. *Aesculus hippocastanum*

SUBJECTS FOR DISCUSSION:

1. Morphological and ecological characteristics of the families: FABACEAE, MYRTACEAE, RUTACEAE, ANACARDIACEAE, HIPPOCASTANACEAE.
2. Latin and common names of each described species from each family, their morphological characteristics, distribution and ecology.
3. Economic and pharmaceutical value of the described species.

4.10. MORPHOLOGY OF SOME SPECIES FROM THE FAMILIES: LINACEAE, RHAMNACEAE, ARALIACEAE, APIACEAE, ELAEAGNACEAE

PRACTICAL WORK nr. 1. Morphology of the Flax plant, fam. Linaceae

sp. *Linum usitatissimum* L., common name – Flax or Linseed

It is a herbaceous, annual plant. The leaf is simple, lanceolate, entire, and alternate. The flower is blue, actinomorphic, type 5, grouped in corymbosely inflorescences. The fruit is a rounded capsule with lenticular shiny seeds (fig. 235).

Nowadays, flax is cultivated for seeds, natural fibres and oils. Two varieties of sp. *L. usitatissimum* are cultivated: *crepitans* is the Linseed type, grown for oil extracted from the seed. It is a relatively short plant which produces many secondary branches; *vulgare* is the Flax type, grown for the fibers extracted from the stem, which is taller and less branched. Canada is a major producing country along with Argentina, India, the USA and Russia. They are native to temperate and subtropical regions of the world. The Flax plant prefers well-drained, moist soils. It cannot grow in the shade, but can tolerate strong winds.

Vegetable product: *Lini semina*



Fig. 235. Morphology of the species *Linum usitatissimum*: A – morphology; B – population of flax

PRACTICAL WORK nr. 2. Morphology of some species from the fam. Rhamnaceae

2.1. Morphology of the Alder buckthorn

sp. *Frangula alnus* Mill., syn. *Rhamnus frangula* L.,

common name – Alder buckthorn

It is a non-spiny deciduous shrub or tree, growing to a height of 3–6 m. It is usually multistemmed, but rarely it forms a small tree with a trunk up to 20 cm in diameter. The bark is dark blackish-brown, with bright lemon-yellow inner bark exposed if cut. The leaves are simple, alternate, ovate-elliptical with 7-9 pairs of pinnate veins and entire margin. The flowers are star-shaped with 5 greenish-white acute triangular petals, axillary (in clusters of 2-10) in the leaf axils. The fruit is a small black berry, ripening from green or red late in the summer to dark purple or black early in the autumn, containing 2 or 3 pale brown seeds (fig. 236).

It is native to Europe, northernmost Africa, and western Asia.

Alder buckthorn grows in wet soils in open woods, hedgerows and bogs, thriving well in sunlight and moderate shade, but less vigorously in dense shade. The plant is toxic.

Vegetable product: *Frangulae cortex*

2.2. Morphology of the Europe Buckthorn plant

sp. *Rhamnus cathartica* L., syn. *Cervispina cathartica* (L.) Moench.,

common name – Europe Buckthorn or Purging buckthorn

It is a small deciduous tree or shrub with thorns (modified twigs). The stem is covered with grey-brown bark. The leaves are opposite, simple, ovate with 2-3 pairs of ovate veins and serrate margin. The flowers are yellowish-green, with 4 petals, dioecious and insect pollinated. The fruit is a globose, black drupaceous-berry, containing 2-4 seeds (fig. 236).

It is native to Europe, northwest Africa and western Asia, from the central British Isles south to Morocco, and east to Kyrgyzstan.

It is shade-tolerant, moderately fast-growing and short-lived. Its fruits are toxic; the seeds and leaves are mildly poisonous for people and animals.

Vegetable product: *Rhamni catharticae fructus*



Fig. 236. Morphology of the species: A – *Rhamnus frangula*; B – *R. cathartica*

PRACTICAL WORK nr. 3. Morphology of some species from the fam. Araliaceae

3.1. Morphology of the Manchurian thorn tree

**sp. *Aralia mandshurica* Rupr. et Maxim.,
common name – Manchurian thorn tree**

It is a deciduous tree or shrub, growing up to 10 m. The bark of the stem is rough and gray with strong prickles. The leaf rachis is with strong prickles too. The leaves are large, double-pinnate compound. The leaflets are with serrate margin and pinnate venation, usually at the tip of the stem. The flowers are white, type 5, in small umbels, united in compound racemes. The fruit is a small black drupaceous berry (fig. 237).

It is native to the eastern regions of Russia, northern China, Japan and Korea. It prefers deep loamy soils in partial shade, but it also grows in poorer soils and in the full sun.

The plant is sometimes cultivated, often in a various forms, for its exotic appearance.

Vegetable product: *Araliae mandshuricae radices*

3.2. Morphology of the Korean Ginseng plant

sp. *Panax ginseng* C.A. Mezer., common name – Korean Ginseng

It is a herbaceous plant with a humanoid root. The leaves are palmate-compound arranged in a whorl. The leaflet is ovate with a serrate margin. The flowers are white, actinomorphic in simple umbel. The plant blooms at the age of 7-8. The fruit is a red berry (fig. 237).

It is found in eastern Asia (mostly northeast China, Korea, Japan and eastern Siberia), typically in cooler and moist climates. It can grow in full shade (deep woodland) or semi-shade (light woodland). It prefers moist soil and humid atmosphere.

The history of the use of Ginseng as a herbal medicine is over 5000 years.

Vegetable product: *Ginseng radices*



A

B

Fig. 237. Morphology of the species: A – *Aralia mandshurica*,
B – *Panax ginseng*

3.3. Morphology of the Siberian ginseng plant

sp. *Eleutherococcus senticosus* Maxim.,

common name - Siberian ginseng

It is a small, deciduous, woody shrub growing to a height of 2 m. The stem is with prickles. The leaves are palmate-compound, with ovate, serrate leaflets. Flowers are white, actinomorphic in simple, rounded umbel. The fruit is a black berry (fig. 238).

Its native habitat is East Asia, China, Japan, and Russia. It grows in mixed and coniferous mountain forests.

It grows in sandy, loamy and heavy clay, acid or neutral soils including soils of low nutritional value. It can tolerate the sun or dappled shade and some pollution.

Vegetable product: *Eleutherococci senticosi rhizomata cum radicibus*



A

B

Fig. 238. Morphology of the species: A - *Eleutherococcus senticosus*;

B - *Hedera helix*

3.4. Morphology of the European ivy plant

sp. *Hedera helix* L., common name – European ivy

It is a woody epiphytic, evergreen vine. It climbs by means of aerial rootlets (fixed roots). The stem is climbing, growing to 20–30 m long. The plant develops 2 types of shoots: 1) fertile with ovate leaves and white-greenish flowers (they are produced from late summer until late autumn) in simple umbels grouped in racemes; late in the autumn form a black berry; 2) sterile with palmate lobed, leathery leaves (fig. 238). It is a familiar sight in gardens, waste spaces, on house walls, tree trunks and in wild areas.

European ivy is native to most of Europe and western Asia.

Ivy grows in a wide variety of soils, and it tolerates drought, frost, and deep shade. It is widely cultivated as an ornamental plant, and it may be invasive.

Vegetable product: *Hederae folia*

PRACTICAL WORK nr. 4. Morphology of some species from the fam. Apiaceae

4.1. Morphology of the Dill plant

sp. *Anethum graveolens* L., common name – Dill

It is an annual, cultivated plant, and growing to a height of 70-120 cm. The stems are smooth, hollow and shiny. The leaves are simple, sected, and thread-like. The flowers are type 5, yellow in flat compound umbel without involucre and involucel. The fruit is diachene, consisting of 2 flattened achenes (fig. 239).

It is believed to be native to the Mediterranean and South and Southwestern Asia. Now it is cultivated, usually in home gardens, all over the world, including South-East Asia.

It prefers a well-drained, moist soil. It cannot grow in the shade.

Dill is cultivated as an aromatic and medicinal plant.

Vegetable product: *Anethi fructus*

4.2. Morphology of the Celery plant

sp. *Apium graveolens* L., common name – Celery

It is a biannual or perennial, aromatic, cultivated plant with bulbous fleshy root. During the first year of growth the plant develops strong leaves, simple, pinnate to bipinnate sected, parsley-like in the rosette with long petiole. In the second year the plant forms the flowering stem with simple alternate,

bipinnate sected leaves. The flowers are type 5, greenish-white in flat compound umbel. The fruit is a diachene, consisting of small oval achenes (fig. 239).

It is a plant native to Europe. Wild celery was found in numerous countries such as Algeria, the Caucasus, Iran, India and America. It prefers moist places and sunny or semi-shaded position.

The plant is largely cultivated as a spice and herb.



Fig. 239. Morphology of the species: A – *Anethum graveolens*; B – *Apium graveolens*.

4.3. Morphology of the Fennel plant

sp. *Foeniculum vulgare* Mill., common name – Fennel

It is a perennial plant in the wild flora and annual when cultivated. It resembles dill, growing to a height of 120-150 cm. The stem is blue-green and hollow. The leaves with inflated leaf base are simple, fan-shaped, feathery – tread-like. The flowers are type 5, yellow in flat compound umbel. The fruit is a diachene, consisting of 2 elongated, costate, green-greyish achenes (fig. 240).

Fennel originates from the Mediterranean but it has been widely adapted at in many parts of the world. It prefers dry or moist soil and can tolerate drought. Plants cannot grow in the shade. It is cultivated as a culinary and medicinal plant.

Vegetable product: *Foeniculi fructus*

4.4. Morphology of the Caraway plant

sp. *Carum carvi* L., common name – Caraway

It is biannual, spontaneous and cultivated plant, growing to a height of 80 cm. The stem is hollow and ridged. It has a tap root system. The whole plant is pleasantly aromatic. The leaves are simple and finely cut feathery. The flowers are type 5, small white to cream in compound umbels. The fruit is a diachene, consisting of brown, elongated, slightly curved with 5 prominent ribs achenes (fig. 240).

It is native to western Asia, Europe, and North Africa. Caraway is distributed throughout practically all of Europe except the Mediterranean region; it is widely known as a cultivated plant. The plant prefers warm, sunny locations and well-drained soil rich in organic matter. In warmer regions, it is planted in the winter as an annual. In temperate climates, it is planted as a summer annual or biennial plant.

Vegetable product: *Carvi fructus*

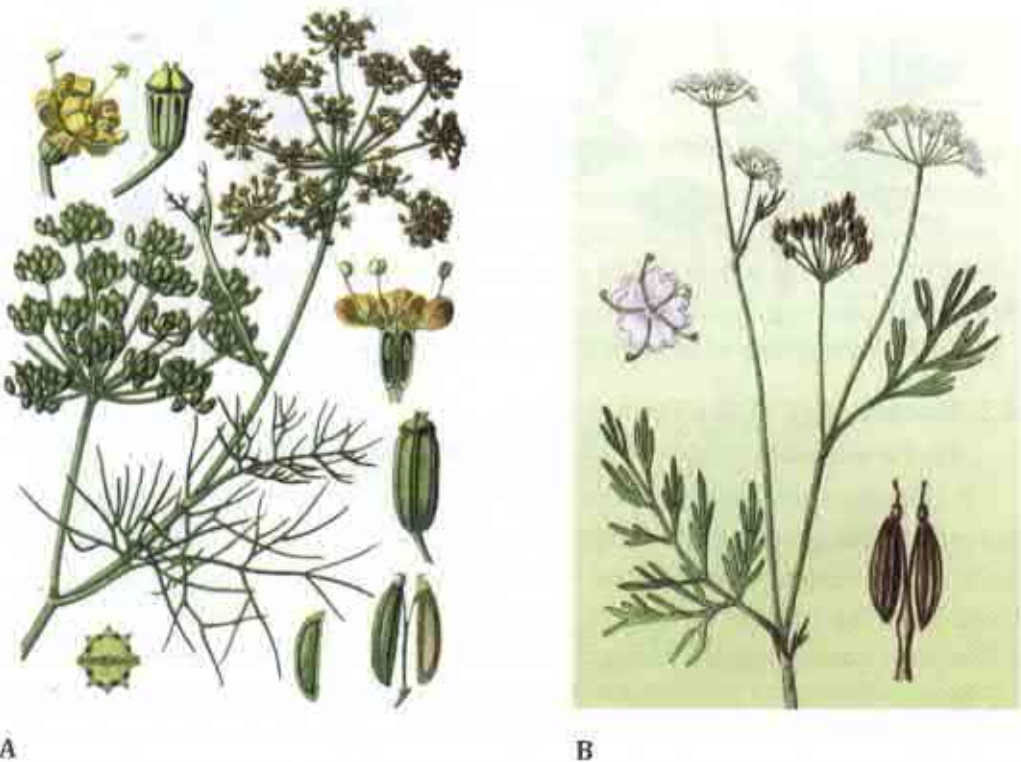


Fig. 240. Morphology of the species: A – *Foeniculum vulgare*; B – *Carum carvi*

4.5. Morphology of the Coriander plant

sp. *Coriandrum sativum* L., common name – Coriander

It is an annual plant growing to a height of 60 cm. The stem is branched blue-green and hollow. The leaves are simple and variable in shape: the lower leaves are parsley-like and the upper ones are feathery, and thread-like. The leaves are very aromatic when crushed. The flowers are type 5, of pretty white to pale and mauve, asymmetrical in rarely compound umbels. The fruit is a rounded, globular, and consisting of 2 fused green-greyish achenes (schizocarp) (fig. 241).

It is native to Southern Europe and Northern Africa, and Southwestern Asia. It prefers warm, sunny or semi-shady places.

Vegetable product: *Coriandri fructus*



**Fig. 241. Morphology of the species: A – *Coriandrum sativum*;
B – *Anisum vulgare*.**

4.6. Morphology of the Aniseed plant

sp. *Anisum vulgare* Gaertn., syn. *Pimpinella anisum* L.,
common name – Aniseed

It is an aromatic, annual plant with erect, tall stem (60 cm). The lower leaves are long stalked, lobed, while the upper leaves are feathery and finely incised further up the stem. Numerous white flowers, type 5 grow in sparse compound umbel. The fruit is schizocarp (diachene, consisting of brown, conical-oblong, small achenes) (fig. 241).

It is native to the eastern Mediterranean region and Southwest Asia. It prefers sunny days and moderate moist soil.

Vegetable product: *Anisi fructus*

4.7. Morphology of the Cultivated carrot plant

sp. *Daucus carota* L., var. *sativus* Hoffin.,
common name – Cultivated carrot

It is a biennial and cultivated plant. The root is conical and enlarged. The leaves are simple many-sected, feathery, thread-like. The flowers are type 5, white in large compound umbel with involucre. The fruit is a diachene, consisting of 2 achenes with thorns (fig. 242).

Wild carrot is native to temperate regions of Europe and Southwest Asia, and got acclimatized to North America and Australia. Domesticated carrots are cultivars of sp. *Daucus carota*, var. *sativus* Hoffin.

4.8. Morphology of the Parsnip plant

sp. *Pastinaca sativa* L., common name – Parsnip

Parsnip is a biennial plant with a rosette of roughly hairy leaves that has a pungent odor when crushed. It is a strong herbaceous plant with enlarged root, 80 cm tall. The leaves are roughly hairy, long stalked, sheathed at the base, lamina sected in large incisions. The greenish-white flowers, type 5 are grouped in compound umbel. Fruit is a diachene, consisting of 2 rounded, flattened achenes (fig. 242).

