МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА ОРГАНИЗАЦИИ ФАРМАЦИИ

ФАРМАЦЕВТИЧЕСКАЯ БОТАНИКА

PHARMACEUTICAL BOTANY

Практикум для студентов фармацевтического факультета

В двух частях

Часть 2

Минск БГМУ 2017

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Включены контрольные вопросы, основные термины и понятия, рисунки, таблицы и задания по цитологии и анатомии растений.
Предназначен для студентов 2-го курса фармацевтического факультета, обучающихся на английском языке.

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TRAINING AND REGISTRATION CARD

Student of 2nd year _____ gr. _____ faculty _____ (III term)

Academic week	Theme of practical classes	Mark	Teacher's signature	Date of working off	Final examination
1.	The plant cell structure 1				
2.	The plant cell structure 2				
3.	The plant cell chemical substances				
4.	***The final lesson "The plant cell"***				
5.	Formative and parenchyma tissues				
6.	Ground tissues				
7.	Excretive tissues				
8.	Strengthening tissues				
9.	Plant conductive tissues				
10.	Fibrovascular bundles				
11.	***The final lesson "Plant tissues"***				
12.	Anatomical structure of caulis				
13.	Anatomical structure of wood stems and rootstock				
14.	Anatomical structure of the root				
15.	Anatomical structure of the leaf				
16.	Independent work under a teacher «Studying the anatomical structure of the plants vegetative organs– I»				
17.	Independent work under a teacher «Studying the anatomical structure of the plants vegetative organs – II»				
18.	***The final lesson «Anatomy of the plants vegetative organs»***				

AWARD CRITERIA OF STUDENTS KNOWLEDGE

10 points are awarded to a student who answered the questions positively, logically, correctly and with using scientific terminology and if student is able to solve problems in an unconventional situation independently and creatively and answer some questions that go beyond the limits of the curriculum.

9 points are awarded to the student who answered the questions without errors, correctly, logically and with using scientific terminology and if student is capable of solving problems in an unusual situation within the curriculum independently and creatively.

8 points are awarded to the student who answered the questions correctly, logically and with using scientific terminology but which allowed an insignificant mistake in answering and if student is capable of solving problems in an unusual situation within the curriculum independently and creatively.

7 points are awarded to the student who answered the questions correctly, logically and with using scientific terminology, which allowed a sensible mistake or 2 insignificant mistakes in answering and if student is capable of solving problems in an usual situation within the curriculum independently and creatively.

6 points are awarded to the student who showed systematic knowledge in the scope of the curriculum, which allowed 2 sensible mistakes or 3 insignificant mistakes in answering and if student is capable of solving problems in an usual situation within the curriculum independently.

5 points are awarded to the student who showed sufficient knowledge in the scope of the curriculum, which allowed a gross mistake or 3 sensible mistakes in answering and if student is capable of solving problems in an usual situation within the curriculum independently.

4 points are awarded to the student who showed sufficient knowledge for the further learning in the scope of the curriculum, which allowed 2 gross mistakes or 4 sensible mistakes in answering and if student is capable of solving problems in an usual situation within the curriculum independently.

3 points (2) are awarded to the student who showed insufficient scope of knowledge for the further learning, which allowed 3 gross mistakes and some sensible mistakes in answering.

2 points (2) are awarded to the student who showed insufficient scope of knowledge for the further learning, which allowed 4 gross mistakes and some sensible mistakes in answering.

1 points (2) are awarded to the student who showed insufficient scope of knowledge for the further learning, which allowed 5 and more gross mistakes in answering, not answering all questions or refusing to answer.

Pharmacy Organization Department Regulations for the Students to Follow

1. **Observe the safety rules in the lecture rooms,** follow the BSMU internal rules of conduct.
2. Arrive for practical classes **without delay according to the schedule**. Late students **are not allowed** to classes**.**
3. In practical classes students should have **gowns, workshops, hats, colored pencils**. Students without gowns and workshops are not allowed for practical classes.
4. Missed classes should be worked out within **2 weeks after the absence.**
5. Students who have not work out the absence within two weeks are not allowed to subsequent studies, final lessons and credit without the faculty Dean's permission**.**

Acquainted with award criteria and department requirements _____ 201___ г. _____ (signature)

Practice № 1. Topic: **THE PLANT CELL STRUCTURE I** «____» _____ 201___ г.

Purpose of the practice: to study the structure features of the plant cell.

CONTROL QUESTIONS

1. The design of a microscope.
2. Rules for working with a microscope. Accident preventatives.
3. Slide preparation and temporary microscopic slide technique.
4. The structure features of the plant cell.
5. Origin, chemical constituents, structure and functions of the cell wall.
6. Physico-chemical properties, structure and functions of cell membranes.

PRACTICAL WORK

Information

Plant cells have a **cell wall** as distinguished from animal cells.

Depending on the walls origin, they can be primary, secondary and tertiary. In the process of vital activity, they can undergo various chemical and physical modifications (sclerosis, suberization, cutinization, mineralization or mucilagination), which are detected by the following microchemical reactions:

Type of the wall	Chemical reagent	Staining
Cellulose	Chlor-zinc-iodine	Sea-green
Suber (reaction to suberin)	Sudan III	Pink
Sclerotic (reaction to lignan)	Phloroglucinol + concentrated H_2SO_4	Pompadour brown

CODE OF GOOD PRACTICE WITH MICROSCOPE LOW-POWERED MAGNIFICATION

1. The microscope is mounted about a hand's width from the edge of the table. Turn on the microscope.
2. Rotating the ***macrometric*** screw install the lenses to a distance of 2–3 cm from the surface of the microscope stage.
3. Check the installation of a *field lens* "by click": it should be fixed in position opposite the hole in the microscope stage.
4. Place the microslide on the microscope stage with *the cover slip on top*.
5. *Looking from the side*, move down the field lens with a *macrometric screw* to a distance of 0.5 cm from the surface of the microslide.
6. Looking into the eye lens and slowly rotating the ***macrometric screw***, get a clear image of the object.
7. Learn the object. Moving the microslide under the lens is done with the table screws.

Notes:

- ✓ The coverslip is often contaminated with fingerprints and dust, so you should clean it with a clean soft cloth.
- ✓ The focus distance of *the microscope low-powered magnification* is *about 1 cm*. If you "went through" it, all actions must be repeated.
- ✓ If the object is so small that it is practically invisible, you should focus the field lens *on the edge of the coverslip*. Then, after having received a clear image the coverslip, move to the operational field in searching of the object. Search is conducted consistently, moving the microslide on the chess «knight» principle.

CODE OF GOOD PRACTICE WITH MICROSCOPE HIGH MAGNIFICATION

1. Get the object clear image *at low-powered magnification* (see above).
2. The microslide interest area is <u>*centered*</u> — move to the field of vision centre.
3. Turn the microscope nosepiece until the *high magnification lens clicks* and place it against the microslide.
4. <u>Looking into the eye lens</u> rotate ***the macrometric screw*** slightly until the image is appear.
5. To obtain a clearer image use ***the micrometric screw*** by turning it in either direction not more than half turn.
6. Study the microslide interest division.

Notes:

✓ The focus distance of the microscope *high magnification* is about *0,1–0,2* cm so the macrometric screw must be rotated very *slowly and smoothly*.

Completion of a task with microscope

1. When you fihish your work, you should lift the draw-tube by the macrometric screw and remove the microslide from the stage.
2. Turn the microscope nosepiece until *the low-powered magnification* lens clicks and fix it against the hole in the microscope stage.
3. Low the lens to the level of the microscope table by macrometric screw. Close the microscope.
5. Turn off the microscope.

Student work accessories in laboratory classes:

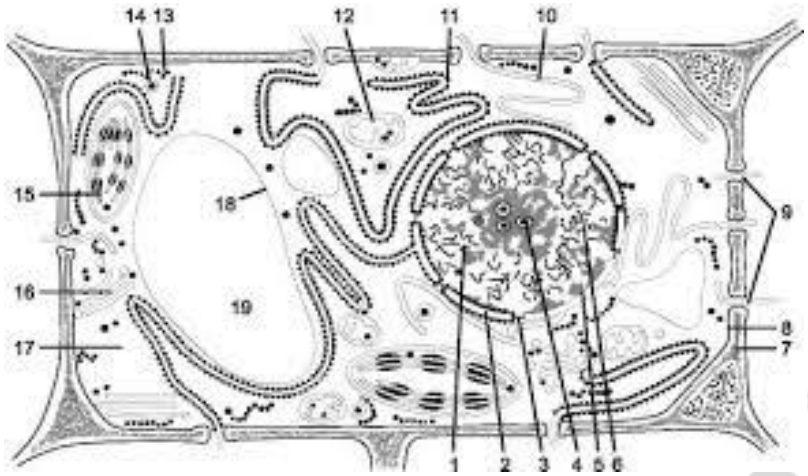
1. A writing pen.
2. A graphite pencil.
3. Colour pencils.
4. A pack of safety razors.
5. An eye dropper in case.
6. A yardwand.

SLICES AND MICROSLICES PREPARING

1. The object should be taken in the left hand so that it rises above the level of the fingers by 3–4 mm. Your right hand holds the blade such that your thumb is on top and the index and middle are below in the same place The blade should be facing left.
2. The surface of the object is previously evened that the slice plan is perpendicular to the axis of the organ.
3. Slices are maked by one blade gliding motion to yourself. It is not necessary to cut through the entire organ, but it is sufficient to cut a narrow strip passing through the outer and inner organ tissues.
4. The thinnest and most even slices are obtained if the slice starts not from the edge of the object, but from its center. The resulting slices are lowered in water into a Petri dish.
5. 2-3 water drops are applied by an eye dropper in the middle of the slide and the thinnest slace are transferred into water by preparation needle. After it should be covered by coverslip. It should be lowered carefully, placing it at an angle of 45° to the slide previously and touching the bottom edge with water.
6. If there is a lot of liquid, and it flows out from under the coverslip — remove the excess with a piece of absorbent paper. If there are places filled with air under the coverslip, add liquid.
7. The plants microscopic research results are made in the form of a picture, which is placed ***on the left side*** of the page, the signatures to it are ***on the right side*** of the page.
8. A picture is done by hand, at first with graphite, then colored pencils. The picture size should be such that it can depict all the necessary details, preserving the proportions, features and color.
9. Your picture is not only your statement of work, but also a method of research. In sketching process the microslide is analyzed more carefully and in detail. The student's task is not only to look at, but also to see all the studied details of the structure and constantly compare them.

