ZAPORIZHZHIA STATE MEDICAL UNIVERSITY
DEPARTMENT OF PHARMACOGNOSY, PHARMACOLOGY AND BOTANY
DEPARTMENT OF FOREIGN LANGUAGES

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PHARMACEUTICAL BOTANY

MANUAL
for the Unified State Qualification Examination (USQE), Stage 1.
the "Krok-1" Integrated Test-Based Exam and the English Language Proficiency Test Preparation
for the Second and Third-Year Students of the Pharmaceutical Faculties,
Specialty 226 "Pharmacy, Industrial Pharmacy",
Specialization "Technology of Perfumes and Cosmetics"

PART I

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P 56 **Pharmaceutical Botany.** Manual for the Unified State Qualification Examination (USQE), Stage 1. the "Krok-1" Integrated Test-Based Exam and the English Language Proficiency Test Preparation for the Second and Third-Year Students of the Pharmaceutical Faculties, Specialty 226 "Pharmacy, Industrial Pharmacy", Specialization "Technology of Perfumes and Cosmetics". Part I. / Yu. I. Korniievskyi, V. H. Korniievska, A. K. Kulichenko, S. V. Panchenko, H. V. Mazulin. – Zaporizhzhia, 2021. – 91 p.

The manual aims to prepare pharmaceutical students for the Unified State Qualification Examination (USQE), Stage 1 that consists of the following parts: the "Krok-1" Integrated Test-Based Exam and the English Language Proficiency Test.

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CONTENTS

PREFACE

Pharmaceutical botany is one of the core disciplines within the training of pharmaceutical students. It deals with medicinal plants, their morphology, and the anatomical structure of plants.

The manual aims at the second and third-year students of the Pharmaceutical faculties, specialty 226 “Pharmacy, Industrial Pharmacy”, specialization “Technology of Perfumes and Cosmetics”. Besides, it is developed under the “Program on pharmaceutical botany” for students of higher pharmaceutical establishments and pharmaceutical faculties of higher medical educational establishments of the 3rd and 4th levels of accreditation.

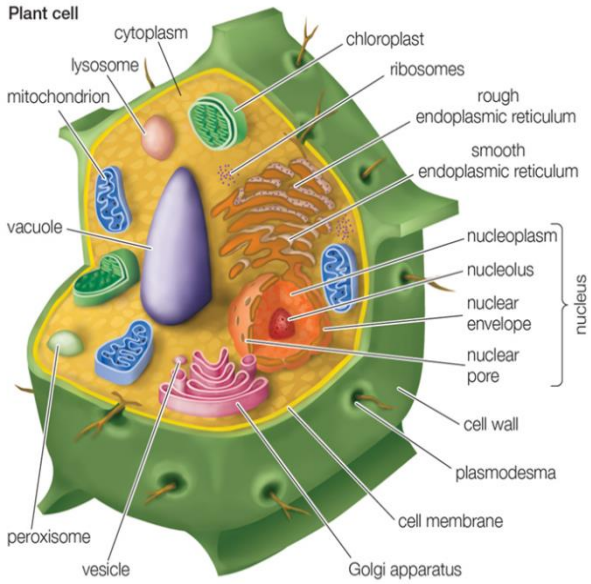
The manual consists of the following parts: “Plant cell”, “Plant tissues”, “Anatomical structure of the vegetative organs”, “ Morphology of plant vegetative organs”, “Morphology of plant generative organs: flowers and inflorescence”. Besides, it contains figures and tests for each part as well as glossary and references.

The manual can be useful for students to prepare for practical classes, final graded tests, the Unified State Qualification Examination (USQE), Stage 1 for the students majoring in “Pharmacy” that consists of the following parts: the “Krok-1” Integrated Test-Based Exam and the English Language Proficiency Test.

I. PLANT CELL

STUDY OF BOTANICAL MICROTECHNOLOGY AND STRUCTURE OF PLANT CELL

Due to the investigation of microscopes, we can master the anatomical structure of plant cells, tissues, and organs. There are two types of microscopes: light and electron ones. Pharmacists usually use light microscopes to analyze medical herbal material. Light microscopes are of two basic types: compound microscopes, which require material being examined to be sliced tiny enough for light to pass through and dissecting microscopes, which permit the viewing of opaque objects.



There are two types of cells: prokaryotic and eukaryotic. Plant cells belong to eukaryotic cells. Eukaryotic cells contain an organized nucleus with a nuclear membrane and numerous membranous organelles. Cells of plants, animals, fungi, and protists are eukaryotic cells.

Plant and animal cells share many structures, such as endoplasmic reticulum, ribosomes, mitochondria, and Golgi apparatus, however, plants contain many structures not found in animals, such as a cell wall, plastids, and vacuoles.

DETERMINATION OF PLASTIDS TYPES AND CELL SAP COMPOSITION

Several kinds of plastids are generally found in living cells, with chloroplasts of green organisms usually being the most conspicuous. Chloroplasts may be from 2 to 10 micrometers in diameter, and each is bounded by an envelope consisting of two delicate unit membranes. Within is a colorless, fluid, enzyme-containing matrix, stroma. Most of the activities of chloroplasts are controlled by genes in the nucleus, but each chloroplast contains a small circular molecule of DNA that encodes a few of many photosynthetic and other activities within the chloroplast itself. Grana (singular granum), which are stacks of coin-shaped double membranes called thylakoids, are suspended in the stroma. Membranes of thylakoids contain green chlorophyll and other pigments. In each chloroplast, there are usually about 40 to 60 grana linked together by arms, and each may contain

from 2 to more than 100 stacked thylakoids. There usually 4 or 5 starch grains in the stroma, as well as oil droplets and enzymes.

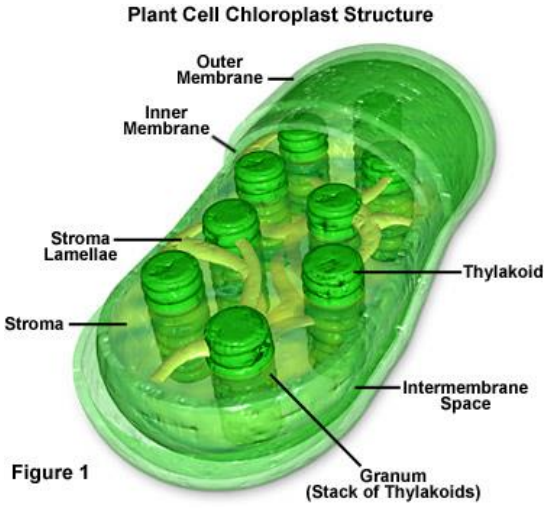
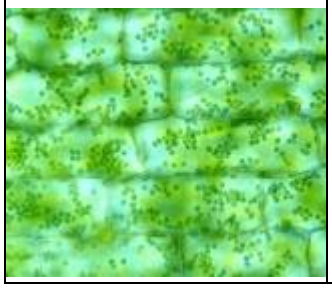
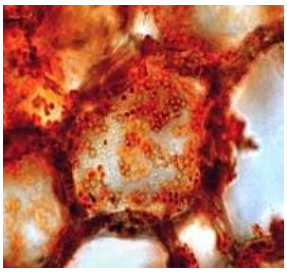
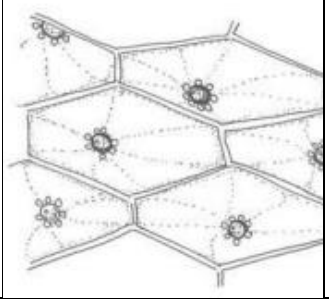
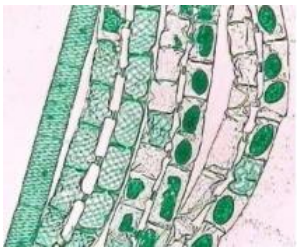


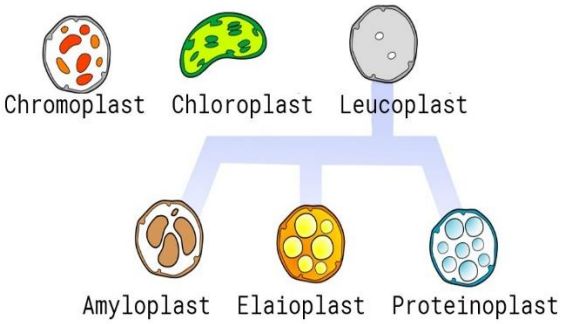
Figure 1

The second type of plastid found in some cells of more complex plants is chromoplast. Although chromoplasts are similar to chloroplasts in size, they vary considerably in shape, often being somewhat angular. Leucoplasts are the third type of plastid common to cells of higher plants. They are essentially colorless and include amyloplasts, which are known to synthesize starches, and elaioplasts which synthesize oils.

Vacuoles are filled with a watery fluid called cell sap, which is slight to significantly acidic and plays a role in maintaining pressures within a cell. Cell sap contains dissolved substances, such as salts, sugars, organic acids, and small quantities of soluble proteins. It also frequently contains water-soluble pigments – anthocyanins, which are responsible for many of the red, blue, or purple colors of flowers and some reddish leaves. Sometimes large crystals of waste products are formed within the cell sap after certain ions have become concentrated there.

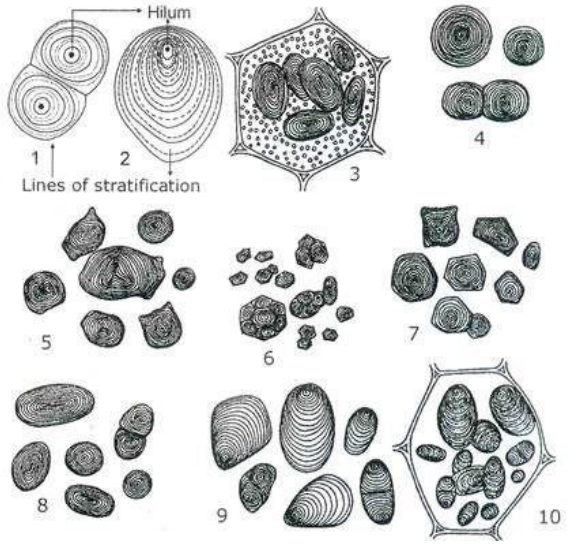
- Chloroplasts are green plastids that provide photosynthesis. Consisting of internal outgrowths-lamellae (thylakoids), they contain chlorophyll a, b and carotenoids. Thylakoids collected in clusters form faces. The main substance of the stroma (matrix).
- Chromoplasts are plastids, colored yellow, orange, or red due to the presence of carotenoids -a, -b, -y.
- Adhesive plasters are colorless plastids without pigments in the protein-lipid stroma. Amyloplasts synthesize secondary starch; proteoplasts form spare proteins; oleoplasts accumulate fatty oils.
- Chromatophores are characteristic of algae; contain chlorophyll a, b, c, d, carotene.

PLASTIDS			
Chloroplasts	**Chromoplasts**	**Adhesive plasters**	**Chromatophores**
			



DETERMINATION OF TYPES OF STORAGE AND SECRETORY CELL SUBSTANCES

Plant cells produce different storage substances. The most abundant of them are starch and proteins which are widely used in the pharmaceutical industry. Carbohydrates, the most abundant organic compounds in nature, are typically composed of carbon, hydrogen, and oxygen. They include sugars, starches, and related substances. They may be used as energy sources for cells, such as energy storage units, or as structural components, such as membranes and organelles. Proteins are principal structural and regulatory molecules of cells. Large crystals of waste products are formed within cell sap after certain ions have become concentrated there. The most abundant are crystals of calcium oxalate. They may be of different shapes: star-like crystal, raphide



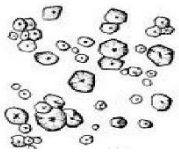
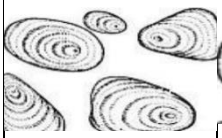
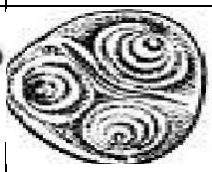
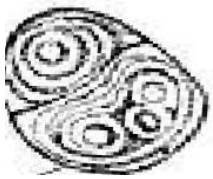
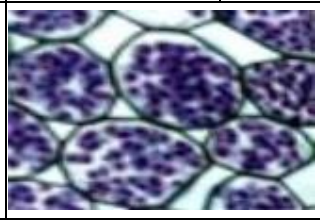
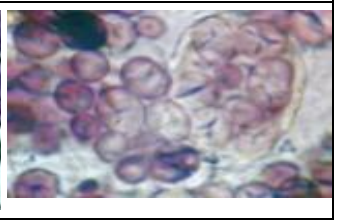
crystal, druse crystal, and crystal sand. Shapes of calcium oxalate crystals are very important in herb identification.

Starch is formed and deposited in plastids. Under the action of iodine-containing reagents, starch grains acquire a dark purple color.

There are 2 types of starch:

- *Primary starch (assimilation)* will be formed during photosynthesis in chloroplasts;
- *Secondary starch* is synthesized from the products of hydrolysis of primary starch:
  - *Transit* is formed and is broken down by enzymes on a way of movement;
  - *Protective* accumulates in the root cover and spare promotes growth and tropism of organs;
  - *It accumulates* in the amyloplasts of storage tissues of rhizomes, tubers, fruits, seeds in the form of starch grains.

There are the following starch grains: concentric (centers coincide), eccentric (centers do not coincide); simple (with 1 center), complex (with several centers of stratification).

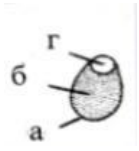
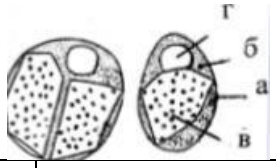
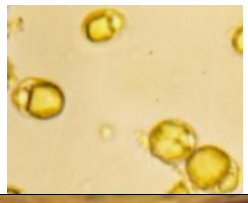
STARCH GRAINS				
Concentric starch grains	*Eccentric starch grains*	*Simple starch grains*	*Complex starch grains*	*Semi-complex starch grains*
				
Starch (starch grains)	Lugol's solution	Blue-purple color		

Inulin. It is detected by a solution of α-naphthol (purple color) or 96% alcohol (formation of spherocrystals).

Glycogen is characteristic of cells of algae and fungi. Stained with Lugol's solution in brown.

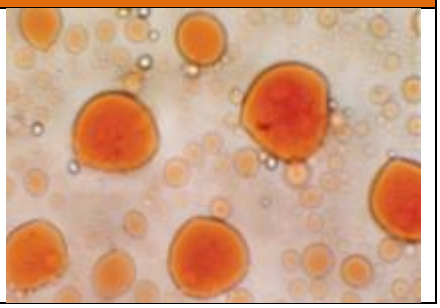
Proteins

Aleyron (protein) grains can be *simple,* which consist of a protein shell and an amorphous protein, occasionally including a globoid*;* and *complex*, in addition to amorphous protein and globoid contain crystalloids.

ALEYRON (PROTEIN) GRAINS		
simple 		*complex* 
Lugol's solution	Yellow color	
Concentrated nitric acid	Yellow color	

Oil

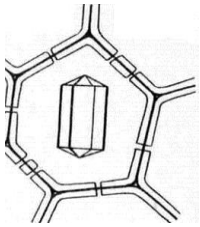
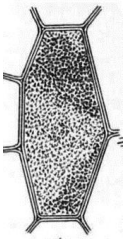
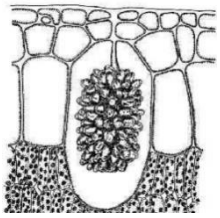
They are accumulated in hyaloplasm or are synthesized in oleoplasts. They are saponified by alkalis, painted by Sudan III in orange.

FATTY OIL		
Sudan III	Orange color	

- Crystalline inclusions are the end products of metabolism.

Calcium oxalate crystals

- *Single crystals* (monohydrates) have the shape of rhombohedrons, octahedra.
- *Druzes* (dihydrates) are star-fused pyramidal crystals.
- *Rafids* (dihydrates) are needle crystals.
- *Styloids* (dihydrates) are elongated, prismatic crystals with pointed ends.
- *Crystalline sand* has the form of small crystals that fill the cavity of the idioblast.

<table>
<tr><th colspan="2">CELLULAR INCLUSIONS</th></tr>
<tr><td colspan="2"><u>$CaC_2O_4 + nH_2O$</u>
<u>Calcium oxalate crystals</u></td></tr>
<tr><td>Monocotyledons</td><td>Dicotyledons</td></tr>
<tr><td><u>Single crystals</u>
  </td><td rowspan="2"><u>Crystal sand</u>
  </td></tr>
<tr><td><u>Rafids</u>
  </td></tr>
<tr><td><u>Styloids</u>
  </td><td><u>Druzes (dihydrates)</u>
  </td></tr>
<tr><td colspan="2"> 
<u>$CaCO_3 + 2HCl$ Cystolith</u>
<u>Calcium carbonate crystals</u></td></tr>
</table>

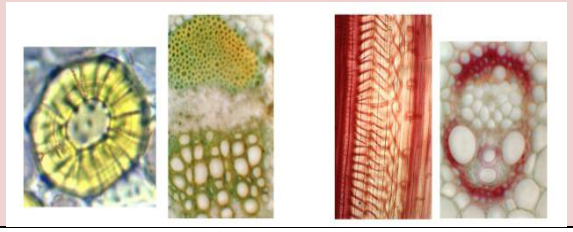
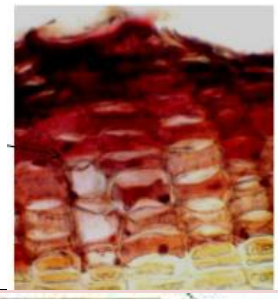
Crystals of calcium carbonate and silica

Cystolitis is an internal growth of the membrane of specialized lithocyst cells.

Secondary changes of the cell membrane

- Woodiness or lignification is impregnation of the shell with lignin. Detect lignin: floroglucin – shells are painted in crimson or cherry color; chlorine-zinc-iodine-yellow color; safranin – red; aniline sulfate-yellow color.

- Shrinking or suberenization is impregnation of the shell with a high-molecular fat-like substance – suberin. Detected: Sudan III – pink-orange color.
- Cell mineralization is detected with the help of phenol – pink color, as well as by burning the rest of the silicon skeleton.
- Cutinization is the process of secretion of a fat-like substance – cutin. Detection: Sudan III – pink-orange color; chlorine-zinc-iodine solution – yellow color.
- Mucus is detected with mascara – mucous cells remain light on a dark background; methylene blue-blue or blue color.

Name of secondary changes	**Substances, which produce secondary changes or cause**	**Reagent or method of determining**	**Result of reaction**
Lignification	Lignine	Aniline Sulphate Pholoroglucinol with acid	Yellow Purple 
Suberization	Suberin	Sudan III	Pink 
Cutinization	Cutin	Sudan III	Pink 
Sliming	Intramolecular changes	Methylene blue	Blue 
Mineralization	Silica, salts, of calcium, magnesium	Burning	Mineral «skeleton»

- *Pores* are non-thickened places in secondary shells.
  - *Simple pores* are straight, oblique, slit-like, and branched.
  - *Complex pores* are bordered and semi-bordered.