The parsnip is native to Eurasia. It is cultivated as a culinary and medicinal plant.

Vegetable product: *Pastinacae fructus*



A

B

Fig. 242. Morphology of the species: A – *Daucus carota*, var. *sativus*;
B – *Pastinaca sativa*

4.9. Morphology of the Garden angelica plant

sp. *Angelica archangelica* L., syn. *A. officinalis* Hoffm.,
common name – Garden angelica

It is a biennial or perennial plant, growing to a height of 200 cm. The stem is stout and hollow, purplish at the base and branching near the top. The leaves are sheathed at the base, simple, pinnate in form, deeply indented and subdivided. The flowers are greenish-white and sweet smelling, type 5, grouped in very large round compound umbel. The fruit is a green-grayish diachene (fig. 243).

It grows wild in Russia, Finland, Sweden, Norway, Denmark, Greenland, and Iceland, mostly in the Northern parts of the countries. It is also widely cultivated and is frequently acclimatized in Northern temperate region. It prefers rich, moist, well-drained soil and partial shade and needs moderate to heavy watering.

Vegetable product: *Angelicae radices*

4.10. Morphology of the Hemlock plant

sp. *Conium maculatum* L., common name - Hemlock

It is a herbaceous biannual, tall plant with a height of up to 200 cm. The stem is stout, hollow, bright green and smooth, usually spotted or streaked with red or purple on the lower half of the stem. The leaves are sheathed and feathery with unpleasant smell. The flowers are small and white in compound umbel. The fruit is a brown-greyish, elongated diachene (fig. 243).

It is native to temperate regions of Europe, West Asia, and North Africa. It grows in damp areas, but also on drier rough grassland, roadsides and waste places.

The plant is very toxic.



Fig. 243. Morphology of the species: A - *Angelica archangelica*; B - *Conium maculatum*

PRACTICAL WORK nr. 5. Morphology of the Sea buckthorn plant, fam. Elaeagnaceae

sp. *Hippophaë rhamnoides* L., common name - Sea buckthorn plant

It is a deciduous shrub or tree growing to a height of 6 m. It has a rough, brown or black bark and a thick, grayish-green crown. The root develops nodules with nitrogen-fixing bacteria. The leaves are alternate, simple,

liniar-lanceolate and hairy. The plants are dioecious. Small yellow flowers are formed on female individuals. The fruit is an elongated, yellow-orange drupe (fig. 244).

It is native to the cold-temperate regions of Europe and Asia. It can grow in nutritionally poor soil. Suitable pH: acid, neutral and basic (alkaline) soils. It cannot grow in the shade. It prefers dry, moist or wet soils and can tolerate drought.

Vegetable product: *Hippophaë fructus*



Fig. 244. Morphology of the species *Hippophaë rhamnoides*: A – flowering plant; B – plant with fruits

SUBJECTS FOR DISCUSSION:

1. Morphological and ecological characteristics of the families: LINACEAE, RHAMNACEAE, ARALIACEAE, APIACEAE, ELAEAGNACEAE.
2. Latin and common names of each described species from each family, their morphological characteristics, distribution and ecology.
3. Economical and pharmaceutical usage of the species.

4.11. MORPHOLOGY OF SOME SPECIES FROM THE FAMILIES: APOCYNACEAE, CAPRIFOLIACEAE, VALERIANACEAE, LAMIACEAE

PRACTICAL WORK nr. 1. Morphology of some species of the fam. Apocynaceae

1.1. Morphology of the Rosy periwinkle plant

sp. *Catharanthus roseus* (L.) G.Don, common name - Rosy periwinkle

It is a shrub, of about 70-100 cm height. It grows in Indonesia, South Africa, Australia. The leaves are evergreen, simple, oblong, ovate-elliptical, entire, opposite or whorled. The flowers are white to dark pink, type 5. The fruit is a follicle with 12-20 seeds (fig. 245).

It is native and endemic to Madagascar, but is grown elsewhere as an ornamental and medicinal plant. It prefers well-drained soil and can grow in nutritionally poor soil. It can grow in semi-shade (light woodland). It prefers moist soil and can tolerate drought.

Vegetable product: *Catharanthi folia*

1.2. Morphology of the Indian snakeroot plant

sp. *Rauwolfia serpentina* (L.) Benth. Ex. Kurz.,
common name - Indian snakeroot

It is an evergreen shrub, growing to a height of 50-90 cm. The plant is originated from Himalaya, India and Indonesia. Its roots are enlarged, long, with irregular nodular, yellowish root stock. The leaves are evergreen, simple, ovate-lanceolate, entire, opposite or whorled. The flowers are pinkish, type 5, and in umbel inflorescences. The fruit is a black drupe (fig. 245).

It is native to the Indian subcontinent and East Asia (from India to Indonesia). It prefers warm, moist forests, shady places near rain-forest. It is cultivated as ornamental and medicinal plant.

The plant is very toxic.

Vegetable product: *Rauwolfiae radices*



Fig. 245. Morphology of the species: A – *Catharanthus roseus*;
B – *Rauwolfia serpentina*

1.3. Morphology of the *Strophanthus Kombe*

sp. *Strophanthus Kombe* Oliver, common name –
Strophanthus Kombe or Kombe arrow poison

It is a herbaceous vine in tropics. The leaves are simple, hairy, ovate, entire and opposite. The flowers are type 5, in cymose inflorescences. The fruit is lignified follicle that contains numerous seeds with hairy husk (fig. 246).

It occurs naturally in Eastern and southern Africa, from South-eastern Kenya and Eastern Tanzania to Eastern Namibia, Botswana, Zimbabwe, Mozambique and northern South Africa.

It is not planted on a large scale. It is usually found growing as vines in the forests between the coast and the centre of Africa. The plant is very toxic.

Vegetable product: *Strophanti semina*

Other species: *S. gratus* (Franch.), *S. hispidus* DC.

1.4. Morphology of the Lesser periwinkle plant

sp. *Vinca minor* L., common name - Lesser periwinkle

It is a herbaceous and climbing vine. The leaves are evergreen, simple, ovate, entire and opposite. The flowers are type 5, blue-violet and solitary on the long peduncle. The fruit is a follicle (fig. 246).

It is native to central and southern Europe, from Portugal and France north to the Netherlands and the Baltic States, east to the Caucasus, and also southwestern Asia in Turkey. It prefers dry or moist soil, shady or semi-shaded place and can tolerate drought.

Vegetable product: *Vincae minoris herba*

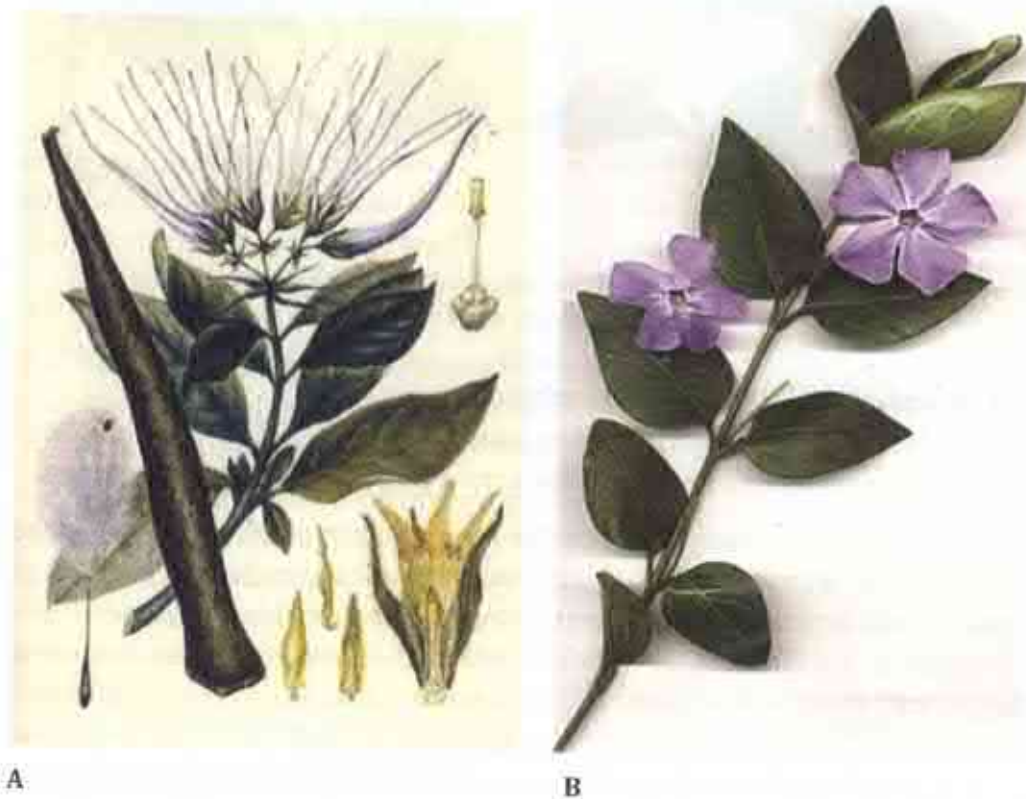


Fig. 246. Morphology of the species: A - *Strophanthus Kombe*,
B - *Vinca minor*

PRACTICAL WORK nr. 2. Morphology of some species from the fam. Caprifoliaceae

2.1. Morphology of the Black elderberry plant

sp. *Sambucus nigra* L., common name – Black elderberry

It is a deciduous shrub or tree growing to a height of 6 m. It has imparipinnate compound leaves with ovate and serrate margin of leaflets. The flowers are cream-white, type 5 and in corymbose umbel. The fruit is a black berry (fig. 247).

The plant is native to most of Europe and North America. It can grow in semi-shade (light woodland) or in open field. It prefers moist soil. It can tolerate atmospheric pollution. It grows in a variety of conditions including both wet and dry fertile soils, primarily in sunny locations.

Vegetable product: *Sambuci flores*.



Fig. 247. Morphology of the species: A – *Sambucus nigra*;
B – *Viburnum opulus*

2.2. Morphology of the Guelder rose

sp. *Viburnum opulus* L., common name - Guelder rose or Dogberry

It is a deciduous tree or shrub with simple, three-lobed and opposite leaves. The flowers are white, type 5 and in corymbose umbel. The fruit is a bright red drupaceous berry with a single flattened seed (fig. 247).

It is native to Europe, Northern Africa and central Asia. It grows best on moist, moderately alkaline soils, though tolerates most soil types well. The plant prefers semi shaded places. It is cultivated as an ornamental and medicinal plant.

Vegetable product: *Viburni fructus*

PRACTICAL WORK nr. 3. Morphology of the Valerian plant, fam. Valerianaceae

sp. *Valeriana officinalis* L., common name - Valerian

It is a perennial herbaceous plant, growing to a height of 100-120 cm with a specific smell. The underground part of the plant represents a rhizome with numerous adventitious roots. The stem is hollow, grooved and hairy towards the base. The leaves are large, simple, opposite, pinnate-sected. Each leaf consists of a series of lance-shaped segments, more or less opposite to each other on either side of the leaf (pinnate). The 5-petal flowers are of pale pink to white color in cymose inflorescences and have a slight fragrance. The fruit is a nutlet (fig. 248).

The plant is native to Europe and some parts of Asia. Valerian grows well in all ordinary soils, but prefers rich, heavy loam, well supplied with moisture.

Vegetable product: *Valerianae rhizomata cum radicibus*



Fig. 248. Morphology of the species *Valeriana officinalis* plant

PRACTICAL WORK nr. 4. Morphology of some species from the fam. Lamiaceae

4.1. Morphology of the White dead nettle plant

sp. *Lamium album* L., common name – White dead nettle

It is a herbaceous perennial spontaneous plant, growing to a height of 30-70 cm. The stem is square, hollow and hairy. The leaves are simple, ovate, opposite with serrate margin. The flowers are white, type 5, double-lipped, zygomorphic, arranged in the whorles at the nodes. The fruit is a nutlet (fig. 249).

They are all herbaceous plants native to Europe, Asia, and Northern Africa, but some of them have become very high-yielding weeds of crop fields and are now widely acclimated across much of the temperate world. It prefers shady and semi-shaded places, well-drained soil and can grow in heavy clay soil.

Vegetable product: *Lamii albi herba*



Fig. 249. Morphology of the species: A – *Lamium album*; B – *Mentha piperita*

4.2. Morphology of the Peppermint plant

sp. *Mentha piperita* L., common name – Peppermint

It is a natural hybrid between spearmint (*Mentha spicata*) and water mint (*Mentha aquatica*) and occurs only in cultivated flora. It is a perennial plant with erect, square, and slightly hairy stem, growing to a height of 60-90 cm. The oval, serrated leaves have pointed tips and are of smooth dark to reddish green color. The mauve flowers are united in elongated, conical spikes (fig. 249).

It is cultivated in Europe, Asia, North Africa, and the United States. Peppermint plant prefers rich, moist soil and *sunny* to partially shady places. It is cultivated as a culinary and medicinal plant.

Vegetable product: *Menthae piperitae folia*

4.3. Morphology of the Lavender plant

sp. *Lavandula angustifolia* Mill, syn. *L. vera* DC, *L. officinalis* Chaix., common name – Lavender

It is a subshrub with many square stems, originated from the Mediterranean region. The leaves are simple, linear, entire, opposite, and hairy. The mauve-violet zygomorphic flowers are whorled and grouped in terminal spikes. The fruit is a nutlet (fig. 250).

It is native to Europe and is found from Cape Verde and the Canary Islands, northern and eastern Africa, the Mediterranean, from southwest Asia to southeast India. Nowadays it is largely cultivated as a medicinal, aromatic and culinary plant. The plant prefers the full sun, well-drained soil, and low water.

Vegetable product: *Lavandulae flores recens*

4.4. Morphology of the Rosemary plant

sp. *Rosmarinus officinalis* L., common name – Rosemary

It is a woody, perennial shrub, originated from the Mediterranean region. Rosemary has a fibrous root system. Evergreen leaves are simple, linear, with rounded apex and opposite arrangement on the stem, green leathery and shiny above, and white with dense, short, woolly hair below. The white, pink, purple, or blue-violet, zygomorphic flowers are whorled. The plant blooms in spring and summer in zones with temperate climates, but the plants can be in constant bloom in warm climates. The fruit is a 4-nutlet (fig. 250).

It is native to the Mediterranean and Asia, but is reasonably hardy in cool climates. The plant prefers a hot sunny position and a slightly alkaline light dry soil.

Vegetable product: *Rosmarini folia*



Fig. 250. Morphology of the species: A – *Lavandula angustifolia*;
B – *Rosmarinus officinalis*

4.5. Morphology of the Common thyme plant sp. *Thymus vulgaris* L., common name – Common thyme or Garden thyme

The plant grows to a height of 15–30 cm and width of 40 cm in cultivated flora. It is a bushy, woody-based evergreen subshrub with small, simple, opposite, oval-elliptical shape, highly aromatic, grey-green leaves. The flowers are of lilac-pink color, tubular, lipped in whorls clusters at the tips of branches. The fruit is a 4-nutlet (fig. 251).

The plant is native to Southern Europe from the Western Mediterranean to Southern Italy. The plant prefers a light, dry calcareous soil and sunny places.

It is cultivated as a culinary, medicinal and aromatic plant.

