

6. Anatomy of Flowering Plants

POINTS TO REMEMBER :

- Study of internal structure of plant is called **anatomy**.
- In plants cells are the basic unit.
- Cells organized into tissues and tissues organized into organs.

THE TISSUES :

- A group of cells having common origin and perform one function.
- Plant tissues are classified into two types:-
 - o **Meristematic tissue.**
 - o **Permanent tissue**

Meristematic tissues :

- Growth in plants is restricted to specific regions with active cell division called meristems.
- Different types of meristems are:-
 - o **Apical meristem:**
 - Occurs in the shoot and root tips.
 - Primary meristem
 - Increase the length of plant
 - o **Intercalary meristem :**
 - Present in-between mature tissues.
 - Primary meristem
 - Occurs in grasses and regenerate parts removed by grazing.
 - o **Lateral meristem:**
 - Occurs in the mature regions of roots and shoots.
 - Also known as secondary meristem.
 - Responsible for producing secondary tissues.
 - Fascicular vascular cambium, interfascicular cambium and cork cambium are example of lateral meristem.
- Axillary bud :
 - o During formation of leaves and elongation of stem, some cells 'left behind' from shoot apical meristem, constitute the axillary bud.
 - o Present in the axils of leaves and are capable for forming a branch or a flower.

Permanent tissues :

- Cells produced from primary or secondary meristem stop dividing and differentiated structurally and functionally, termed as **permanent cells**.

- A group of permanent cell constitutes the permanent tissues.
- Permanent tissues having similar in structure and function are called **simple tissues**.
- Permanent tissues having many different types of cells are called **complex tissues**.

Simple tissues :

- **Simple tissues made of only one type of cells.**

Parenchyma :

- Forms major component within organs.
- Cells are isodiametric.
- Thin cell wall made of cellulose.
- Cells may be spherical, oval, round, polygonal or elongated shape.
- Cells are closely packed or have small intercellular space.
- Perform various functions such as photosynthesis, storage, secretion.

Collenchyma :

- Found either in homogeneous layer or in patches.
- Cell wall thickened in the corner due to deposition of **cellulose, hemicelluloses and pectin**.
- Cells are oval, spherical or polygonal in shape
- Often contain **chloroplasts**.
- **No intercellular spaces**.
- Provide mechanical support to the growing part of the plant such as young stem and petiole of a leaf.

Sclerenchyma :

- Consists of long, narrow cells
- Cell wall is thick and lignified.
- Cell wall with few or numerous pits.
- Cells are usually dead and without protoplast.
- Provides mechanical support to the organs.
- Sclerenchymas are of two types on the basis of origin, form, structure.

Fibres :

- Thick walled
- Elongated and pointed cells
- Generally occurs in group in various parts of the plant.

Sclereids :

- Spherical, oval or cylindrical in shape.
- Highly thickened dead cells with very narrow cavities (lumen).
- Commonly found in fruit walls of nuts; pulp of guava, pear and sapota; seed coats of legumes and leaves of tea.

Complex tissues :

- Made of more than one type of cells and these work together as a unit.

- Xylem and phloem constitute the complex tissues in plants.

Xylem :

- Functions as conducting tissues for water and minerals from roots to stem and leaves.
- Provides mechanical support to the plant.
- It consists of four different kinds of elements:-
 - o **Tracheids**
 - o **Vessels**
 - o **Xylem fibres and**
 - o **Xylem parenchyma.**
- **Tracheids :**
 - o Elongated or tube like cells.
 - o Thick and lignified walls and tapering ends.
 - o Cells are dead and without protoplasm.
 - o Inner layers of cell walls have thickenings which vary in forms.
- **Vessels.**
 - o Is a long cylindrical tube-like structure made up of many cells called vessel members.
 - o Each with lignified walls and a large central cavity.
 - o Cells are devoid of protoplasm.
 - o Vessel members are interconnected through perforations in their common walls.
 - o Presences of vessels are the characteristics of the angiosperm.
- **Xylem fibres :**
 - o Have highly thickened walls and obliterated central lumen.
 - o Either septate or aseptate.
- **Xylem Parenchyma :**
 - o Cells are living and thin-walled.
 - o Cell walls are made up of cellulose.
 - o They stored food materials in the form of starch or fat.
 - o Also store materials like tannins.
 - o The radial conduction of water takes place by the ray parenchymatous cells.
- The primary xylem is of two types-
 - o **Protoxylem**
 - o **Metaxylem.**