II. PLANT TISSUES

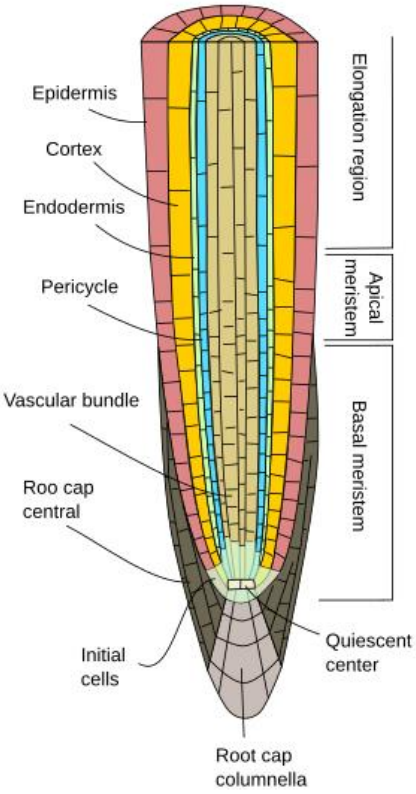
STUDY AND DETERMINATION OF PRIMARY AND SECON- DARY MERISTEMS STRUCTURE

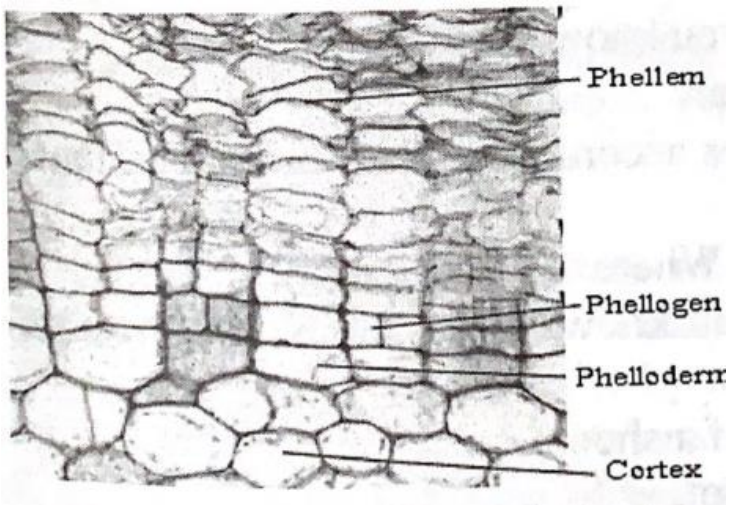
Meristematic tissues are tissues where cells actively divide. Plants have four types of meristems: apical, lateral, intercalary, and wound.

Apical meristems occur near the tips of roots and shoots and produce primer tissues. These meristems account for primary growth, which is the elongation of roots and shoots.

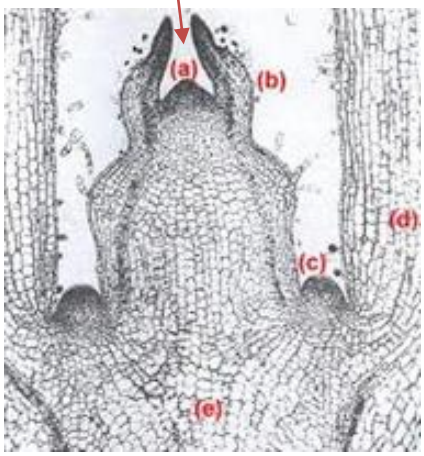
Lateral meristems are cylindrical meristems, that are formed in subapical regions of roots and shoots of woody plants, they include vascular cambium and cork cambium (or phellogen). Lateral meristem produces secondary growth, which increases the girth of the plant.

Intercalary meristems can be found between mature tissues. These meristems are most common in grasses, where they occur at the bases of nodes (leaf attachment areas), which occur at intervals along stems. Intercalary meristems, like apical meristems, produce increases in the length.



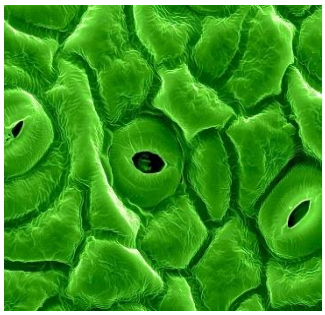


a) apical meristem

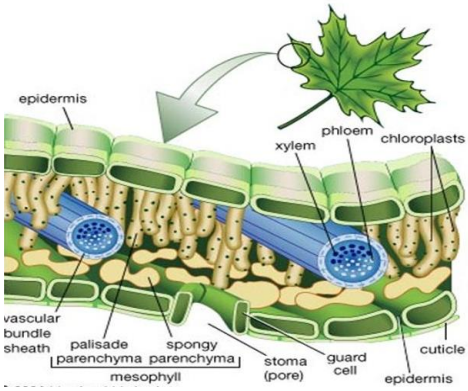


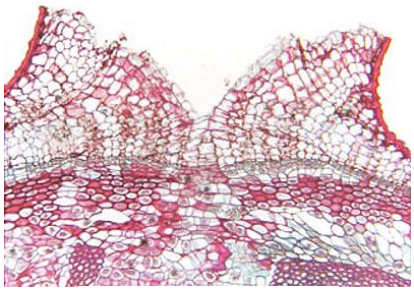
STUDY AND DETERMINATION OF DERMAL TISSUE STRUCTURE: EPIDERMIS, PERIDERM, RHYTIDOME

Dermal tissues cover the plant body. The dermal tissue that covers the primary body of plants is the epidermis. It has several functions, including absorption of water and minerals, secretion of the cuticle, protection against herbivores, and control of the gas exchange. Each of these functions is attributable to one or more of the features of the epidermis, such as the presence of the cuticle, few intercellular spaces called stomata, and multifunctional outgrowths called trichomes. Each stoma is surrounded by two guard cells, which are surrounded by distinctively shaped cells called subsidiary cells. They function as reservoirs for water and ions that enter and leave guard cells.



Stomata



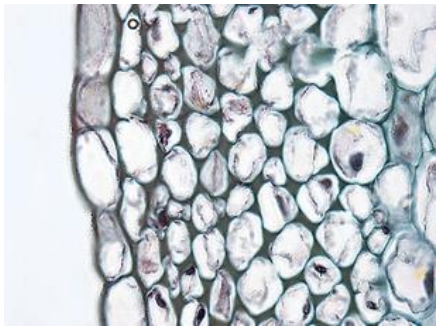


Periderm

The epidermis is short-lived in many plants. When the epidermis ruptures a secondary dermal tissue, periderm that consists of phellogen (cork cambium), phellem (cork) and phelloderm (secondary cortex), replaces it.

STUDY AND DETERMINATION OF GROUND AND VASCULAR TISSUES STRUCTURE

Tissues that support plants are called mechanical tissues. There are two types of mechanical tissues: collenchyma and sclerenchyma.



Collenchyma

Collenchyma cells are elongate (up to 2 mm long) cells having unevenly thickened primary cell walls. They support growing regions of shoots, and therefore common in expanding leaves, petioles, and elongating stems (near the apical meristem)

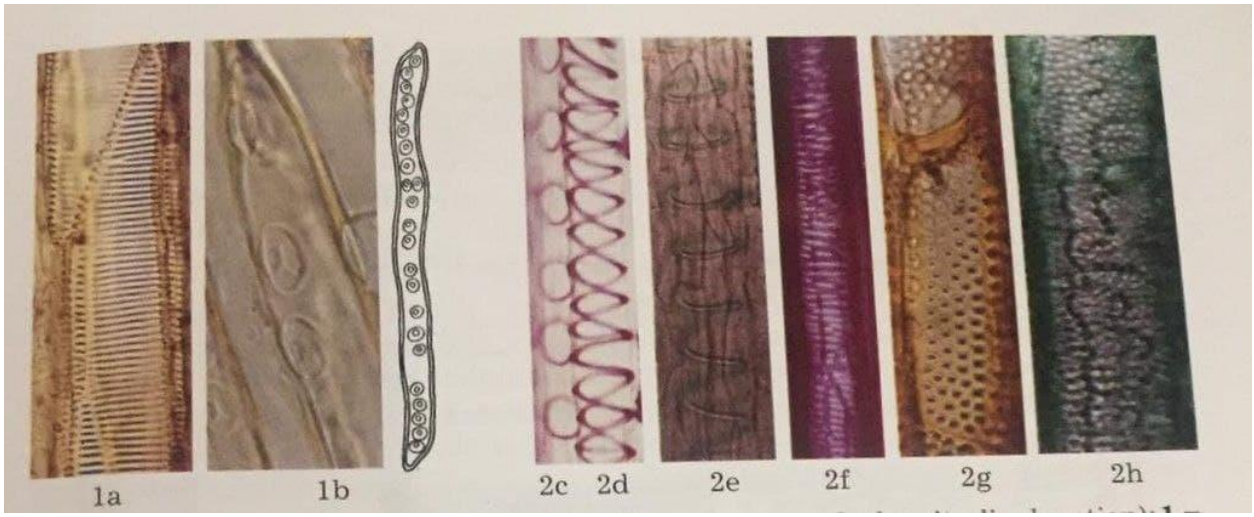
Sclerenchyma

Sclerenchyma cells are rigid and have thick, no stretchable secondary cell walls. They support and strengthen no extending regions of plants such as

mature stems, and are usually dead at maturity.

Conductive tissues

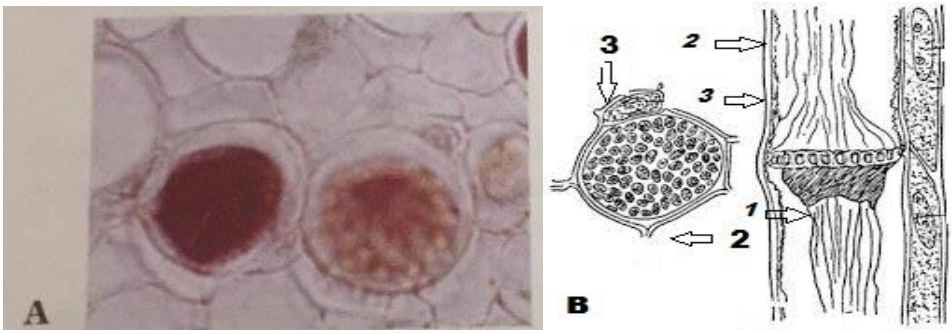
Conductive tissues provide locomotion through the plant of two streams of substances: *ascending current* that brings water and solution of mineral substances from the root to overground parts of plants and *descending current* that brings products of photosynthesis from leaves to all parts of plants. Ascending current is realized by tracheids and vessels of the descending current by sieve cells, sieve tubes with companion cells, or sieves without companion cells of phloem. *Tracheids* are the conductive elements of the xylem. They are dead prosenchymatous cells with mucronated tips and lignificated cell walls. Tracheids intercommunicate and conduct substances with the help of bordered pits. If they are absent, tracheids are similar libriform realizes the mechanical function. Tracheids similar to vessels can be spiral and porous *Vessels* are the most progressive conductive elements of the xylem. They are formed from cells of procambium or cambium, which stretch, their transverse walls perforate or solve, protoplast die off, cells walls become thicker and lignificated. The formed vessel is articulated capillary. Primary vessels are narrow, secondary ones are wide. According to the character of internal thickening of the wall and its apertures, there are annulate, spiral, reticulate, ladder-shaped, pitted vessels, etc. Between different types of vessels and separate segments that form a vessel, passages (annulate spiral vessel) are observed. Vessels function for a short time because they are occluded gradually by tillies that represent outgrowths of the parenchyma inside the *vessel.*



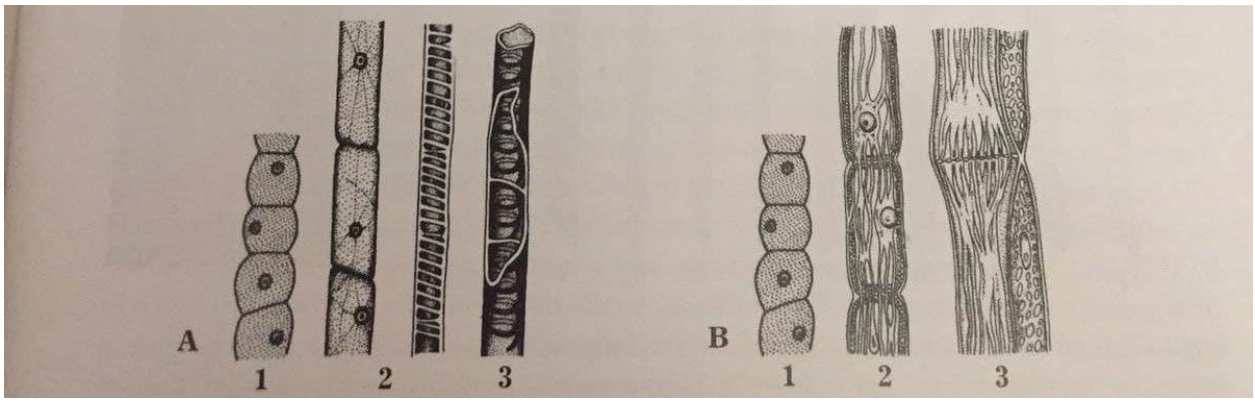
Conductive elements of the ascending current in the longitudinal section): 1 – tracheids: a – ladder thickenings, b – porous thickenings; 2 – vessels: c – annulate thickenings, d – spiral thickenings, e – spiro-annular thickenings, f – ladder-shaped thíckenings, g – pitted thickenings, h – reticulate thickenings.

Bast (or phloem) tissue is mainly composed of sieve-tube and companion

cells. Sieve tubes are formed from a row vertically situated.

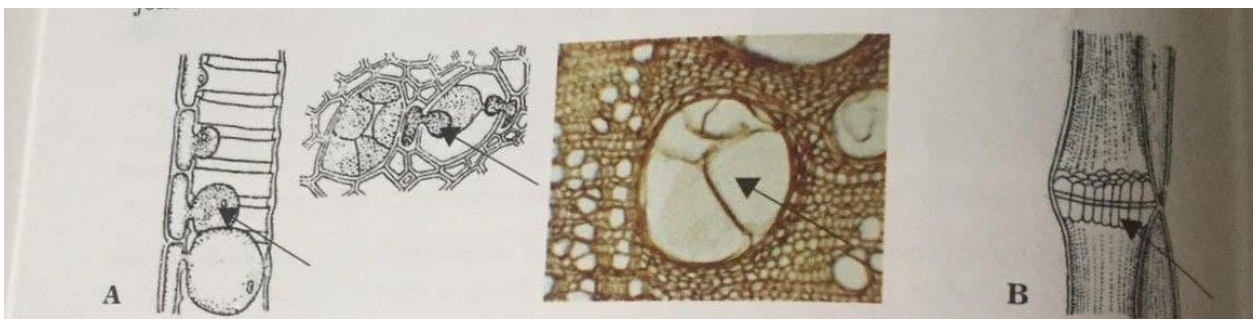


Conductive elements of the descending current (sieve tube with the companion cells): A – in the cross-section; B – in the longitudinal section; 1 – a segment of the sieve tube, 2 – sieve plate, 3 – companion cell.



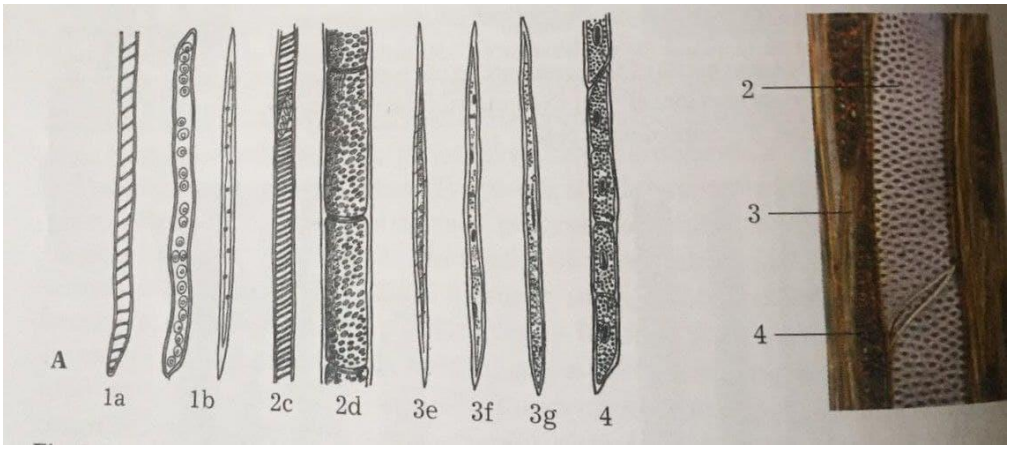
Formation of the vessel (A) and sieve tube with the companion cells (B): 1 – procambium or cambium, 2 – formation of the element, 3 – formed element.

The walls of sieve tubes are cellulose. Nuclei are destroyed and the cytoplasm loses selective capacity and irritability. Next to sieve tubes comparison cells are situated, which are formed from the longitudinal division of sieve tube segments. They are live cells with a nucleus, a dense cytoplasm, and a thin cellulose wall. Companion cells produce enzymes that proceed into sieve tubes and stimulate their work. In autumn the perforations of sieve plates are closed by calluses. In spring calluses can be dissolved and the work of the sieve tube commences. Conductive tissues do not pass through the plant independently. They join with other tissues and form complicated tissue xylem and phloem.



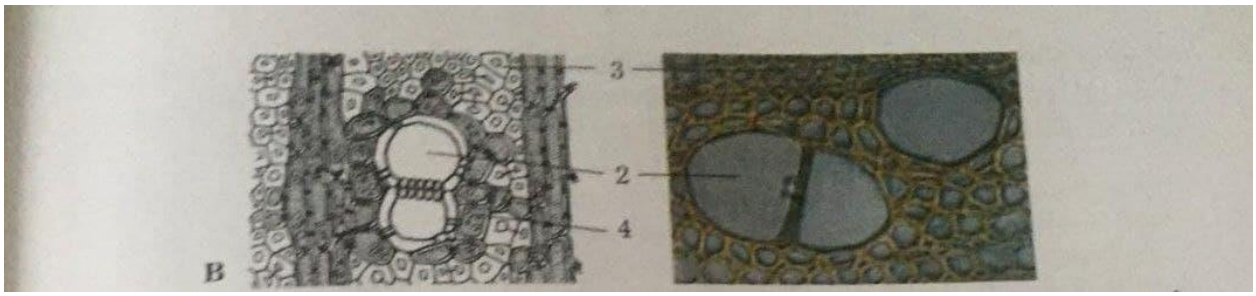
Age-specific changes in the conductive elements in the longitudinal section and the cross-section: A – tillys in the vessels; B – calluses body of the sieve tube.