Vegetable product: *Thymi herba*

4.6. Morphology of the Wild thyme plant

sp. *Thymus serpyllum* L., common name –
Wild thyme or Creeping thyme Breckland thyme

It is a low, usually prostrate subshrub growing to 2 cm in length with creeping stems up to a height of 10-15 cm in spontaneous flora. A lot of erect twigs arise up from creeping shoot. The leaves are simple, ovate, opposite and entire. Whorls of lilac to pink lipped flowers grow in clusters at the tips of erect branches. The fruit is a 4-nutlet (fig. 251).

It is native to most of Europe and North Africa. The plant requires a light well-drained preferably calcareous, dry or moderately moist soil in a sunny position.

Vegetable product: *Serpylli herba*



Fig. 251. Morphology of the species: A - *Thymus vulgaris*; B - *T. serpyllum*

4.7. Morphology of the Lemon balm or Common balm

sp. *Melissa officinalis* L., common name –
Lemon balm or Common balm

It is a perennial aromatic plant occurring both in the wild and cultivated flora. It is a brush-like plant. It has a square stem with simple leaves. They are ovate, opposite, crenate margin, and prominent leaf venation. The flowers are

white, lipped in whorled at the nodes along the stem. Bees are attracted to the flowers. The fruit is a 4-nutlet (fig. 252). The plant is used to attract bees for honey production.

It native to South-central Europe, Iran, and Central Asia, but now it is acclimated in the Americas. The plants prefer sandy and loamy fertile, moist and well drained soils. The plants grow in semi-shade, and can tolerate partial shade.

Vegetable product: *Melissae herba*

4.8. Morphology of the Catnip (Catmint) plant

sp. *Nepeta cataria* L., common name - Catnip or Catmint

It is a perennial aromatic plant spread in the wild and cultivated flora. It is a branched plant growing to a height of 30-100 cm with a strong rather disagreeable smell on hairy. The stem is square. The leaves are simple, heart-shaped, opposite, with serrate margin, and downy on the underside. The flowers are white, 2-lipped (the upper lip is spotted with dark violet, and the anthers are deep red-purple), in dense whorls at the tips of stems (fig. 252).

It is native to Southern and Eastern Europe, the Middle East, central Asia, and parts of China. The plant prefers well-drained soils and can grow in very alkaline soils. It cannot grow in the shade. It prefers dry or moist soil.

Vegetable product: *Nepetae herba*



Fig. 252. Morphology of the species: A – *Melissa officinalis*; B – *Nepeta cataria*

4.9. Morphology of the Garden sage plant

Sp. *Salvia officinalis* L., common name – Garden sage or Common sage

It is a barely branching, semishrubby, perennial aromatic plant growing to a height of 30-70 cm in cultivated flora. Old square stems become woody at the base. The leaves are grayish-green, simple, opposite with veined surface, oblong, rounded apex, rugose on the upper side and velvety on the underside because of many short soft hairs. The flowers are tubular, 2-lipped, of blue-violet colour in whorls in the intervals towards the ends of stems. The fruit is a 4-nutlet (fig. 253).

It is native to the Mediterranean region, though it is spread in many places throughout the world. Sage prefers dry sunny conditions, dry or moist soil and can tolerate drought. Sage is largely cultivated as a medicinal and aromatic plant.

Vegetable product: *Salviae folia*



Fig. 253. Morphology of the species: A – *Salvia officinalis*;
B – *Scutellaria baicalensis*

4.10. Morphology of the Baical skullcap plant

sp. *Scutellaria baicalensis* Georgi, common name – Baical skullcap

It is a perennial plant, growing to a height of 20-30 cm. The stem is square, stout, hollow, bright green and smooth, at the base is blotched with purple or red hairy. The leaves are opposite simple, lanceolate, with acute apex and entire lamina. The flowers are tubular, 2-lipped (prominent upper and lower lips) and a bright violet colour. The fruit is a 4-nutlet (fig. 253).

It is native to North America. The plant prefers dry to medium moisture, well-drained soil, open places and full sunny areas. The plant is cultivated as a medicinal plant in Siberia, Mongolia, the Russian Far East, China and Korea.

Vegetable product: *Scutellariae herba*

4.11. Morphology of the Great basil plant

sp. *Ocimum basilicum* L., common name – Great basil or Sweet basil

It is a bushy annual (perennial) plant growing to a height of 30-80 cm. The stem is square, very branched, with opposite, light green, silky leaves with oval and slightly toothed margins of the lamina. The whorls of small, white, 2-lipped flowers appear towards the tops of the stems and are arranged in a terminal spike. The fruit is a 4-nutlet (fig. 254).

It is native to the tropical and warm temperate regions of all six inhabited continents, especially to India, southern Asia and Middle East. Basil is very sensitive to cold. It grows best in hot, dry conditions. The plant is often grown as an annual, especially in cooler climates. It prefers sunny areas and moderate moist to dry soils. It is cultivated as an aromatic, culinary and medicinal plant.

4.12. Morphology of the Motherwort plant

sp. *Leonurus cardiaca* L., common name – Motherwort

It is a perennial plant, growing to a height of 100-150 cm. The stem is square, stout, hollow, erect, that may be purple. The downy leaves occur in opposite pairs up the stem and are divided into 3 to 5 deeply incised lobes. The pinkish-white, 2-lipped flowers appear in whorls at the leaf axils. The fruit is a 4-nutlet (fig. 254).

It is native to Europe (much of Northern and Central Europe) and Asia. The plant grows in the full sunny or shaded places, in any type of soil.

Vegetable product: *Leonuri herba*



**Fig. 254. Morphology of the species: A – *Ocimum basilicum*;
B – *Leonurus cardiaca***

SUBJECTS FOR DISCUSSION:

1. Morphological and ecological characteristics of the families: APOCYNACEAE, CAPRIFOLIACEAE, VALERIANACEAE, LAMIACEAE.
2. Latin and common names of each described species from each family, their morphological characteristics, distribution and ecology.
3. Economic and pharmaceutical usage of the described species.

4.12. MORPHOLOGY OF SOME SPECIES FROM THE FAMILIES: SOLANACEAE, SCROPHULARIACEAE, PLANTAGINACEAE

PRACTICAL WORK nr. 1. Morphology of some species from the fam. Solanaceae

1.1. Morphology of the Belladonna plant

sp. *Atropa belladonna* L.,

common name - Belladonna or Deadly nightshade

It is a perennial herbaceous plant, often grown as a subshrub to a height of 1.5m. Its underground part is a branched rhizome with strong roots. The leaf is simple, ovate-lanceolate with entire margin. The anisophylly is characteristic of Belladonna. The flower is bell-like, dull purple with green tinges and faintly scented, axillary, actinomorphic. The fruit is false berry (fused with calyx) which is shiny-black (fig. 255).

It is native to temperate Southern and central Europe, North Africa, and Western Asia, but has been cultivated and spread outside its native range. The plants like a sunny places and do well on hillsides and dry, rocky places. Belladonna is a very toxic plant.

Vegetable product: *Belladonnae folia*

1.2. Morphology of the Jimson weed plant

sp. *Datura stramonium* L.,

common name - Jimson weed or Devil's snare

It is an annual, herbaceous, foul-smelling bush with a long, thick, fibrous and white root. The stem is erect, dichotomous, smooth, pale yellow-green, and branched up to a height of 60-150 cm. It forks off repeatedly into branches, and each fork forms a leaf and a single, erect flower. The leaf is simple with large and dentate-sinuate margin. The upper surface of the leaves is dark green, and the lower one is light green. Venation is prominent on the lower surface. The fragrant flowers are white-greenish to creamy or violet, actinomorphic, long-tubular, trumpet-shaped, and grow on short stems from either from axils of the leaves or the places where the branches fork. The calyx is long and tubular, swollen at the bottom, and sharply angled, surmounted by five sharp teeth.

The corolla, which is folded and only partially open, is funnel-shaped, and has prominent ribs. The fruit is a capsule with strong thorns (fig. 255).

It is believed to have originated in Mexico, but now it is spread in many other European and Asian regions. The area of distribution is along roadsides, old fields, pastures, waste places. The plant likes warm and sunny places, nitrogen-rich and moderately moist soils. The plant is very toxic.

Vegetable product: *Stramonii folia*



Fig. 255. Morphology of the species: A - *Atropa belladonna*; B - *Datura stramonium*

1.3. Morphology of the Downy thorn-apple plant

sp. *Datura innoxia* Mill.,

common name - Downy thorn-apple or Indian-apple

It is an annual shrubby plant that typically reaches a height of 60-150 cm. Its branching stems and leaves are covered with short and soft greyish hairs, giving the whole plant a grayish appearance. The leaf is simple, entire, hairy, elliptic entire-edged with pinnate venation. The flowers are white, long-tubular and trumpet-shaped, 12-22 cm long. The fruit is an egg-shaped spiny capsule and it splits open when ripe, dispersing the seeds (fig. 256). Another means of dispersion is by the fruit spines getting caught in the fur of animals. All parts of the plant emit a foul odor similar to rancid peanut butter.

It is native to Central and South America and is also spread in Africa, Asia, Australia and Europe. It is cultivated as an ornamental and medicinal plant. The plant is toxic.

Vegetable product: *Daturae innoxiae herba, D. semina*

1.4. Morphology of the European scopolia

sp. *Scopolia carniolica* (L.) Jucq., common name – European scopolia

It is a herbaceous, perennial plant with a strong, branching rhizome. The leaves are simple, elliptical-lanceolate. The flowers are axillary, pendent with corolla – brownish outside, and yellow inside. The fruit is a capsule with a lid (poxid) (fig. 256).

It grows on wet soils in beech forests of Southeastern Europe both in lowlands and mountainous zones. The plants prefer well-drained, dry or moist soils in the full shade (deep woodland) or semi-shade (light woodland). The plant is toxic.

Vegetable product: *Scopoliae rhizomata*

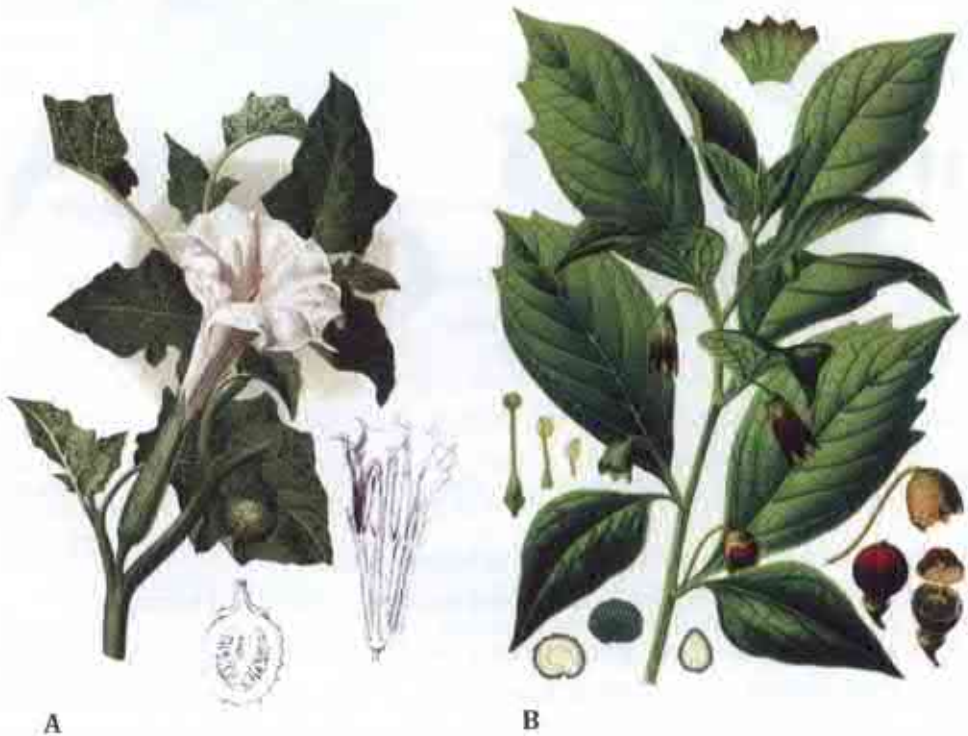


Fig. 256. Morphology of the species: A – *Datura innoxia*; B – *Scopolia carniolica*

1.5. Morphology of the Black henbane plant

sp. *Hyoscyamus niger* L., common name – Black henbane

It is a herbaceous plant, growing to a height of 40-70 cm. The stem and leaves are hairy and sticky. The leaves are simple, sessile with prominent venation and sinuate margins. The flowers are yellowish with red or violet venation. The fruit is pixid (fig. 257).

It originated in Eurasia, and is now globally distributed. It prefers dry or moist soil, sunny areas and cannot grow in the shade. Black henbane grows on waste places. The plant is toxic.

Vegetable product: *Hyoscyami folia*



Fig. 257. Morphology of the species: A – *Hyoscyamus niger*; B – *Nicotiana tabacum*

1.6. Morphology of the Cultivated tobacco plant

sp. *Nicotiana tabacum* L., common name – Cultivated tobacco

It is a herbaceous plant, growing to a height of 100-120 cm. The plant has the tap root system. The stem is branching. At the stem base the leaves are simple, long, shortly stalked or unstalked, oblonged-elliptic, shortly acuminate at the apex, decurrent at the base, entire margins and pinnate venation. The

upper leaves decrease in size and become sessile and the smallest of them are oblong-lanceolate or elliptic. The flowers are yellow-pinkish, and tubular. The fruit is ovoid or ellipsoid capsule, surrounded by a persistent calyx (fig. 257). All parts of the plant are sticky, covered with short glandular hairs, which exude a yellow secretion containing nicotine.

N. tabacum is native to tropical and subtropical America, but it is now commercially cultivated worldwide.

It is sensitive to temperature, air, ground humidity and the type of land. The optimal conditions are: temperatures of 20–30 °C, atmospheric humidity of 80 to 85%, and soil without a high level of nitrogen. The plant is toxic.

Vegetable product: *Nicotianae folia*

1.7. Morphology of the Kangaroo apple plant

sp. *Solanum laciniatum* L., common name - Kangaroo apple plant

It is a spontaneous, evergreen, perennial shrubby plant, growing to a height of 200 cm with a strong tap root. The stem is branching, of green to purple brown colour and often striped. The leaves are large, simple, usually deeply sected (pennate-sected). The flowers are blue, violet to purple, trumpet-rotate. The fruit is a yellow-orange, egg-shaped berry (fig. 258).

It is native to eastern Australia. The plant is toxic. It cannot grow in the shade and prefers moist soil.

Vegetable product: *Solani laciniati folia*

1.8. Morphology of the Bittersweet nightshade plant

sp. *Solanum dulcamara* L., common name - Bittersweet nightshade

It is a herbaceous vine, which scrambles over other plants, and is often of 1–2 m in length. It is green, slightly or densely pubescent with glandular or protective hairs. The leaves are simple, entire, ovate-lanceolate with long-acute apex. The flowers are violet, star-like. The fruit is an elongated red berry (fig. 258).

It is native to northern Africa, Europe, and Asia, but has spread throughout the world. It can grow in semi-shade (light woodland) or in open places. It prefers moist soil.