Task 1. To study the structure of a plant cell.

1. Make 5–10 transverse slices of Cucurbita pepo stem.
2. Select the thinnest slice, place on a slide, apply 2–3 drops of water, cover with a cover slip.
3. Study the microslide at the low-powered and then at the high magnifications. 4. Make the designation to the figure.



The structure of a plant cell:

1 –
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19 –

Task 2. To catch on microchemical reactions to the cell wall.

1. Prepare two transverse slices of the Cucurbita pepo stem, place on slides. Apply a drop of chlorine-zinc-iodine at the first slice; then remove the reagent with a piece of absorbent paper, apply a drop of glycerin, cover with a cover slip**.**
2. The second slice is stained with phloroglucinol and sulfuric acid.
3. Study slices with the microscope low-powered and high magnifications. Find cells with blue-violet-colored cell walls and cells with brown cell walls (sclerotic walls).
4. Scetch 1–2 cells, designate the colored walls and the reaction to cellulose and lignin.
5. Write down:

- The reaction to cellulose is …… staining.
- The reaction to lignin is ……... staining.
- The reaction to suberin is ……. staining.

Practice № 2. Topic: **THE PLANT CELL STRUCTURE II** «____» _____ 201___ г.

Purpose of the practice: to study the structure features of the plant cell.

CONTROL QUESTIONS

1. Cell organoids, their classification, origin, structure, functions.
2. Features of plant cell organoids.
3. Plastids. Types of plastids. Features of their structure.
4. Mitochondria, their structure and functions.
5. Nucleus, its structure and functions.
6. Vacuole, its origin, structure and role in the cell life. Composition of cellular fluid.
7. Osmotic states of a plant cell.

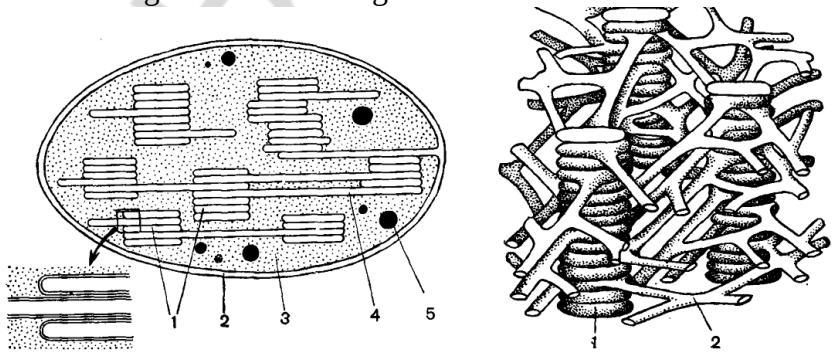
PRACTICAL WORK

Task 1. To study the shape and main parts of cells.

1. Prepare the Elodea leaf microslide — place the leaf on a slide, apply a drop of water, cover with a cover slip.
2. Study the microslide with a microscope low-powered magnification to find parenchymal (at the center of leaf) and prozehimal (on the edge of leaf) cells.
3. Scetch 1–2 cells, designate their shape, visible parts (cell wall, cytoplasm, plastids) and turgor state.

Task 2. To study the structure of a chloroplast.

1. Study the structure of a chloroplast.
2. Make designations for the figure.



The structure of a chloroplast:

1 –
2 –
3 –
4 –
5 –
6 –
7 –

3. Complete the table:

Plastids type	Plastids function
Chloroplasts	
Chromoplast	
Leukoplast	

Practice № 3. Topic: **THE PLANT CELL CHEMICAL SUBSTANCES** «____» _____ 201___ г.

Purpose of the practice: to study the different types of chemical substances in the plant.

CONTROL QUESTIONS

1. The main groups of chemical substances in the cell.
2. Storage compound in the cell, their features.
3. Spare carbohydrates. Starch, its types. Starch grains, their characteristics and localization. Microchemical reactions to starch. Plants, which rich in starch.
4. Spare proteins. Aleurone grains — their formation, composition, structure and localization. Microchemical reactions to proteins. Plants, which rich in proteins.
5. Spare fats. The form of fat storage. Microchemical reactions to fats. Plants, wich rich in fats.
6. Excretory substances, their classification and diagnostic value.

PRACTICAL WORK

INFORMATION

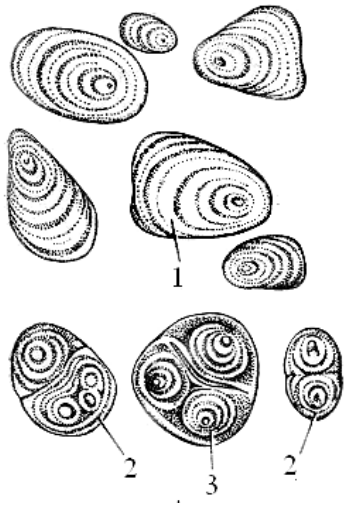
Storage compound	Chemical reagent	Staining
starch	Lugol's solution	Blue-violet
proteins	Lugol's solution	Golden yellow
	Nitric acid	yellow
fatty oils	Sudan III	Pink-orange
Excretory substances	**Chemical reagent**	**Staining**
tannins	1% ferric ammonium alum solution	Black-blue or black-green
alkaloids	Dragendorff's reagent	Brick red
essential oils	Sudan III	Orange-red

Task 1. To study the starch grains structure features.

1. Prepare starch microslide from potato tuber — rub potato lobule on the slide, apply 2–3 drops of water, cover with a cover slip.
2. Study the microslide with the microscope low-powered magnification, find starch grains, the center of the layering, determine the nature of lamination (eccentric).
3. Remove the microslide from the stage, stain it with Lugol's solution: draw the water with a piece of absorbent paper, apply a drop of Lugol's solution from the opposite side of the cover slip.
4. Study the microslide with the microscope low-powered magnification, find starch grains. Pay attention to their coloring.
5. Write down the microchemical reaction to starch:

_____

6. Make designations for the figure.



Potato starch grains:

1 –

2 –

3 –

Task 2. To study the aleuron grains complex structural features and presence of fat droplets in the castor-oil plant seed.

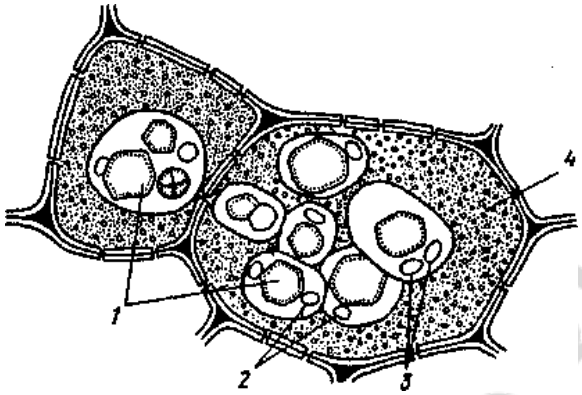
1. Prepare two microslide of Ricinus communis seed pulp — use a preparation needle to take a piece of pulp, loosen it, stain one by Sudan III, the second one — by Lugol's solution. Cover with a cover slip.
2. Study the microslide with the microscope low-powered and high magnifications and find aleurone grains complex and fat droplets (red-orange).
3. Write down a microchemical reaction to fatty oils:

_____

4. Write down a microchemical reaction to proteins:

_____

5. Make designations for the figure.

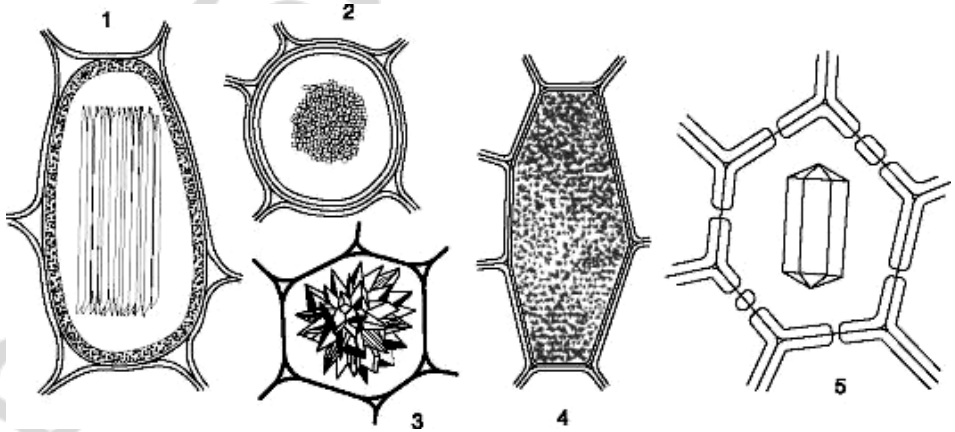


The castor-oil plant seed aleuron grains:

1 –
2 –
3 –
4 –

Task 3. To study the features of crystalline depositions in the cell.

1. Prepare the onion skin microslide.
2. Study single crystals in onion skin and scetch it.
3. Make designations for the figure.



Forms of calcium oxalate crystals:

1 –

2 –

3 –

4 –

5 –

Practice № 4. Topic: **THE FINAL LESSON "THE PLANT CELL"** «____» _____ 201___ г.

Purpose of the practice: final control of students' knowledge.

CONTROL QUESTIONS

1. The design of a microscope.
2. Rules for working with a microscope. Accident preventatives.
3. Slide preparation and temporary microscopic slide technique.
4. The structure features of the plant cell.
5. Origin, chemical constituents, structure and functions of the cell wall.
6. Structure and functions of cell membranes.
7. Physico-chemical properties of cell membranes.
8. Cell organoids, their classification, origin, structure, functions.
9. Nucleus, its structure and functions.
10. Vacuole, its origin, structure and role in the cell life.
11. Composition of cellular fluid.
12. Osmotic states of a plant cell.
13. The main groups of chemical substances in the cell.
14. Storage compound in the cell, their features.
15. Spare carbohydrates. Starch, its types.
16. Starch grains, their characteristics and localization. Microchemical reactions to starch.
17. Plants, which rich in starch.
18. Spare proteins. Aleurone grains – their formation, composition, structure and location.
19. Microchemical reactions to proteins.
20. Plants, which rich in proteins.
21. Spare fats. The form of fat storage.
22. Microchemical reactions to fats.
23. Plants, wich rich in fats.
24. Excretory substances, their classification and diagnostic value.

Practice № 5. Topic: **FORMATIVE AND PARENCHYMA TISSUES** «____» _____ 201___ г.

