ANATOMY OF FLOWERING PLANTS

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CLASS: XI **BIOLOGY**

What is a tissue? Name the two main kinds of tissues based on whether the cells are capable of dividing or not.

A tissue is a group of cells having a common origin and usually performing a common function. Tissues are classified into two main groups, namely, meristematic and permanent tissues based on whether the cells are capable of dividing or not.

What are meristems? State the location and function of different types of meristems.

The actively dividing cells that are found only in the growing regions of the plant body are called meristems.

Depending on the region where they are present, meristematic tissues are classified as apical, lateral and intercalary

Apical meristem: They are present in the growing tips of stems and roots.

Function – It helps in increasing the length of the stem and root

Intercalary meristem: They lie at the base of leaves or internodes.

Function – It helps in the longitudinal growth of plants

Lateral meristem: It lies on the lateral sides of the stem and root.

Function – helps in increasing the thickness of stem and root

Apical meristem and intercalary meristem help in the formation of the primary plant body. Therefore, they are called primary meristems.

Lateral meristem is formed in the mature regions of roots and shoots of plants. Hence, they are known as secondary meristem.

What is lateral meristem? Give examples.

The meristem that occurs in the mature regions of roots and shoots of many plants, particularly those that produce woody axis and appear later than primary meristem is called the secondary or lateral meristem.

They are cylindrical meristems. Fascicular vascular cambium, interfascicular cambium and cork-cambium are examples of lateral meristems.

These are responsible for producing the secondary tissues.

What are permanent tissues?

Following divisions of cells in both primary as well as secondary meristems, the newly formed cells become structurally and functionally specialised and lose the ability to divide. Such cells are termed permanent or mature cells and constitute the permanent tissues.

Differentiate between simple tissues and complex tissues.

Simple Tissue	Complex Tissue
It is made of only one kind of cells	It is made of more than one kind of cells
Eg., Parenchyma, Collenchyma, Sclerenchyma.	Eg., Xylem and Phloem

Give the salient features of parenchyma.

- **Parenchyma** forms the major component within organs.
- The cells of the parenchyma are generally isodiametric.
- They may be spherical, oval, round, polygonal or elongated in shape.
- Their walls are thin and made up of cellulose.
- They may either be closely packed or have small intercellular spaces.
- The parenchyma performs various functions like photosynthesis, storage, secretion.

Give the salient features of collenchyma.

- The collenchyma occurs in layers below the epidermis in dicotyledonous plants.
- The cells are much thickened at the corners due to a deposition of cellulose, hemicellulose and pectin.
- Collenchymatous cells may be oval spherical or polygonal and often contain chloroplasts. These cells assimilate food when they contain chloroplasts.
- Intercellular spaces are absent.
- They provide elasticity and mechanical support to the growing parts of the plant such as young stem and petiole of a leaf.

Give the salient features of sclerenchyma

- Sclerenchyma consists of long, narrow cells with thick and lignified cell walls having a few or numerous pits.
- They are usually dead and without protoplasts.
- On the basis of variation in form, structure, origin and development, sclerenchyma may be either fibres or sclereids.
- The fibres are thick-walled, elongated and pointed cells occuring in various parts of the plant.
- The sclereids are spherical, oval or cylindrical, highly thickened dead cells with very narrow cavities (lumen).
- These are commonly found in the fruit walls of nuts; pulp of fruits like guava, pear and sapota; seed coats of legumes and leaves of tea.
- Sclerenchyma provides mechanical support to organs.

Name the three basic tissue systems in the flowering plants based on their location. Give the tissue names under each system.

No	Tissue system	Tissues present
1	Epidermal tissue system	Epidermis, trichomes, hairs, stomata
2	Ground tissue system	Parenchyma, collenchyma, sclerenchyma, mesophyll
3	Vascular tissue system	Xylem, phloem, cambium

Describe the structure and functions of epidermis.

The epidermal tissue system forms the outer -most covering of the whole plant body and comprises epidermal cells, stomata and the epidermal appendages the trichomes and hairs.

The epidermis is the outermost layer of the primary plant body. It is made up of elongated, compactly arranged cells, which form a continuous layer.