Wood (or xylem) can be of primary or secondary origin. It consists of the conductive tissue – vessels and tracheids, the mechanical tissue – libriform (or wood fibers), the storage tissue – storage parenchyma.



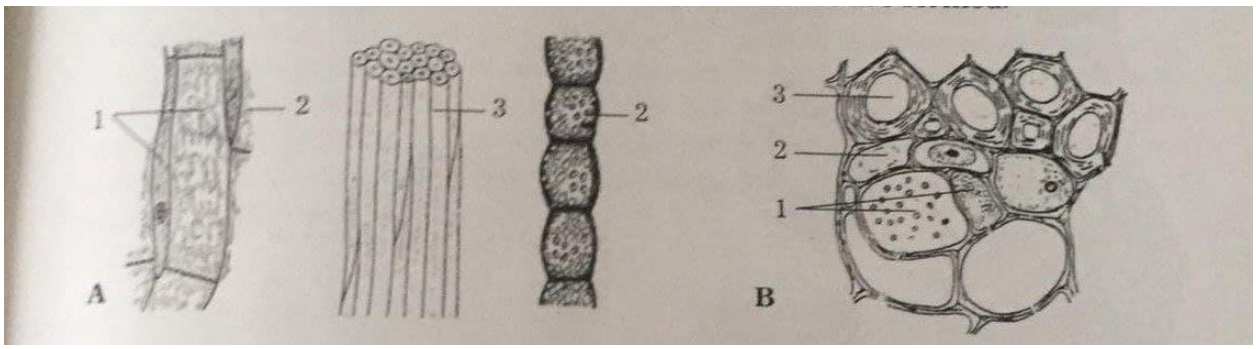
Elements of wood (or xylem): A – in the longitudinal section: 1 – tracheid spiral thickenings, b – porous thickenings; 2 – vessels: c – spiral thickenings, d – poan thickenings; 3 – libriform: e – wood-fiber, faster fiber, g – replacing fiber; 4 – wooden parenchyma.

Typical to the root absorption zone and are preserved in the root conductive zone of monocots. Monocots have the multiradiate bundle with more than 6 rays, and dicots can have at the most 6 rays of xylem.



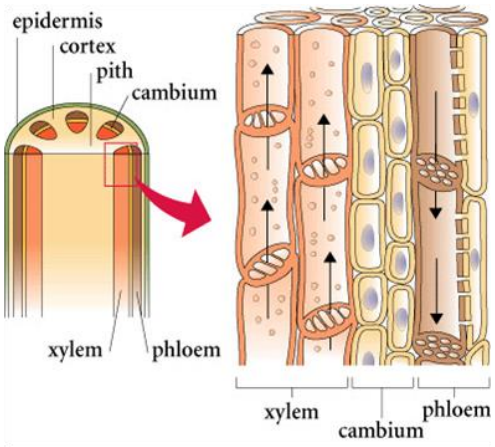
Elements of wood (or xylem) (continuation): B – in the cross section: 2 – vessels, 3 – libriform, 4 – wooden parenchyma.

Bast (or phloem) can be of the primary or secondary origin. It consists of conductive tissues – sieve cells (or sieve tubes) and companion cells, the mechanical tissue – bast fibers, and the storage tissue – bast parenchyma. Often in the phloem, lacticifers or other secretory structures are formed.



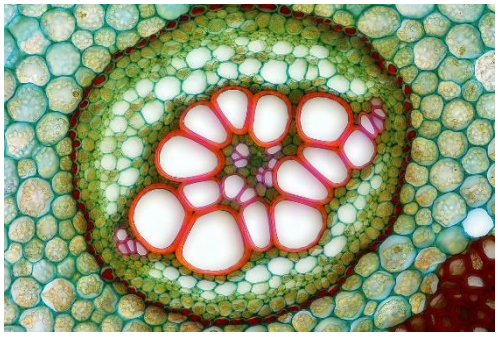
Elements of bast (or phloem): A – in the longitudinal section: B – in the cross- section; 1 – sieve tube with companion cells, 2 – bast parenchyma, 3 – bast fiber with cross striation.

Vascular tissues are specialized for long-distance transport of water and dissolved solutes. They ramify throughout the plant and are easily seen as veins in leaves. Vascular tissues typically contain transfer cells, secretory cells, and fibers in addition to parenchyma and conducting cells. Xylem and phloem are two kinds of vascular tissues in plants.



STUDY AND DETERMINATION OF VASCULAR STRUCTURE: RADIAL, CONCENTRIC, COLLATE AND BICOLLATERAL

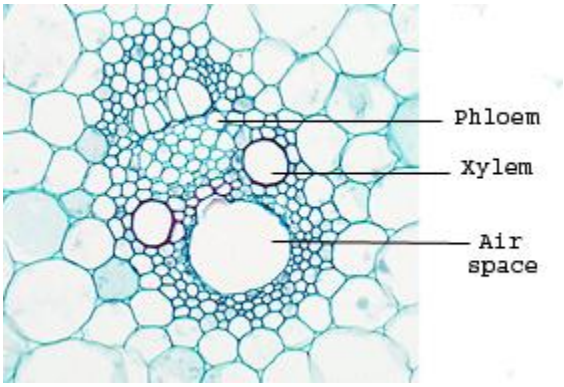
Vascular bundles are classified according to special relationships of xylem and phloem. There are several types of vascular bundles:



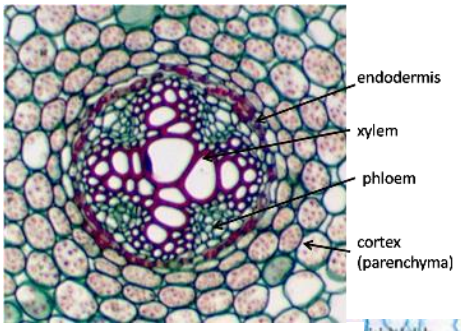
Concentric vascular bundle

1. collateral bundles have xylem on one side and phloem on the other side;
2. bicollateral bundles have phloem on both sides of the xylem;
3. concentric bundles which are divided into

– amphicribral – phloem surrounding the xylem;
– amphivasal xylem surrounding the phloem;
– radial bundles xylem occurs in radial directions, and phloem takes place between them.



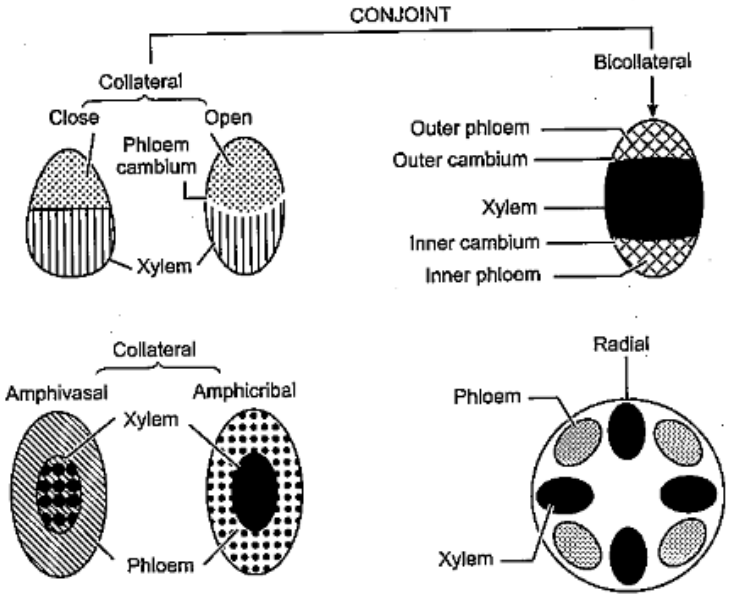
Collateral vascular bundle



Radial vascular bundle

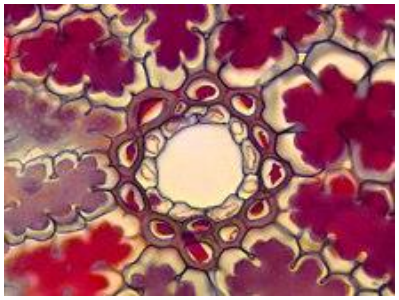
Bicollateral vascular bundle

All these types are typical for some divisions, classes, families, and plant organs. E.g.: radial polyarch vascular bundle is typical only for roots of monocot plants (dicot have radial tetrarch vascular bundle); closed collateral vascular bundle – for stems and leaves of monocot plants; opened collateral vascular bundle – for dicot and gymnosperm plant; bicollateral vascular bundle —only for some families of dicot plants (*Cucurbitaceae* (pumpkin family), *Solanaceae* (nightshade family), *Betulaceae*, *etc.*). Concentric vascular bundles are common only for rhizomes: with phloem inside – for monocot, with xylem inside – for ferns.



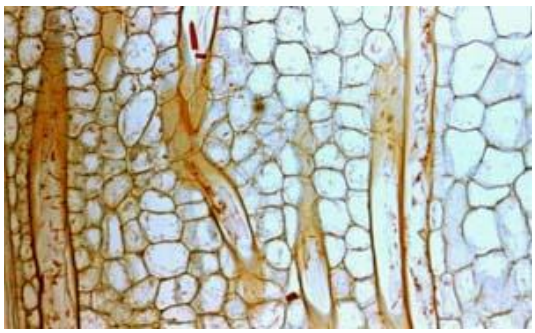
Various types of vascular bundle

STUDY AND DETERMINATION OF SECRETORY AND GROUND TISSUES STRUCTURE



Resin duct

Plants secrete a variety of substances from structures called secretory structures. Secretory structures are seldom classified as a separate type of plant tissue because they often integrate with other tissues. There are two types of secretory structures: external secretory structures and internal secretory structures. Ground tissue differentiates from the ground meristem and constitutes most of the primary body of the plant. Cortex and pith of stems and roots consist almost entirely of ground tissue. Ground tissue is covered by the epidermis and surrounds vascular tissues. It has several functions, including storage, basic metabolism, and support.

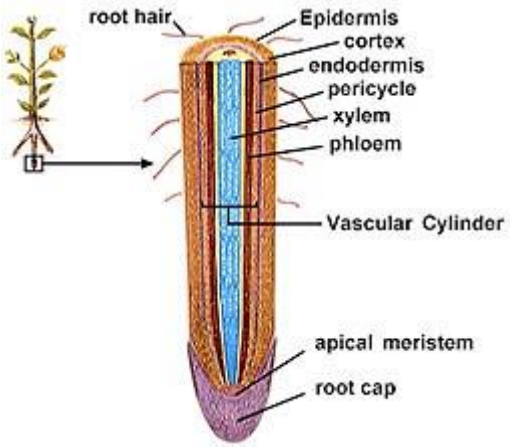


Laticifer

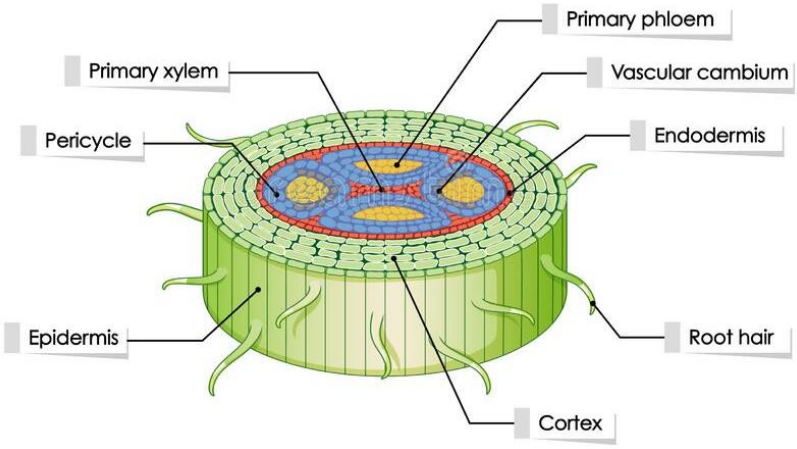
III. ANATOMIC STRUCTURE OF THE VEGETATIVE ORGANS

PRIMARY AND SECONDARY ANATOMICAL OF MONOCOT AND DICOT PLANTS ROOTS

The root is descending axis of the plant, normally below ground. The subapical region of roots has traditionally been divided into three regions: zones of cellular division, cellular elongation, and cellular maturation. Primary tissues differentiate in or distally to the zone of cellular maturation. The epidermis surrounds the root, which is usually one cell thick. The epidermis covers the entire root except for the root cap and usually lacks stomata. The epidermis is the cortex, which is formed by the ground meristem. The cortex usually occupies the largest cross-sectional area of the root and consists of three concentric layers: hypodermis, storage parenchyma cells, and endodermis. The stele includes all of the tissues inside the cortex. It consists of a pericycle, vascular tissues, and sometimes a parenchymatous pith. Xylem and phloem in roots alternate with each other. In monocot roots, the vascular bundle is polyarch, closed, and radial. In dicot roots with primary structure vascular bundle is closed, radial, and tetrarch. Dicot roots with secondary vascular bundle structure have opened collateral vascular bundles in the stele, which are arranged in a circle. Between them, there are wide medullary rays which starting in the primary xylem and are situated in the center of a root. Dicot roots with secondary non-bundle structure have a solid ring of vascular cambium, a solid zone of phloem above it, and a solid zone of xylem below cambium. In the center, there is primary xylem. Primary medullary rays stretch from it. Secondary rays are formed by cambium.



Root longitudinal section

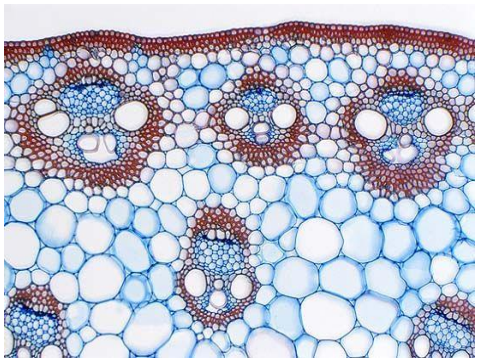


Cross section of dicot root

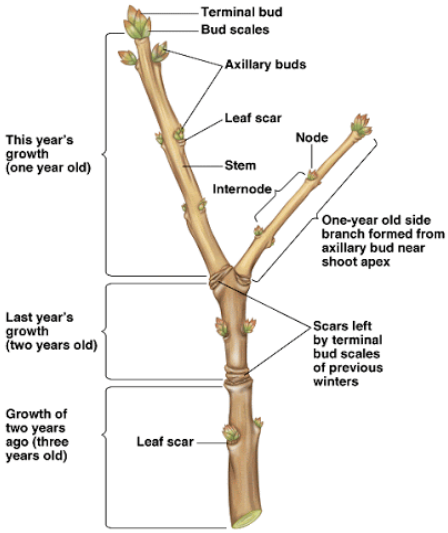
ANATOMICAL STRUCTURE OF MONOCOT PLANT STEM AND RHIZOME

The stem is a collection of integrated tissue arranged as nodes and internodes.

Most monocots are herbaceous plants that do not attain great size. Stems have neither a vascular cambium nor a cork cambium and, thus, produce no secondary vascular tissues or cork. As in herbaceous dicot, surfaces of the stem are covered by the epidermis, but xylem and phloem tissues produced by procambium appear in cross-section as discrete vascular bundles, scattered throughout the stem. The type of vascular bundle is closed collateral.



Cross section of corn stem

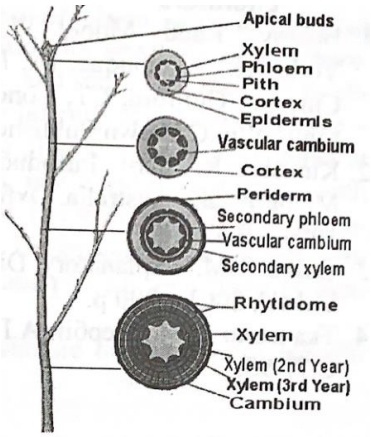


External structure of shoot

The rhizome of monocot has three zones: dermal, primary bark, and stele in the cross-section. Dermal tissue is the epidermis. Primary bark consists of oval crumbly cells of ground parenchyma, cells of endodermis are horseshoe-like, and endodermis is doubled (it is a diagnostic feature of lily of the valley). There are two types of vascular bundles in stele: closed collateral (near pericycle) and concentric centerphloem, which are chaotically arranged in the parenchyma. Pith is in the center.

ANATOMICAL STRUCTURE OF DICOT PLANT STEM AND RHIZOME

In general, plants that complete their life cycles within one year (annuals) have green herbaceous stems. Their tissues are largely primary, although cambium may develop some secondary tissues. Herbaceous dicot stems have discrete patches of xylem and phloem called vascular bundles, which occur in a ring that separates the cortex from the pith, although in a few plants xylem and phloem are produced as continuous rings. As previously noted, procambium produced only primary xylem and primary phloem.



Stem of dicot plant

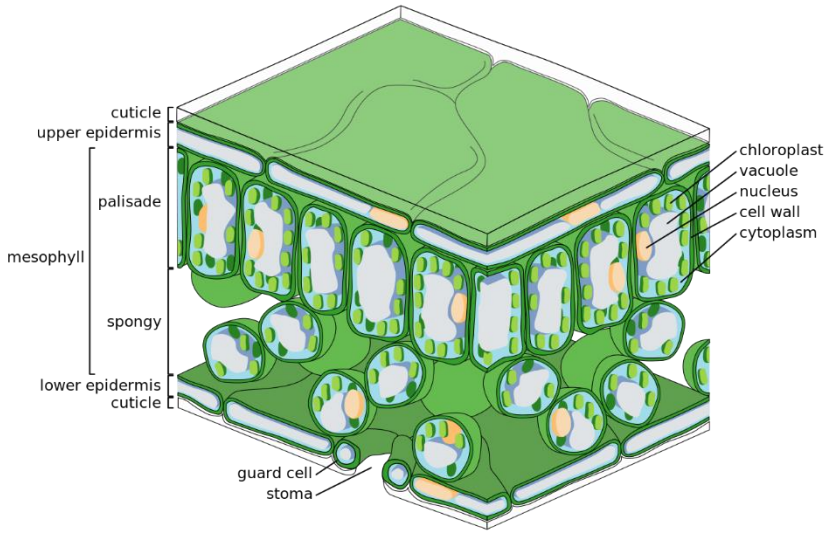
The arrangement of primary tissues in woody dicot stems is very similar to that found in herbaceous

dicot stems during the early stages of growth. As soon as the vascular cambium and the cork cambium start functioning, however, obvious differences begin to appear, the most conspicuous of which involve the secondary xylem, or wood.