Purpose of the practice: to study the structure features of formative and parenchyma tissues

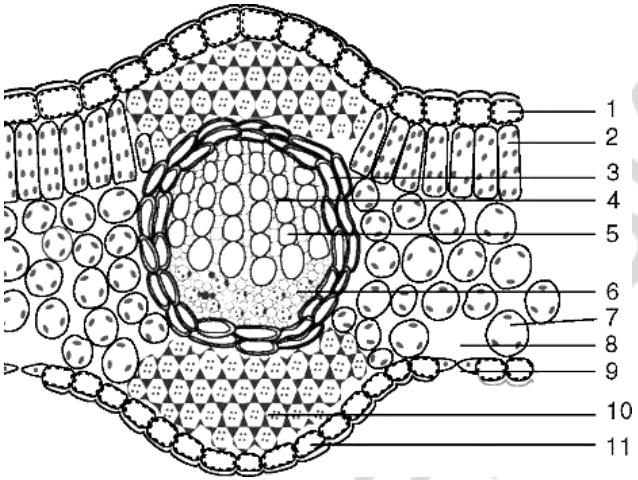
CONTROL QUESTIONS

1. Concept of the tissue. Principles of tissue classification.
2. Formative tissues, their types and classification. Their general characteristics.
3. Primary meristem, their types, origin, localization and functions.
4. Secondary meristem, their origin, localization and functions.
5. Parenchyma tissues, their classification, cytological characteristic, localization and functions.

PRACTICAL WORK

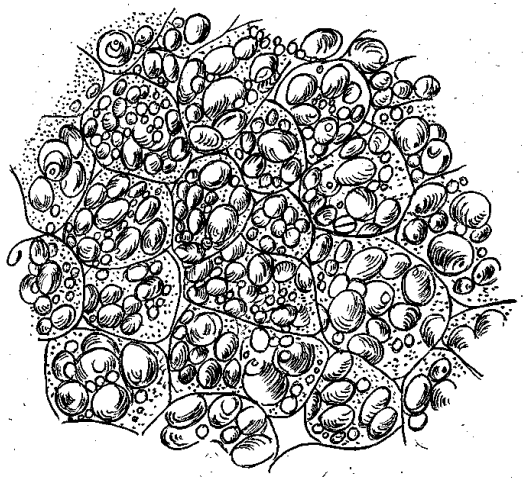
Task 1. To study the structure features of parenchyma tissue – **palisade parenchyma.**

1. Study the chlorenchyma structural features on the transverse section of the leaf.
2. Make designations for the figure.



Task 2. Study the structure features of the parenchyma tissue – the reserve parenchyma.

1. Prepare the potato tuber microslide — make a thin slice, place on a slide, stain with Lugol's solution, add 1–2 drops of water, cover with cover slip.
2. Study the microslide at low-powered magnification, pay attention to the cells size and shape, find the cell membrane, cytoplasm and starch grains.
3. Make designations for the figure with numbers: cell membrane, cytoplasm, starch grains, intercellular spaces.



Potato tuber storage parenchyma

Task 3. To study the structural features of the parenchyma tissue – aerenchyma. 1. Study Potamogeton natans stem transverse section microslide with microscope low-powered magnification. Pay attention to large air cells. 2. Scetch a section of the slice and designate: 1 – parenchyma cells; 2 – intercellular spaces (air cells).	

Practice № 6. Topic: **GROUND TISSUES** «____» _____ 201___ г.

Purpose of the practice: To study the structure features of the plant ground tissues.

CONTROL QUESTIONS

1. General characteristics of ground tissues and their classification.
2. Cytological features of the epidermis.
3. Diagnostic differences between the epidermis of mono- and dicotyledonous plants.
4. The structure and significance of stomata. Types of stomatal apparatus.
5. Cytological characteristics of epilblema.
6. Cytological characteristics, functions and origin of suber and cork.
7. Diagnostic signs of the epidermis.
8. Differences in the shape of epidermal cells in mono- and dicotyledonous plants.
9. Structure and meaning of trichomes. Types of indumentum.

BASIC BOOK NAMES AND CONCEPTS

Epidermis –

Scarfskin –

Stomata –

Satellites –

Trichomes –

Phellem –

Guttation –

Periderm –

Suberin –

Cork –

Lenticels –

PRACTICAL WORK

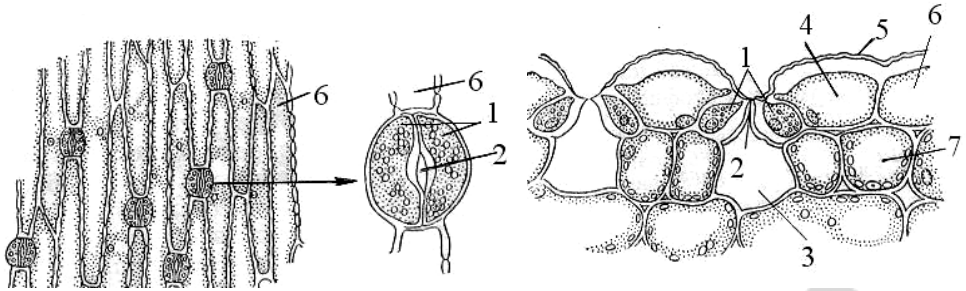
Task 1. To study the structure of the mono- and dicotyledonous plants leaf epidermis.

1. 1. Study the microslide of the Iris leaf epidermis (monocotyledonous plant).

2. Study the microslide at microscope low-powered magnification. Find and designate: epidermal cells, stomata, stomata guard cells and stomatal pore.

2. 1. Study the microslide of the Geranium leaf (dicotyledonous plant).

2. Study the microslide at microscope low-powered magnification. Find and designate: scarfskin, epidermal cells, stomata guard cells, stomatal pore, air cell, satellite cells (accessory cells) and mesophyll cells.



The Iris leaf epidermis:

1 –

2 –

6 –

The Geranium leaf epidermis:

1 –

2 –

3 –

4 –

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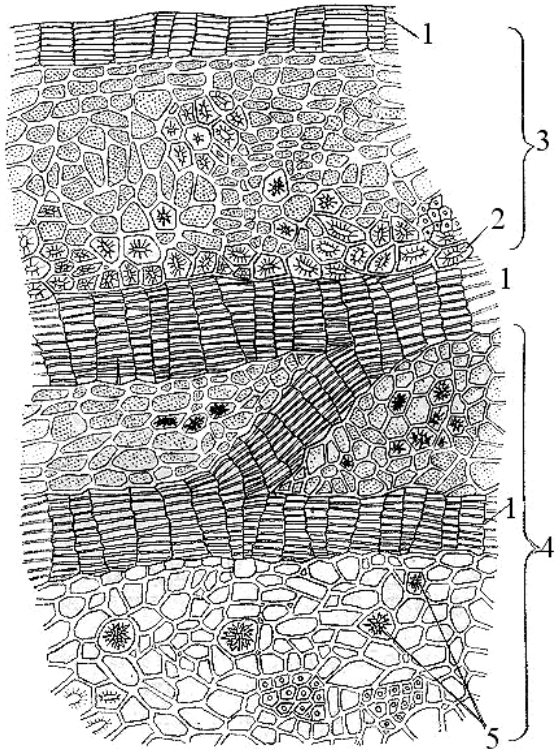
6 –

7 –

Task 2. To study the structure of the cork.

1. Study the microslide of the Quercus robur cortex and find suber cells and layers of dead tissue.

2. Make designations for the figure.



The structure of the Quercus robur cortex transverse section:

1 –

2 –

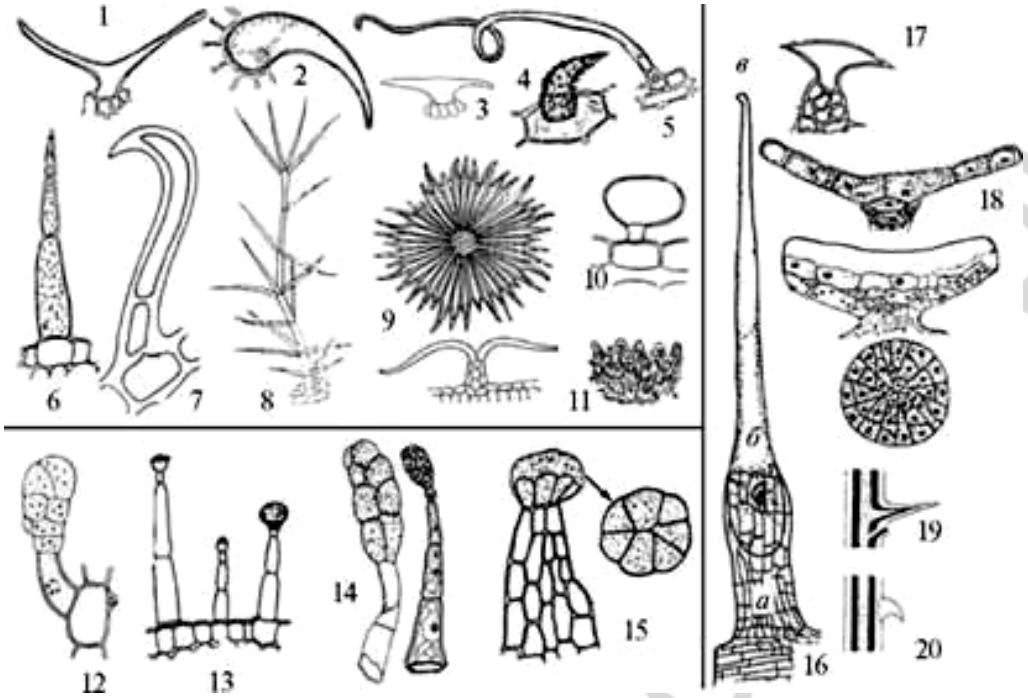
3 –

4 –

5 –

Task 3. To study the structure of various types of trichomes.

1. Prepare a Urtica urens leaf microslide. Boil in 3 % alkali solution, wash with water, place on a slide in a drop of glycerin, cover it with a cover slip.
2. Study the microslide at microscope low-powered and high magnifications. Find a capitate trichome, a cnida, a retort-like trichome and cystolithes.
3. Make designations for the figure.



Epidermis trichomes:

1-11 – simple trichomes:

1 –

2 –

3 –

4 –

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8 –

9 –

10 –

11 –

12-15 –glandular hair:

12 –

13 –

14 –

15 –

16-20 – emergence:

16 –

17 –

18 –

19 –

20 –

Practice № 7. Topic: **EXCRETIVE TISSUES** «____» _____ 201___ г.