- The first formed xylem elements are called **protoxylem**.
- The later formed primary xylem is called **metaxylem**.
- **Endarch**: the protoxylem lies towards pith and metaxylem towards the periphery of the organ (in stem)
- **Exarch**: in root the protoxylem lies towards periphery and metaxylem lies towards the centre.

Phloem :

- Transports food materials usually from leaves to other part of plant.
- It is composed of four elements:-
 - **Sieve tube elements.**
 - **Companion cells.**
 - **Phloem parenchyma.**
 - **Phloem fibres.**
- **Sieve tube elements :**
 - Long tube like structure arranged longitudinally
 - Associated with companion cells.
 - End walls are perforated to form sieve plates.
 - A mature sieve element possesses peripheral cytoplasm and a large vacuole but lacks nucleus.
 - The function of sieve elements controlled by nucleus of companion cells.
- **Companion cells :**
 - Specialized parenchymatous cells.
 - Closely associated with sieve tube elements.
 - Connected with sieve tube element by pit field.
 - Helps in maintaining pressure gradient in the sieve tubes.
- **Phloem parenchyma :**
 - Made up of elongated tapering cylindrical cells
 - Have dense cytoplasm and nucleus.
 - Cell wall made of cellulose and has pits through plasmodesmatal connections exist between the cells.
 - Store food materials and other substances like resins and latex and mucilages.
 - It is absent in monocotyledons.
- **Phloem fibres :**
 - Also known as bast fibres.
 - Made of sclerenchymatous cells.
 - Absent in primary phloem but present in secondary phloem.
 - Much elongated, unbranched and have pointed, needle like apices.
 - Cell wall is quite thick.
 - On maturity lose their protoplasm and become dead.
 - Phloem fibres of jute, flax and hemp are used commercially.

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

THE TISSUE SYSTEM :

- On the basis of their structure and location there are three types of tissue systems.
 - o Epidermal tissue system.
 - o Ground or fundamental tissue system.
 - o Vascular or conducting tissue system.

Epidermal tissue system :

- Forms the outermost covering of the whole plant body and comprises:
 - o Epidermal cells.
 - o Stomata
 - o Epidermal appendages like trichomes and hairs.
- Epidermis consists of single layer parenchymatous cells.
- Cells are elongated, compactly arranged, which form continuous layer.
- Epidermis is usually single layered.
- Outside the epidermis covered with waxy thick layer called **cuticle**.
- Cuticle absent in epidermis of root.
- **Stomata** are the structure present in the epidermis of leaf.
- Stomata regulate the process of transpiration and gaseous exchange.

Stomata :

- Each **stoma** composed of two bean shaped cell called **guard cells**.
- In grasses the guard cells are dumb-bell shaped.
- Outer wall of guard cell is thin and inner wall is thick.
- Guard cell possesses chloroplast and regulates the opening and closing of stomata.
- Epidermal cells in the vicinity of guard cell called **subsidiary cells**.
- Stomatal aperture, guard cells and subsidiary cells together called **stomatal apparatus**.
- The **root hairs** are unicellular elongations of the epidermal cells and help absorb water and mineral from the soil.

Trichomes :

- On stem the epidermal hairs are called **trichomes**.
- Trichomes are usually multicellular.
- May be branched or unbranched and soft or stiff.
- Sometimes secretory.
- **Trichomes** help in preventing water loss due to transpiration.

The ground tissue system :

- All the tissues except epidermis and vascular bundles constitute the **ground tissue**.

- It consists of simple tissues such as parenchyma, collenchyma, Sclerenchyma.
- Parenchymatous cells are present in cortex, pericycle, pith and medullary rays.
- In leaves, the ground tissue consists of thin-walled chloroplast containing cells called **mesophyll**.