Fig. 258. Morphology of the species: A – *Solanum laciniatum*; B – *S. dulcamara*

INDIVIDUAL PRACTICAL WORK
ANALYZE AND DETERMINE THE MORPHOLOGY
OF THE FOLLOWING SPECIES:

sp. *Lycopersicon esculentum* L., syn. *Solanum lycopersicon* L.,
common name – Tomato (fig. 259)

sp. *Capsicum annum* L., common name – Bell pepper (fig. 259)

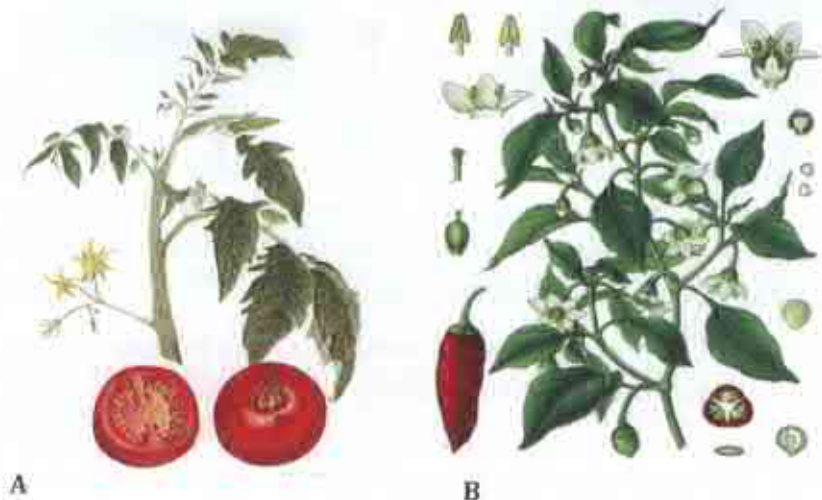


Fig. 259. Morphology of the species: A – *Lycopersicon esculentum*;
B – *Capsicum annum*

Solanum melongena L., common name – Eggplant (fig. 260)

Solanum tuberosum L., common name – Potato (fig. 260)



A



B

Fig. 260. Morphology of the species: A – *Solanum melongena*; B – *S. tuberosum*

PRACTICAL WORK nr. 2. Morphology of some species from the fam. Scophulariaceae

2.1. Morphology of the Purple foxglove

sp. *Digitalis purpurea* L., common name – Purple foxglove

It is a biennial herbaceous plant, growing to a height of 70-100 cm. The stem is erect. In the first year the plants form the basal rosette of simple leaves, long-stalked, covered with grey-white pubescent and glandular hairs. In the second year the plant develops the erect, flowering stem with alternate simple, elliptical-lanceolate, hairy, and prominent venation on the lower surface of leaves. The flowers are campanulate, of pink colour, with red spots inside, and united in unilateral raceme. Some plants, especially those under cultivation, may develop the flowers of pink, rose, yellow, or white colour. The fruit is a capsule which splits open at maturity to release numerous tiny seeds (fig. 261).

It is native and widespread throughout most of temperate Europe. The plant grows in almost any soil, but avoids very wet or very dry places. It prefers a humus-rich soil in partial shade but it also grows in the full sun. It is cultivated as an ornamental and medicinal plant. The plant is toxic.

Vegetable product: *Digitalis purpureae folia*

2.2. Morphology of the Woolly Foxglove

sp. *Digitalis lanata* Ehrl.,

common name – Woolly Foxglove or Grecian Foxglove

It is a herbaceous plant, growing to a height of 50-100cm. The leaves in the basal rosette are petiolate and lanceolate. The stem leaves are alternate, sessile and elongated elliptical-lanceolate with white hairs on the underside and especially the at leaf base. The flowers are tubular and bell-shaped, of creamy-white color and purplish-brown netting as well as a long broad lip, zygomorphic, united in raceme inflorescences. The flowers usually bloom in the second year. Both the flowers and stems are also woolly or hairy. The fruit is an ovoidal capsule (fig. 261).

It is found mostly in Eastern Europe. The plant prefers part shade place and humus rich soil. The plant also prefers sandy, loamy, and clay soils. It can grow under dry or moist conditions. The plant is toxic.

Vegetable product: *Digitalis lanatae folia*



Fig. 261. Morphology of the species: A - *Digitalis purpurea*; B - *D. lanata*

2.3. Morphology of the Woolly mullein plant

sp. *Verbascum phlomoides* L., common name – Woolly mullein (fig. 7A).

It is a herbaceous biennial plant, growing to a height of 50-100cm. The plants first form a dense rosette of petiolate, oblong or ovate-elliptical leaves at the ground level, subsequently giving off a single tall (about 100 cm), un-

branched flowering stem. The stem leaves are alternate, the lower leaves are petioled and with truncate or subcordate bases, but the upper ones are sessile, elliptical or lanceolate. All leaves are densely woolly-tomentose with prominent venation and crenate margin. The flowers are zygomorphic, yellow in raceme inflorescences. The fruit is a capsule (fig. 262).

It is native to Europe and Asia. The plants grow well in the sunny areas and different types of soil.

Vegetable product: *Verbasci flores*

2.4. Morphology of the Common toadflax

sp. *Linaria vulgaris* L., common name – Common toadflax

It is a herbaceous plant with short spreading roots and an erect stem, growing to a height of 60 cm. The leaves are simple, alternate, linear-lanceolate, entire and sessile. The flowers are zygomorphic with spruce, united in a terminal raceme. The fruit is a dry capsule (fig. 262).

It is native to most of Europe, Northern Asia, and the United Kingdom. The plant is widespread on ruderal spots, along roads, in dunes. The plants grow under various conditions and on a wide range of soil types, from sandy and gravelly soils to more fertile, mainly chalky soils. It prefers sunny places and is moderately tolerant of shade and drought conditions.



Fig. 262. Morphology of the species: **A** – *Verbascum phlomoides*; **B** – *Linaria vulgaris*

PRACTICAL WORK nr. 3. Morphology of some species from the fam. Plantaginaceae

3.1. Morphology of the Great plantain plant

sp. *Plantago major* L., common name – Great plantain

It is a perennial, herbaceous plant, growing to height of 20-35 cm. The leaves are simple petioles, wide-oval with ovate venation in the basal rosette. The flowers are pinkish, small and in dense spike. The fruit is a capsule (fig. 263).

The plant is native to most of Europe and Northern and central Asia, but it is largely spread in the world. The plants can grow in nutritionally poor soils and prefer moist soil and semi-shaded, but it can tolerate sunny and full shaded areas.

Vegetable product: *Plantaginis majoris folia*



Fig. 263. Morphology of the species: A – *Plantago major*;
B – *P. psyllium*

3.2. Morphology of the Psyllium plant

sp. *Plantago psyllium* L., syn. *Plantago indica* L.,
common name – Psyllium

It is a herbaceous plant with erect brownish stem. The leaves are opposite, linear-lanceolate, entire, narrowed at both ends. The leaves and the stems are covered with grayish hairs. The flowers with creamy or yellowish corolla are small and united in spike-headed inflorescences with ovate-lanceolate to narrow lanceolate bracts. The fruit is a dry capsule with narrow-elliptic reddish-brown and shiny seeds (fig. 263).

It is native to Western Asia, Southern Europe and Cuba.

The plants prefer moist surface of the sandy soil, and warm, sunny conditions.

Vegetable product: *Psylli semina*

Other species: *P. lanceolata* L., common name – English plantain or Narrowleaf plantain; *P. media* L., common name – Hoary plantain

SUBJECTS FOR DISCUSSION:

1. Morphological and ecological characteristics of the families: SOLANACEAE, SCROPHULARIACEAE AND PLANTAGINACEAE.
2. Latin and common names of each described species from each family, their morphological characteristics, distribution and ecology.
3. Economical and pharmaceutical usage of the species.

4.13. MORPHOLOGY OF SOME SPECIES FROM THE FAMILY: ASTERACEAE

PRACTICAL WORK nr. 1. Morphological characteristics of the Aster plant organs



Fig. 264. Morphology of simple leaf of some species: A – ovate with dentate margin, sp. *Tussilago farfara*; B – runcinate, sp. *Taraxacum officinale*; C – double pinnate sected, sp. *Achillea millefolium*; D – sected to thread, sp. *Matricaria chamomilla*

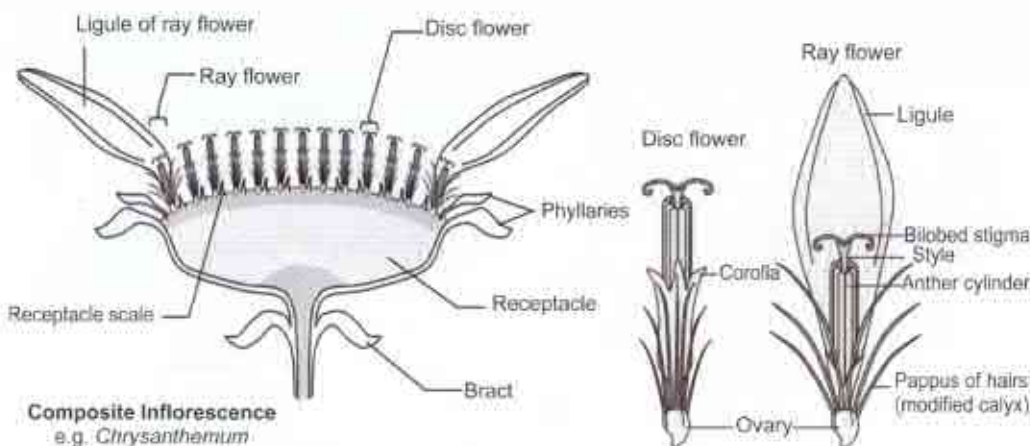


Fig. 265. Morphology of heterogeneous calatidium inflorescence

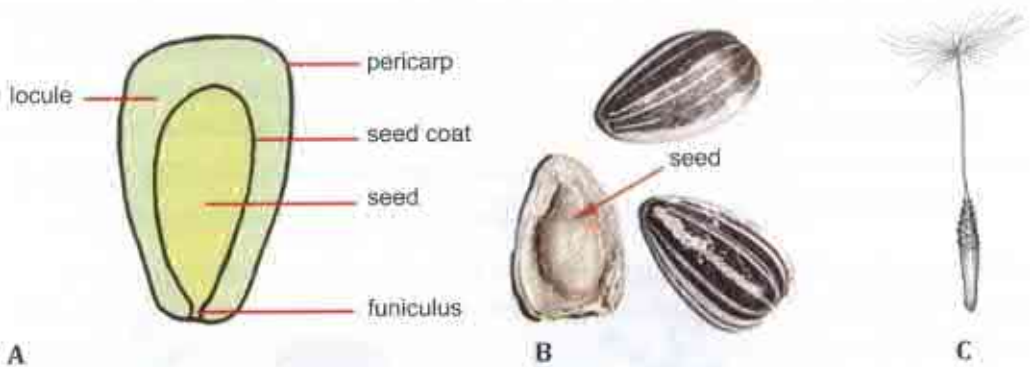


Fig. 266. The achene fruits: A – longitudinal section; B – achenes of Sunflower; C – achene with pappus (parachute) of Dandelion

PRACTICAL WORK nr. 2. Morphology of some species from the fam. Asteraceae

2.1. Morphology of the Chamomile plant

sp. *Matricaria camomilla* L., syn. *Camomilla recutita* L.,
common name – Chamomile

It is a herbaceous, annual plant with branched, erect and smooth stem, which grows to a height of 15–60 cm. The leaves are simple, long and narrow bi- and three-sected. The ligulate, white, ray flowers and tubular, yellow, disc flowers form the capitulum. The hollow receptacle is swollen and lacks scales. This property distinguishes chamomile from chamomile species (*Anthemis arvensis*), which has a receptacle with scales. The flowers bloom from early summer to midsummer, and have a strong, aromatic smell. The fruit is a small achene (fig. 267).

It can be found near populated areas all over Europe and temperate Asia, and it has been widely introduced in temperate North America and Australia. It often grows near roads, around landfills, and in cultivated fields as a weed, because the seeds require open soil to survive.

Vegetable product: *Chamomillae flores*

2.1. Morphology of the Pot marrygold plant

sp. *Calendula officinale* L., common name – Pot marrygold

It is a herbaceous, annual plant, growing to a height of 80 cm, with branched lax or erect stems. The leaves are oblong-lanceolate, 5–17 cm in length, hairy on both sides, and with margins entire or occasionally waved or weakly toothed. The inflorescence is calathidium, surrounded by two rows of hairy bracts; it has a single ring of ray florets surrounding the central disc. The disc florets

are tubular and hermaphrodite, and generally of a more intense orange-yellow colour than the female, tridentate, peripheral ray florets. The fruit is a thorny curved achene (fig. 267).

It is probably native to southern Europe, though its long history of cultivation makes its precise origin unknown, and it may possibly be of garden origin.

Vegetable product: *Calendulae flores*



Fig. 267. Morphology of the species: A – *Matricaria recutita*; B – *Calendula officinalis*

2.2. Morphology of the Dandelion

sp. *Taraxacum officinale* (L.) Weber ex F.H.Wigg.,
common name – Dandeloin

The plant develops unbranched taproots and produces one or more than ten stems that are typically 5–40 cm tall. The leaves are simple, runcinate in the basal rosette. Each flowering stem lacks bracts and has one single calathidium, consisting of only ligulate and bisexual yellow florets (flowers). The fruit is an achene with silky pappus (pappi) which forms the parachutes for good dissemination. The plant contains laticifers with milky latex (fig. 268).

It can be found growing in temperate regions of the world, in lawns, on roadsides, and other areas with moist soils.

Vegetable product: *Taraxaci radices*

2.3. Morphology of the Sunflower plant

sp. *Helianthus annuus* L., common name - Sunflower

It is an annual plant has an erect rough-hairy stem, reaching typical by the height of 3 metres. The leaves are simple, petiolate, ovate, rough and mostly alternate. The calathidium is large surrounding by some rows of green and rough bracts. The outer flowers, which resemble petals, are called ray flowers (ligulate) and are sexually sterile and may be of yellow, red, orange, or other colors. In the center of the head the flowers are called disk flowers (tubular). They are bisexual, usually of yellow color. These mature into fruit (sunflower «seeds») (fig. 268). Wild *H. annuus* is a widely branched annual plant with many flower heads.

Sunflower is a native of North America and was first domesticated in the Americas. Nowadays it is grown as a crop for its edible oil and edible fruits (sunflower seeds). To grow best sunflowers need the full sun. They grow best in fertile, moist, well-drained soil with heavy mulch.



Fig. 268. Morphology of the species: A - *Tussilago farfara*; B - *Helianthus annuus*

2.4. Morphology of the Horse-heal plant

sp. *Inula helenium* L., common name – Horse-heal

It is a perennial herb, the stem of which attains a height of about 90–150 cm. The leaves are simple, alternate, ovate-elliptical, large and toothed, the lower ones are stalked and other leaves are embracing the stem. The leaves are green on the upper side in the light has scattered hairs and with thick layer of wool on the underside. The calathidium is heterogenous, consisting of yellow, ray, ligulate flowers and 100-250 yellow, disc, tubular, flowers (fig. 269). The root is thick, branching and mucilaginous, and has a bitter taste and a camphoraceous odor.

It is native to Europe and Asia from Spain to Western China and got acclimatized in some parts of North America. It grows commonly in rich, moist, well-drained calcareous soils and prefers sun-light or partial shade places.