Rhizome of dicot occurs vascular and nonvascular bundle structure.

ANATOMICAL STRUCTURE OF MONOCOT, DICOT AND CONIFERS LEAVES

If a typical leaf is cut transversely and examined with the aid of a microscope, three regions stand out: the epidermis, the mesophyll, and veins. The epidermis is a single layer of cells covering the entire surface of the leaf. The epidermis on a lower surface of the blade can sometimes be distinguished from the upper epidermis by the presence of stomata. Except of guard cells, upper epidermal cells contain no chloroplasts, their function being primarily protection of delicate tissues to the interior. A thin coating of waxy cutin (the cuticle) is normally present, although it may not be visible with ordinary light microscopes without being specially stained. In addition to the cuticle, many plants produce other waxy substances on their surfaces.

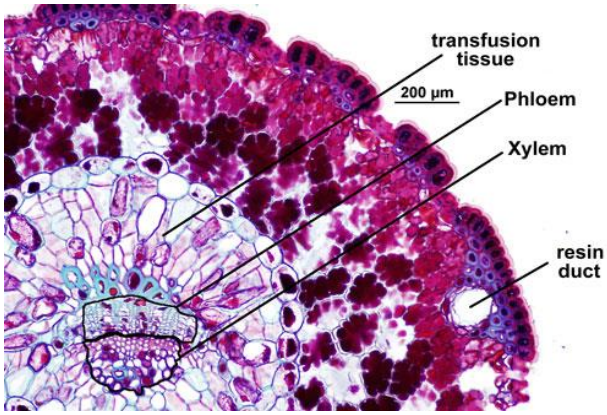


Cross section of leaf

The mesophyll (“middle leaf”) includes the major photosynthetic tissues: palisade parenchyma (is found only in dicot beneath the upper epidermis, may be one or more cell layers thick, depending on the plant, packed with chloroplasts; is a primary site of PSN in dicot); spongy parenchyma (is found in both monocot and dicot, in dicot, will be found below the palisade layer; in both, forms large air spaces for “storage” for carbon dioxide, oxygen and large surface area for absorption of carbon dioxide into cells, they also contain chloroplasts; major site of PSN).

In the center, we can observe veins. The veins contain vascular tissues.

Anatomical structures of leaves are of several types: isolateral (common

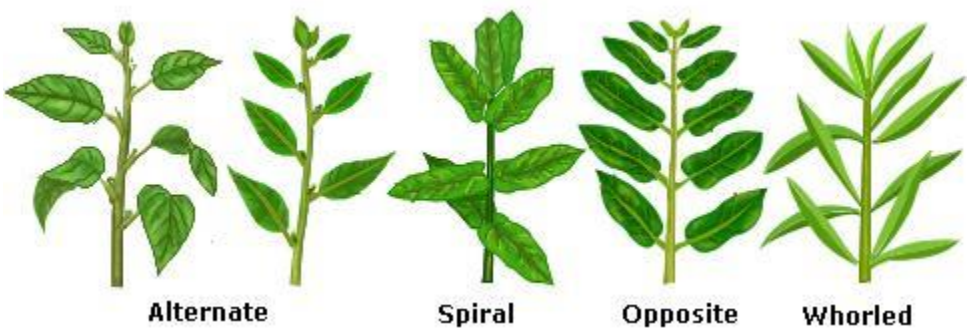


Cross section of pine

for monocot and dicot plants); bifacial (common for dicot); radial (common for gymnosperm).

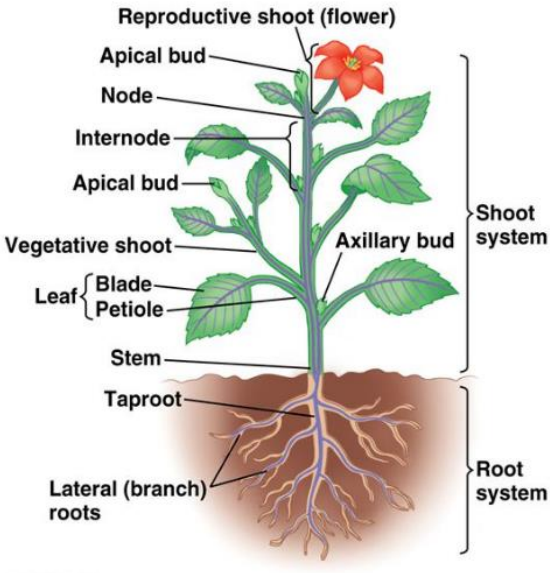
IV. MORPHOLOGY OF PLANT VEGETATIVE ORGANS

Ontogenetically, roots can have several sites of origin. Primary it has its origin in embryo, derived from a portion of the hypocotyl – the root axis. Later in development roots can have other sites of origin. Lateral (branch) roots typically arise from primary roots. Their origin is from the pericycle. Lateral roots arise endogenously from older root(s). In contrast, adventitious roots are those roots that



Types of phyllotaxis

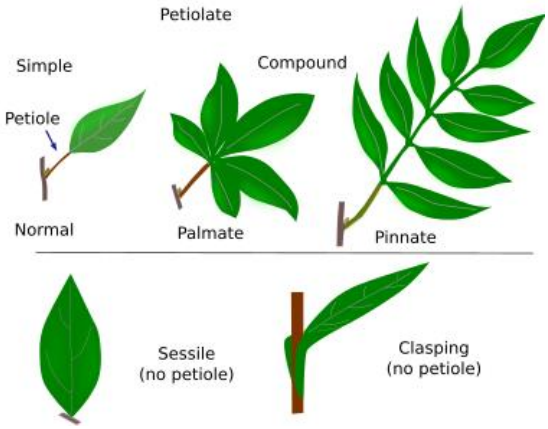
originate from tissues of other plant organs. Adventitious roots originate from stems or leaves. If the plant has a root system that is composed of one main root with only small lateral roots that plant is said to have a taproot system. Taproots are generally derived directly from radicle (embryonic root) and the root apical meristem. In contrast, some plants have a root system that is composed of many similar-sized roots. This type of system is called a fibrous root system. In this case, the primary root of the short-lived embryo and the majority of roots are lateral roots.



Dicot plant

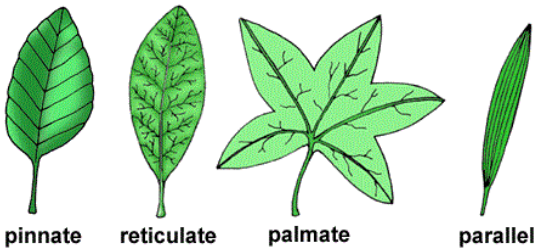
The stem is a collection of integrated tissue arranged as nodes and internodes. Nodes are regions where leaves attach to stems, and internodes are parts of stems between nodes.

The shape of the stem in cross-section may be different: cylindrical, triangular, square (e.g.: plants from the Lamiaceae family), elliptic, oval. According to position in space, stems are divided into straight, horizontal, clinging, and climbing. There are the following types of stem branching: dichotomic, monopodial, and sympodial.



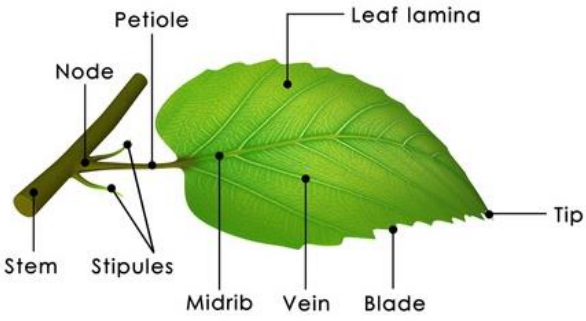
Leaf types

In general, the leaf consists of the blade – a flat part of the leaf, and the petiole – the stem attaching the leaf to the node of the stem. Leaves are divided into simple and compound. A simple leaf is a leaf with only one lamina. Leaves, which lack a petiole, are called sessile. A compound leaf is a leaf with two or more lamina (called leaflets). It is often difficult to distinguish a leaflet from a simple leaf; they look the same. It is important to keep in mind that the leaf is defined by its development and position, not just by its appearance. In general, compound leaves can be recognized by the absence of a bud at the base of the leaflet. There are several different types of compound leaves, including: palmate (leaves with the leaflets attached to a common point like the fingers of a human hand); pinnate/bipinnate/tripinnate (leaves with the leaflets aligned along a central stalk (called a rachis) like the tines of a comb); ternate/bitemate (leaves with three leaflets and in which terminal leaf is not stalked).



Types of venation

The arrangement of leaves on the stem is called phyllotaxy and there are several possibilities. Common types include **opposite** (two leaves per node), **alternate** (one leaf per node) and whorled (more than two leaves per node), and **rosulate**.



Leaf structure

Types of venation are parallel (seen in the monocots) and netted (seen in dicots). Dicot leaves may have pinnate venation or palmate venation. The Ginkgo tree, which is a gymnosperm, has leaves with dichotomous venation. It is unique.

OVERGROUND METAMORPHOSIS OF THE SHOOT AND ITS PARTS

A – thorns:

1– terminal thorn of the plum tree (*Prunus*)

2 – axillary (or lateral) thorn of the hawthorn or whitethorn (*Crataegus*)

B – tendril of the grape (*Vitis*)

C – strawberry shoots (*Fragaria*)

D – phylloclades of the butcher's-broom (*Ruscus aculeatus*):

E – succulent (sappy stem) of the cactus (*Cactus*)

F – gigantic bud (head of cabbage)

G – overground tuber of the kohlrabi (*Brassica gongiloides*)

UNDERGROUND METAMORPHOSIS OF THE SHOOT AND ITS PARTS

A – rhizome of the couch- grass (*Agropyron repens*)

B – tuber of the potato (*Solanum tuberosum*)

C – bulb:

1– simple (*Allium cepa*)

2 – complex (*Allium sativum*)

D – corm

V. MORPHOLOGY OF PLANT GENERATIVE ORGANS: FLOWERS AND INFLORESCENCE

There are the following parts of the flower: highly specialized shoot = the stem + leaves. In flowers, the shoot is highly modified and contains the reproductive structures. Certain flowers have a maximum of four different kinds of structures: sepals, petals, stamens, and carpels. The flower possessing all four of these is defined as a complete flower. If anyone (or more) of the four is absent, the flower is incomplete. The flower that has both male and female reproductive structures is perfect. Unisexual flowers are imperfect. Some flowers are actinomorphic (radially symmetrical) and others are zygomorphic (bilaterally symmetrical).

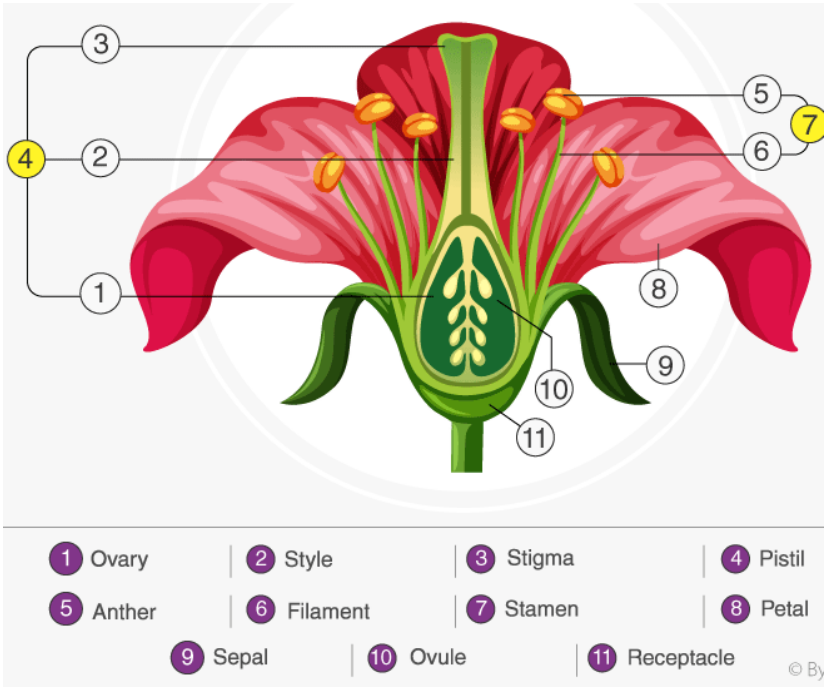
The flower is attached to the rest of the plant by a pedicel or peduncle. The pedicel expands at the top into a receptacle. The various whorls of floral appendages are attached to the receptacle. In a complete flower, the outermost whorl of appendages consists of sepals, collectively making up the calyx. They are often green and photosynthetic and can vary in number, shape, size, and function.

Moving toward the center of the flower, the next whorl of appendages is comprised of the petals, collectively the corolla. They are usually a color other than green and can again vary in an amazing variety of ways.

The calyx and corolla comprise the non-reproductive portion of the flower and are together referred to as the perianth. This term is applicable whether both whorls and only one are present. The reproductive parts of the flower occur in the inner two whorls. Inside the whorl of petals are the stamens. In the “typical” flower, the stamen is comprised of two parts, the filament, and the anther. Again, variation can occur in any feature of these organs. Collectively, the “male” reproductive organs of the flower are called androecium.

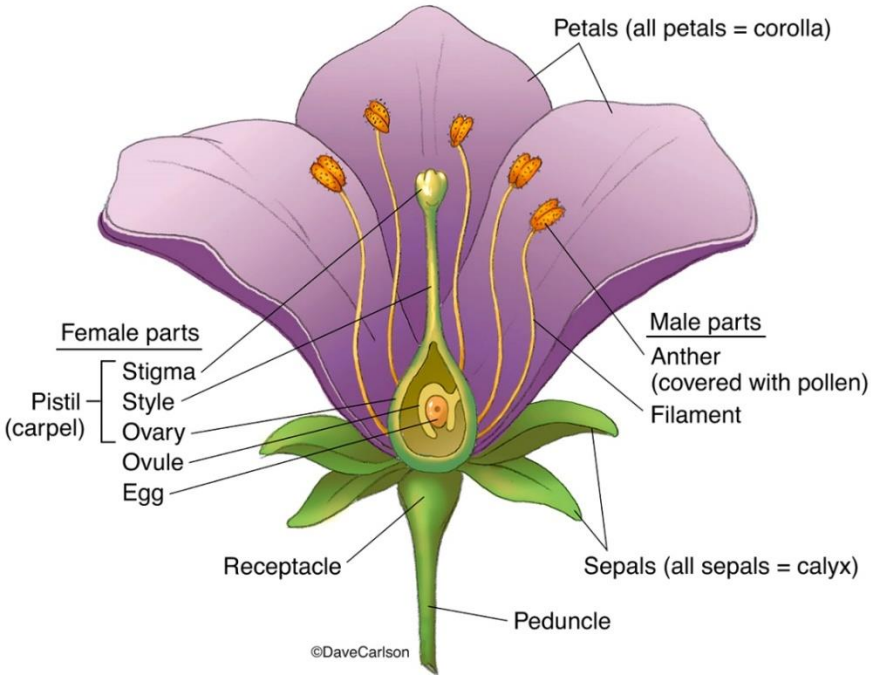
The “female” parts of the flower, the carpels, comprise the innermost whorl of appendages (although these may be fused into a single structure). The collective term for the carpels of a flower is gynoecium. In the “typical” flower carpel there are three parts: the stigma, the style, and the ovary. The carpels may be separate from each other or they may be fused into a compound ovary. Ovules are located inside the ovary, attached to a tissue called placenta.

The position of the ovary to the other parts of the flower is also variable. There are three different positions. A hypogynous flower has the other three whorls of appendages attached below the level of the ovary, resulting in a superior ovary position. An epigynous flower has the ovary sunken down into the tissue of the receptacle so that the point of attachment of the other flower parts is above the level of the ovary, resulting in an inferior ovary position. Some flowers have the other appendages located on a cup-like structure that comes about halfway up the ovary. This is a perigynous flower.



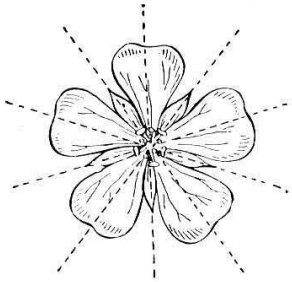
Flowers are grouped on plants in a variety of patterns. An inflorescence is a collection of flowers and there are many types of the inflorescence, ranging from solitary (a single flower terminating a branch) to much more complicated and crowded arrangements with various kinds of branching.

Flower structure

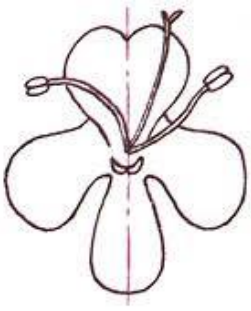


Flower symmetry

A – actinomorphous (or regular)



B – zygomorphous (or irregular, or bilateral)



C – asymmetrical

Flower types

The shape of the choripetalous corolla

A – actinomorphous

1– stellar

2 – cruciform

3 – carnation-shaped

B – zygomorphous (papilionaceous): Fabaceae

Flower corolla

The shapes of gamopetalous corolla:

A – actinomorphous

1 – tubular

2 – campaniform

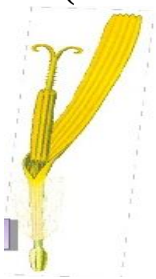
3 – tubular-campaniform-shaped

4 – ladybell-shaped

5 – funnelform

B – zygomorphous

1 – ligulate (or semifloret)



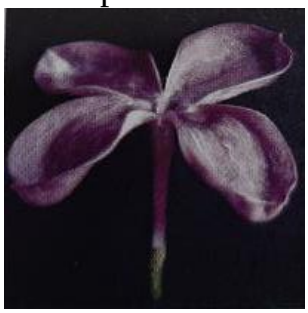
2 – false-ligulate

3 – funnelform

4 – thimble-shaped

5 – bilabiate

6 – patelliform



6 – unilabiate

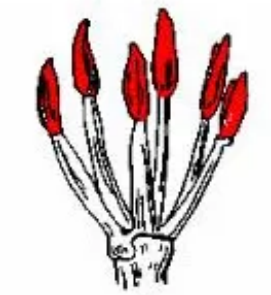
7 – rotate

7 – bilabiate with spur

Types of androecium

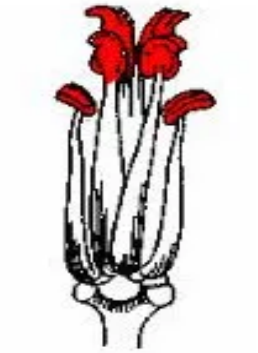
A – according to the size of stamens (relatively to each other):

1 – equal

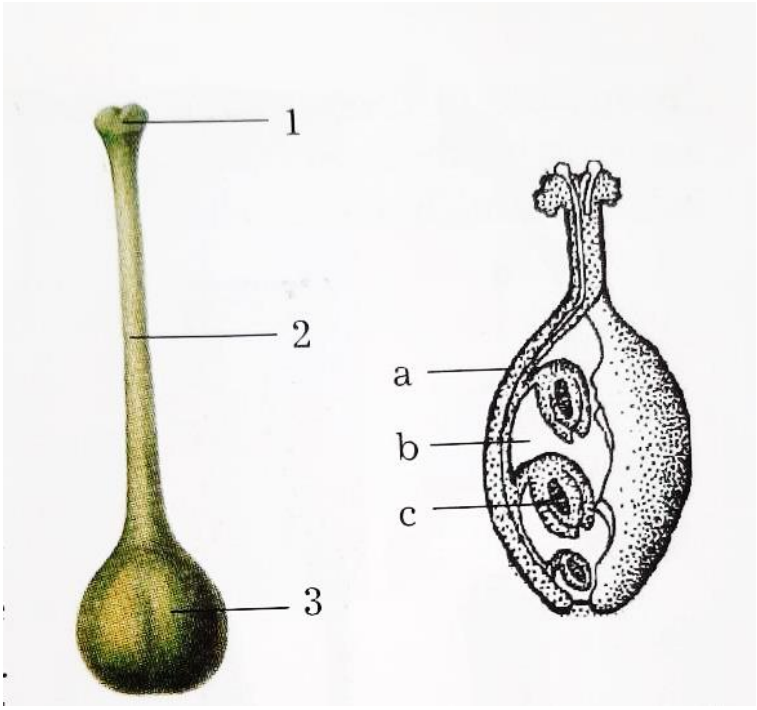


2 – didymous

3 – tetradymous



The structure of the pistil and its ovary



1 – stigma, 2 – style, 3 – ovary: *a – ovary wall, b – ovary nest, c – ovule.*

Types of gynoeceum

A – apocarpous **B** – monocarpous **C** – cenocarpous

The inflorescence

Flowers can be disposed separately, on the apex of the stem, in the axils, but mostly they are collected on the special shoot and form the inflorescence.