Purpose of the practice: To study the structural features of plant excretive tissues.

CONTROL QUESTIONS

1. Excretive tissues, their cytological features, localization and functions.
2. The structures of external secretion, their characteristic and significance.
3. The structures of internal secretion, their characteristics and significance.

BASIC BOOK NAMES AND CONCEPTS

Lacticifers –

Trichomes –

Osmophores –

Gydatodes –

Nectarium –

Lysigenic containers –

Schizogenic conceptacles –

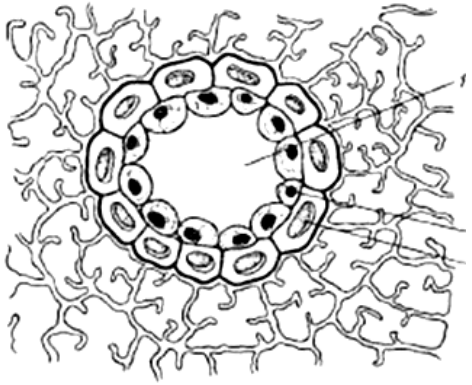
Emergence –

Idioblasts –

PRACTICAL WORK

Task 1. To study the structure of schizogenic excretive canals.

1. Study the Pinus sylvestris needle transverse section microslide at microscope low-powered magnification. Pay attention to resin canals.
2. Designate on the figure: resin canal lacune, secreting cells and strengthening cells surrounding resin canal.



The schizogenic conceptacle on the Pinus sylvestris needle transverse section:

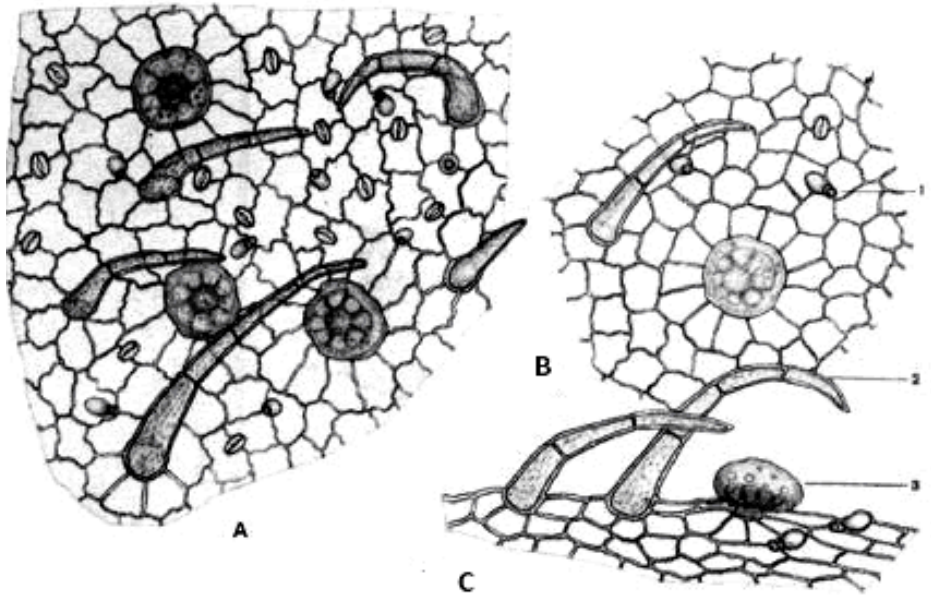
1 –

2 –

3 –

Task 2. To study the structure of essential oil glands.

1. Prepare a Origanum vulgare leaf microslide: boil a Origanum vulgare leaf in 3 % alkali solution for 2–3 minutes, rinse in water, place on a slide in a drop of glycerin and cover with a cover slip.
2. Study the microslide at microscope low-powered and high magnifications. Find and designate in the figure: simple trichomes, capitate trichomes, essential oil glands with 8 excretory cells and epidermal cells.

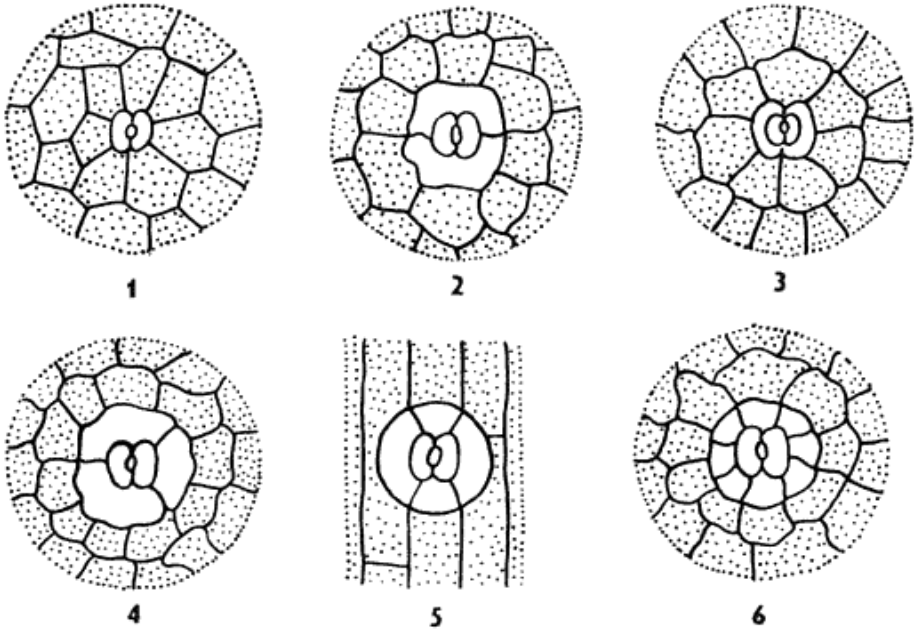


The Origanum vulgare leaf epidermis :

A – the leaf underside epidermis;
B – the leaf upper side epidermis;
C – leaf edge:
1 –
2 –
3 –

Task 3. To study the main types of plant leaf stomatal apparatus.

1. Study the presented figure.
2. Identify and write the type of stomata.



Types of plant leaf stomatal apparatus:

1 –
2 –
3 –
4 –
5 –
6 –

Practice № 8. Topic: **STRENGTHENING TISSUES** «____» _____ 201___ г.

Purpose of the practice: To study the features of strengthening tissues.

CONTROL QUESTIONS

1. Strengthening tissues, their types, cytological characteristics, localization and functions.
2. Collenchyma, its types, cytological characteristics, origin and localization in the plant.
3. Sclerenchyma, its types, cytological characteristics, origin and localization in the plant.
4. Sclereids, their cytological features and localization.

BASIC BOOK NAMES AND CONCEPTS

Collenchyma –

Sclerenchyma –

Sclereids –

Idioblasts –

Fibers of libriform –

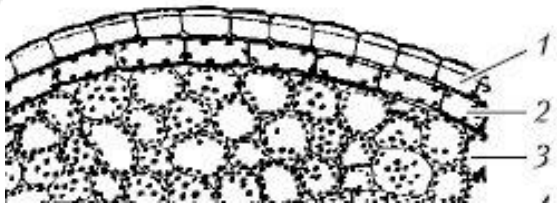
Bast fibers –

Lignin -

PRACTICAL WORK

Task 1. To study the structural features of the collenchyma cells in the caulis (herbaceous plant stem) and wood stem.

1. Study the Trifolium pretense caulis transverse section. Find the collenchyma, determine its type. Designate in the figure: epidermis, collenchyma, chlorenchyma.
2. Study the Sambucus nigra branch transverse section. Find and designate collenchyma in the figure and determine its type.
3. Compare the Trifolium pretense caulis and the Sambucus nigra branch collenchyma structure.

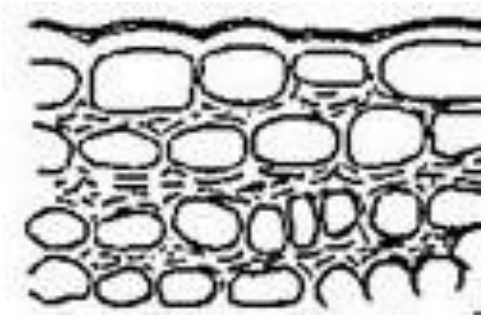


The Trifolium pretense caulis collenchyma:

1 –

2 –

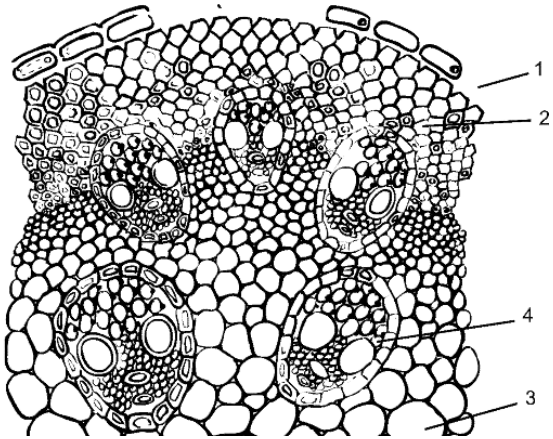
3 –



The Sambucus nigra branch collenchyma

Task 2. To study the structural features of sclerenchyma cells.

1. Study the monocotyledonous plant stem transverse section and find sclerenchyma.
2. Designate in the figure: epidermis, sclerenchyma, parenchyma cells, conducting bundle.



The Zea mays stem transverse section:

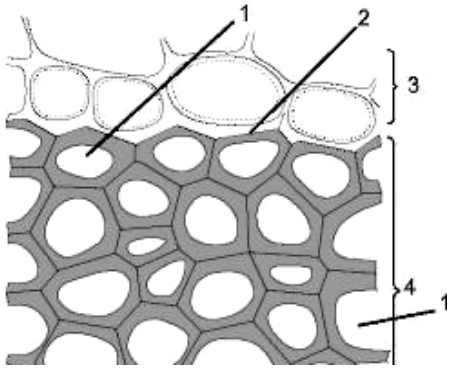
1 –

2 –

3 –

4 –

3. Designate in the figure: sclerenchyma cells, cell wall, cell lacune and parenchyma cells.



Structure of sclerenchyma cells:

1 –

2 –

3 –

4 –

Task 3. To study the structure features of stone cells.

1. Prepare the Pyris fruit pulp microslide — use a preparation needle to take a piece of pulp, place it on a slide, loosen it, stain it with phloroglucinol and sulfuric acid, apply 2–3 drops of glycerin, cover with cover slip.
2. Place the microslide on the microscope stage, study with a microscope low-powered magnification, find sclereides, draw 2–3 cells and designate the cell wall (thick), pore channels, cell lacune.