Vegetable product: *Inulae radices*



A



B

Fig. 269. Morphology of the species: A – Inula helenium;
B – Achillea millefolium

2.5. Morphology of the Common yarrow plant

sp. *Achillea millefolium* L., common name - Common yarrow

It is an erect herbaceous, perennial plant that produces from one to several stems of 0.2–1 m in height, and has a spreading rhizomatous growth form. The leaves are distributed along the stem, with the leaves near the middle and bottom of the stem being the largest. The leaves are hairy in various degree (pubescence). The leaves are simple, 5–20 cm long, bipinnate or tripinnate, almost feathery, and arranged spirally on the stems. The heterogenous calathidia are grouped in corymb. The calathidium contains ray, ligulate, white flowers and disk tubular, flowers which are of white to pink colour. The fruit is a small achene (fig. 269). The plant has a strong, sweet scent, similar to that of chrysanthemums.

It is native to temperate regions of the Northern Hemisphere in Asia, Europe, and North America. It prefers sunny places, dry or moist soil and can tolerate drought.

Vegetable product: *Millefolii herba*

2.6. Morphology of the Wolf's bane plant

sp. *Arnica montana* L., common name - Wolf's bane or Leopard's Bane

It is a flowering, perennial plant about 18–60 cm tall. The simple, ovate-lanceolate leaves with rounded tips, entire margin and curvate veins are bright colored and grouped in basal rosettes. The stem leaves are opposite, ovate and sessile. The calathidium inflorescence is composed of yellow-orange disc florets in the center and orange-yellow ray florets on the external part. The fruit is achene with pappus (fig. 270).

It is widespread across most of Europe and partially in Siberia. It mostly grows on alpine meadows and of a height of about 3 000 m.

Vegetable product: *Arnicae flores*

2.7. Morphology of the Absinthe wormwood plant

sp. *Artemisia absinthium* L., common name - Absinthe wormwood

It is a herbaceous, perennial plant with fibrous roots. The stems are straight, growing to a height of 0.8–1.2 m., grooved, branched, and silvery-green. The leaves are simple, spirally arranged, greenish-grey above and white below, covered with silky silvery-white trichomes, and bearing minute oil-producing glands. The basal leaves are up to 25 cm long, bipinnate to

tripinnate with long petioles. The stem leaves are smaller, 5–10 cm long, less divided, and with short petioles. The uppermost leaves can be both simple and sessile. The pale yellow, tubular flowers are grouped in spherical heads (calathidium), which are arranged in panicles (compound raceme). The fruit is a small achene (fig. 270).

The plant is native to temperate regions of Eurasia and Northern Africa. It grows naturally on uncultivated, arid soil, on rocky slopes, and at the edge of footpaths and fields. The plants prefer dry soils and sunny places.

Vegetable product: *Absinthii herba*



Fig. 270. Morphology of the species: A - *Arnica montana*; B - *Artemisia absinthium*

2.8. Morphology of the Three-lobed Beggarticks plant

sp. *Bidens tripartita* Linn., syn. *B. acuta* (Wieg.) Britt., *B. comosa* (A. Grey) Wiegand, common name - Three-lobed Beggarticks

It is a perennial herbaceous plant with a strong tap root. The erect stem grows about 60-70 cm high, angular, solid and marked with small brown spots, so as to almost give it the dark purple appearance. The leaves are simple, three-lobed (are divided into 3 segments) with serrate margin are opposite.

The lower leaves are petiolate. The uppermost leaves are sometimes found undivided and sessile. The calathidium is of brownish-yellow colour, usually without ray florets the disk florets being perfectly regular and tubular. The calathidium is surrounded by leafy involucre. The outer leaflets, about eight in number, are pointed and spreading and extend much behind the flower-head. The fruits are achenes with four ribs, two of which are provided with reflexed prickles, causing them to adhere to a coat of an animal, thus helping in the dissemination of the seeds (fig. 271).

It is native to much of Eurasia, North Africa and North America. The plants prefer moist and shady places.

Vegetable product: *Bidentis herba*



A

B

Fig. 271. Morphology of the species: A - *Bidens tripartita*; B - *Echinacea purpurea*

2.9. Morphology of the Purple Coneflower plant sp. *Echinacea purpurea* (L.) Moench, common name - Purple Coneflower

It is a herbaceous, drought-tolerant perennial plant growing up to 140 cm in height. It grows from a short caudex with fibrous roots. It develops erect stem, usually unbranched. Both the basal and cauline (stem) leaves are arranged alternately. The leaves are normally hairy with a rough texture, having uniseriate

trichomes. The basal leaves and the lower stem leaves are petiolated, and as the leaves progress up the stem the petioles often decrease in length. The lamina leaf is ovate-lanceolate or linear with ovate venation (fig. 271).

The flowers are united together into the single rounded cone-shaped calathidium at the ends of long peduncles. The calathidium consists of mauve-purple ligulate flowers at the margin and dense, tubular, yellow-brownish flowers on the conical disc.

They are found only in eastern and central North America, where they are found growing in moist or dry prairies and open wooded areas. The plant prefers loamy or sandy, well-drained soils, and sunny places. Nowadays it is cultivated as an ornamental and medicinal plant.

Vegetable product: *Echinaceae flores*

Other species: *E. pallida* Nutt., common name – Pale purple Coneflower

2.10. Morphology of the Dwarf everlast plant

sp. Helichrysum arenarium L.,

common name – Dwarf everlast or immortelle

It is a perennial plant and grows to be on the average of 30-40 cm in height. The leaves are simple, flat, the lower ones being elliptical in shape, while the upper ones are linear. They are wooly on both sides. The flower heads are arranged in corymb inflorescences. The corolla is bright golden yellow. The fruit is small achene (fig. 272).

It is found in Europe and Asia as well as in the mountains of Uzbekistan, but usually on sandy grasslands and heathland. This plant prefers the sun to part-shade places with well-drained sandy soil.

Vegetable product: *Helichrysi flores*

2.11. Morphology of the Coltfoot plant

Sp. Tussilago farfara L.,

common name – Coltfoot or Sun before father

It is a perennial herbaceous plant that spreads by seeds and rhizomes. The Coltfoot plant is often found in colonies of dozens of plants. The head (calathidium), which resembles dandelions, appears early in the spring before the leaves on the long (about 20-30 cm height) scaly stalk. The leaves are simple, long petioled with large, oval lamina, which resemble a colt's foot in cross section, shiny on the upper side and wool-hairy on the lower side. The leaves have large angular teeth on their margins (fig. 272).

The species is native to Europe and parts of western and central Asia and the plant is widespread across Europe, Asia, and North Africa. The plants prefer the moist soil, and be exposed to direct sunlight.

Vegetable product: *Farfarae folia*



Fig. 272. Morphology of the species: A - *Helichrysum arenarium*; B - *Tussilago farfara*

2.12. Morphology of the *Cardus marianus* plant sp. *Sylibum marianum* L., common name - *Cardus marianus* or Milk thistle

It is a herbaceous plant growing to a height of 30-200 cm. The stem is grooved and more or less cottony, sometimes it can be hollow. The leaves are simple, oblong to lanceolate with pinnate-lobed lamina and spiny edges. They are hairless, shiny green, with milk-white veins. The flower heads (calathidium) are of red-purple colour. The calathidium is surrounded by triangular, spine-edged appendages, tipped with stout yellow spine bracts. The achenes are black, with a simple long white pappus, surrounded by a yellow basal ring (fig. 273).

It is originally native of Southern Europe through to Asia. Nowadays it is found throughout the world. It cannot grow in the shade and prefers dry or moist soil.

Vegetable product: *Sylibi fructus*

2.13. Morphology of the Globe artichoke

sp. *Cynara scolymus* L., common name, Globe artichoke

It is a perennial herbaceous plant growing to a height of 120 cm. The stem is erect and branching at the apical part. The leaves are simple, pinnate sected, green on the upper side and hairy, grayish on the lower side. The mauve-purple tubular flowers form the spherical head (calathidium), is surrounded by some rows of hairy and pointed bracts. The fruit is an achene (fig. 273).

It is native to the Mediterranean region, the Middle East, northwestern Africa, and the Canary Islands. It prefers moderately heavy and sandy, well-drained soils and sunny position. The Globe artichoke is cultivated as a culinary, medicinal and ornamental plant.

Vegetable product: *Cynarae folia*



A

B

Fig. 273. Morphology of the species: A - *Sylibum marianum*; B - *Cynara scolymus*

2.14. Morphology of the Cornflower

sp. *Centaurea cyanus* L., common name - Cornflower

Cornflower is an annual plant growing to a height of 60-70 cm, with grey-green branched stems. The leaves are simple, entire, lanceolate, 1-4 cm long. The flowers are most commonly of intense blue colour. They grow in flowerheads (calathidia), with a ring of a few large, spreading ray florets surrounding the central cluster of disc florets (fig. 274).

It is native to Europe and often grows as a weed in grains, such as wheat, barley, rye, or oats. Cornflower prefers open, sunny fields and can tolerate partial shady places. Mature plants tolerate drought, but prefer well-draining soils with plenty of moisture. Cornflower is cultivated as an ornamental and medicinal plant.

Vegetable product: *Centaurei cyani flores*



Fig. 274. Morphology of the species: **A** – *Centaurea cyanus*; **B** – *Cichorium intybus*

2.15. Morphology of the Common chicory

sp. *Cichorium intybus* L., common name – Common chicory

Chicory develops a strong root with erect, branched stem about 80-90 cm tall. The stem may be round, hollow, nearly leafless, of green to reddish-brown colour that produces a milky sap when cut. The plant forms the basal rosette of oblong leaves with rough hairs on the upper and lower surfaces. The lower stem leaves are stalked and are larger than the upper ones. The leaves are sessile and lanceolate. The margins of the lamina may be irregular, shallowly toothed or deeply dissected. The heads (calathidia) are 2 to 4 cm in diameter, and usually form bright blue, rarely white or pink ligulate flowers, surrounded by two rows of involucre bracts. The inner flowers are longer and erect, the outer ones are shorter. The flowers usually bloom in the morning

and close later in the afternoon. The achenes have no pappus (feathery hairs), but do have toothed scales on the top (fig. 274).

It is native to Africa, both temperate and tropical Asia and Europe. It grows as a wild plant on roadsides, waste places and cultivated fields. It cannot grow in the shade. It prefers moist soil. Common chicory is cultivated as an alimentary and medicinal plant.

Vegetable product: *Cichori herba*

**INDIVIDUAL PRACTICAL WORK
ANALYZE AND DETERMINE THE MORPHOLOGY
OF THE FOLLOWING SPECIES:**

Solidago virgaurea L., common name – European goldenrod (fig. 275)

Tanacetum vulgare L., common name – Common tansy (fig. 275)



A



B

Fig. 275. Morphology of the species: A – Solidago virgaurea; B – Tanacetum vulgare

Actium lappa L., common name – Greater burdock (fig. 276)

Tagetes patula L., common name – French marigolds (fig. 276)



Fig. 276. Morphology of the species: A - *Arcetium lappa*; B - *Tagetes patula*

Pyrethrum (Chrysanthemum) cinerariaefolium L.,
common name - Pyrethrum daisy (fig. 277)

Helianthus tuberosus L., common name - Jerusalem artichoke (fig. 277)



Fig. 277. Morphology of the plant species: A - *Pyrethrum cinerariaefolium*;
B - *Helianthus tuberosus*

SUBJECTS FOR DISCUSSION:

1. Morphological and ecological characteristics of the family Asteraceae.
2. Latin and common names of species from the Aster family, morphological characteristics, distribution and ecology.
3. Economic and pharmaceutical usage of the Aster species.

MONOCOTYLEDONS – cl. LILIOPSIDA
(selected families)

**4.14. MORPHOLOGY OF SOME SPECIES
FROM THE FAMILIES:
LILIACEAE, ALLIACEAE, ASPARAGACEAE,
DYOSCORIACEAE, ARACEAE, POACEAE**

**PRACTICAL WORK nr. 1. Morphology of some species from the
fam. Liliaceae**

1.1. Morphology of the True Aloe plant

sp. *Aloë vera* (L.) Burm., syn. *A. barbadensis* Mill.,
common name – True Aloe

It is a perennial herbaceous plant with the stem growing to a height of 60–100 cm. The plant develops rhizome. The leaves are evergreen, simple, linear, thick and succulent, of green to grey-green colour, with some varieties showing white flecks on their upper and lower stem surfaces. The leaves grow to about 50 cm long, with margins that are pinkish with many small spines. The flowers are yellowish-reddish, tubular, united in the terminal raceme. The fruit is a capsule (fig. 278).

It grows wild in tropical climates around the world (Central America and Asia, Africa) and is cultivated for agricultural and medicinal uses. It is adapted to arid climates. Aloes do not tolerate overwatering and prefer sunny position, but they can tolerate partial or semi-shaded places.

Vegetable product: *Aloë folia*

Other species: *A. arborescens* Mill., common name – Candelabra aloe



A



B

Fig. 278. Morphology of the species: A – *Aloë vera*; B – *A. arborescens*

1.2. Morphology of the Lily of the valley

sp. *Convallaria majalis* L., common name - Lily of the valley

It is a perennial herbaceous plant, growing to a height of 20-40 cm with horizontal, slender rhizome. Two (rare more) leaves are simple, ovate-elliptical, entire with ovate venation. The flowers are of type 3, campanulate, united in unilateral raceme inflorescences. The fruit is a red berry (fig. 279).

It is native throughout the cool temperate Northern Hemisphere in Asia, and Europe, where it largely avoids the Mediterranean and Atlantic margins. Lily of the valley prefers shady or semi-shady locations with fresh, humus and nutrient-rich soils. It can grow under woody plants and in shady perennial beds.

Vegetable product: *Convallariae folia*, *C. flores*, *C. herba*

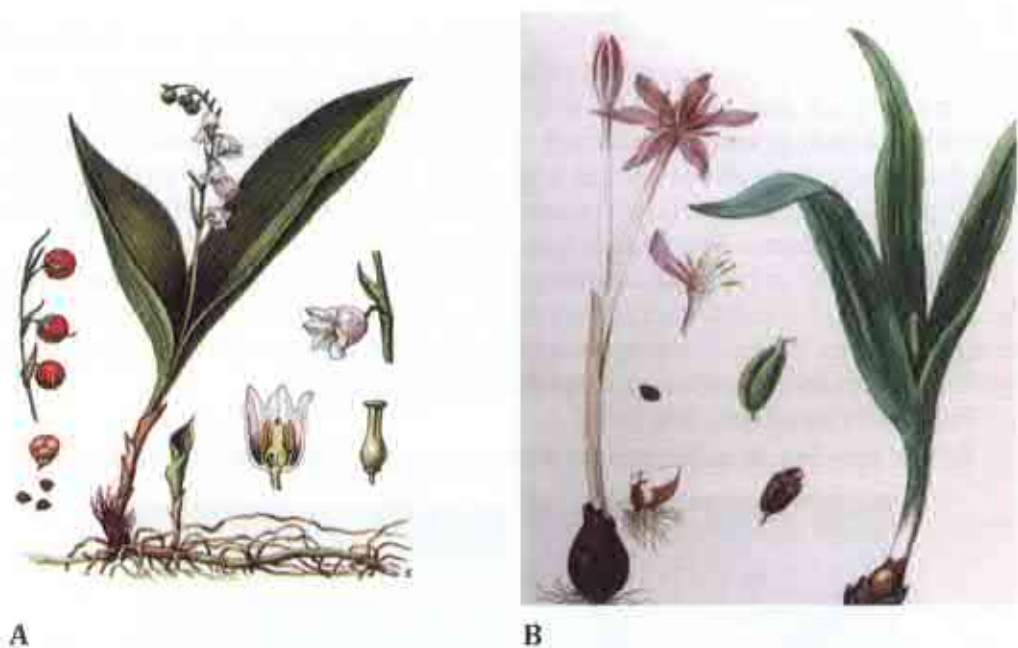


Fig. 279. Morphology of the species: A - *Convallaria majalis*; B - *Colchicum autumnale*

1.3. Morphology of the Autumn crocus

sp. *Colchicum autumnale* L., common name - Autumn crocus

It is a perbaseous perennial plant, growing to a height of 15-20 cm. It develops a tuber-bulb. The leaves are simple, linear, entire, with a prominent midrib. The flowers are of type 3, actinomorphic and solitary. The plant blooms in the autumn. The fruit is a locular capsule (fig. 279).