Epidermis is usually single layered. Epidermal cells are parenchymatous with a small amount of cytoplasm lining the cell wall and a large vacuole. The outside of the epidermis is often covered with a waxy thick layer called the cuticle which prevents the loss of water. Cuticle is absent in roots.

Stomata are structures present in the epidermis of leaves. Stomata regulate the process of transpiration and gaseous exchange.

The cells of epidermis bear a number of hairs.

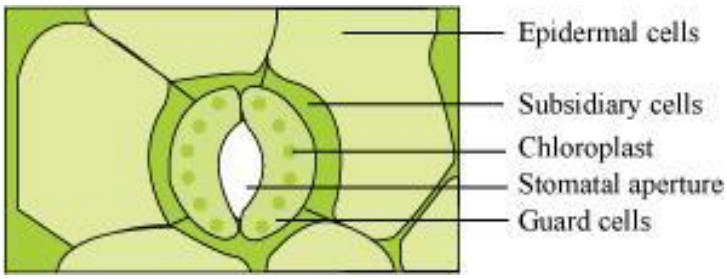
What is stomatal apparatus? Explain the structure of stomata with a labelled diagram.

Stomata are small pores present in the epidermis of leaves.

They regulate the process of transpiration and gaseous exchange. The stomatal pore is enclosed between two bean-shaped guard cells.

The inner walls of guard cells are thick, while the outer walls are thin. The guard cells are surrounded by subsidiary cells.

These are the specialised epidermal cells present around the guard cells. The pores, the guard cells, and the subsidiary cells together constitute the stomatal apparatus.



What is stele?

All tissues on the inner side of the endodermis such as pericycle, vascular bundles and pith constitute the stele.

The transverse section of a plant material shows the following anatomical features, (a) the vascular

bundles are conjoint, scattered and surrounded by sclerenchymatous bundle sheaths (b) phloem

parenchyma is absent. What will you identify it as?

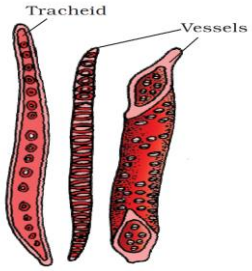
The monocot stem is characterised by conjoint, collateral, and closed vascular bundles, scattered in the ground tissue containing the parenchyma.

Each vascular bundle is surrounded by sclerenchymatous bundle-sheath cells. Phloem parenchyma and medullary rays are absent in monocot stems.

Why are xylem and phloem called complex tissues?

Xylem and phloem are known as complex tissues as they are made up of more than one type of cells. These cells work in a coordinated manner, as a unit, to perform the various functions of the xylem and phloem.

Xylem helps in conducting water and minerals. It also provides mechanical support to plants. It is made up of the following components:



- Tracheids
- Vessels
- Xylem parenchyma
- Xylem fibres.

Tracheids are elongated, thick-walled dead cells with tapering ends.

Vessels are long, tubular, and cylindrical structures formed from the vessel members, with each having lignified walls and large central cavities.

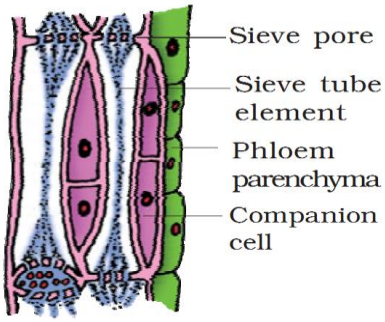
Both tracheids and vessels lack protoplasm. Xylem fibres consist of thick walls with an almost insignificant lumen.

They help in providing mechanical support to the plant.

Xylem parenchyma is made up of thin-walled parenchymatous cells that help in the storage of food materials and in the radial conduction of water.

Phloem helps in conducting food materials. It is composed of:

- Sieve tube elements
- Companion cells
- Phloem parenchyma
- Phloem fibres



Sieve tube elements are tube-like elongated structures associated with companion cells.

The end walls of sieve tube elements are perforated to form the sieve plate. Sieve tube elements are living cells containing cytoplasm and nucleus.