The biological importance of the inflorescences consists in increasing the guarantee of cross-pollination.

The inflorescence is a generative shoot with flowers and bracts. The inflorescence has a main axis and lateral axes of the first, second and subsequent orders. Flowers can be with the pedicles or without pedicles (flowers are called

sessile), have green or modified bracts, or coverings leaves.

There is the characteristic base of different classifications and morphological descriptions of the types of inflorescence:

- location on the shoot (apical and axillary);
- way of shoot growth (monopodial (or botryoid) and sympodial (or cymose));
- degree and order of the shoot branching (simple, compound homogeneous and heterogeneous, combined homogeneous and heterogeneous);
- presence or absence and character of bracts (leafed with green bracts (or frundous), leafed with scaly bracts (or bracteous), aphyllous (or bare, leafless);
- flower sex, which is included in the inflorescence (monogamous: pistillate bisexual flowers): (or female), staminal (or male) and polygamous are with the unisexual and sex activity closed (or indefinite), if the shoot apex appear early, it halts its ends with a flower, which blossoms before the underlying flowers;
- apex activity; closed (or indefinite), if the shoot apex appears early, it halts its growth, ends with a flower, which blossoms before the underlying flowers: opened (or definite) inflorescence, in the main axis has an unlimited growth, it does not end with a flower, the flowers blossom consistently from bottom to the top.

The simple monopodium inflorescences are opened or closed, with the sessile flowers or on the pedicles. The simple monopodial inflorescences are raceme, spike, spadix, catkin, head, corymb, umbel, anthodium.

A *raceme,* or *cluster* – the main axis is lengthened, flowers on the pedicles. A raceme is unilateral, bilateral, dense, friable, intermittent, upright, hanging and drooping. A *spike* – the main axis is lengthened; the flowers are sessile, alternate. A *catkin* or *ament* – the main axis is drooping, deciduous, the flowers are sessile, unisexual (e. g., poplar, willow). A *corymb* – the main axis is more or less well developed, the flowers are alternate and the pedicles of the lower flowers are longer than at the overhead ones, that is why the flowers are almost at one level (e. g., pear, hawthorn). An *umbel* – the main axis is strongly shortened, the pedicles are approximately identical.

There are the following *compound monopodial heterogeneous inflorescences*: panicle or anthodiums; compound corymb of the anthodiums.

Panicles. They are abundantly branching out axes of the following orders, bearing flowers, racemes (racemose panicle), or corymbs (corymbose panicle) on a

protractedly growing main axis. A *compound umbel* consists of the simple umbels, which are situated on the much shortened main axis. Near the base of the pedicle, axes can be bracts, which are formed involucre and involucels, respectively. A *compound spike* consists of the elementary inflorescences – the spikelets. A *compound corymb* has simple corymbs. Flowers are situated in the plane.

The lateral branching and sympodial growth are characteristics of the sympodial inflorescences. They are usually closed because an early appearing apex flower stops the development of the main axis. Growth of the inflorescence is continued by the underlying lateral shoot or lateral shoots of the following orders, which also end with flowers. The sympodial inflorescences are subdivided into the following types: monochasium, dichasium, pleiochasium (or false umbel), false whorl.

Sympodial inflorescences: monochasium: simple monochasium, winding, bostryx, glome; dichasium; pleiochasium (or false umbel); false whorl.

A *simple monochasium.* The main axes end with a flower. The lateral axis is the only one. A *compound monochasium* has a few lateral axes, every axis gins only from one outgrowing axis of the next order. A winding, or sulcus, vestryx, a glome are the varieties of the difficult monochasium. A *winding* has teral axes of different orders, which grow in different sides (e. g., gladiolus). A *bostryx* or *scorpioid.* The lateral axes of the second and following orders are directed to one side (e. g., potato, hog bean). A *glome* has very short lateral axes; flowers are situated close to each other (e. g., beetroot). Two lateral axes of the second and following orders are located opposite each other (e. g., carnation). *A pleiochasium or false umbel.* The lateral axes of the following order are located verticillate, carry flowers. *A false whorl or vertical.* It is the pleiochasium or dichasium with the short pedicles, located around the stem in one plane.

The *thyrses*, or *combined heterogeneous inflorescences* are characterized by the main axis, which grows monopodialy, lateral axes grow sympodialy, and the degree of the branching the inflorescence reduces to its apex. The thyrses can be closed and opened, with an alternate and opposite location. The raceme of the bostryxs, a raceme of the double winding, corymbose thyrses, spike-shaped thyrses, a catkin-shaped thyrsus, thyrses from false whorls are the examples of morphological variations of the thyrses.

SIMPLE MONOPODIAL INFLORESCENCES

A – raceme (or cluster),

B – spike

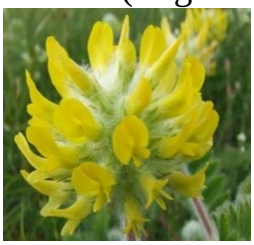
C – umbel

D – corymb (or pelta)

E – catkin (or ament)

F – spadix

G – head (or glome)



H – anthodium (or calathium)

COMPOUND MONOPODIAL HOMOGENEOUS INFLORESCENCES

A – panicle (or compound raceme)

B – compound spike

C – compound umbel

D – compound corymb

COMPOUND MONOPODIAL HETEROGENEOUS INFLORESCENCES

A – compound corymb of the anthodiums

B – panicle of the anthodiums

SYMPODIAL INFLORESCENCES

A – monochasium

1 – simple monochasium

2 – winding (or sulcus)

3 – bostryx (or scorpioid)

4 – glome

B – dichasium

C – pleiochasium (or false umbel).

THYRSES

A – raceme of bostryx

B – amentum-like

DIVERSITY OF FRUITS

Monocarpous fruits are formed from the monocarpous gynoecium. The ovary is superior.

The *follicle* is dry, explosive along the ventral suture, it is many-seeded (e.g., larkspur). *Legume* is dry, explosive along two sutures; seeds are attached to the valves (e.g., pea). *Loment legume* is dry, dehiscence crosswise into joints (e.g., tick trefoil). *Fleshy legume* is indehiscence fruit with fleshy pericarp. *Nutlet* is dry, indehiscence; one-seeded with solid pericarp (e.g., burnet). *Fleshy drupe* is

indehiscence; one-seeded, pericarp consists of exocarp (peel), fleshy mesocarp, and endocarp (or stone) (e. g., apricot). *Dry drupe* is indehiscent, one-seeded, in which mesocarp is semi-dry or dry and inedible (e.g., almond).

Apocarpous fruits are formed from the apocarpous gynoecium and superior ovary. There are dry and fleshy fruits and consist of carpels.

Three- follicle and *pollyfollicle* are dry fruits (e.g., aconite, delphinium). It consists of several follicles, which are explosive along one suture. *Polynutlet* consists of numerous dry indehiscent nutlets (e.g. buttercup). The nutlet can be represented by false fruits: *cynorodium* (e.g., dog-rose) – polynutlet, which is situated into a growing, fleshy convex receptacle – *hypanthium; phraga* (e.g., strawberry) – polynutlet, which is situated into a growing, fleshy convex receptacle; *sudmersed polynutlet* – nutlets are advanced into a solid receptacle (e.g., lotos). *Aggregate-accessory* fruit consists of numerous juicy acine; which are situated on the convex receptacle (e. g., raspberry). *Fleshy pollyfollicle* consists of numerous juicy, explosive, follicles in which an abdominal seam is well observed. (e.g., magnolia-vine).

Cenocarpous fruits are formed from the cenocarpous gynoecium. The ovary is superior or inferior. Cenocarpous fruits can be dry and fleshy indehiscent and dehiscence, fatiscent along (schizocarp), and transversely (a loment).

Schizocarpous fruits are divided in half, radially or into parts on mericarps. Schizocarpous fruits, which are formed from the superior ovary, are the following: coenobium (or tetranutlet) (e.g., labiate), kalatch (e.g., mallow). *Coenobium* is formed from cenocarpous bilocular ovary, where at the early stage of development an additional transverse partition dividing the ovary into four parts appears. That is why four-seeds fruit is formed. *Kalatch* is a fruit consisting of several mericarps situated in the receptacle around remains of the pistil in the form of "beak". The calyx with calicle remains in fruit. Such fruit is characteristic of representatives of the Malvaceae family. Schizocarpous fruits, which are formed from the inferior ovary, are the following: cremocarp (e.g., carrot, fennel, dill), disamara (e.g., maple), regma (e.g., euphorbia). *Cremocarp* is a fruit often divided into two mericarps drooping from filiform carpophore – the floral stalk divided into two. *Disamara* is a fruit divided into two mericarps, each having one wing – the stretched part of a dry, skinny pericarp. *Regma* is a fruit, in which mericarps open and fall out simultaneously and the column remains in the center.

Pseudomonocarpous fruits are dry, indehiscent one-seeded, and unilocular. They are formed from the cenocarpous gynoecium. Only one seed-bud is developed in the ovary after semination.

The *nut* is formed from the superior or inferior ovary with several carpels, which contain one ovule each. But only one carpel and ovule are developed

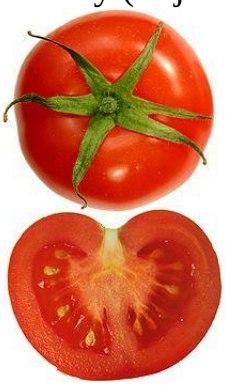
properly. Pericarp may be ligneous (e.g., hazel), or skinny (e.g., linden). Fruits often have leaf-like bracts (e.g., cupule of the hazel). *Winged nut* or *samara* is formed with two carpels from the superior ovary. There is a filmy growth on the border of the pericarp (e.g., birch). *Acorn* is formed with tree carpels, from the inferior ovary (e.g., oak). Pericarp is skinny. Acorn has a cup-shaped cupule which is formed from the imbricated, accrete, skinny leaflets. *Caryopsis* or *corn seed* is formed with two carpels, from the superior ovary. Only one seed is developed. The pericarp is glumaceous, it is adjacent densely on accretes with seed hull. *Cypsela* is formed with two carpels, from the inferior ovary. The pericarp is skinny and may be with pappus (e.g., dandelion), corona, and hapteron (e.g., beggars-ticks).

THE MAIN CLASSIFICATION GROUPS OF FRUITS

A. due to consistence of pericarp

1 – dry

2 – fleshy (or juicy)



B. due to way of the semen release

1– dehiscent (or explosive)

2 – indehiscent

C. due to the number of semen

1 – one-seeded

2 – many-seeded

D. due to the type of gynoeceum

1 – monocarpous

2 – apocarpous

3 – cenocarpous

Monocarpous fruits

A. follicle

B. legume

C. loment legume

D. fleshy legume

E. nutlet

F. fleshy drupe

Apocarpous fruits

A. three-follicle

B. pollyfollicle

C. polynutlet

D. phraga

E. cynorodium

F. aggregate-accessory fruit

Cenocarpous fruits

A. berry

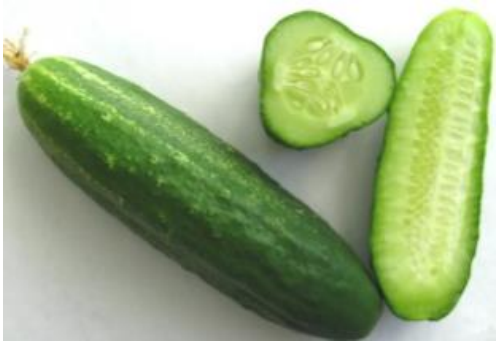
1– from superior ovary

2 – from inferior ovary

B. hesperidium

C. pirenarium

D. pepo



E. pome

F. granatum

G. silique

H. loment silique

I. silicle

J. fruitcase dehiscent

1– denticles

2 – holes

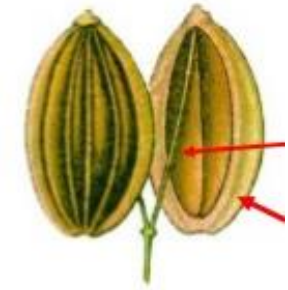
3 – lid

4 – seams

K. coenobium

L. kalatch

M. cremocarp



N. disamara

O. regma

Pseudomonocarpous fruits

A. acorn

B. nut

C. winged nut

D. caryopsis

E. cypsela

1 – without remains of calyx

2 – with coma

3 – with corona

4 – with hapteron

DIVERSITY OF COLLECTIVE FRUITS

Collective fruit (or *multiple fruits*) is aggregated of mature fruits, which developed from flowers of one dense inflorescence. Pedicles and axis of the inflorescence become fleshy and take part in fruit formation.

A. fig tree

B. pineapple

C. hop

D. alder

TESTS

I. PLANT CELL

1. The above membrane component of plant cells includes...
A. microfilaments
B. plasmalemma
C. microtubules
D. glycocalyx
E. cell wall

2. Cytoplasmic filaments, which go through pores of the cell wall, provide an interrelation of protoplasts and metabolism between them. They are …
A. microtubules
B. plasmodesmas
C. fibrils
D. microfilaments
E. cytoskeleton

3. Organic compounds of plant cells of non-carbohydrate nature include ...
A. pectin substances
B. inulin
C. fiber
D. waxes
E. mucus

4. As a result of the action of methylene blue solution on the cut of marshmallow root, secretory cells are colored blue. It indicates the presence of ...
A. glycogen
B. starch
C. mucus
D. inulin
E. lipids

5. While microscopical analysis of the leaves we discovered a thick layer of the lipoid substance. This is …
A. suberin
B. lignin
C. mucus
D. cutin
E. calcium carbonate

6. Under the action of chlorinziniodine the thickened, colorless cell walls of collenchymas turned violet. Thus, cell walls are …

A. lignified
B. cutinized
C. cellulose
D. mineralized
E. suberinized

7. Processing of the plant microslide with phloroglucinol with concentrated hydrochloric acid resulted in the crimson-red coloring of cell walls, which indicates the presence of …

A. pectin
B. cellulose
C. hemicellulose
D. lignin
E. suberin

8. Pericarp of nuts, the stone of cherry, the wood of stems are solid because they accumulated ... in their cell wall.

A. silica
B. chitin
C. lignin
D. suberin
E. calcium carbonate.

9. While the studies of a plant cell under a microscope it is indicated structures having the form of a heap of depressed membrane cisterns and bubbles. This is a…

A. endoplasmic reticulum;
B. Golgi apparatus
C. plastids
D. mitochondrion
E. calcium microbody

10. The cytoplasm of a plant cell is isolated from the cell wall by...

A. hyaloplasma
B. tonoplast (vacuolar membrane)
C. plasmalemma
D. nucleus envelope
E. endoplasmic reticulum

11. Green pigments of the plants are contained in ...

A. chromoplasts

B. amyloplasts
C. chlorophylls
D. proleoplasts
E. mitochondria

12. Carotin, phyllixanthin, and licopin are pigments, which color petals, fruits, and leaves of plants and are accumulated in ...
A. proteoplast
B. amyloplasts
C. chloroplasts
D. oleoplasts
E. chromoplasts

13. Plastids contain pigments that act as antioxidants and are provitamins. What are these pigments?
A. only chlorophylls
B. carotenoids
C. anthochlor
D. anthocyanins
E. cyanins

14. It is known that bluish-purple petal coloration of a plant under examination varies up to pink or light pink according to pH of cellular fluid of vacuole. It is caused by the presence of…
A. phycobilins
B. carotins
C. anthocyanins
D. chlorophylls
E. xanthophylls

15. Secondary reserve starch is formed in the ...
A. chromoplasts
B. chloroplasts
C. amyloplasts
D. oleoplasts
E. proteoplast

16. Microscopic examination of a potato tuber showed some cell inclusions that become blu-violet as affected by Lugol's iodine solution. These inclusions are…
A. drops of fatty oil
B. aleurone grains
C. inulin crystals

D. starch granules
E. calcium oxalate crystals

17. Starch is discovered by the action of Lugol's solution (dark and blue coloration) on the root. This starch is ...
A. secondary, preserve
B. primary, anabolic
C. secondary, transitional
D. primary, preserve
E. secondary, reserve

18. Thin cuts of Inula helenium roots are put into ethyl alcohol 96 %. While microscopical analysis of the cuts we found out spherocrystals. This indicates the presence of...
A. fat
B. starch
C. protein
D. mucus
E. inulin

19. On superficial preparation of Convallaria majalis (lily-of-the-valley) leaf bunches of needl-shaped crystals are distinguishable in cells-idioblasts of the mesophyll. These are…
A. cells of cystoliths
B. raphides
C. druses
D. singles crystals
E. stilloids

20. Investigated plant is determined as Urtica dioica on the basis of morphological diagnostic features. It is verified while the microscopical study by the present of the…
A. druses
B. cystolith
C. raphids
D. styloids
E. single crystals

21. The above membrane component of plant cells includes...
A. microfilaments
B. plasmalemma
C. microtubules

D. glycocalyx
E. cell wall

22. Cytoplasmic filaments, which go through pores of the cell wall, provide an interrelation of protoplasts and metabolism between them. They are …
A. microtubules
B. plasmodesmas
C. fibrils
D. microfilaments
E. F-cytoskeleton

23. Organic compounds of plant cells of non-carbohydrate nature include ...
A. pectin substances
B. inulin
C. fiber
D. waxes
E. mucus

24. As a result of the action of methylene blue solution on the cut of marshmallow root, secretory cells are colored blue. It indicates the presence of ...
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E. lipids

25. While microscopical analysis of the leaves we discovered a thick layer of the lipoid substance. This is …
A. suberin
B. lignin
C. mucus
D. cutin
E. calcium carbonate

26. Under the action of chlorinziniodine the thickened, colorless cell walls of collenchymas turned violet. Thus, cell walls are …
A. lignified
B. cutinized
C. cellulose
D. mineralized
E. suberinized

27. Processing of the plant microslide with phloroglucinol with concentrated hydrochloric acid resulted in the crimson-red coloring of cell walls, which indicates the presence of …

A. pectin
B. cellulose
C. hemicellulose
D. lignin
E. suberin

28. Pericarp of nuts, the stone of cherry, the wood of stems are solid because they accumulated ... in their cell wall.

A. silica
B. chitin
C. lignin
D. suberin
E. calcium carbonate

II. PLANT TISSUES

1. Investigated tissue has a large nucleus, thick cytoplasm without vacuoles; numerous mitochondria and ribosomes; poor developed endoplasmic reticulum; no crystals. This is ...