It is native to West Asia, Europe, parts of the Mediterranean coast, down the East African coast to South Africa. The plants prefer sunny places on moderately moist soil. The plant is toxic. It is cultivated as a medicinal and ornamental plant. Colchicine alkaloid from the Autumn crocus is used in plant breeding to produce polyploid strains. The plant is toxic.

Vegetable product: *Colchici stigmata*

1.4. Morphology of the Medicinal Solomon's seal

sp. Polygonatum odoratum L., syn. P. officinale L.,

common name – Medicinal Solomon's seal

It is a colonizing herbaceous perennial plant, growing to a height of 70-90 cm. The plants develop strong rhizomes. The leaves are simple, entire, and ovate-elliptical with ovate base and ovate venation on arching stems. The flowers are of type 3, white, fragrant and axillary. The fruit is a black berry (fig. 280).

It is native to Europe, the Caucasus, Siberia, the Russian Far East, China, Korea and Japan. It prefers moist soil in shaded or semi-shaded places.

Other species: *P. multiflorum (L.) All., common name – Solomon's seal,*

P. verticillatum (L.) All., common name – Whorled Solomon's seal

1.5. Morphology of the White hellebore plant

sp. Veratrum album L., syn. V. lobelianum Bernh.,

common name – White hellebore

It is a perennial herbaceous plant, growing to a height of 100-130 cm in open mountain fields. It develops a stout vertical rhizome covered with remnants of old leaf sheaths. The leaves are simple, sessile, ovate-elliptical with ovate venation. The flowers are white-greenish in compound racemes. The fruit is a capsule (fig. 280).

It is native to Europe and parts of western Asia (Western Siberia, Turkey, Caucasus). It prefers places with full sun, but can grow in semi-shade (light woodland) or in open places. It grows well in the moist soil. The plant is toxic.

Vegetable product: *Veratri folia*

Other species: *V. nigrum L., common name – Black false hellebore*



Fig. 280. Morphology of the species: A – *Polygonatum officinale*; B – *Veratrum album*

PRACTICAL WORK nr. 2. Morphology of some species of the fam. Alliaceae

2.1. Morphology of the Bulb onion plant

sp. *Allium cepa* L., common name – Bulb onion

It is a biennial herbaceous plant, growing to a height of 40-60 cm and develops a swollen bulb with succulent scales inside, covered by dry scales. A bundle of fibrous roots extends for a short distance from the underside of the bulb disc into the soil. The leaves are simple, hollow tubular (fan-shape) and of bluish-green colour. The base of each leaf is flattened, usually with a white sheath that grows out of the basal disc of the bulb. The flowers are of type 3, white in a dense globular umbel. The fruit is a small capsule (fig. 281). The onion is commonly a biennial or a perennial plant, but it is usually treated as an annual one and it harvests in its first growing season.

Allium species, including *A. cepa* are native to the Northern Hemisphere, being spread throughout the Holarctic region, from dry subtropics to the boreal zone, but predominantly in Asia. Bulb onion is a vegetable and is the most widely cultivated species of the genus *Allium*.

2.2. Morphology of the Garlic plant

sp. *Allium sativum* L., common name – Garlic

It is a biennial herbaceous plant with bulblets (cloves), covered by whitish or pinkish tunic (papery coats – scales) and all united in common dry tunics on the basal disc. The leaves are simple and linear, attached to an underground stem. The flowers are of type 3, white in dense, rounded head – umbel. The young flower head is enclosed in a long-beaked pair of enclosing bracts, which become papery and split to reveal the flowers. The fruit is a small capsule (fig. 281).

It is native to the Mediterranean area. Garlic is typically grown as an annual plant in herb and vegetable gardens. Garlic grows in wet, poorly-drained soils and sunny or semi-shaded place. Today, garlic is grown in temperate and tropical regions all over the world, and many cultivars have been selected to suit different climates.



A



B

Fig. 281. Morphology of the species: A – *Allium cepa*; B – *A. sativum*

**INDIVIDUAL PRACTICAL WORK
ANALYZE AND DETERMINE THE MORPHOLOGY
OF THE FOLLOWING SPECIES:**

Allium porrum L., common name – Leek (fig. 282)

Allium ursinum L., common name – Ramsons or Wild garlic (fig. 282)



A



B

Fig. 282. Morphology of the species: Allium porrum; A.ursinum

**PRACTICAL WORK nr. 3. Morphology of the Asparagus plant,
fam. Asparagaceae**

sp. *Asparagus officinalis* L., common name – Asparagus

It is a perennial, herbaceous plant growing to a height of 100-150 cm and developing stout stems with much-branched, feathery foliage. The „leaves“ are in fact needle-like cladodes (modified stems) in the axils of scale-like leaves (modified leaves). The adventitious roots form a fibrous root system from the strong rhizome. The flowers are bell-shaped, of greenish-white to yellowish colour, with six tepals partially fused together at the base. The flowers are arranged in clusters of 2-3 in the junctions of the branchlets. The plant is usually dioecious, with male and female flowers on separate individuals, but sometimes hermaphrodite flowers are found. The fruit is a small red berry of 6-10 mm in diameter, which is poisonous to humans (fig.283).

It is native to most of Europe, northern Africa and western Asia, and is widely cultivated as a vegetable crop. It likes sunny and moist places and is sensitive to wind and cold. It is cultivated as a vegetable and medicinal plant.



Fig. 283. Morphology of the species: *Asparagus officinale*

PRACTICAL WORK nr. 4. Morphology of species from the fam. Dioscoreaceae

4.1. Morphology of the Kaukasisk jams plant

sp. *Dioscorea caucasica* Lipsky, common name – Kaukasisk jams

It is a perennial, dioecious, herbaceous, voluble and climbing by tendrils vine of up to 4 m in length. Its underground part is a horizontal strong rhizome 1.5-2.0 m long. The leaves are simple, alternate, and ovate with entire margin. The flowers are white-greenish, unisexual in axillary racemes. The fruit is a capsule (fig. 284).

It is native to tropics and subtropics, rare in temperate zone of Asia. The plant prefers humid and warm places.

Vegetable product: *Dioscoreae rhizoma cum radicibus*

4.2. Morphology of the Japanese Yam plant

sp. *Dioscorea nipponica* Makino, common name – Japanese Yam

It is a perennial, dioecious, herbaceous voluble and climbing by tendrils vine. Its underground part is a strong rhizome. The leaves are simple, palmately-lobed. The flowers are white-greenish, unisexual and in axillary racemes. The fruit is a capsule (fig. 284).

It is native throughout the tropical and warm temperate regions of the world. The plant prefers humid and warm conditions on the slopes. The plant may be invasive.

Vegetable product: *Dioscoreae rhizomata cum radicibus*

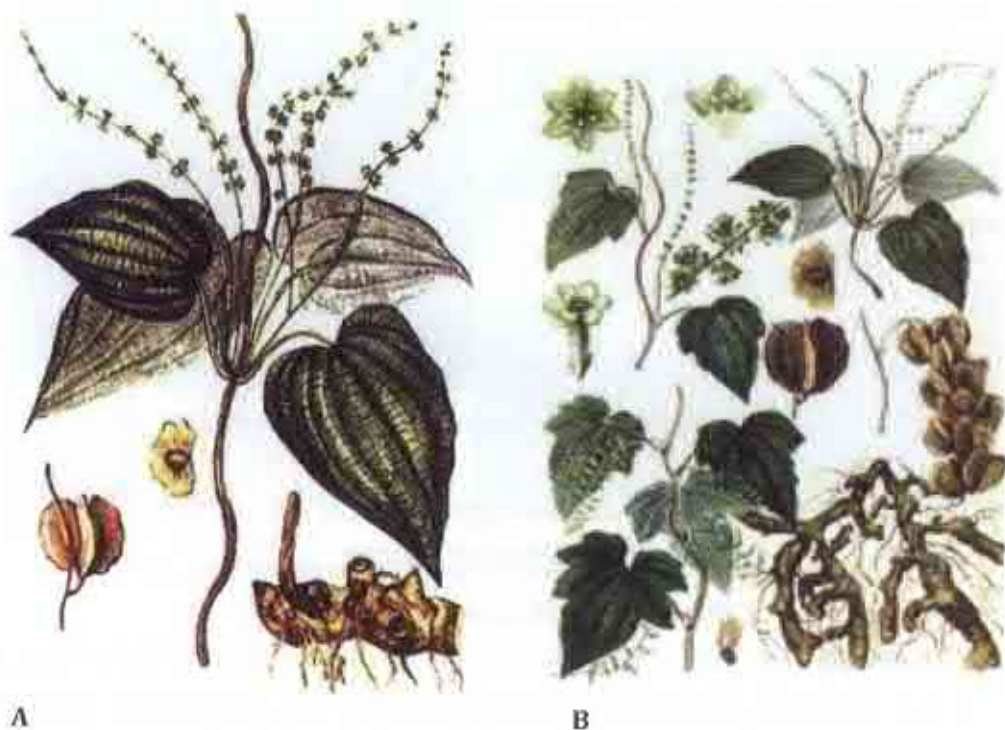


Fig. 284. Morphology of the species: A – *Dioscorea caucasica*; B – *D. nipponica*

PRACTICAL WORK nr. 5. Morphology of the Sweet flag plant from the fam. Araceae

sp. *Acorus calamus* L., common name – Sweet flag

It is a tall perennial wetland herbaceous, perennial plant growing to 70-100 cm with a strong horizontal rhizome. The leaves are simple, long-linear, entire. The solid, triangular flower-stems emerge from the axils of the outer leaves. The flowers are densely crowded with tiny greenish-yellow corolla arranged in diamond-shaped pattern on a semi-erect spadix, covered by a spathe. The fruit is a berry filled with mucus, which when ripe falls into the water and thus disperses (fig. 285).

Sweet Flag is native to India, central Asia, southern Russia and Siberia, and perhaps Eastern Europe. It also grows in China and Japan. The habitats are edges of small lakes, ponds and rivers, marshes, swamps, and wetlands.

Vegetable product: *Calami rhizomata*



Fig. 285. Morphology of the species *Acorus calamus*

PRACTICAL WORK nr. 6. Morphology of species from the fam. Poaceae

6.1. Morphology of the Couch grass plant

*sp. Agropyron repens L., syn. Elymus repens (L.),
common name - Couch grass*

It is a perennial herbaceous plant with creeping rhizomes which enable it to grow rapidly across grassland. The stem is a hollow culm, growing to 40-120 cm. The leaves are simple, linear, flat, hairy, entire with parallel venation. The flowers are of type 3, in spikelets united in a compound spike. The glumes are 7-12 mm long, usually without an awn or with only a short one. The fruit is a caryopsis (fig. 283).

It is native to most of Europe, Asia, the Arctic biome, and northwest Africa. Couch grass has become acclimated throughout much of the world, and is often listed as an invasive weed.

Vegetable product: *Agropyri rhizomata*

6.2. Morphology of the Corn or maize plant

sp. *Zea mays* L., common name – Corn or maize

It is an annual cultivated plant. The leaves are simple, wide-linear, entire and with parallel venation. The flowers are of type 3, unisexual. The female flowers are united in spadix in the leaf axill. The male flowers are united in panicle inflorescences at the tip of the stem. The fruit is a caryopsis on the spadix, covered with many spathes (fig. 286).

Most historians believe maize was domesticated in the Tehuacan Valley of Mexico, later the crop spread through out much of the Americas. Nowadays, Corn is cultivated as an important crop plant.

Vegetable product: *Maydis stigmata* and *Maydis amyllum*

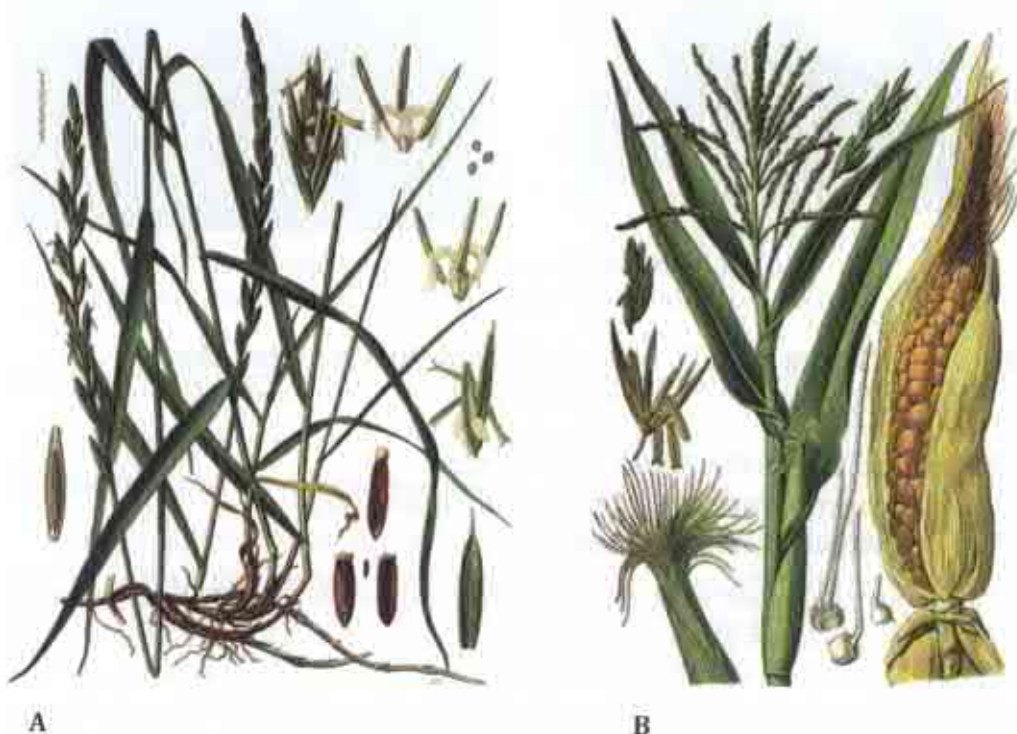


Fig. 286. Morphology of the species: A – *Agropyron repens*; B – *Zea mays*

INDIVIDUAL PRACTICAL WORK
ANALYZE AND DETERMINE THE MORPHOLOGY
OF THE FOLLOWING SPECIES:

Avena sativa L., common name - Oat (fig. 287)

Hordeum vulgare L., common name - Barley (fig. 287)