Companion cells are parenchymatous in nature. They help in maintaining the pressure gradient in the sieve tube elements.

Phloem parenchyma helps in the storage of food and is made up of long tapering cells, with a dense cytoplasm. Phloem fibres are made up of elongated sclerenchymatous cells with thick cell walls.

Name the vascular element which is absent in Gymnosperms.

Gymnosperms lack vessels in their xylem.

What are the two types of primary xylem? How do they differ from each other?

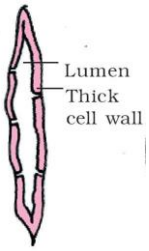
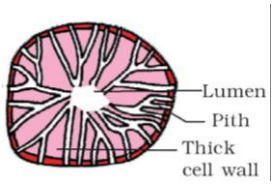
Protoxylem and metaxylem.

Protoxylem	Metaxylem
The first formed primary xylem is called **protoxylem.**	The later formed primary xylem is called **metaxylem.**
The protoxylem lies towards the centre (pith) in stems.	The metaxylem lies towards the periphery of the organ in stems.
The protoxylem lies towards periphery in roots.	The metaxylem lies towards the centre in roots.

Define the following:
(a) Protophloem (b) Metaphloem

The first formed primary phloem consists of narrow sieve tubes and is referred to as **protophloem** and the later formed phloem has bigger sieve tubes and is referred to as **metaphloem.**

How do fibres differ from sclereids?

Fibres	Sclereids
The fibres are **elongated, pointed** cells and **thick-walled**.	The sclereids are spherical, oval or cylindrical, **highly thickened** dead cells with very **narrow cavities** (lumen).
They occur almost in all parts of the plant. 	They occur in the fruit walls of nuts; pulp of fruits like guava, pear and sapota; seed coats of legumes and leaves of tea. 

Distinguish between dicot root and monocot root.

Dicotyledonous Root	Monocotyledonous Root
PERICYCLE It is made of one or two layers of parenchyma cells. It **takes part** in the formation of **secondary roots** and in the **formation of cambium for secondary growth.**	**PERICYCLE** It is made of one or two layers of parenchyma cells. It **does not take part** in the formation of secondary roots and in the formation of cambium for secondary growth.
VASCULAR BUNDLE Vascular bundles are radial. Xylem patches are **2-6. Diarch to Hexarch** Xylem is exarch.	**VASCULAR BUNDLE** Vascular bundles are radial. Xylem patches are **many (polyarch).** Xylem is exarch.
PITH Pith is **very small or absent**. It is made up of parenchyma cells	**PITH** Pith is **large and well developed**. It is made up of parenchyma cells

Distinguish between dicot stem and monocot stem.

DICOT STEM	MONOCOT STEM
Epidermis Multicellular **trichomes present**	**Epidermis** **Trichomes absent**
Hypodermis **2 or 3 layers of collenchymatous cells** provide mechanical strength to the young stem.	**Hypodermis** **2 or 3 layers of sclerenchymatous cells**
Cortex Rounded thin walled **parenchymatous** cells with conspicuous intercellular spaces.	**Ground Tissue** The Ground tissue is not differentiated into cortex and pith. It is parenchymatous.
Endodermis The cells of the endodermis are rich in **starch grains**	**Endodermis** **Absent**
Pericycle Pericycle is present above the phloem in the form of semi-lunar patches of **sclerenchyma cells.**	**Pericycle** **Absent**
Vascular bundle Arranged in the form of a **ring** **Conjoint, open, and endarch.**	**Vascular bundle** **Scattered** **Conjoint closed and endarch.**

	Peripheral vascular bundles are smaller than the centrally located ones. The **phloem parenchyma is absent** and water-containing cavities are present within the vascular bundles.
Pith **Parenchymatous** cells with large intercellular spaces.	**Pith** **Absent**

Distinguish between dicot leaf and monocot leaf.