A. meristem
B. endosperm
C. periderm
D. epidermis
E. epiblema

2. Stem thickens due to the function of the …

A. apical meristem
B. lateral meristem
C. traumatic meristem
D. intercalary meristem
E. endodermis

3. The main role in the formation of lateral roots belongs to ...

A. cambium
B. procambium
C. pericycle
D. apical meristem
E. lateral meristerm

4. While the microscopical analysis of the perennial plant stem we find covering tissue of the secondary origin, which is formed by the activity of…

A. cambium
B. procambium
C. phellogen
D. cortex parenchyma
E. pericycle

5. Lenticels are discovered in the periderm of the perennial plant stem, they are formed by the activity of …

A. phellogen
B. procambium
C. cambium
D. cortex parenchyma
E. pericycle

6. While the microscopical analysis of the axis organ between secondary phloem and secondary xylem we find the tissue in the form of the multi-layer ring. Cells are alive, thin-walled, densely closed, flattened, and are situated in radial layers. So, this tissue is…

A. procambium
B. cambium
C. phellogen
D. pericycle
E. phelloderm

7. Covering tissue has root hairs, have no stoma; and cuticle. This is ...

A. exoderm
B. epidermis
C. periderm
D. velamen
E. epiblema

8. Microscopical examination of a transverse section of root revealed investing tissue consisting of thin-walled, closely joining cells with root fibrille. This tissue is called…

A. epiblem
B. root cap (pileorhiza)
C. epiderm
D. endoderm
E. periderm

9. In the leaf epidermis one can see complexes containing pairwise approximate semilunar cells with chloroplast. These are ...

A. trichomes
B. hydatodes
C. stomas
D. glandules
E. lenticels

10. Leaves of the plants Brassicaceae (Mustard) Family are covered by the epidermis, which has stoma apparatus with three subsidiary cells of different size. These types of stoma apparatus are called ...

A. paracytic
B. diacytic
C. anisocytic
D. anomocytic
E. tetracytic

11. The microscopical study of the leaf epidermis shows that stomas have four subsidiary cells, two of which are lateral and two are polar with regard to the slit. So, the type of stoma apparatus is…

A. diacytic
B. tetracytic
C. anisocytic
D. anomocytic
E. paracytic

12. While the microscopical study of the triennial stem on the cross-section we detected covering tissue, which consists of densely close dead brown cells, with thick cell walls, which impregnate with suberin. This is…

A. epihlema
B. cork
C. epidermis
D. collenchyme
E. chlorenchyma

13. When studying the stem covered with periderm researchers have concluded that gaseous exchange takes place through…

A. stomata
B. hydatodes
C. lenticels
D. pores
E. throughput cells

14. While the microscopical analysis we find complex tissue, which consists of periderm aggregate. This is ...

A. exoderm
B. epidermis
C. epiblema
D. cortex
E. velamen

15. Plants of the Lamiaceae Family have rounded exogenous secretory structures with a short unicellular stalk and 8-12 radially situated secretory cells. These are ...

A. hydatodes (or water stomas)
B. nectarines
C. osmophores
D. essential oil glandules
E. glandular hairs

16. While the microscopical analysis of the plant (in the epidermis) we discover glandules, where cells are situated by two cells in 3-6 layers, so the plant belongs to the Family

A. Lamiaceae (Mint)
B. Scrophulariaceae (Figwort)
C. Solanaceae (Potato)
D. Apiaceae (Carrot)
E. Asteraccae (Sunflower)

17. Microscopical examination of the leaf revealed water stomata on its serration. These stomata are for exudation of liquid drop moisture. This process is called

A. transpiration
B. photosynthesis
C. guttation
D. internal secretion
E. gas exchanger

18. In the flower we determine secretory structures, which excrete a sugary solution that attracts pollinators. This is…

A. sticky hair
B. osmophores
C. stinging hair
D. **nectaries**
E. hydathodes

19. The studied tissue has a large nucleus, a thick cytoplasm without vacuoles; numerous mitochondria and ribosomes; a poor developed endoplasmic reticulum; no crystals. This is …

A. epidermis
B. meristem
C. endosperm
D. periderm
E. epiblema

20. Leaves of the plants Mustard (Brassicaceae) family are covered by the epidermis, which has stoma apparatus with three subsidiary cells of different size. These types of stoma apparatus are called …

A. diacytic
B. paracytic
C. anomocytic
D. anisocytic
E. tetracytic

21. When studied stem covered with periderm researchers have concluded that gaseous exchange takes place through

A. pores
B. lenticels
C. hydathodes
D. stomata
E. throughput cells

22. Essential oil glandules that consist of 8 secretory cells placed in 2 lines and 4 tiers are typical for most plants of the following family

A. Lamiaceae (Mint)
B. Solanaceae (Nightshade)
C. Asteraceae (Sunflower)
D. Scrophulariaceae (Figwort)
E. Apiaceae (Carrot)

23. On the cross-section of the Citrus exocarp we discovered large secretory structures without epy exact outline. This is …

A. schizogenous conceptacle
B. cells-idioblast
C. lysigenous conceptacle
D. articulate lacticifer
E. non-articulate lacticifer

24. The microscopical examination of a leaf revealed water stomata on its serration. These stomata are for exudation of liquid drop moisture. This process is called
A. photosynthesis
B. transpiration
C. internal secretion
D. gas exchange
E. **guttation**

25. While the microscopical analysis of the leaves we discovered structures, which consist of long stalk and small secretory multicellular head. They are …
A. covering hairs
B. stringing hairs
C. hydathodes
D. glandular hairs
E. thorns

26. While the microscopical analysis we find complex tissue, which consists of alive cells with thickened and cutinized external cell walls, stomas, and hairs. This is …
A. epidermis
B. periderm
C. cortex
D. epiblema
E. velamen

27. Cambium is a …
A. covering tissue
B. primary meristem
C. secondary meristem
D. conductive tissue
E. basic tissue

28. While the microscopical analysis of the axis organ between secondary phloem and secondary xylem we find a tissue in the form of the multi-layer ring. Cells are alive, thin-walled, densely closed, flattened, and are situated in radial layers. So, this tissue is …
A. procambium
B. phellogen
C. pericycle
D. cambium
E. phelloderm

29. The cells of leaf mesophyll are elongated, densely close with thin, straight walls and large quantity of chloroplasts, so, chlorenchyma is …
    A. spongy
    B. palisade
    C. folded
    D. storage
    E. aerenchyma

30. A characteristic feature of strengthening tissues of plants is that such tissues consist essentially of dead cells. However, there exists one type of strengthening tissues consisting of living cells. What contains a living protoplast?
    A. sclereids
    B. libriform
    C. collenchyma
    D. perivascular fibers
    E. bast fibers

31. While the microscopical analysis of the longitudinal section of the flax (Linum) stem on the periphery we find groups of tightly closed prosenchymatous cells with pointed ends and strongly thickened lamellar cellulose cell walls, which are penetrated with oblique pores. So, this is …
    A. wood fibers
    B. cortex fibers
    C. tracheids
    D. bast fibers
    E. vessels

32. On the cross-section of the pumpkin (Cucurbita) stem it can be well seen that open conductive bundles have two parts of phloem: inner and outer. These bundles are
    A. collateral
    B. radial
    C. bicollateral
    D. concentric with the phloem in the center
    E. concentric with the xylem in the center

33. While the microscopic analysis of the rhizome we have found centroxylem conductive bundles, so the plant belongs to …
    A. fern
    B. algae
    C. dicot
    D. monocot
    E. gymnospermae

34. Descending stream of organic substances from leaves to all plant organs is provided by …
    A. vessels
    B. tracheids
    C. bast fibers
    D. sieve tubers
    E. wood fibers

35. In the pulp of leaves (tea, begonia, ivy) sclereids that are dumbbell-shaped or have a form of tubular bones. They are ...
    A. macrosclereids
    B. threalike sclereids
    C. astrosclereids
    D. osteosclereides
    E. brachysclereids

36. The cells of leaf mesophyll are elongated, densely close with thin, straight walls and large quantity of chloroplasts, so, chlorenchyma is …
    A. spongy
    B. folded
    C. palisade
    D. storage
    E. aerenchyma

III. ANATOMY OF THE VEGETATIVE ORGANS

1. Conductive bundle is discovered on the cross-section of the axis organ; its phloem and xylem are situated separately, which take turns radially. So, this type of bundle is ...

A. radial
B. centroxylem
C. centrophloem
D. collateral
E. bicollateral

2. On the root section of Helianthus annuus a secondary fascicular structure was found. This means that the section has been made in the zone of…

A. absorption
B. growth and elongation
C. cell division
D. fixation and conduction
E. root cap (pileorhiza)

3. While the microscopical study of the root cross-section we determine cover tissue, which consists of thin-walled, tightly closed cells with root hairs. This is ...

A. epiblema
B. root cap
C. periderm
D. endoderm
E. epiderm

4. While the microscopical analysis of the root cross section of a dicot plant made in the absorption region we discovered a line of cells with lenticular suberizing thickening-Casparian strips. These are cells…

A. endoderm
B. exoderm
C. mesoderm
D. pericycle
E. central cylinder

5. While the microscopical study of the primary cortex of the root we determine under epiblema 3-4 lines of big, multangular, and tightly deed cells with partly suberized cell walls. This tissue is ...

A. mesoderm
B. endoderm
C. exoderm
D. epiblema
E. phellogen

6. In the root of the primary structure storage substances are reserved in…

A. mesoderm
B. pericycle
C. endoderm
D. central cylinder
E. exoderm

7. On the cross-section of the beet edible root we see some rings of the cambium. They form additional conductive bundles and storage parenchyma So, the structure of this edible root is…

A. secondary, rmonocambial
B. secondary, polycambial
C. primary, polycambial

D. primary, monocambial
E. transitional, monocambial

8. On the slides of the bark stem of Tillia cordata (small-leaved lime) there were determined dense strands of fiber which are the part of ...
A. pith rays;
B. soft bast;
C. spring xylem;
D. lamellar collenchyma;
E. hard bast

9. While microscopical analysis of the phloem stem we find complex such histological, elements as sieve tubes with companion cells, bast fibers, bast parenchyma. It's typical for ...
A. bryophytes
B. gymnospermous
C. fern
D. angiospermous
E. club mosses

10. The studied stem has gum ducts, in bast there no companion cells and in the wood there no vessels. Spring tracheids carry out the conductive function and autumn tracheids - mechanical function. These anatomy features are typical for ...
A. Tillia (small-leaved lime)
B. Betula (birch)
C. Pinus (pintree)
D. Helianthus (sunflower)
E. Cucurbita (pumpkin)

11. While the microscopical study of the rhizome cross-section of the monocot plant we determine that cells of the inner layer of primary cortex have U-shaped thickenings of the cell walls. This tissue is ...
A. pencycle
B. phellogen
C. exoderm
D. endoderm
E. epiblema

12. While the microscopical study of the pine leaf we find that layer thick-walled cells, which carry out protective and mechanical function, is situated under the epidermis. This is…

A. hypodermis
B. endodermis
C. crystalliferous
D. collenchyma
E. sclerenchyma

13. Investigated axial organ without nodes has radial symmetry, positive geotropism, provides mineral nutrition, and anchoring in the soil. This organ is …
A. stem
B. leaf
C. root
D. rhizome
E. seed

14. From the given underground organs we choose metamorphoses of the root, namely …
A. tubers of potato
B. rhizomes of Convallaria majalis (lily-of-the-valley)
C. edible root of carrot
D. bulbs of garlic
E. corms of saffron

15. A plant has an erect stem with only one leaf growing from each node. What phyllotaxy is characteristic of this plant?
A. parallel
B. verticillate
C. opposite
D. alternate
E. dichotomous

16. Hop sprouts wind around support and climb upwards. That means that they are
A. creeping
B. erect
C. recumbent
D. tenant
E. trailing

17. Examination of a medicinal plant revealed that its underground organ had nodes, internodes, scals-haped, buds and secondary roots. Therefore, this underground organ is

A. tuber
B. rhizome
C. stolon
D. storage root
E. root bulb

18. If each node of the stem has more than two leaves, this leaf arrangement is...
A. spiral
B. arranged opposite
C. cross-arranged opposite
D. rosette
E. whorled

19. The examination of a medicinal herb revealed that its leaves were divided down to the base of the leaf blade with segments radiating from a common point in a fan manner. These leaves are
A. pinnatipartite
B. pinnatisected
C. palmatisected
D. palmatipartite
E. palmatilobate

20. On the slides of the bark stem of Tillia cordata (small-leaved lime) there have been determined dense strands of fiber which are the part of …
A. soft bast
B. spring xylem
C. hard bast
D. lamellar collenchyma
E. pith rays

21. The studied stem has gum ducts, in bast there are no companion cells and in woods, there are no vessels. Spring tracheids perform the conductive function and autumn tracheids – the mechanical function. These anatomic features are typical for …
A. Betula (birch)
B. Tillia (small-leaved lime)
C. Pinus (pintree)
D. Helianthus (sunflower)
E. Cucurbita (pumpkin)

IV. MORPHOLOGY OF THE VEGETATIVE ORGANS

1. Investigated axial organ without nodes has radial symmetry, positive geotropism, provides mineral nutrition, and anchoring in the soil. This organ is ...

A. stem
B. root
C. leaf
D. rhizome
E. seed

2. From the given underground organs we choose metamorphoses of the root, namely ...

A. tubers of potato
B. edible root of carrot
C. rhizomes of Convallaria majalis (lily- of-the-valley)
D. bulbs of garlic
E. corms of saffron

3. The studied mycorrhia of Ouercus robur (English oak) the symbiosis roots of the higher plant with ...

A. fungus
B. alga
C. nitrogen-fixing bacteria
D. lichen
E. cyanobacterium

4. The apical bud of the generative shoot early stops its development, and growth and branching of the inflorescence are provided by two lateral buds, which are situated oppositely under the apex. So, shoot grows ...

A. tillering
B. equaldichotomic
C. monopodialy
D. unequal-dichotomic
E. pseudodichotomic

5. Among the given specimens of aboveground shoot metamorphoses there are such, that develop from lateral buds in leaf angle and provide vegetative reproduction. These are ...

A. bulbs
B. stolons
C. air bulbils

D. tubers
E. shoot

6. The macroscopical analysis of the branch of the Crataegus (hawthorn) with a thorn testifies, that the thorn is a metamorphosis of the ...
A. petiole
B. stipules
C. leaf blade
D. shoot
E. cells of the epidermis

7. While the investigation of the medicinal plant we find, that its underground organ has nodes, internodes, filmy leaves, buds and adventitious roots, so this is ...
A. edible root
B. rhizome
C. tuber
D. bulb
E. corm

8. On the considered underground organ there are well-seen nodes in the form of scars, reduced to scales leaves, additional roots, and buds. This is…
A. corm
B. tuber
C. root
D. rhizome
E. bulb

9. The Lamiaceae (Mint) family plants have the property that couples of leaves in two neighbor node are situated in mutually antithetic planes
A. distichous crosswise opposite
B. crosswise
C. whorled
D. turbinal
E. contortuplicate

10. Leaf has one main vein from which lateral veins go away evenly. This type of venation is called…
A. arcuate
B. palmate
C. pinnate
D. parallel

E. dichotomous

11. While analyzing the officinal raw material it is determined, that leaves are cut up to the base of the blade, its segments are situated fan-like. So, these leaves are…

A. pinatisected
B. palmatisected
C. palmatipartite
D. pinnatipartite
E. palmatilobate

12. Low stem leaves of the Leonurus cardiaca are divided until the middle of the lamina into 3 or 5 parts. This means that they are

A. impuri - pinnaticornpound
B. tripartit or palmatidissected
C. tripartit or palmaticompound
D. tripartit or palmatipartite
E. impari-pinnalipartite

13. Leaves of the Pisum sativum (pea) attach to the prop with help of the tendrils. These tendrils are metamorphoses of ...

A. petiole of the compound leaf
B. leaflets of the compound leaf
C. simple leaves
D. petioles
E. stipules

14. Leaves of the Acacia (myall) have overgrown flat petioles, which carry out photosynthesis function. They are called ...

A. cladode
B. thorns
C. tendril
D. phyllode
E. pitcher leaf

15. While the morphological study of the plant it is indicated that at the base of the compound leaf there are paired thorns, they are a metamorphosis of the ...

A. rachises
B. leaflets
C. stipules
D. petiolules

E. petiole

16. Low stem leaves of the Leonurus cardiaca are divided until the middle of lamina into 3 or 5 parts. This means that they are:

A. tripartitor palmatipartite
B. tripartit or palmatidissected
C. tripartit or palmaticompound
D. impari-pinnaticompound
E. impari-pinnatipartite

17. Roots of the plants Fabaceae (Legume) family are determined by the presence of …

A. fungus-roots
B. reproductive buds
C. root nodules on the roots
D. corm
E. bulbs

18. The studying of the main root ontogenesis showed that the root is generated from…

A. embryo root of the seed
B. apical meristem
C. pericycle
D. lateral meristem
E. intercalary meristem

V. MORPHOLOGY OF THE GENERATIVE ORGANS

1. Dissected flowers of the lily-of-the-valley have 6 white leaflets which connate into the lady bell-shape. This perianth is ...