Practice № 9. Topic: **PLANT CONDUCTIVE TISSUES** «____» _____ 201___ г.

Purpose of the practice: To study the structural features of conductive tissues.

CONTROL QUESTIONS

1. Mechanisms of ascending and descending streams in a plant.
2. Conductive tissues, their species, characteristics and meaning.
3. Features of the structure, origin and localization of tracheids and vessels, the concept of xylem.
4. The structure of sieve cells, sieve tubes and companion cells, the phloem concept.

BASIC BOOK NAMES AND CONCEPTS

Vessels –

Tracheids –

Sieve tubes –

Companion cells –

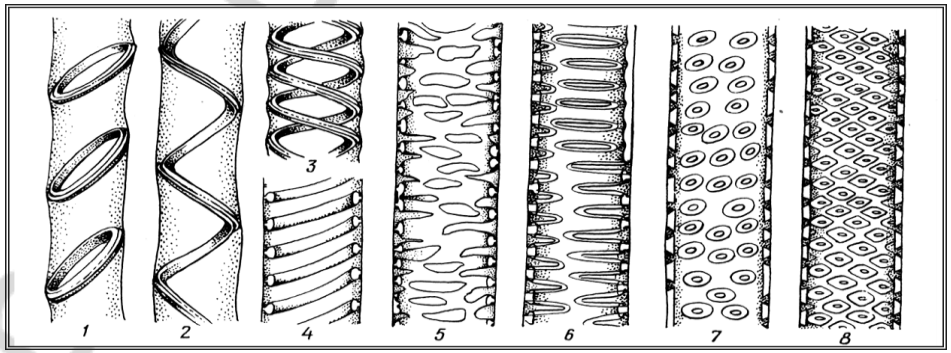
Bast parenchyma –

Pores –

Plasmodesmata –

PRACTICAL WORK

Task 1. Make designations for the types of tracheate elements walls secondary thickening:



1 –

2 –

3 –

4 –

5 –

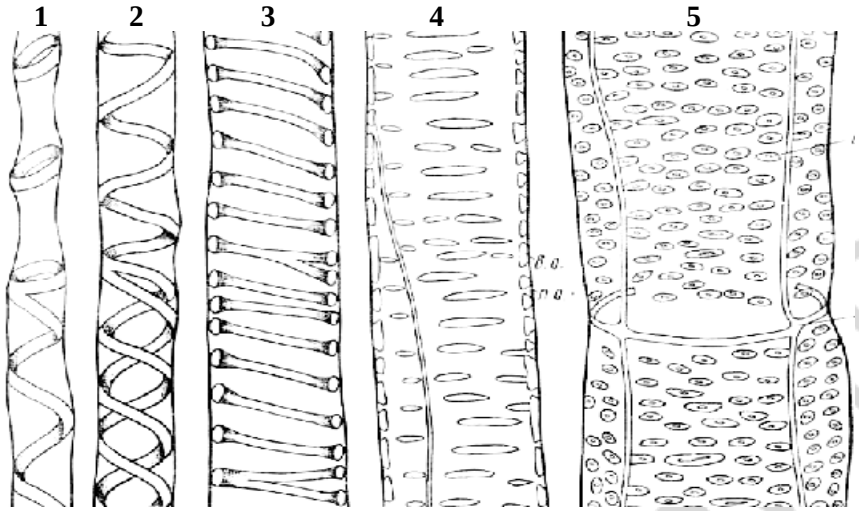
6 –

7 –

8 –

Task 2. To study the structure of the vessels (trachea).

1. Make a thin longitudinal section of the Helianthus annuus stem, place on a slide, stain with phloroglucinol and sulfuric acid, cover with a cover slip and study at microscope low-powered and high magnification.
2. Find vessels with different types of thickening. Pay attention to their diameter and location: the annular vessels are formed earlier than others and therefore are furthest from the cambium (a narrow layer of prosenhymatous cells between the sieve tubes and vessels).
3. Study the figure and designate the vessels: spiral-annulate, spiral, ladder-shaped, porous and spiral vessel in a section.



Vessels on the longitudinal section of the stem:

1 –

2 –

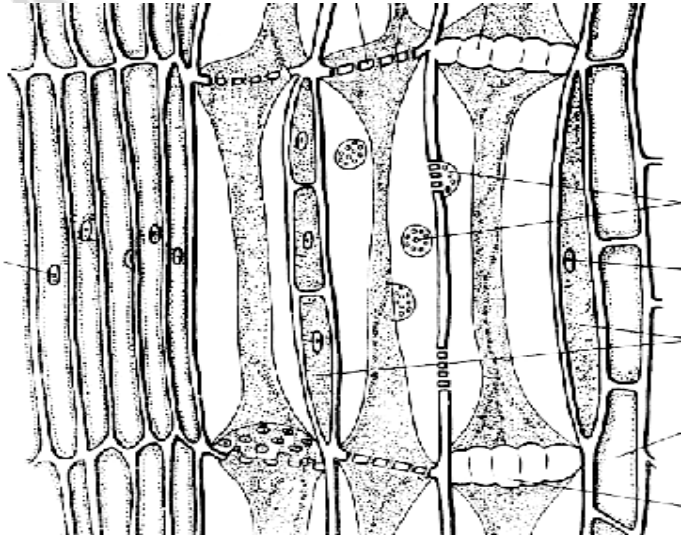
3 –

4 –

5 –

Task 3. To study the structure of the sieve tubes.

1. Make a thin longitudinal section of the Helianthus annuus stem, place on a slide, stain with phloroglucinol and sulfuric acid, cover with a cover slip and study at microscope low-powered and high magnifications.
2. Find the sieve tubes. Satellite cells are between the sieve tubes, they are narrow and with more thick contents.
3. Study the figure and designate: sieve tubes (a sieve plate and sieve fields in them), companion cells, cambium.
4. Compare the structure of tracheids and vessels. Write down the differences in them.



Sieve tubes and satellite cells on the longitudinal section of the stem:

1 –

2 –

3 –

4 –

5 –

Practice № 10. Topic: **FIBROVASCULAR BUNDLES** «____» _____ 201___ г.

Purpose of the practice: to study the structural features of fibrovascular bundles.

CONTROL QUESTIONS

1. Phloem and xylem, their structure, origin and localization.
2. Fibrovascular bundles.
3. Fibrovascular bundles structure, types and localization.

BASIC BOOK NAMES AND CONCEPTS

Conducting bundle –

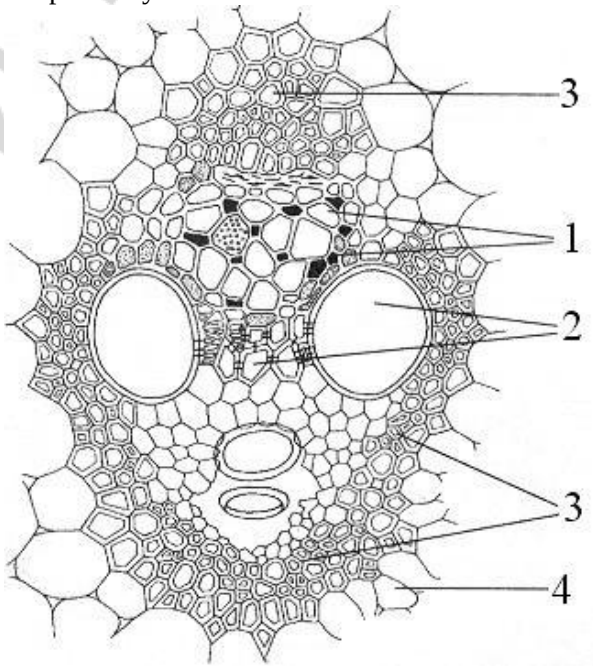
Xylem –

Phloem –

PRACTICAL WORK

Task 1. To study the structure of a closed collateral bundle.

1. Study the Zea mays stem microslide at low-powered magnification, choose a larger (toward the center) bundle, sketch it.
2. Designate on the figure: phloem, xylem, sclerenchyma (mechanical lining of the bundle) and parenchyma.



The closed collateral bundle structure:

1 –

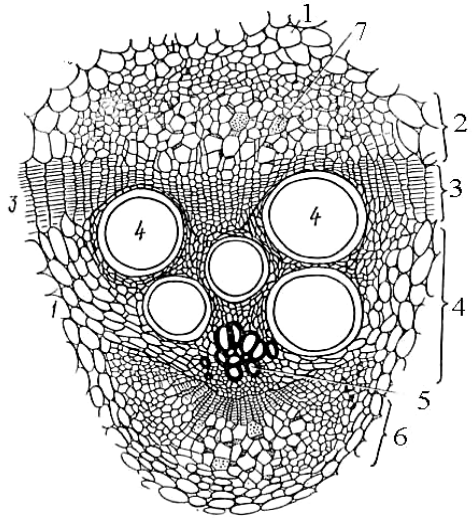
2 –

3 –

4 –

Task 2. To study the structure of the bicollateral bundle.

1. Study the Cucurbita pepo stem transverse section microslide at low-powered magnification, find the bicollateral bundle.
2. Designate on the figure: the external phloem, inner phloem, cambium, primary phloem, secondary phloem, parenchyma and the sieve plate.
3. Compare the structure of the closed collateral and open bicollateral bundles, write down differences in the location of phloem, sclerenchyma, xylem composition and the presence of the formative tissue.

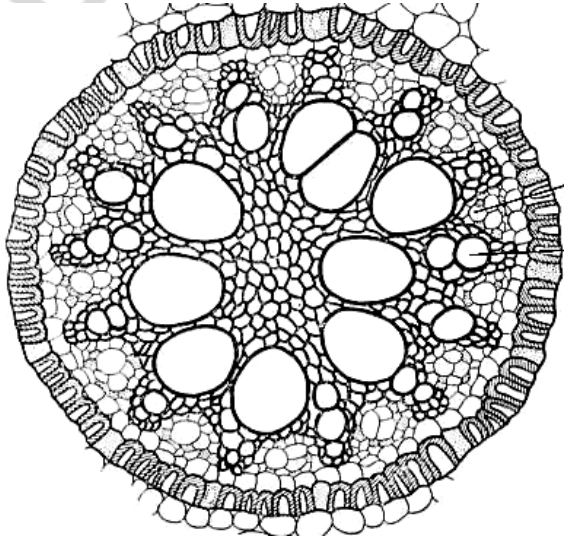


The structure of the bicollateral bundle:

1 –
2 –
3 –
4 –
5 –
6 –
7 –

Task 3. To study the structure of a radial bundle.