DICOT LEAF	MONOCOT LEAF
It is a dorsiventral leaf.	It is an Isobilateral leaf.
Bulliform cells are absent in epidermis	Bulliform cells are present in the epidermis
Guard cells are kidney shaped.	Guard cells are dumb bell shaped.
Stomata are fewer in the upper epidermis, more in the lower epidermis	Stomata are equally distributed in the upper epidermis and lower epidermis
Mesophyll is differentiated into Palisade and spongy parenchyma	Mesophyll is not differentiated into Palisade and spongy parenchyma
Bundle sheath cells are parenchymatous	Bundle sheath cells are sclerenchymatous

What are bulliform cells? How do they help in rolling and unrolling of grass leaves?

In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty. colourless cells. These are called **bulliform cells**.

When the bulliform cells in the leaves have absorbed water and are turgid, the leaf surface is exposed.

When they are flaccid due to water stress, they make the leaves curl abaxial inwards to minimise water loss.

Explain the process of secondary growth in stems of woody angiosperm with help of schematic diagrams.
What is the significance?

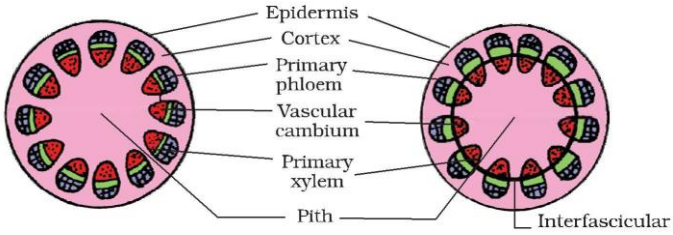
In woody dicots, the strip of cambium present between the primary xylem and phloem is called the intrafascicular cambium.

The interfascicular cambium is formed from the cells of the medullary rays adjoining the interfascicular cambium.

This results in the formation of a continuous cambium ring. The cambium cuts off new cells toward its either sides.

The cells present towards the outside differentiate into the secondary phloem, while the cells cut off towards the pith give rise to the secondary xylem.

The cambium is more active on the inner side than on the outer. So the amount of the secondary xylem produced is more than that of the secondary phloem.

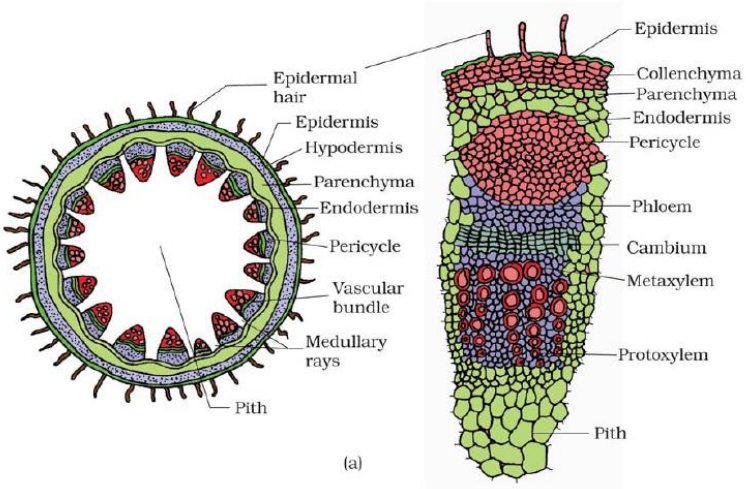


Cut a transverse section of young stem of a plant from your school garden and observe it under the microscope. How would you ascertain whether it is a monocot stem or dicot stem? Give reasons.

The dicot stem is characterised by the presence of conjoint, collateral, and open vascular bundles, with a strip of cambium between the xylem and phloem.

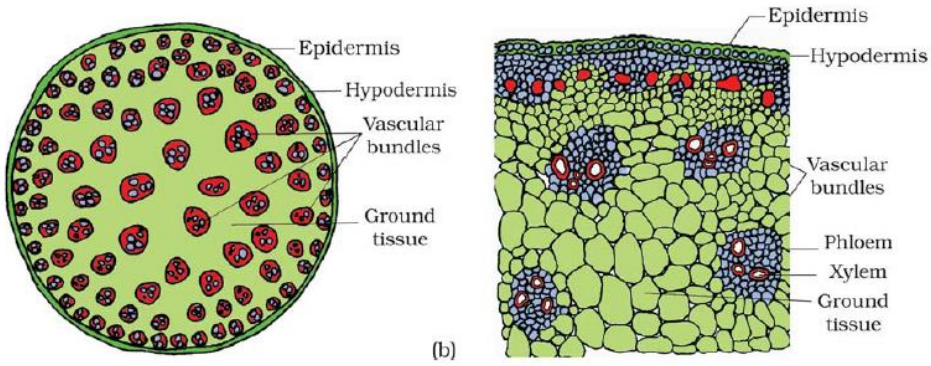
The vascular bundles are arranged in the form of a ring, around the centrally-located pith.