A. simple corolliform
B. simple calyciform
C. double with orolliform calyx
D. double with calyciform calyx
E. double calyciform

2. Corolla is zygomorphous, gamopetalous, consists of tuber and two free parts – upper is formed by two and lower by three accrete petals. Corolla of such type is…

A. ligulate
B. unilabiate
C. larvform

D. thimblform
E. bilabiate

3. Androecium was considered in the flower. It consists of two long and two short stamens. So, the androecium of the flower is ...

A. tetradelphous
B. tetradymous
C. diadelphous
D. didymous
E. polyadelphous

4. Flowers of Brassica oleracea (cultivated cabbage) have four long stamens and two – short. So, the type of the androecium is ...

A. tetradymous
B. didymous
C. monoadelphous
D. diadelphous
E. polyadelphous

5. In Adonis vernalis (adonis) flower gynoecium consists of numerous free carpels, it is ...

A. lysicarpous
B. monocarpous
C. syncarpous
D. paracarpous
E. apocarpous

6. Dissected flower has inferior ovary, since the pistil is ...

A. cenocarpous, receptacle is concave, accrete with ovary
B. cenocarpous, receptacle is concave, not accrete with ovary
C. monocarpous, receptacle is concave, accrete with ovary
D. monocarpous, receptacle is flat, not accrete with ovary
E. monocarpous, receptacle is convex, not accrete with ovary

7. The common feature of the inflorescences of Plantago major (plantain) (spike) and Zea mays (maize) (spadix) is the presence of sessile flowers on well-developed main axis, which grows monopodialy, that is typical of the inflorescences….

A. aggregate
B. botryoid compound
C. cymose
D. botryoid simple

E. thyrsus

8. Monopodial inflorescences of plantain (spike) and maize (car) have one trail in common: their flowers are placed on the well-developed principal axis. This is typical for the following inflorescences….

A. cvmose
B. thyrsus
C. complex botrioid
D. simple botrioid
E. aggregate

9. Acorus calamus has inflorescence, which consists of numerous small sessile flowers, situated on the thick fleshy axis. So, this is ...

A. spadix
B. spike
C. umbel
D. corymb
E. head

10. The flowers of Astragalus dasyanthus (milk vetch) sit on the shorted and thickened main axis, forming a simple inflorescence, which is called ...

A. spike
B. corymb
C. catkin
D. panicle
E. glome

11. The Cerasus vulgaris (cherry-tree) has shorted main axes of inflorescence, its pedicles are about of equal length, and they grow from one point. This is typical for inflorescence ...

A. umbel
B. corymb
C. raceme
D. spike
E. anthodium

12. The birch has compound male and female inflorescences, the main axis is drooping. It consists of dichasiums of unisexual flowers. So, the inflorescence of the birch is

A. spadix
B. raceme
C. catkin

D. spike
E. glome

13. During the field practice the student determines the plant which has inflorescence with horizontal overgrown axis, sessile flowers, and leaf involucre, so this inflorescence is ...

A. anthodium
B. spike
C. com
D. glome
E. panicle

14. During the field practice the student found a plant with a disk-shaped structure of its rachis, sessile flowers, and husk. This inflorescence is called:

A. spadix
B. glomus
C. raceme
D. spike
E. anthodium

15. In the inflorescence of Ledum palustre (wild rosemary) the main axis is shorted, the nodes are brought together, flowers arc situated approximately on the same level. So, this inflorescence is ...

A. clove
B. corymb
C. bostryx
D. spike
E. catkin

16. Small yellow flowers of the Brassicaceae (Mustard) l family plant aggregate in inflorescence, which is called …

A. raceme, panicle
B. corymb, umbel
C. head, anthodium
D. spike, spadix
E. compound umbel, compound corymb

17. Leafed inflorescence of the Althaea officinalis (marshmallow) has a well-developed main axis, where flowers on the short flower stalk are situated in turn. This is…

A. raceme
B. umbel

C. corymb
D. panicle
E. dichasium

18. Inflorescence of the Chelidonium majus (rock poppy) has reduced main axis, which cods by apical flower and has some development lateral axes, equal in length, and situated in circles. So, that inflorescence is called ...
A. head
B. simple umbel
C. false umbel (or pleiochasium)
D. bostryx
E. compound umbel

19. We have selected monocarpous onseeded fruit, its endocarp is lignificated, with sclereids, and mesocarp is fleshy. This is ...
A. drupe
B. legume
C. silique
D. fruit case
E. berry

20. You need to specify a monocarpous onseeded fruit with hard scleroid endocarp and soft mesocarp. This fruit is…
A. legume
B. bacca
C. capsule
D. silique
E. monodrupe

21. While studying the flower, it is determined that pistil is formed by one free carpel. So, gynoecium is called…
A. lysicarpous
B. apocarpous
C. cenocarpous
D. monocarpous
E. syncarpous

22. What is the type of a fruit with the following properties: many-seeded, indehiscent, with a juicy pericarp, it is produced from cenocarpous gynoecium
A. hesperidium
B. silique

C. phraga
D. cynarodium
E. cocnobium

23. Fleshy false cenocarpous fruit of the Rosaceae (Rose) family is formed from hypantium and inferior ovary. Seeds are surrounded by cartilaginous endocarp. This is ...

A. pome
B. silicic
C. achenc
D. silique
E. fruit case

24. An onseeded fruit is pscudomonocarpous with a lignificated pericarp. The seed accretes not with the pericarp. This is ...

A. silique
B. silicic
C. achene
D. nutlet
E. pseudomonocarpous drupe

25. Select the type of a fruit by the following properties: a coenocarp fruit whose mericarps have 5 axial main edges between which secondary edges can be contained. A lot of ethereal oils are contained in the ethereal channels of its pericarp…

A. cremocarp
B. cypsela
C. nut
D. legume
E. silique

26. The investigated plant has box-shaped schizocarp fruit, which comes apart into three explosive mericarps when maturated. This is ...

A. tetranutlet
B. cremocarp
C. regma
D. hesperidium
E. capsule (or fruit case)

27. An onseeded nuciform fruit cracks not by maturation. It has a corn cup, which is formed by overgrowth and lignification of the flower stem and bracts. This is…

A. disamara
B. nut
C. nutlet
D. acorn
E. corn seed

GLOSSARY

Achene is a small dry pseudomonocarpous one-seeded indehiscent fruit with a skinny pericarp (typical for the Asteraceae family).

Acid is a substance that dissociates in water liberating hydrogen ions.

Acorn is a dry fruit formed with three dehiscent carpels from the inferior ovary with a skinny pericarp; it has a cup-shaped cupule formed from the imbricated.

Active transport is the consumption of energy by a cell in moving a substance across a plasma membrane against a diffusion gradient.

Adventitious buds are developed on any part of vegetative organs; they provide vegetative reproduction.

Adventitious roots are developed along with shoots or on leaves.

Aerenchyma is a venting tissue with the large air cavity; especially well-developed in hygrophytes and hydrophytes.

Agar is a gelatinous substance produced by certain red algae and also by some brown algae; it is often used as a culture medium, particularly for bacteria.

Aggregate fruit is a fruit formed from a single flower; has several to many pistils.

Aleuronic grains are hard inclusions of reserve proteins in storage tissues of the seeds, bulbs, rhizomes and other organs; form from exsiccant vacuoles.

Algin is a gelatinous substance produced by certain brown algae; it is used in a wide variety of food substances and pharmaceutical, industrial, and household products.

Androecium is an aggregate of the stamens of the male part of the flower.

Angiosperm is a high seeded plant with a flower, which after double fertilization develops into a fruit.

Annual plant is a plant that completes its entire life cycle in a single vegetation period.

Annual ring is a single season's production of xylem (wood) by the vascular cambium.

Anther is the pollen-bearing part of a stamen.

Anthocyanes are water-soluble pigments found in the cell sap; differ in colour from red to blue.

Apical meristem is a meristem at the tip of a shoot or root and provides their growth lengthwise.

Archegoniophore is a stalk bearing an archegonium.

Archegonium is the multicellular female gametangium of bryophytes and most vascular plants other than angiosperms.

Ascending current delivers water and solutions of mineral substances

from the root to the over ground parts of plants.

Asexual reproduction is any form of reproduction without involving the union of gametes.

Assimilation is cellular conversion of the raw material into protoplasm and cell walls.

Axil is the angle formed between a stem and the petiole of a leaf on the shoot.

Bark is the peripheral part of the stem and the root located from outside.

Berry is a cenocarpous many-seeded fruit with a juicy pericarp.

Callose is a carbohydrate complex that develops in sieve tubes in autumn and can dissolve in the spring.

Callus is the undifferentiated tissue that develops around injured areas of stems and roots and promotes wound healing.

Calyx is a green part of a flower consisting of sepals.

Cambium is a meristem producing secondary conductive tissues – phloem and xylem.

Capsule is a dry cenocarpous fruit that splits in various ways when matured.

Carpel is an ovule–bearing unit that is part of pistil.

Caryopsis is dry pseudomonocarpous one-seeded inehiscent fruit, in which the pericarp is tightly fused to the seed; it does not split when matured; typical for the Grass family.

Casparian strip is thickening of tangential and radial cell walls of the endoderm.

Cell is the basic structural and functional unit of all living organisms; an elementary live system capable of self-regulation and self-renewal, in plants, it consists of the protoplasm surrounded by the cell wall.

Cell biology is the biological discipline involving the study of cells and their functions.

Cell cycle is a sequence of events involved in the division of a cell.

Cell idioblasts are secretory cells situated among homogenous tissues; differ in size, color and content.

Cell membrane – see *plasma membrane.*

Cell sap is the liquid content of a vacuole containing organic and inorganic substances.

Cell wall is a part of the plant cell surrounding the protoplast and is the product of its life activity; has the protective function.

Central cell nucleus is an essential organelle of the eukaryote cell containing chromatin its main function is hereditary information transfer.

Chlorenchyma is the basic tissue composed of parenchyma cells that contain chloroplasts; carries out chlorophyll chloroplast the function of photosynthesis.

Chloroplasts are disk-like organelle containing chlorophyll found in cells of most photosynthetic organisms.

Chromoplast is a plastid containing carotenoids, the pigments are usually yellow to orange.

Cladophyll is a flattened modified green stem that resembles a leaf; also called phylloclade.

Class is one of the highest taxonomic categories of classification between a division and an order.

Coleoptile is the first leaf of the cereal germ covering apical meristem and the leaf primordium.

Coleorhiza is a protective sheath surrounding the emerging radicle (immature root) of members of the Poaceae family.

Collective fruit is an aggregate of fruits derived from flowers of a dense inflorescence.

Collenchyma is the live mechanical tissue composed of cells with unevenly thickened walls.

Community is a collective term for all the living organisms sharing a common environment and interacting with one another.

Companion cell is a phloem element with a large nucleus, thick cytoplasm, and a great number of ferments; it forms during the longitudinal division of the sieve tube; it regulates the activity of the sieve tube.

Compound leaf is a leaf consisting of several leaflets falling separately in autumn.

Compound starch grain has several formation centers.

Conductive bundle is an aggregation of conductive elements (vessels, tracheides and sieve tubes), mechanical and parenchymal tissues; function in conducting water and organic substances.

Cork is a tissue composed of cells, which walls are impregnated with suberin at aging; the outer layers of the tissue of an older woody stem; produced by the cork cambium.

Cork cambium is a secondary lateral meristem, which forms periderm.

Corm is a vertically oriented, thickened food-storage stem with a large disk, filmy leaves and without fleshy leaves.

Corn seed – see *caryopsis.*

Corolla is a part of a flower consisting of petals.

Cosmopolite is a species distributed almost all over the globe.

Cotyledon is an embryo leaf ("seed leaf") that usually either stores or absorbs nutrients.

Cremocarp is a dry cenocarpous fruit of the Carrot family, which consists of two mericarp.

Cuticle is a waxy or fatty layer of varying thickness on the outer walls of epidermal cells.

Cutin is the waxy or fatty substance, a ticle is composed of it.

Cutting is any vegetative plant part used for vegetative propagation.

Cytology – see *cell biology.*

Ccytoplasm is the protoplasm of a cell without nucleus.

Deciduous is a plant shedding leaves annually.

Descending current brings products of photosynthesis from leaves to all parts of plants.

Development changes in the form of a plant resulting from the growth and differentiation of its cells into tissues.

Dichasium can be two lateral axes of the second and following orders located opposite each other.

Dicotyledon is a class of angiosperms, which seeds commonly have two cotyledons, frequently abbreviated to dicot.

Diffusion is the random movement of molecules or particles from a region of higher concentration to a region of lower concentration, ultimately resulting in uniform distribution.

Dioecious is a plant having unisexual flowers or cones, with the male and the female flowers or cones located on different plants.

Disinfestation is the eradication of insects and rodents.

Diuretic is a substance tending to increase the flow of urine.

Division is the largest undivided category of classification of organisms within a kingdom.

DNA is standard abbreviation of deoxyribonucleic acid, the carrier of genetic information in cells and viruses.

Dormancy is a period of the growth inactivity in seeds, buds, bulbs, and other plant organs even when environmental conditions normally required for growth are met.

Double fertilization is a sexual process of the angiosperms; the more or less simultaneous union of one sperm and egg (forming a zygote) and union of another sperm and the central cell nuclei (forming a primary endosperm nucleus) that occur in the megagametophyte of flowering plants.

Drupe is a simple fleshy fruit whose single seed is enclosed within a hard endocarp.

Druses are crystal cell inclusions in the shape of asterisks.

Ecology is the biological discipline involving the study of the relationships of organisms to each other and their environment.

Ecosystem is a system involving interactions of living organisms with one another and with their non-living environment.

Elater is a straplike appendage attached to a horsetail (Equisetum) spore; also a spindle-shaped sterile cell occurring in large amounts in liverwort sporangia; both types of elaters facilitate spore dispersal.

Embryo is immature sporophyte that develops from a zygote within an ovule or archegonium after fertilization.

Endemic plants are ones that distributed on the certain small territory.

Endocarp is the innermost hard layer of a fruit surrounding the seed.

Endoderm is the inner layer of cells of the primary cortex of axis organs.

Endoplasmic reticulum is a complex system of interlinked double-membrane channels subdividing the cytoplasm of a cell into compartments; it can be covered with ribosomes.

Endosperm is a food-storage tissue in the seeds of most plants.

Epicotyl is the part of an embryo or germ above the attachment point of the cotyledon(s).

Epidermis is the exterior tissue, usually one cell thick, covering leaves, young stems and other parts of plants.

Epigynous is a flower part attached above the ovary.

Epiphyte is an organism that is attached to and grows on another organism without parasitizing it.

Essential oil is biologically active fluid volatile organic substances of the plant origin with a specific odor.

Eukaryote is an organism which cells contain the complete nucleus.

Evolution is irreversible process of the historical development of nature on the Earth involving converting one organic forms to qualitatively different ones due to their adaptation to the changed conditions of existence.

Exocarp is the outermost layer of a fruit wall.

False umbel. There are the lateral axes of the secondary order located verticillately; they carry flowers.

Fatty oil is fluid plant fat accumulating in oleoplasts as drops; it is the best source of energy in the cell.

Fertilization is formation of a zygote through the fusion of two gametes.

Fiber is a long thick-walled cell having the mechanical function.

Filament is a threadlike body of certain bacteria, algae and fungi.

Flora is historic aggregate of plants of a definite territory.

Floret is a small flower that is a part of the inflorescence of members of the Asteraceae family and the Poaceae family.

Flower is a modified, shortened, unbranched and limited in its growth shoot.

Follicle is a dry fruit that splits along one side.

Forest is plant association where wood forms prevail.

Fruit is a mature ovary usually containing seeds and covered with the pericarp; forms after the pistil's fertilization.

Fucoxanthin is a brownish pigment occurring in brown and other algae.

Fungi deal with a Kingdom of living nature; heterotrophic one – and multicellular eukaryotic organisms different in structure and form of the vegetative body – mycelium; contains storage substances – glycogen and fats; the cell wall contains chitin.

Gametangium is a plant sexual organ, in which gametes are produced.

Gamete is a male or female sex cell; one of two cells that unite, forming a zygote.

Gametophyte is the haploid (n) generation in the life cycle of plants that develops from a haploid spore and carries sexual organs.

Generative cell is the cell of the male gametophyte of angiosperms that divides producing two sperms; also, the cell of the male gametophyte of gymnosperms that divides producing a sterile cell and a spermatogenous cell.

Genetics is a biological discipline that studies heredity.

Genotype is the genetic constitution of an organism, determining its hereditary characteristics.

Genus is a category of classification between a family and a species.

Germination is the beginning or resumption of growth of a seed, spore or bud.

Glandular hair is exogenous secretory structure; consists of a long multicellular stalk and small secretory capitulum.

Glandule is an exogenous secretory structure, producing and extracting essential oils; consists of short stalk and secretory capitulum, which may include different number of cells.

Graft is transplantation of the part of the shoot from one plant to another, which is resistant to unfavorable conditions, with their further accreting.

Granum is a series of stacked thylakoids within a chloroplast.

Growth is progressive increase in size and volume through natural development.

Gum canal – see *resin canal.*

Guttation is the exudation of drops of water with solutions of mineral salts through hydathodes from leaves due to the root pressure.

Gymnosperm is a plant, which seeds are not enclosed within an ovary during their development (e. g., pine tree).

Gynoecium is an aggregate of the pistils (or carpels) – female reproductive organs, being usually in the center of the flower.

Hairs are growths of the epidermis, which differ in form and size are diagnostic features for microscopical analyses.

Haustorium is a protuberance of a fungal hypha or plant organ such as a root that functions as a penetrating and absorbing structure.

Herb is a life form of annual, biannual or perennial plants that have herbaceous overground shoots.

Herbarium is a collection of dried pressed specimens, usually mounted on paper and provided with a label giving information as for their names and place of collection.

Heterospory is the production of both microspores and megaspores.

Heterotrophic is incapable of synthesizing food and, therefore, dependent on other organisms for it.

Hybrid is heterozygous offspring of two parents that differ in one or more inheritable characteristics.

Hydathode is the structure at the tip of a leaf vein, through which water is forced as drops by the root pressure.

Hypanthium is a part of the flower of some families (e. g., Rosaceae, Fabaceae), which is formed by accreting of the receptacle and parts of the perianth.

Hypocotyl is the portion of the shoot in germs of flowering plants between the radicle and the cotyledon(s).

Hypodermis is one or several layers of thick-walled cells immediately beneath the epidermis; has mechanical and water–bearing functions.

Hypogynous is something that has flower parts attached below the ovary

Inferior ovary is an ovary formed by accreting parts of the flower (calyx, corolla, and stamens) with the concave receptacle.