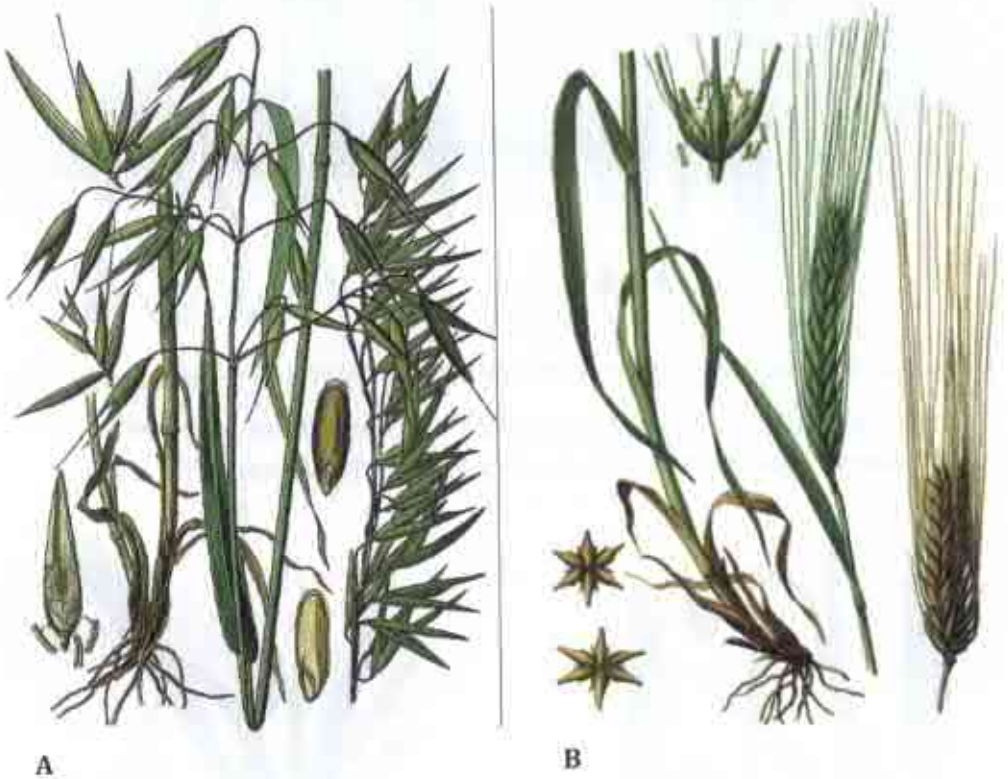


Fig. 287. Morphology of the species: A - *Avena sativa*; B - *Hordeum vulgare*

Oryza sativa L., common name - Rice (fig. 288)

Secale cereale L., common name - Cereal rye (fig. 288)

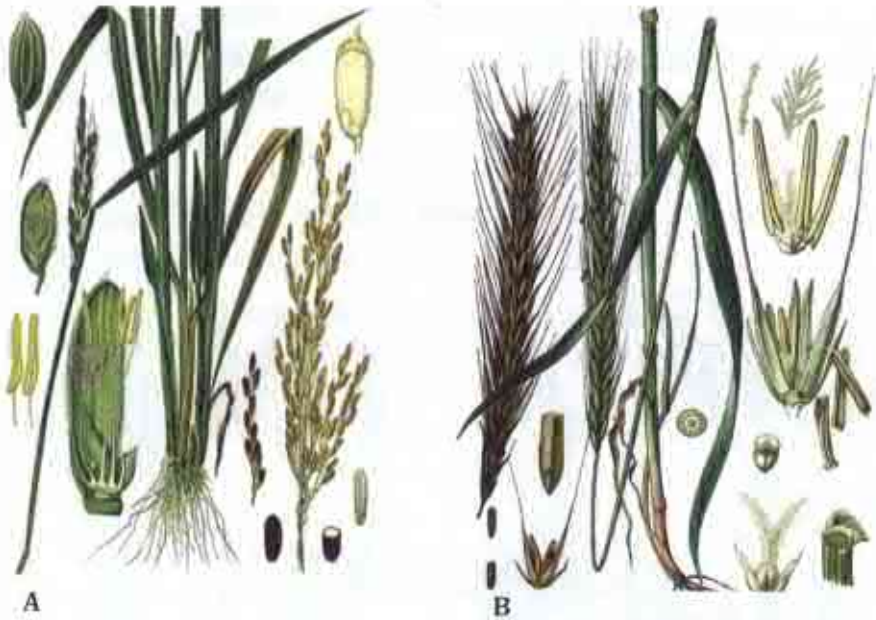


Fig. 288. Morphology of the species: A - *Oryza sativa*; B - *Secale cereale*

Triticum aestivum L., common name - Bread wheat (fig. 289)

Saccharum officinarum L., common name - Sugar cane (fig. 289)

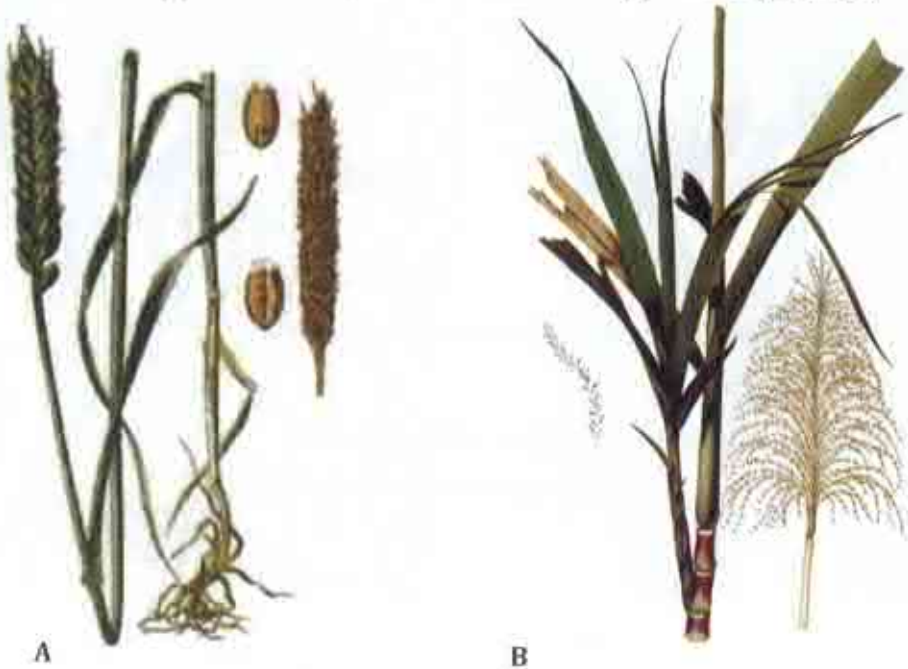


Fig. 289. Morphology of the species: A - *Triticum aestivum*; B - *Saccharum officinarum*

**SUBJECTS FOR THE TEST ON „FLOWERING PLANTS
div. *MAGNOLIOPHYTA*“:**

1. Characteristics of flowering plants.
2. Characteristics of Dicot and Monocot classes.
3. Characteristics of each selected family from the Dicot class.
4. Latin and common names of species from each studied family, morphological characteristics, distribution and ecology.
5. Characteristics of each selected family from the Monocot class.
6. Latin and common names of species from each studied family, morphological characteristics, distribution and ecology.

TEST SAMPLES

- 1) m.c. Choose the species from the fam. Ranunculaceae:
 - a) Adonis vernalis;
 - b) Aconitum nappelus;
 - c) Delphinium consolida;
 - d) Berberis vulgaris;
 - e) Heleborus purpurascens.
- 2) m.c. Choose the characteristics of the fam. Papaveraceae:
 - a) leaves - simple;
 - b) fruit - capsule or silica-capsule;
 - c) fruit - caryopsis;
 - d) it contains laticifers;
 - e) woody plants.
- 3) m.c. Choose the characteristics of the fam. Asteraceae:
 - a) herbaceous plants;
 - b) simple leaves;
 - c) solitary flowers;
 - d) inflorescence - calatidium;
 - e) fruit - achene.
- 4) m.c. Choose the family from cl. Monocotyledones:
 - a) Apiaceae;
 - b) Alliaceae;
 - c) Asteraceae;
 - d) Araceae;
 - e) Liliaceae.
- 5) m.c. Choose the species from the fam. Rosaceae:
 - a) Sorbus aucuparia;
 - b) Matricaria recutita;
 - c) Polygonum bistorta;
 - d) Potentilla erecta;
 - e) Crataegus monogyna.
- 6) m.c. Choose the characteristics of the fam. Lamiaceae:
 - a) opposite, simple leaves;
 - b) alternate leaves;
 - c) two lipped-flowers;
 - d) aromatic plants;
 - e) trees.
- 7) m. c. The characteristics of the Horsetail plant are:
 - a) perennial, herbaceous;
 - b) develops 2 types of stems;
 - c) leaves are fan-like;
 - d) the stem is articulated, and hollow;
 - e) leaves are reduced scale-like.
- 8) s. c. Choose the species which develop the solitary flower:
 - a) Tussilago farfara;
 - b) Betula alba;
 - c) Papaver somniferum;
 - d) Calendula officinalis;
 - e) Polygonum hydropiper.
- 9) m.c. Choose the species with laticifers:
 - a) Taraxacum officinale;
 - b) Chelidonium majus;
 - c) Anethum graveolens.
 - d) Papaver somniferum;
 - e) Viola tricolor;
- 10) m.c. Choose the woody species:
 - a) Helianthus annuus;
 - b) Mentha piperita;
 - c) Quercus robur;
 - d) Betula alba;
 - e) Berberis vulgaris.

HOW TO ASSESS THE PRACTICAL SKILLS EXAMINATION ON PHARMACEUTICAL BOTANY

A) Identification and description of micropreparation:

- type of micropreparation (superficial; cross, longitudinal or radial section; emulsion);
- name of micropreparation (organ, plant species);
- cytological or anatomical description.

Example:

- root of *Iris germanica*, cross section;
- on the cross section we distinguish (from the outside to the centre): one-layer rhizoderma (epiblema) with absorption hairs; the cortex consisting of the exoderma (well compact parenchymal cells with thick cell wall), mesoderma – the largest s/zone with spherical, parenchymal cells and endoderma – one-layer cells with Caspary cells (the cell wall is thickened like the letter „U“; central cylinder (stele) with vascular bundle, consisting of phloem (outside) and xylem (inside).

B) The identification of herbarium:

- **common name of plant;**
- **scientific name of species (Latin name);**
- **taxonomy:** genus, family, classes, division, regnum.

Example:

- **common name of plant – Great palantain;**
- **scientific name of species (Latin name) – *Plantago major*;**
- **taxonomy:** genus – *Plantago*, family – *Plantaginaceae*, classes – *Magnoliopsida*, division – *Magnoliophyta*, regnum – *Plantae*.

LIST OF PLANT SPECIES

Higher spore plants

Div. *Lycopodiophyta*

Fam. *Lycopodiaceae*

1. *Lycopodium clavatum* L.
2. *L. selago* L.

Div. *Pteridophyta*

Fam. *Equisetaceae*

1. *Equisetum arvense* L.
2. *E. palustre* L.
3. *E. sylvatica* L.

Fam. *Polypodiaceae*

1. *Anthyrium filix-femina* (L.) Roth.
(*Polypodium filix-femina* (L.) Roth.)
2. *Dryopteris filix-mas* (L.) Schott.
(*Polypodium filix-mas* (L.) Schott.)
3. *Polypodium vulgare* L.

Gymnosperms - Naked seed plants

Div. *Pinophyta*

(*Gymnospermatophyta*)

Fam. *Cycadaceae*

1. *Cycas revoluta* Thunb.

Fam. *Ginkgoaceae*

1. *Ginkgo biloba* L.

Fam. *Cupressaceae*

1. *Cupressus sempervirens* L.
2. *Juniperus communis* L.
3. *J. sabina* L.
4. *Sequoia sempervirens* (D. Don)
5. *Thuja occidentalis* L.
6. *T. orientalis* L.

Fam. *Taxaceae*

1. *Taxus baccata* L.
2. *T. brevifolia* Nutt.

Fam. *Pinaceae*

1. *Abies alba* Mill.
2. *Larix decidua* Mill. (*L. europea* DC.)
3. *Picea abies* (L.) Karst.
(*P. excelsa* (Lam.)

4. *Pinus sylvestris* L.

5. *P. montana* Miller.

Fam. *Ephedraceae*

1. *Ephedra distachya* L.
2. *E. equisetina* Bge.

Flowering plants

Div. *Magnoliophyta*

(*Angiospermatophyta*)

Dicotyledons - cl. *Magnoliopsida*

Fam. *Anacardiaceae*

1. *Cotinus coggygria* Scop.
2. *Rhus coriaria* L.

Fam. *Apiaceae*

1. *Ammi majus* L.
2. *A. visnaga* L. (Lam.)
3. *Anethum graveolens* L.
4. *Angelica archangelica* L.
5. *A. palustre* L.
6. *Anisum vulgare* Gaertn.
(*Pimpinella anisum* L.)
7. *Anthriscus sylvestris* (L.) Hoffm.
8. *Apium graveolens* L.
9. *Carum carvi* L.
10. *Cicuta virosa* L.
11. *Conium maculatum* L.
12. *Coriandrum sativum* L.
13. *Daucus carota* L.
14. *D. carota* L., var. *sativa* Dc.
15. *Foeniculum vulgare* Mill.
16. *Levisticum officinale* Koch.
17. *Pastinaca sativa* L.
18. *Petroselinum crispum* (Mill.) Nym.

Fam. *Apocynaceae*

1. *Catharanthus roseus* G. Don.
2. *Rauwolfia serpentina* (L.) Benth.
3. *Strophanthus Kombe* Oliv.
4. *S. gratus* Franch.
5. *S. hispidus* A. DC.
6. *Vinca minor* L.

Fam. Araliaceae

1. *Aralia mandshurica* Rupr. et Maxim.
2. *Eleutherococcus senticosus* Maxim.
3. *Hedera helix* L.
4. *Panax ginseng* C.A.Mey

Fam. Asteraceae**S/fam. Tubuliflorae**

1. *Arctium lappa* L.
2. *Artemisia absinthium* L.
3. *A. vulgaris* L.
4. *Cnicus benedictus* L.
(*Cardus benedictus* L.)
5. *Cynara scolymus* L.
6. *Echinops sphaerocephalus* L.
7. *E. ritro* L.
8. *Petasites hybridus* (L.) Gaerth. Mey et Scherb. (*P. officinalis* Moench.)
9. *Silybum marianum* L.
(*Cardus marianus* L.)
10. *Senecio platyphylloides* Somm. et Lev.
(*Senecio platyphyllus* Bois.)
11. *Tanacetum vulgare* L.
12. *Bidens tripartita* Linn. (*B. acuta* (Nieg.) Britt.) (*B. cernua* L.)
13. *Xanthium strumarium* L.

S/fam. Radiiflorae

14. *Achillea millefolium* L.
15. *Arnica montana* L.
16. *Bellis perennis* L.
17. *Calendula officinalis* L.
18. *Carlina acaulis* L.
19. *Matricaria chamomilla* L.
(*Chamomilla recutita* L.)
20. *Echinacea pallida* Nutt.
21. *E. purpurea* (L.) Moench.
22. *Gnaphalium uliginosum* L.
23. *Helianthus annuus* L.
24. *H. tuberosus* L.
25. *Helichrysum arenarium* L.
26. *Inula helenium* L.
27. *Pyrethrum cinerariifolium* L.
(*Chrysanthemum cinerariifolium* L.)
28. *P. roseum* (Adam.) M.B.
(*Pyrethrum carneum* M.B.)
29. *Solidago canadensis* L.