1. Study the Iris root transverse section microslide at low-powered magnification.
2. Find and sketch the structure of a radial bundle.
3. Designate on the figure: pericycle (formative tissue), xylem (radial rays), phloem and parenchyma.

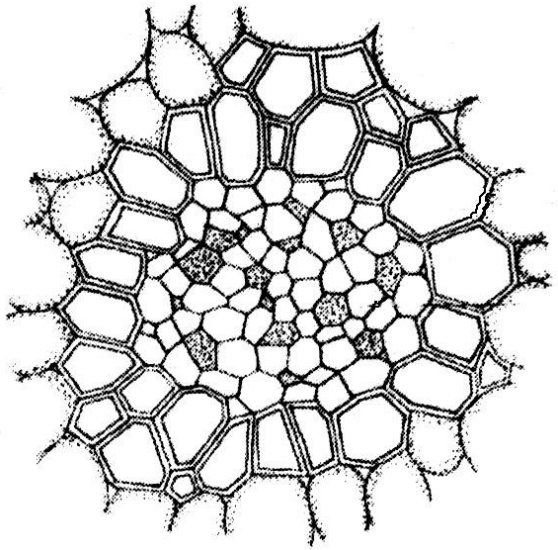


The structure of a radial bundle:

1 –
2 –
3 –
4 –

Task 4. To study the structure of concentric fibrovascular bundle.

1. Study the Convallaria majalis rootstick transverse section microslide at low-powered magnification.
2. Designate on the picture: phloem, xylem, parenchyma.



The structure of concentric fibrovascular bundle:

1 –

2 –

3 –

Practice № 11. Topic: **THE FINAL LESSON «PLANT TISSUES»** «____» _____ 201___ г.

Purpose of the practice: students' knowledge control of the topic of plant tissue.

CONTROL QUESTIONS

1. Concept of the tissue. Principles of tissue classification.
2. Formative tissues, their types and classification. Their general characteristics.
3. Primary meristem, their types, origin, localization and functions.
4. Secondary meristem, their origin, localization and functions.
5. Parenchyma tissues, their classification, cytological characteristic,
6. localization and functions.
7. General characteristics of ground tissues and their classification.
8. Cytological features of the epidermis.
9. Diagnostic differences between the epidermis of mono- and dicotyledonous plants.
10. The structure and significance of stomata. Types of stomatal apparatus.
11. Cytological characteristics of epilblema.
12. Cytological characteristics, functions and origin of suber and cork.
13. Diagnostic signs of the epidermis.
14. Differences in the shape of epidermal cells in mono- and dicotyledonous plants.
15. Structure and meaning of trichomes. Types of indumentum.
16. Types of stomatal apparatus.
17. Excretive tissues, their cytological features, localization and functions.
18. The structures of external secretion, their characteristic and significance.
19. The structures of internal secretion, their characteristics and significance.
20. Strengthening tissues, their types, cytological characteristics, localization and functions.
21. Collenchyma, its types, cytological characteristics, origin and localization in the plant.
22. Sclerenchyma, its types, cytological characteristics, origin and localization in the plant.
23. Mechanisms of ascending and descending streams in a plant.
24. Conductive tissues, their species, characteristics and significance.
25. Features of the structure, origin and localization of tracheids and vessels, the concept of xylem.
26. The structure of sieve cells, sieve tubes and satellite cells, the phloem concept.
27. Sclereids, their cytological features and localization.
28. Phloem and xylem, their structure, origin and localization.
29. Fibrovascular bundles, their structure, types and localization.

Practice № 12. Topic: **ANATOMICAL STRUCTURE OF CAULIS** «____» _____ 201___ г.

Purpose of the practice: to study the features of the structure of the caulis (herbaceous plant stem).

CONTROL QUESTIONS

1. Features of procambium and cambium initiation in the monocotyledonous and dicotyledonous plants herbaceous stems.
2. Types of the dicotyledonous plants herbaceous stem anatomical structure.
3. Features of the monocotyledonous plants herbaceous stem structure.

BASIC BOOK NAMES AND CONCEPTS

Primary cortex –

Pith –

Pericycle –

Epidermis –

Procambium –

Cambium –

PRACTICAL WORK

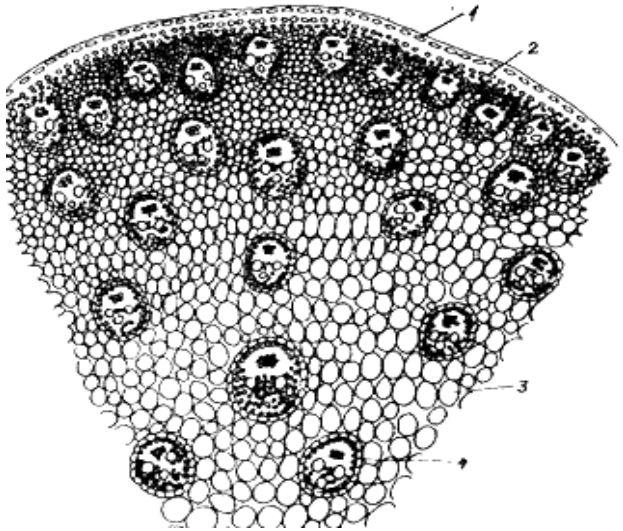
Tissues location in the stem

	Monocotyledonous	**Dicotyledonous**
Growth apex	**Stem apical point:** - initial cells; - promeristem (tunic, body)	ditto
Primary structure	**1. Epidermis** **2. Primary cortex** (it can be not expressed) **3. Centralis axis cylinder:** - pericycle, - procambium, - closed collateral bundles located randomly, - pith	1. **Epidermis** 2. **Primary cortex** 3. **Centralis axis cylinder:** а) pericycle, procambium, arranged circle wise collateral bundles, pith – ***bundle structure***; б) pericycle, procambium, phloem and xylem like complete ring, pith – ***non-bundle structure***
Secondary structure		**Epidermis** **Primary cortex** **1. Centralis axis cylinder:** pericycle, cambium. а) arranged circle wise open collateral bundles – ***bundle structure***; б) interfascicular cambium completes the secondary phloem and xylem, complete ring of phloem and xylem are formed – ***in-between structure***; в) cambium is rings of phloem and xylem – ***nonbundle structure***.

Task 1. To study the tissues and their location in the primary structure stem of a monocotyledonous plant (in terms of Zea mays stem).

1. Study the Zea mays stem transverse section microslide at low-powered magnification.
2. Find and designate on the figure borders of three main parts of the stem:

1) ground tissue — epidermis;
2) primary cortex (don't be expresed) — pericyclic sclerenchyma;
3) centralis axis cylinder: 1 — close collateral bundles, in which to designate: a) phloem, b) xylem, c) strengthening tissue; 2 — parenchyma.



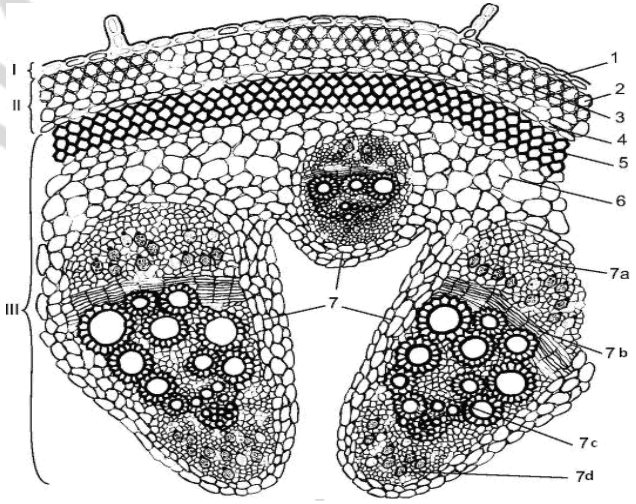
The Zea mays stem transverse section:

1 –
2 –
3 –
4 –
5 –
6 –
7 –

Task 2. To study the secondary bundle structure of the dicotyledonous herbaceous plant stem ((in terms of Cucurbita pepo stem).

1. Study the Cucurbita pepo stem transverse section microslide at low-powered magnification.
2. Find and designate on the figuree borders of three main parts of the stem:

1) ground tissue – epidermis;
2) primary cortex: angular collenchyme, chlorenchyma, endodermis.
3) centralis axis cylinder: parenchyma, bicollateral bundles (external and internal phloem, xylem, cambium in them).



The Cucurbita pepo stem transverse section:

I – **II –** **III –**

1 –
2 –
3 –
4 –
5 –
6 –
7 –

7a - 7b - 7c - 7d -

Practice № 13. Topic: **ANATOMICAL STRUCTURE OF WOOD STEMS AND ROOTSTOCK** «____» _____ 201___ г.

Purpose of the practice: to study the anatomical structure features of the wood stems and rootstock.

CONTROL QUESTIONS

1. Features of the tree stems structure.
2. Differences in the stem of wood plants from the stem of herbaceous plants.
3. Anatomical structure and features of Pinophyta stems.
4. Features of the rootstock as an stem underground metamorphosis.
5. Anatomical structure of monocotyledonous plants rootstock.
6. Anatomical structure of dicotyledonous plants rootstock.
7. Differences in the structure of monocotyledonous and dicotyledonous plants rootstocks.

BASIC BOOK NAMES AND CONCEPTS

Wood –

Pith –

Bast –

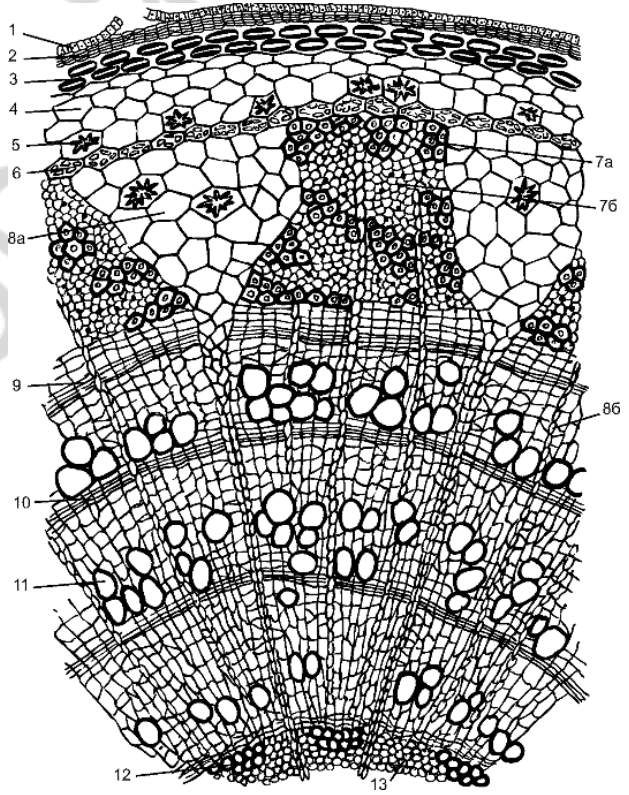
Periderm –

Rootstock –

PRACTICAL WORK

Task 1. To study the location of tissues in the dicotyledonous woody plant stem (in terms of Tilia cordata stem).