The ground tissue is differentiated into the collenchyma, parenchyma, endodermis, pericycle, and pith. Medullary rays are present between the vascular bundles.



The monocot stem is characterised by conjoint, collateral, and closed vascular bundles, scattered in the ground tissue containing the parenchyma.

Each vascular bundle is surrounded by sclerenchymatous bundle-sheath cells. Phloem parenchyma is absent and water-containing cavities are present.



How is the study of plant anatomy useful to us?

The study of plant anatomy helps us to understand the structural adaptations of plants with respect to diverse environmental conditions.

It also helps us to distinguish between angiosperms and gymnosperms. Such a study is linked to plant physiology.

Hence, it helps in the improvement of food crops. The study of plant-structure allows us to predict the strength of wood. This is useful in utilising it to its potential.

The study of various plant fibres such as jute, flax, etc., helps in their commercial exploitation.

What is periderm? How does periderm formation take place in dicot stem?

Periderm is composed of the phellem, phellogen and phelloderm.

During secondary growth, the outer epidermal layer and the cortical layer are broken because of the cambium.

To replace them, the cells of the cortex turn meristematic, giving rise to cork cambium or phellogen. It is composed of thin-walled, narrow and rectangular cells

Phellogen cuts off cells on its either side. The cells cut off toward the outside give rise to the phellem or cork. The suberin deposits in its cell wall make it impervious to water.

The inner cells give rise to the secondary cortex or phelloderm. The secondary cortex is parenchymatous.

Describe the internal structure of a dorsiventral leaf with the help of a labelled diagram.

Dorsiventral leaves are found in dicots. The vertical section of a dorsiventral leaf contains three distinct parts.

Epidermis:

Epidermis is present on both the upper surface (adaxial epidermis) and the lower surface (abaxial epidermis).

The epidermis on the outside is covered with a thick cuticle. Abaxial epidermis bears more stomata than the adaxial epidermis.

Mesophyll:

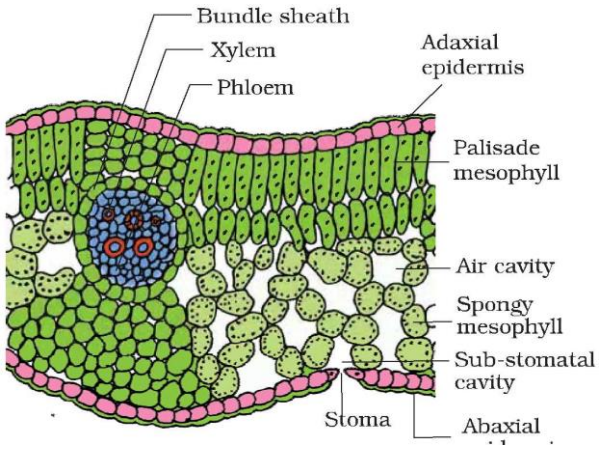
Mesophyll is a tissue of the leaf present between the adaxial and abaxial epidermises.

It is differentiated into the palisade parenchyma (composed of tall, compactly-placed cells) and the spongy parenchyma (comprising oval or round, loosely-arranged cells with inter cellular spaces).

Mesophyll contains the chloroplasts which perform the function of photosynthesis.

Vascular system:

The vascular bundles present in leaves are conjoint and closed. They are surrounded by thick layers of bundle-sheath cells.



What is primary growth in plants?

The growth of the roots and stems in length with the help of apical meristem is called the primary growth.

What is secondary growth in plants?

The increase in girth or thickness of the roots and stems with the help of lateral meristem or cambium is called the secondary growth.