30. *S. virgaurea* L.
31. *Tagetes patula* L.
32. *Tussilago farfara* L.

S/fam. Liguliflorae

33. *Centaurea cyanus* L.
34. *Cichorium intybus* L.
35. *Rhaponticum carthamoides* (Willd.) Iljin (*Leuzea carthamoides* D.C.)
36. *Taraxacum officinale* (L.) Weber ex F.H. Wigg.

Fam. Berberidaceae

1. *Berberis vulgaris* L.

Fam. Betulaceae

1. *Alnus incana* L. Moench.
2. *A. glutinosa* (L.) Gaerth.
3. *Betula verrucosa* Ehrh.
(*B. alba* L., *B. pendula* Roth.)
4. *Corylus avellana* L.

Fam. Brassicaceae

1. *Armoracia rusticana* G. Gaertn., B. Mey. et Scherb. (*Cochlearia armoracia* L., *C. rusticana* Lam.)
2. *Brassica alba* L. (*Sinapis alba* L.)
3. *B. juncea* (L.) Czern. (*S. juncea* L.)
4. *B. napus* L.
5. *B. nigra* (L.) Koch. (*Sinapis nigra* L.)
6. *B. olearacea* L. var. *capitata* L., var. *gemmifera* (DC.), var. *botrytis* L., var. *gongyloides* L.)
7. *B. rapa* L.
8. *Capsella bursa-pastoris* (L.) Medic. (*Thlaspi bursa-pastoris* L.)
9. *Cheiranthus cheiri* L.
10. *Erysimum diffusum* Ehrh. (*E. canescens* Roth.)
11. *Rhaphanus raphanistrum* L.
12. *R. sativus* L.

Fam. Cannabaceae (Cannabinaceae)

1. *Cannabis sativa* L.
2. *C. ruderalis* Janisch.
3. *Humulus lupulus* L.

Fam. Caprifoliaceae

1. *Sambucus nigra* L.

2. *S. ebulus* L.
3. *Viburnum opulus* L.

Fam. Cucurbitaceae

1. *Bryonia alba* L.
2. *Cucumis melo* L.
3. *C. sativus* L.
4. *Cucurbita pepo* L.
5. *Cytrullus lanatus* (Thunb.) Matsum et Nakai.

Fam. Ericaceae

1. *Arctostaphylos uva-ursi* (L.) Spreng
2. *Ledum palustre* L.
3. *Vaccinium myrtillus* L.
4. *V. vitis idaea* L.
5. *V. uliginosum* L.

Fam. Fabaceae

1. *Arachis hypogaea* L.
2. *Astragalus* sp. L.
3. *Cassia acutifolia* Delile
(*Senna acutifolia* L.)
4. *C. angustifolia* L.
(*Senna angustifolia* L.)
5. *Gleditschia triachantoides* L.
6. *Glycine max* (L.) Merr. (*G. hispida* L.)
7. *Glycyrrhiza glabra* L.
8. *Laburnum* sp. Medik.
9. *Medicago sativa* L.
10. *Melilotus officinalis* (L.) Lam.
11. *Ononis spinosa* L. (*O. vulgaris* L.)
12. *Phaseolus vulgaris* L.
13. *Pisum sativum* L.
14. *Robinia pseudoacacia* L.
15. *Sophora japonica* L.
16. *S. pachycarpa* C.A. May
17. *Trifolium arvense* L.
18. *T. pratense* L.
19. *Thermopsis lanceolata* R. Br.

Fam. Fagaceae

1. *Castanea sativa* Mill.
2. *Fagus silvatica* L.
3. *Quercus robur* L.
(*Q. pedunculata*, *Q. pedunculiflora* C. Koch)
4. *Q. petraea* (Matt.) Liebl. (*Q. sessiliflora* Salisib.)

Fam. Grossulariaceae

1. *Grossularia reclinata* (L.) Mill.
2. *Ribes nigrum* L.
3. *R. rubrum* L.

Fam. Hippocastanaceae

1. *Aesculus hippocastanum* L.

Fam. Hypericaceae

1. *Hypericum perforatum* L.
2. *H. elegans* Stephan ex Willd.
3. *H. tetrapterum* Fr.

Fam. Lamiaceae

1. *Calamintha nepeta* (L.) Savi.
2. *Hyssopus officinalis* L.
3. *Lamium album* L.
4. *Lavandula angustifolia* Mill.
(*L. vera* D.C., *L. officinalis* Chaix.)
5. *Leonurus cardiaca* L.
6. *L. quinquelobatus* Gilib.
7. *Melissa officinalis* L.
8. *Mentha piperita* L.
9. *M. longifolia* L.
10. *M. spicata* Huds.
11. *Monarda fistulosa* L.
12. *M. didyma* L.
13. *Nepeta cataria* L.
14. *Ocimum basilicum* L.
15. *Ortosiphon stamineus* Benth.
16. *Rosmarinus officinalis* L.
17. *Salvia officinalis* L.
18. *S. nemorosa* L.
19. *S. pretensis* L.
20. *S. sclarea* L.
21. *S. verticillata* L.
22. *Satureja montana* L.
23. *S. hortensis* L.
24. *Scutellaria baicalensis* Georgi.
25. *S. altissima* L.
26. *Thymus vulgaris* L.
27. *T. serpyllum* L.

Fam. Linaceae

2. *Linum usitatissimum* L.
3. *L. flavum* L.

Fam. Malvaceae

1. *Abutilon indicum* (L.) Sweet
2. *Althaea officinalis* L.
3. *A. rosea* L.
4. *Gossypium herbaceum* L.
5. *G. barbadense* L.
6. *Malva sylvestris* L.
7. *M. neglecta* Wallr.

Fam. Myrtaceae

1. *Eucalyptus globulus* Labill.
2. *E. cinerea* Muell.
3. *E. viminalis* L.
4. *Myrtus communis* L.

Fam. Nymphaeaceae

1. *Nuphar lutea* (L.) Sm. (*N. luteum* (L.) Link.) (*Nymphaea lutea* L.)
2. *Nymphaea alba* L.

Fam. Papaveraceae

1. *Chelidonium majus* L.
2. *Glaucium flavum* L.
3. *Macleaya microcarpa* (Maxim.)
4. *Papaver somniferum* L.
5. *P. rhoeas* L.

Fam. Passifloraceae

1. *Passiflora caerulea* L.
2. *P. incarnata* L.

Fam. Polygonaceae

1. *Fagopyrum esculentum* Moench.
(*F. sagittatum* Gilib.)
2. *F. tataricum* (L.) Gaertn.)
3. *Polygonum aviculare* L.
4. *P. bistorta* L.
5. *P. hydropiper* L.
6. *P. persicaria* L.
7. *Rheum palmatum* L.
var. *tanguticum* Maxim.
8. *Rumex confertus* Willd
9. *R. acetosa* L.
10. *R. acetosella* L.
11. *R. crispus* L.

Fam. Primulaceae

1. *Primula elatior* (L.) Hill.
2. *P. veris* L.
(*P. officinalis* (L.) Mill.)
3. *P. vulgaris* Huds.

Fam. Ranunculaceae

1. *Aconitum napellus* Rap.
2. *Adonis vernalis* L.
3. *A. aestivalis* L.
4. *A. annua* L.
5. *Delphinium consolida* L.
(*Consolida regalis* Gray)
6. *Helleborus purpurascens* Waldst. et Kit.
7. *H. caucasicus* Braun.
8. *H. orientalis* Lam.
9. *Nigella arvensis* L.
10. *N. sativa* L.
11. *Pulsatilla montana* (Hoppe) Reicheinb.
12. *Ranunculus acris* L.
13. *Ranunculus ficaria* L.
(*Ficaria verna* Huds.)

Fam. Rhamnaceae

1. *Frangula alnus* Mill. (*Rhamnus frangula* L.)
2. *Rhamnus cathartica* L.

Fam. Rosaceae**S/fam. Spiraeoideae**

1. *Spiraea sp.* L.
2. *Filipendula ulmaria* (L.) Maxim.
(*Spiraea ulmaria* (L.) Maxim.)

S/fam. Rosoideae

3. *Agrimonia eupatoria* L.
4. *Fragaria vesca* L.
5. *Geum urbanum* L.
6. *Potentilla erecta* (L.) Raensch.
(*P. tormentilla* (L.) Neck.)
7. *P. alba* L.
8. *P. anserina*
9. *P. argentea* L.
10. *P. reptans* L.
11. *Rosa canina* L.
12. *R. centifolia* L.
13. *R. cinnamomea* L.
14. *R. damascena* Mill.
15. *R. gallica* L.
16. *Rubus idaeus* L.
17. *R. caesius* L.
18. *R. fruticosus* L.
19. *Sanguisorba officinalis* L.

S/fam. Maloideae (Pomoideae)

20. *Aronia melanocarpa* (Michx.) Elliot
21. *Chaenomeles japonica* L.
22. *Crataegus monogyna* L.
23. *Cydonia oblonga* L.
24. *Malus domestica* (L.) Borkh.
25. *Pyrus communis* L.
26. *Sorbus aucuparia* L.

S/fam. Prunoideae

27. *Prunus cerasus* L. (*Cerasus vulgaris* Mill.)
28. *P. avium* L. (*Cerasus avium* (L.) Moench.
29. *P. domestica* L.
30. *P. armeniaca* L. (*Armeniaca vulgaris* L.)
31. *P. amygdalus* L. (*Amygdalus communis* L.)
32. *P. persica* (L.) Batsch. (*Persica vulgaris* L.)
33. *P. spinosa* L.

Fam. Rutaceae

1. *Ruta graveolens* L.
2. *Citrus aurantium* L.
3. *C. limon* (L.) Burm.
4. *C. paradisi* Macfad.
5. *C. reticulata* Andrews.

Fam. Salicaceae

1. *Salix alba* L.
2. *S. caprea* L.
3. *S. viminalis* L.
4. *Populus alba* L.
5. *P. nigra* L.
6. *P. tremula* L.

Fam. Saxifragaceae

1. *Bergenia crassifolia* L.

Fam. Schisandraceae

1. *Schisandra chinensis* (Turcz.) Baill.

Fam. Scrophulariaceae

1. *Digitalis grandiflora* Mill.
2. *D. ferruginea* L.
3. *D. lanata* Ehrh.
4. *D. purpurea* L.
5. *Linaria vulgaris* L.
6. *Verbascum phlomoides* L.
7. *V. thapsiforme* Schrad.
8. *V. thapsus* L.

Fam. Solanaceae

1. *Atropa belladonna* L.
2. *Capsicum annuum* L.
3. *Datura stramonium* L.
4. *D. innoxia* Mill.
5. *Hyoscyamus niger* L.
6. *Lycopersicon esculentum* L.
7. *Nicotiana tabacum* L.
8. *Physalis alkekengi* L.
9. *Scopolia carniolica* Jacq.
10. *Solanum tuberosum* L.
11. *S. melongena* L.
12. *S. laciniatum* Ait.
13. *S. dulcamara* L.
14. *S. nigrum* L.

Fam. Theaceae

1. *Camellia japonica* L.
2. *Thea sinensis* L.
(*Camellia thea* Link., *C. chinensis* L.)

Fam. Tiliaceae

1. *Tilia argentea* Desf. ex DC.
2. *T. cordata* Mill.
3. *T. platyphyllos* Scop.

Fam. Plantaginaceae

1. *Plantago lanceolata* L.
2. *P. major* L.
3. *P. media* L.
4. *P. psyllium* L. (*P. indica* L.)

Fam. Valerianaceae

1. *Valeriana officinalis* L.
2. *V. tuberosa* L.

Fam. Violaceae

1. *Viola arvensis* L.
2. *V. odorata* L.
3. *V. tricolor* L.

Fam. Urticaceae

1. *Urtica dioica* L.
2. *U. urens* Janisch.

Monocotyledons – cl. *Liliopsida*

Fam. Alliaceae

1. *Allium cepa* L.
2. *A. porrum* L.
3. *A. sativum* L.
4. *A. ursinum* L.

Fam. Amaryllidaceae

1. *Galanthus nivalis* Ledeb.
2. *G. plicatus* M.B.
3. *Agave americana* L.
4. *Yucca shidigera* (Dill.) L.

Fam. Asparagaceae

1. *Asparagus officinale* L.
2. *A. tenuifolium* L.

Fam. Araceae

1. *Acorus calamus* L.
2. *Arum maculatum* L.

Fam. Dioscoreaceae

1. *Dioscorea caucasica* Lipsky.
2. *D. nipponica* Makino.
3. *D. polystachya* Turcz.

Fam. Iridaceae

1. *Crocus sativus* L.
2. *Gladiolus communis* L.
3. *Iris germanica* L.

Fam. Liliaceae

1. *Aloë arborescens* Mill.
2. *A. vera* (L.) Burm.
3. *Colchicum autumnale* L.
4. *Convallaria majalis* L.
5. *Lilium martagon* L.
6. *Polygonatum officinale* L.
(*P. odoratum* L.)
7. *P. multiflorum* L.
8. *Tulipa gesneriana* L.
9. *Veratrum album* L.
(*V. lobelianum* Bernh.)
10. *V. nigrum* L.

Fam. Poaceae

1. *Agropyron repens* L.
(*Elymus repens* L.)
2. *Avena sativa* L.
3. *Hordeum vulgare* L.
4. *Oryza sativa* L.
5. *Saccharum officinarum* L.
6. *Secale cereale* L.
7. *Triticum aestivum* L.
8. *T. durum* Desf.
9. *Zea mays* L.

PRACTICAL ACTIVITIES ON PHARMACEUTICAL BOTANY



The Laboratory of Pharmaceutical botany



Working with the herborized plants (Plant systematics)



Evaluation of practical skills on herbaria (Plants systematics)



Analyzing the botanical materials (Plant morphology)



Analysis micropreparation (Vegetal cytology)



Working on license thesis (Scientific research in plant anatomy)



**Evaluation of preserved and fixed botanical materials
(Plant morphology)**



Analysis and identification of the preserved plant species (Plant systematics)



Morphological analysis in the plant collection of the Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Analysis of the plant collection of the Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy according to the taxonomic index (Study practice on Pharmaceutical botany)



**Primary labeling and arrangement of the collected plants for drying
(Study practice on Pharmaceutical botany)**



**Analysis of the collected botanical materials in the Botany laboratory
of the Scientific Center of Medicinal Plant Cultivation of
Nicolae Testemitanu State University of Medicine and Pharmacy
(Study practice on Pharmaceutical botany)**



Analyzing and herborizing the botanical materials in the Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Identification and herborization of the botanical materials in the Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Harvesting the vegetable product *Lavandulae herba* in the Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Harvesting the vegetable product *Calendulae flores* in the Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Botanical expedition in the adjacent forest of Scientific Center of Medicinal Plant Cultivation of *Nicolae Testemitanu* State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Botanical excursion in the medicinal plant collection of the Botany Garden (Institute) of ASM (Study practice on Pharmaceutical botany)



"Vegetal gold" - the results of study practice day in the plant collection of the Scientific Center of Medicinal Plant Cultivation of Nicolae Testemitanu State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)



Happy at the end of practice day in the Scientific Center of Medicinal Plant Cultivation of Nicolae Testemitanu State University of Medicine and Pharmacy (Study practice on Pharmaceutical botany)

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