Inflorescence is a collective term for a group of flowers attached to a common axis in a specific arrangement.

Integument is the outermost layer of an ovule; usually develops into a seed coat; a gymnosperm ovule usually has a single integument, and an angiosperm ovule usually has two integuments.

Internode is a shoot region between nodes.

Isogamy is sexual reproduction in certain algae and fungi having gametes that are alike in size.

Lamina – see *blade.*

Laticifer is the inner secretory tissue; specialized cells or ducts resembling vessels; they form branched networks of latex-secreting cells.

Leaf is a flattened, usually photosynthetic structure arranged in various ways on a shoot.

Leaf arrangement is an order of the leaf position on the stem relatively to each other.

Leaflet is one of the subdivisions of a compound leaf

Leaf scar is the scar left on a stem when a leaf separates from it through abscission.

Leaf trace is an aggregation of conductive bundles of the leaf, which enter the node.

Legume is a monocarpous dry fruit, dehiscent along to ventral and dorsal seams; the seeds being attached along the edges.

Lenticel is the outer structure of the periderm, which permits gas exchange between the interior of a plant and the external atmosphere.

Leucoplast is a colourless plastid commonly associated with starch, fatty oil and protein accumulation.

Liana is a ligneous and herbal climbing plant, which cannot maintain vertical position without support.

Life form is the habitus of the plant, formed due to the ecological factors and hereditarily fixed.

Lignification is a secondary change of the cell wall as a result of lignin appearance in its composition; provides fastness and solidity of the cell wall.

Lignin is a compound organic substance, with which certain cell walls (e. g., those of wood) become impregnated.

Lipid is a general term for fats, fatty substances, and oils.

Long-day plant is a plant in which flowering is not initiated unless exposure to more than a critical day length occurs.

Meadow is the type of herbaceous vegetation formed mainly with perennial mesophytes, which develop during the whole vegetative period.

Megagametophyte is the female gametophyte of angiosperms, which in approximately 70 % the of species investigated contains eight nuclei.

Megaphyll is a leaf having branching veins; it is associated with a leaf gap.

Megasporangium is a sporangium, in which megaspores are formed.

Megaspore is a spore that develops into a female gametophyte.

Meristems is the tissue that produces all the primary tissues other than the epidermis and stele (e.g., cortex, pith).

Mesocarp is the middle region of the pericarp that lies between the exocarp and the endocarp.

Mesophyll is the parenchyma (chlorenchyma) tissue between the upper and lower epidermis of a leaf.

Metabolism is the sum of all the interrelated chemical processes occurring in a living organism.

Metamorphose is the modification of the form and structure of the organ or its part in connection with realization of the additional functions.

Microfilament is a protein filament consisting of actin; involved in cytoplasmic streaming.

Microsporangium is a sporangium of the heterosporous plants, in which microspores are formed.

Microspore is a spore of the heterosporous plants that develops into: male gametophyte.

Microsporophyll is a leaf, usually reduced in size, on or within which microspores are produced.

Microtubule is an unbranched tube-like proteinaceous structure commonly found inside the plasma membrane where it apparently regulates the addition of cellulose to the cell wall.

Middle lamella is a layer of the substance, rich in pectin that cements two adjacent cell walls together.

Mineralization is a secondary chemical change of the cell wall as a result of its impregnation with mineral substances.

Molecule is the smallest unit of an element or compound retaining its own identity; consists of two or more atoms.

Monocotyledon is a class of angiosperms whose seeds have a single cotyledon; commonly abbreviated to *monocot.*

Monoecious is something that has unisexual male and female flowers or cones on the same plant.

Multiple fruits – see *collective fruits*.

Mushroom is a sexually initiated phase in the life cycle of a club fungus, usually consisting of an expanded cap and stalk.

Mycelium is a vegetative body of the fungus consisting of fungal hyphae.

Mycorrhiza is a symbiotic association between fungal hyphae and a higher plant root.

Node is region of a shoot where the leaf is attached.

Nucellus is the ovule tissue, within which an embryo sac develops.

Nuclear envelope is a porous double membrane enclosing a nucleus.

Nucleic acid is the DNA that does not code for a gene.

Nucleolus is a somewhat spherical body within a nucleus; contains primarily RNA and protein; there may be more than one nucleolus per nucleus.

Nucleotide is the structural unit of the DNA and the RNA.

Nucleus is the organelle of a living cell that contains chromosomes and is essential to the regulation and control of all the cell functions.

Nut is a one-seeded pseudomonocarpous dry fruit with a hard, thick pericarp; a nut develops with a cup or cluster of bracts at the base.

Nutrient is a substance that provides the elements and energy for the organic molecules that are the building material, from which an organism develops.

Ocrea is a tubulated formation of the stipules, which accrete and envelop the stem.

Oogamy is sexual reproduction, in which the female gamete, or egg, is non-motile and large than the male gamete, or sperm, which is motile.

Oogonium is a female sex organ of certain algae and fungi; it consists of a single cell that contains one to several eggs.

Organelle is a membrane–bound body in the cytoplasm of a cell; there are several kinds, each with a specific function.

Osmosis is the diffusion of water or other solvents through a semipermeable membrane from a region of higher concentration to a region of lower concentration.

Osmotic pressure is the pressure that can be developed by a solution during its movement through a semipermeable membrane to the solution with higher concentration.

Ovary is the enlarged basal portion of a pistil that contains an ovule or ovules and usually develops into a fruit.

Ovule is a structure of seed plants that contains a female gametophyte

and has the potential to develop into a seed.

Palisade mesophyll is a mesophyll that has one or more relatively uniform rows of tightly packed, elongat, columnar parenchyma (chlorenchyma) cells beneath the upper epidermis of a leaf.

Papilla is a small, usually rounded or conical growth of the epidermis.

Parasitism is an intimate association between two dissimilar organisms that is harmful to one of them.

Parenchyma consists of thin-walled cells varying in size, shape, and function; is the most common type of the plant cell.

Pectin is a high-molecular polysaccharide occurring primarily in the middle lamella; when combined with organic acids and sugar, it becomes a jelly.

Pedicel is the individual stalk of a flower, with the help of which it is attached to the stem.

Perennial plant is a plant that lives for more than two vegetative periods.

Perianth is the calyx and corolla of flower.

Pericarp is a general term for all the layers of a fruit wall.

Pericycle is a primary lateral meristem; outer layer of the central cylinder cells of the stem and root, with the help of which phylogen, mechanical fibers, secretory structures and lateral roots are formed.

Periderm is a complex secondary covering tissue formed on the surface of stems and underground organs of woody plant forms; composed of cork cells, phylogen and phyloderm.

Perigynous is something that has flower parts attached around the ovary.

Petal is a unit of a corolla; it is usually flattened and colored.

Petiole is the stalk of leaf, with the help of which it is attached to the stem.

Phellogen – see *cork cambium*

Phloem is a complex conducting tissue, which transports products of photosynthesis from leaves to places of their use.

Photosynthesis is the conversion of light energy to chemical energy; water, carbon dioxide, and chlorophyll are all essential to the process, which ultimately produces carbohydrate, with oxygen being released as a by-product photosynthetic units.

Phylloclade – see *chladophyll.*

Pistil is a female reproductive structure of a flower, composed of one or more carpels and consisting of an ovary, style, and stigma.

Pit is a more or less round or elliptical thin area in a cell wall; pits occur in a more or pairs opposite each other, with or without shallow, domelike borders.

Pith is the central tissue of a dicot stem and certain roots; it usually consists of storage parenchyma cells; can be hollow.

Plant anatomy is the botanical discipline that studies the internal structure of plants and laws of their development.

Plant community is an association of plants inhabiting a common environment and interacting with one another.

Plant ecology is the science that deals with the relationships and interactions between plants and their environment.

Plant geography is the botanical discipline that studies laws of plant distribution over the surface of the earth.

Plant morphology is the botanical discipline that studies external structure of plants, its changes due to the influence of environmental conditions and historical development.

Plant physiology is the botanical discipline that studies general processes, peculiarities of life activity of plant organisms and their interrelation with the environment.

Plant taxonomy is the botanical discipline that studies the classification, nomenclature, and identification of plants.

Plasma membrane is also called cell membrane – a biological membrane of the cytoplasm adjoined to the cell wall and surrounds vacuoles.

Plasmodesma. There are minute strands of the cytoplasm that extend between adjacent cells through pores in the walls.

Plasmolysis is the shrinking in volume of the protoplasm of a cell and the separation of the protoplasm from the cell wall due to loss of water via osmosis.

Pleochasium – see *false umbel.*

Pneumatophore is a spongy root extending above the surface of water, produced by a plant growing in water; pneumatophores facilitate oxygen absorption.

Pollen grain is a structure derived from the microspore of seed plants that develops into a male gametophyte.

Pollen tube is a tube that develops from a pollen grain and carries the sperms to the female gametophyte

Pollination is the transfer of pollen from an anther to a stigma.

Pome is a cenocarpous fleshy fruit; hypanthium takes part in its formation.

Population is a group of organisms, usually of the same species occupying a given area at the same time.

Pore – see *pit.*

Prickle is a pointed outgrowth from the epidermis or cortex beneath the epidermis.

Primary tissue is the tissue produced by an apical meristem (e.g., epidermis, cortex, primary xylem and phloem, pith).

Primordium is an organ or structure (e.g., leaf, bud) at its earliest stage of development.

Procambium is a primary lateral meristematic and phloem tissue,

which produces the primary xylem and phloem.

Prokaryote is the Epikingdom of the organisms which do not have distinct nucleus surrounded with membrane (e. g., bacteria).

Proplastid is a tiny, undifferentiated organelle that can duplicate itself and that may develop into a chloroplast, leucoplast, or other type of plastid.

Protein is a polymer composed of many amino acids linked together by peptide bonds.

Protoplast is the unit of the protoplasm within a plant cell wall; contains the cytoplasm with nucleus and other organelles.

Rachis is the axis of a pinnately compound leaf carrying the leaflets.

Radicle is the part of an embryo in a seed that develops into a root.

Ray. There are radially oriented rows of parenchyma cells that conduct nutrients, water with mineral salts in the stems and roots of woody plants; they are generally continuous across the vascular cambium between the xylem and the phloem; the portion within the wood is called a xylem ray, while the extension of the same ray in the phloem is called a pliloem ray

Receptacle is the commonly expanded tip of a pedicel, which the various parts of a flower (e. g., calyx, corolla) are attached.

Relicts are plants preserved from the geological epoch up to our time.

Reproduction is the development of new individual organisms through either sexual or asexual ways.

Resin canal is a tubular duct of many conifers and some angiosperms that is lined with resin–secreting cells.

Rhizoid is a one- or multicellular root or root-hair-like growth of algae, fungi, the gametophytes of bryophytes, and certain structures of some vascular plants; functions in anchorage and absorption water and nutrients.

Rhizome is a modified underground shoot, usually horizontally oriented, that may be superficially root–like in appearance but that has nodes, internodes, filmy leaves, buds and adventitious roots; functions in accumulation of nutrients and vegetative reproduction.

Ribosome is a granular sumbmicroscopic cell organoid composed of two subunits consisting of RNA and proteins; situated on membranes of the endoplasmic reticulum, in the nucleus, plastids, mitochondria; syntheses protein; very numerous in living cells.

Root is an underground vegetative axis plant organ that functions in anchorage, absorption of water with mineral salts, transport of these solutions to other organs and vegetative reproduction; there are main, lateral and adventitious roots.

Root cap is a thimble-shaped mass of cells at the tip of a growing root; has the protective function.

Root hair is a growth of epiblema cells that is part of an epidermal cell of the root; absorbs solutions of water and mineral substances from the soil.

Root nodule is a small thickening of lateral or adventitious roots where nitrogen-fixing bacteria accumulate nutrients; typical for the roots of leguminous plants and alders.

Root system is aggregate of roots of single plant; there is the tap root system with a well-developed main root and the fibrous root system where adventitious roots do not differ from each other.

Samara is a dry fruit whose pericarp extends around the a seed in the form of a wing.

Sapwood. There are young outer layers of wood transporting water and minerals in a tree trunk; sapwood is usually lighter in color than heartwood.

Schizocarp is a dry fruit formed by the cenocarpous genoecium; dehiscent into two mericarps after maturation; typical for Apiaceae family.

Science is a branch of study involved with the systematic observation, recording, organization, and classification of facts, from which natural laws are derived and used predictively.

Sclereid is a sclerenchyma dead cell with a very thickened lignified cell wall penetrated with chinked simple pores; situated by one or in groups in the stem, leaf mesophyll, fruit endocarp and seed cover.

Sclerenchyma is the mechanical tissue composed of lignified cells with thick walls; functions in strengthening and support of the plant.

Secondary tissue is a tissue produced by the vascular cambium or the cork cambium (e.g., virtually all the xylem and phloem in tree trunk).

Secretory cells are alive thin walled cells producing a secret; can be situated by one; can form the head of the glandular trachoma.

Secretory tissues are synthesize, accumulate and extract secrets outside (exogenous tissues) or to the neighboring tissues (endogenous tissues).

Seed is a generative organ of seed plants formed from the ovule containing an embryo and protected by a *seed coat.*

Seed coat is the outer boundary layer of a seed; it is developed from the integument(s).

Semi–compound starch grain has several formation centres; is surrounded with common starch layers

Sepal is a unit of the calyx that can be green or sometimes colored; often functions in protecting the unopened flower bud.

Sessile is without petiole; attached directly by the base.

Sexual reproduction is reproduction involving the union of male and female gametes.

Sieve cell is a longitudinal thin phloem cell with oblique ends; typical for gymnospermous and spore–bearing plants.

Sieve plate is a transverse area of the wall of a sieve tube that contains several to many perforations that permit cytoplasmic connections between similar adjacent cells.

Sieve tube is a conductive phloem elements of the seed plants consisting of the vertical row of alive cells separated by the sieve plates; functions in transport of organic substances.

Silique is a dry fruit that splits along two "seams" with the seeds borne on a central septum.

Simple fruit is a fruit that develops from a single pistil.

Simple genoecium is formed by one carpel.

Simple leaf is a leaf with the blade undivided into leaflets.

Simple starch grain has one formation center.

Sliming is a secondary chemical change when cell walls transfer into mucus sniphyte.

Sorus is a cluster of sporangia; the term is most frequently applied to clusters of ferns sporangia.

Sperm is a male gamete; except for those of red algae and angiosperms, sperms are frequently motile and are usually smaller than the corresponding female gametes.

Spine is a relatively strong, sharp-pointed, woody structure usually located on a stem; it is usually a modified bud, leaf or its part.

Spongy mesophyll is a mesophyll that has loosely arranged cells and numerous air spaces; situated in the lower part of the leaf just above the lower epidermis.

Sprout is a shoot that grows horizontally along the surface of the ground; typically has long internodes.

Stamen is a male pollen-producing structure of a flower; it consists of an anther and a filament.

Starch grain. There are hard inclusions of the reserve starch, which form in amyloplasts and have formation center, night and light layers; there are simple, compound and semi–compound starch grains.

Stele is the central cylinder of tissues in a stem or root; consists primarily of xylem and phloem.

Stem is a vegetative plant organ of higher plants; axis part of the shoot; consists of nodes and internodes.

Steppe is a temperate zone with xerophytic plants.

Stigma is a apical pollen receptive area of a pistil.

Stipule is one of a pair of appendages of varying size, shape, and texture present at the base of the leaves of some plants.

Stolon is an over- or underground thin stem that grows vertically;

typically has relatively long internodes; sometimes ends with a bulb or a bud; functions in vegetative reproduction.

Stoma is a minute pore or opening in the epidermis of leaves, herbaceous stems; it is flanked by two guard cells that regulate its opening and closing and thus regulate gas exchange and transpiration.

Stroma is the main substance of the cell structures (cytoplasm, organoids and walls).

Suberin is a fatty substance found primarily in the cell walls of cork and the Casparian strips of endodermal cells.

Suberization is a secondary chemical change of the cell wall, impregnation of the cell wall with suberin that leads to die-off of the alive content of the cells.

Subshrub is the life form of the perennial plant up to 1m high with a lignified lower part of the shoot and herbal upper one, which dies every year.

Succulent. There are drought-resistant xerophytes with a fleshy, sappy stem or leaves where much water accumulates (e.g., cactuses).

Superior ovary is an ovary that is free as for the calyx, corolla, and other floral parts; situated above them or at the same level, so the sepals and petals appear to be attached at its base.

Symbiosis is an intimate association between two dissimilar organisms that benefits both of them.

Tannins are complex polyphenol biological active compounds with cementing properties and astringent taste.

Tendril is a modified leaf or leaflet; coils on contact with a support and aids the plant in climbing.

Thallus is a multicellular plant body that is usually flattened and not organized into roots, stems, or leaves.

Thorn is a pointed outgrowth from an epidermis or cortex beneath the epidermis (e. g. rose).

Thylakoids are disk-like membranes, which include chlorophyll; they are arranged in stacks that form the grana of chloroplasts.

Tissue is an aggregation of cells having a common structure, origin and functions.

Tracheid is a non–perforated xylem cell that is tapered at the ends and has thick lignified walls containing bordered pits.

Transpiration is a physiological process that regulates the extraction of water in the vapor form; most transpiration takes place through the stomata.

Tree is a large perennial plant (up to 100 m high), which lives for many years and has a well-developed root system and the aboveground part consisting of the thick trunk covered with periderm or bark and head (crown).

Trichomes – see *hairs.*

Tropism. There are growth movements of plant organs or their parts due to one-side influence of terrestrial attraction (geotropism), illumination (phototropism), water (hydrotropism) and chemical substances (chemotropism).

Trunk is the main well developed stem of tree.

Tuber is a modified part of root or a shoot; the organ of the vegetative reproduction and storage of nutrients.

Vacuolar membrane is a plasmatic membrane dividing the cytoplasm from the vacuole; has selective permeability and capacity to ion transport; also called tonoplast.

Vacuole is a pocket of the fluid that is separated from the cytoplasm of a cell by tonoplast and filled with cell sap; it may occupy more than 99 % of the cell volume in plants.

Vascular cambium is a narrow cylindrical sheath of cells that produces the secondary xylem and phloem in stems and roots and provides their growth in width.

Vascular plant is a plant having xylem and phloem.

Vessel is the tubular xylem elements, which cells have lost their cytoplasm and irregularly thickened, occur in the xylem of most angiosperms and a some other vascular plants; each vessel is composed of vessel members laid end to end; the perforated or open-ended walls of the vessel members permitting water to pass through freely.

Whorled is something that has three or more buds, leaves or flowers at a node.

Xylem is the complex tissue that provides the ascending current of water and dissolved minerals utilized by a plant; it consists of conductive elements (vessels and tracheides), mechanical (wood fibers) and storage (wood parenchyma); can be primary and secondary in its origin.

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