Name the two kinds of lateral meristems involved in secondary growth.

The two kinds of lateral meristems are vascular cambium and cork cambium.

What is vascular cambium?

The meristematic layer that is responsible for cutting off vascular tissues xylem and phloem is called vascular cambium.

In the young stem it is present in patches as a single layer between the xylem and phloem. Later it forms a complete ring.

How does the formation of cambial ring occur in dicot stem?

In dicot stems, the cells of cambium present between primary xylem and primary phloem is the **intrafascicular cambium**.

The cells of medullary cells, adjoining the intrafascicular cambium become meristematic and form the interfascicular cambium. Thus, a continuous ring of cambium is formed.

Differentiate between spring wood and autumn wood.

Spring wood	Autumn wood
The wood formed during spring season is called spring wood or early wood.	The wood formed during winter season is called autumn wood or late wood.
During spring season, cambium is very active and produces a large number of xylary elements having wider vessels.	During winter, the cambium is less active and forms fewer xylary elements having narrow vessels.

Differentiate between heart wood and sap wood.

Heartwood	Sapwood
This central region of the stem that comprises dead elements with highly lignified walls and is dark brown due to deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils is called heartwood.	The peripheral region of the secondary xylem is lighter in colour and is known as the sapwood.
It is hard, durable and resistant to the attacks of microorganisms and insects.	It is soft and not resistant to the attacks of microorganisms and insects.
It does not conduct water but it gives mechanical support to the stem.	It is involved in the conduction of water and minerals from root to leaf.

Define the term bark. What is the difference between soft bark and hard bark?

Bark is a non-technical term that refers to all tissues exterior to the vascular cambium, therefore including secondary phloem.

Bark refers to a number of tissue types, viz., periderm and secondary phloem.

Bark that is formed early in the season is called early or soft bark. Towards the end of the season late or hard bark is formed.

What are lenticels? Mention their function.

The lens- shaped openings formed on the epidermis are called lenticels.

Lenticels permit the exchange of gases between the outer atmosphere and the internal tissue of the stem.

These occur in woody trees due to rupturing of epidermis caused by secondary growth.

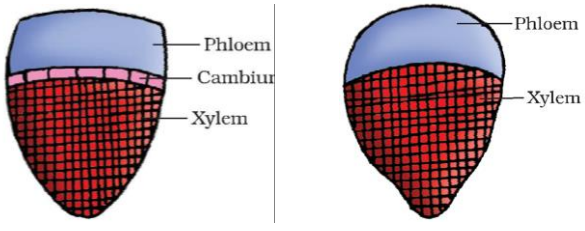
What are medullary rays?

At some places, the cambium forms **a narrow band of parenchyma**, which passes through the secondary xylem and the secondary phloem in the radial directions. These are the **secondary medullary rays**

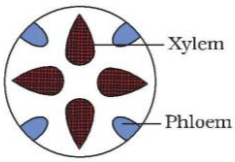
Explain the vascular tissue system in angiosperms.

Vascular tissue system

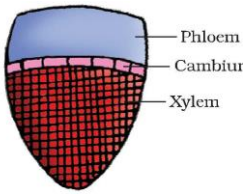
- It mainly comprises of complex permanent tissues - xylem and phloem. Cambium may or may not be present.
- **Conjoint vascular bundle**: Xylem and phloem are arranged on the same radius of vascular bundle. Such types of vascular bundles are found in stems and leaves.



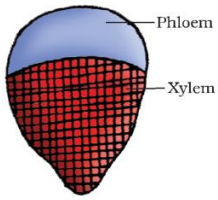
- **Radial vascular bundle:** Xylem and phloem are arranged alternately on different radii. Such types of vascular bundles are present in roots.



- **Open vascular bundle:** It contains cambium between xylem and phloem. Cambium has the ability to form secondary tissues. It is the characteristic feature of dicotyledonous stem.



- **Closed vascular bundle:** It lacks cambium between xylem and phloem. Since cambium is absent, it lacks the ability to form secondary tissues. Closed vascular bundle is the characteristic feature of monocotyledonous stems.



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