1. Study the Tilia cordata branch transverse section microslide at low-powered magnification. Pay attention to tissues colour.
2. Study the figure and designate it.

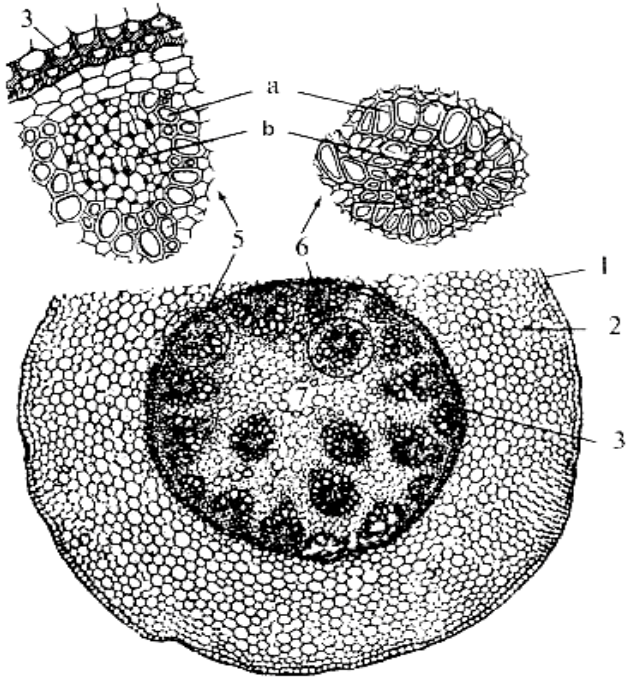


The Tilia cordata stem transverse section:

1 –
2 –
3 –
4 –
5 –
6 –
7 –
7а –
7б –
8 –
8а –
8б –
9 –
10 –
11 –
12 –
13 –

Task 2. To study the structural features of a monocotyledonous plant rootstock.

1. Study the Convallaria majalis rootstock transverse section permanent preparation. Pay attention to the bundles location.
2. To study the figure, paint it and designate it.



The Convallaria majalis rootstock transverse section:

1 –
2 –
3-
4 –
5 –
6 –
a –
b –

Practice № 14. Topic: **ANATOMICAL STRUCTURE OF THE ROOT** «____» _____ 201___ г.

Purpose of the practice: to study the structural features of mono- and dicotyledonous plants roots.

CONTROL QUESTIONS

1. Cytological characteristics of different root zones.
2. Primary structure of the root (suction zone).
3. Structure of the root of monocotyledonous herbaceous plant and woody plant.
4. Features of the secondary anatomical structure of a dicotyledonous plant root.

BASIC BOOK NAMES AND CONCEPTS

Root –

Root fibrils –

Epiblema –

PRACTICAL WORK

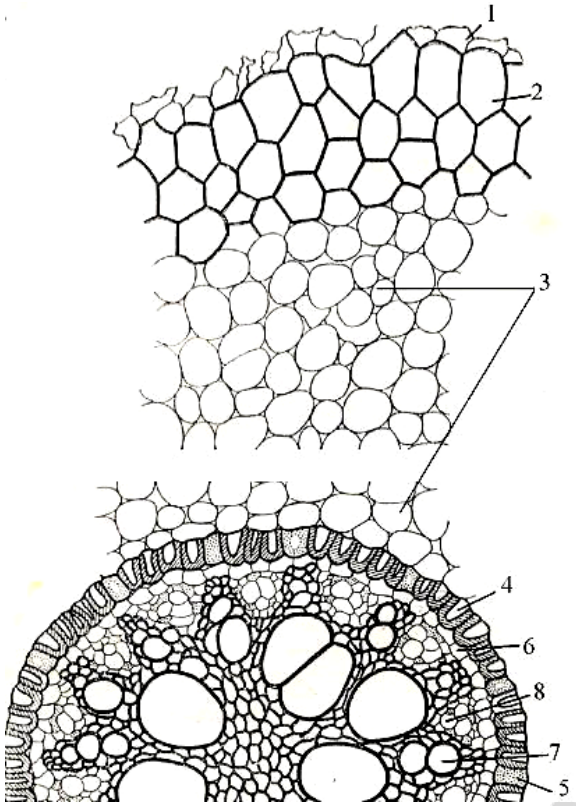
The root is an underground, vegetative and axial organ of the plant with apical growth and radial symmetry.

Tissues arrangement in the roots

Zones	Monocotyledonous	Dicotyledonous
Zone of division	root cap, initial cell, dermatogen, periblem, plepome	ditto
Pull-apart zone	dermatogen, periblem, plepome	pericycle, procambium
Suction zone	epiblema, primary cortex (exoderm, mesoderm and endoderm), pericycle and radial fibrovascular bundle (more than 6 xylem rays)	epiblema, primary cortex (exoderm, mesoderm and endoderm), pericycle and radial fibrovascular bundle (1–6 xylem rays)
Conducting area	sclerotic exoderm, mesoderm and endoderm, pericycle (forms lateral roots), radial fibrovascular bundle; perennial plants secondary growth is due to the thickening ring	secondary cortex (suber, phloem, centralis axis cylinder parenchyma), cambium, secondary xylem, primary xylem is in the star form

Task 1. To study the location of tissues in the monocotyledonous plant primary structure root.

1. Study the Iris root transverse section (in the conducting area) microslide at low-powered magnification.
2. Find borders of three main parts of the root: ground tissue, primary cortex, centralis axis cylinder. Determine the number of primary xylem rays.
3. Designate the figure.



The Iris root transverse section:

1 –

2 –

3 –

4 –

5 –

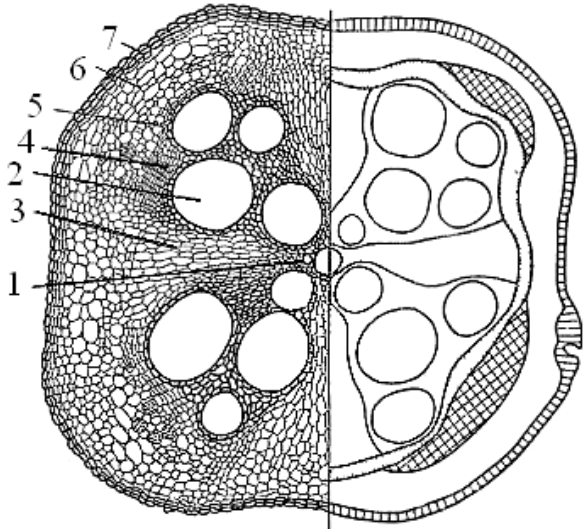
6 –

7 –

8 –

Task 2. To study the location of tissues in the dicotyledonous plant secondary structure root.

1. Study the Cucurbita pepo root transverse section microslide at low-powered magnification.
2. Find primary xylem rays in the center of the root and determine their number.
3. Designate the figure.



The Cucurbita pepo root transverse section:

1 –

2 –

3 –

4 –

5 –

6 –

7 –

Practice № 15. Topic: **ANATOMICAL STRUCTURE OF THE LEAF** «____» _____ 201___ г.

Purpose of the practice: to study the leaf anatomical structure features.

CONTROL QUESTIONS

1. The leaf structure.
2. Anatomic structure of the dorsoventral leaf.
3. Structure features of isolateral leaves.
4. Anatomical structure of Gramineae leaves.
5. Structure of Pinophyta leaf.

BASIC BOOK NAMES AND CONCEPTS

Leaf –

Mesophyll –

Stoma –

Leaf stalk –

Vein –

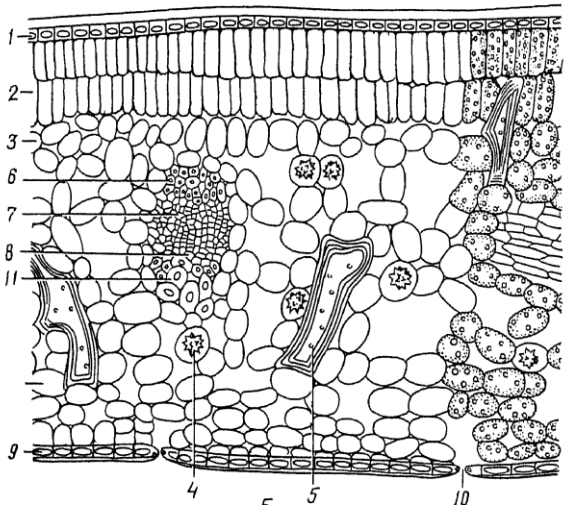
Scarfskin –

PRACTICAL WORK

Leaves types	Epidermis	Mesophyll	Vein (fibrovascular bundle)
Dorsoventral leaf	On the upper epidermis the cells are larger than on the lower epidermis, they have scarfskin, stomata are absent or they are a few; there are many stomata on the lower epidermis	The mesophyll is differentiated into palisade tissue (its main function is photosynthesis) and cancellous tissue (gas exchange and transpiration)	Closed collateral or bicollateral bundles, xylem adjacent to the upper epidermis, phloem - to the lower epidermis; central veins have sclerenchyma facing, sometimes collenchyma
Isolateral leaf	There are no differences in the structure of the upper and lower epidermis, the stomata are located evenly	The palisade mesophyll adjoins to the upper and lower epidermis, the cancellous mesophyll is a thin layer between the palisade layers	The same structure as the dorsoventral leaf
Gramineae leaf	The upper and lower epidermis cells are elongated form, they are small above the strengthening tissue; there are motor cells; stomata are located evenly	The mesophyll is not differentiated into palisade and cancellous tissue	The bundles are surrounded by a layer of accessory cells in the rosettes form (Panicum)

Task 1. To study the dorsoventral leaf anatomical structure.

1. Study the Camellia sinensis leaf microslide at low-powered and high magnifications.
2. Designate on the figure: the upper epidermis, palisade chlorenchyma, cancellous chlorenchyma, closed collateral fibrovascular bundle (xylem, phloem), bundle sclerenchyma facing, collenchyma, druses, sclereids, the lower epidermis, stoma.

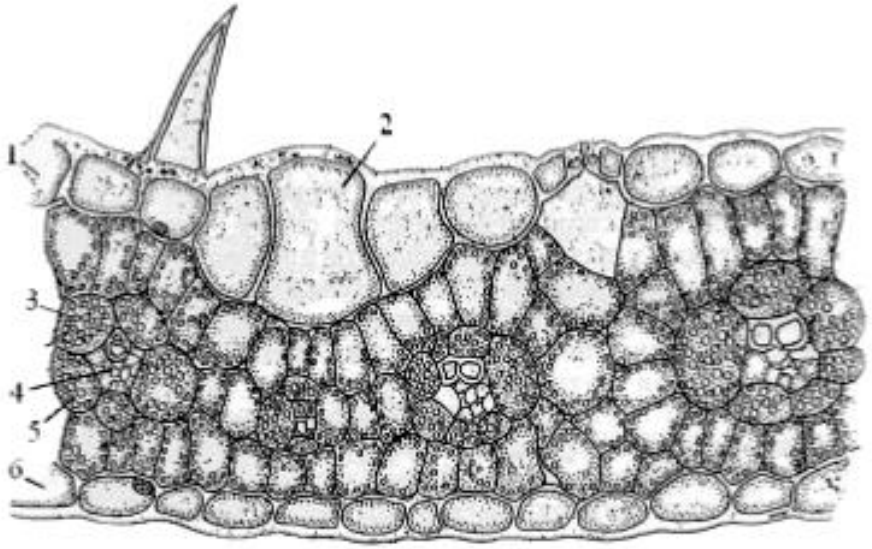


The Camellia sinensis dorsoventral leaf anatomical structure:

1 –
2 –
3 –
4 –
5 –
6 –
7 –
8 –
9 –
10 –
11 –

Task 2. To study the isolateral leaf anatomical structure.

1. Prepare a transverse section microslide of the leaf with an isolateral type of mesophyll. Stained it with phloroglucinol and sulfuric acid.
2. Study the microslide at low-powered magnification.
3. Designate on the figure: the upper epidermis, motor cells, mesophyll, conductive bundle, accessory cells, the lower epidermis.



The Zea mays isolateral leaf anatomical structure:

1 –
2 –
3 –
4 –
5 –
6 –

Practice № 16–17. Topic: **INDEPENDENT WORK UNDER A TEACHER "STUDYING THE ANATOMICAL STRUCTURE OF THE PLANTS VEGETATIVE ORGANS"** «____» _____ 201___ г.

Purpose of the practice: to study the structure features of plant vegetative organs.

CONTROL QUESTIONS

Look information material in the guidance papers to the lessons № 12–17.

LESSON PROBLEMS

1. To prepare an unknown object transverse section microslide.
2. To recognize the tissues by their cytological characteristics and color after the reagents action.
3. To recognize the plant vegetative organ by its anatomical structure.

PRACTICAL WORK

Task 1. Determine the vegetative organs of plants.

1. Prepare a one of the objects transverse section microslide according to the generally accepted procedure. Study it at microscope low-powered and high magnification. Find the borders of the three main zones of the axial organ. Designate. Study the tissues structure features and draw them on the slice sector.
2. Designate the tissues on the slice according to the description plan (appendix 1).
3. Determine the microslide for the identification guide-key (appendix 2).

Draw the following conclusions:

1. What plant organ is the body of interest (root, stem, rootstock or leaf)?
2. Which structure (primary or secondary) has the body of interest?
3. Which class (monocotyledonous or dicotyledonous) belongs the body of interest?
4. Conclusions and microslide should be presented to the teacher.
5. Repeat the above actions to all proposed objects.

Appendix 1

Plan for the description of plant axial organ transverse section microslide (select with reference to the body of interest)

1. Type of ground tissue:

a) epidermis. Note the degree of membrane thickening, scarfskin and trichomes presence and their type; stomata and type of stomatal apparatus;
b) epiblema (rizodermis) with root fibril;
c) periderm. Specify number of layers.

2. Primary cortex:

a) the primary cortex consists of a collenchyma (lamellar, angular, lacunar), chlorophyll-bearing parenchyma, endoderm (starch sheath). (Endoderm may not be expressed) or
b) the primary cortex consists of a homogeneous chlorophyll-bearing parenchyma or an aerenochyma or
c) the primary cortex consists of a storage parenchyma and an endoderm. The endoderm can be with Casparian strip, with lecotropal thickenings or endoderm may be not expressed or
d) the primary cortex consists of the exoderm, the mesoderm (ground tissue) and the endoderm (with Casparian strip or with lecotropal thickenings) or
e) primary cortex is not expressed.

When you describe and sketch the primary cortex tissues, you should present the number of each tissue cells layers, their size and location, the character cell walls thickening and the presence of cellular inclusions. Sometimes in the primary cortex there can be dead cells of strengthening tissue and they must be noted in the description and in the picture.

3. Centralis axis cylinder:

Pericycle:

a) one-layered or multilayered or
b) pericyclic origin strengthening tissues (designate the nature of location: areas, ring and number of cell layers) or
c) is not expressed.

Fibrovascular bundles: bicollateral, open collateral, closed collateral, concentric or one radial.

Location of fibrovascular bundles:

a) the bundles are isolated from each other and are arranged randomly on a slice;
b) the bundles are isolated from one another and arranged in one circle. Designate on the picture bundles size (all the same or alternate large and small), the presence of bundle sclerenchyma facing, the type of tissue between the bundles (living parenchyma cells, lignified parenchyma or sclerified parenchyma);
c) the bundles run into one another forming an annular arrangement of the conducting tissues (the phloem ring is outside the cambium and the xylem ring is to the center with a clearly visible primary xylem). Rings can be expressed in the xylem, they should be noted in the description and in the picture.

The pith rays originate from the pith or are located opposite the primary xylem rays.

Pith:

a) is well developed. Designate cells size, shape and location or
b) is destroyed (partially or completely) or
c) no pith.

Appendix 2

Table for determining the plants axial vegetative organs

1	+	The fibrovascular bundle in the centralis axis cylinder is radial. Primary cortex is much larger than the centralis axis cylinder.
	-	Fibrovascular bundles are a different type.
2	+	The xylem rays in the radial fibrovascular bundle are not more than 6. **The dicotyledonous plant primary structure root**.
	-	The xylem rays in the radial fibrovascular bundle are more than 6. **The monocotyledonous plant primary structure root**.
3	+	Fibrovascular bundles are collateral, closed and arranged irregularly. Pericyclic sclerenchyma may be present in the centralis axis cylinder. Ground tissue is epidermis. Primary cortex is not expressed. **Monocotyledonous plant stem.**
	-	Fibrovascular bundles are a different type.
4	+	Fibrovascular bundles are open, collateral or bicollateral, separated from each other and arranged in a circle (can be fused together).
	-	Fibrovascular bundles are concentric (they may also be collateral), or there is no bundle structure.
5	+	Ground tissue is epidermis. Primary cortex is differentiated by collenchyma, chlorenchyma and starch endoderm. **The stem of a herbaceous dicotyledonous plant.**
	-	Ground tissue is periderm or epidermis, the primary cortex is not differentiated by collenchyma and chlorenchyma.

6	+	Fibrovascular bundles are collateral and concentric, they can be located in the centralis axis cylinder or in the primary cortex. Storage parenchyma or aerenchyma is well developed in the primary cortex. Pericyclic sclerenchyma is not present. **The rootstock of a monocotyledonous plant.**
	-	The centralis axis cylinder is non-bundle structure.
7	+	Ground tissue is suber. Fibrovascular bundles are collateral, open and delimited by the pith rays. In the center the primary xylem is in the star form. **The root of a dicotyledonous plant.**
	-	Ground tissue is suber (less often the epidermis). Primary cortex is not differentiated by collenchyma, chlorenchym and endoderm and is represented, as a rule, by a storage parenchyma. Fibrovascular bundles are open, collateral or bicollateral and circle-wise located. In the center of the axis cylinder a pith or a lacune is expressed. **The rootstock of a dicotyledonous plant.**
8	+	Ground tissue is suber. Primary cortex is differentiated into lamellar collenchyma, chlorenchyma and starch endoderm. In the centralis axis cylinder xylem (wood) is dense with annual rings, radially dissected by the pith rays. The pith (parenchyma) is in the center.
	-	**The stem of a woody dicotyledonous plant.** Ground tissue is suber. Primary cortex is absent. Annual rings and crossing pith rays are visible in the wood. Opposite the primary pith rays in the center the star of xylem is located (the number of rays is less than 6). **The plurannual root of a dicotyledonous plant.**

Write down the vein of the definition. Draw a section of the vegetative organ.

Practice № 18. Topic: **THE FINAL LESSON "ANATOMY OF PLANTS VEGETATIVE ORGANS"** «___»_____ 201___ г.

Purpose of the practice: students' knowledge control on the topic of plant vegetative organs anatomy.

CONTROL QUESTIONS	
1. Learn to distinguish the main parts of the stem transverse section. 2. Recognize and describe individual stem tissues after the reagents action. 3. To make a scheme of the tissues location in the primary and secondary structure stem. 4. Learn to recognize the main parts of the stem: ground tissue, primary cortex, centralis axis cylinder. 5. Learn to distinguish the wood stem from the caulis. 6. Anatomical structure of Pinophyta stems. 7. Features of the rootstock as an stem underground metamorphosis. 8. Anatomical structure of monocotyledonous plants rootstock. 9. Anatomical structure of dicotyledonous plants rootstock. 10. Differences in the structure of monocotyledonous and dicotyledonous plants rootstocks. 11. Cytological characteristics of different root zones. 12. Primary structure of the root (suction zone). 13. Structure of the root of monocotyledonous herbaceous plant and woody plant. 14. Features of the secondary anatomical structure of a dicotyledonous plant root. 15. The leaf structure.	16. Anatomic structure of the dorsoventral leaf. 17. Structure features of isolateral leaves. 18. Anatomical structure of Gramineae leaves. 19. Structure of Pinophyta leaf.

RECOMMENDED LITERATURE

Main

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