The vascular tissue system :

- Vascular system consists of complex tissues – xylem and phloem.
- Xylem and phloem together constitute the vascular bundle.
- In dicot presence of cambium between xylem and phloem called **open vascular bundle**.
- Vascular bundle without cambium is said to be **closed vascular bundle**.
- **Radial vascular bundle**: xylem and phloem arranged alternate manner on the different radii.
- **Conjoint vascular bundle**: xylem and phloem are situated at the same radius of vascular bundle.

ANATOMY OF DICORYLEDONOUS AND MONOCOTYLEDONOUS PLANTS :-

Dicotyledonous Root :

- The outermost layer is epidermis.
- Presence of unicellular **root hairs** in epidermis.
- The **cortex** constitutes many layer thin-walled parenchyma cells with **intercellular spaces**.
- The innermost layer of cortex is **endodermis**.
- Endodermis consists of single layered barrel-shaped cells without intercellular spaces.
- Presence of **casparian strip** in the endodermis.
- Next to endodermis there is few layer parenchymatous cells form **pericycle**.
- Initiation of **lateral root** and **vascular cambium** during secondary growth takes place from the cells of pericycle.
- The parenchymatous cells present in-between xylem and phloem is called **conjunctive tissue**.
- The number of xylem and phloem bundle is three or four.
- All the tissues on the inner side of endodermis such as pericycle, vascular bundles and pith constitute the **stele**.

Monocotyledonous Root :

- **Monocot root have similar tissues as in dicot except :-**
 - o It contains more than six xylem bundles called polyarch.
 - o Pith is large and well developed.
 - o Do not undergo any secondary growth.

Dicotyledonous Stem :

- Outermost layer is **epidermis**.
- Epidermis covered with thin layer of **cuticle** and has **trichomes** and few **stomata**.
- The cells arranged in multiple layers in-between epidermis and pericycle constitute the **cortex**.
- **Cortex has three sub-zones :**
 - o **Hypodermis**: a few layers of collenchymatous cells below epidermis.
 - o **Cortical layers**: consists of rounded thin walled parenchymatous cells with intercellular spaces.
 - o **Endodermis**: it is the innermost layer of cortex. Cells are rich in starch grains and are referred to as **starch sheath**.

- **Pericycle** : present on the inner side of the endodermis and above the phloem in the form of semi-lunar patches of Sclerenchyma.
- **Medullary rays**: a few layers of radially placed parenchymatous cells present in between vascular bundles.
- A large number of **vascular bundles** arranged in **a ring**.
- Each vascular bundle is **conjoint, open** and **endarch** protoxylem.
- The central portion of stem constitutes the **pith**.

Monocotyledonous Stem :

- **It has similar tissues with the dicot stem except in following-**
 - o Sclerenchymatous hypodermis.
 - o Vascular bundles are **scattered** in the ground tissue.
 - o Each vascular bundle is covered by **bundle sheath** cells.
 - o Vascular bundles are **conjoint** and **closed**.
 - o Peripheral vascular bundles are smaller than central one.
 - o Phloem parenchyma is absent.
 - o Water containing cavities are present within the vascular bundles.

Dorsiventral (Dicotyledonous) Leaf :

- Vertical section of a Dorsiventral leaf shows three main parts:
 - o Epidermis.
 - o Mesophyll cells.
 - o Vascular systems.
- Epidermis covers both upper (**adaxial**) and lower (**abaxial**) surface of the leaf has a conspicuous cuticle.
- Abaxial surface has more stomata than the adaxial epidermis.
- Tissue between upper and lower epidermis called **mesophyll**.
- Mesophyll cells are two types:
 - o **Palisade parenchyma**
 - o **Spongy parenchyma**
- Adaxially placed **palisade parenchyma** is made up of elongated cells arranged vertically, parallel to each other.
- **Spongy parenchyma**: oval or round and loosely arranged cells below the palisade parenchyma.
- **Vascular bundles** are seen in the midrib and veins.
- The vascular bundles are surrounded by a layer of thick walled **bundle sheath cells**.

Isobilateral (Monocotyledonous) leaf :

- It is similar with Dorsiventral leaf in many respect except –
 - o Stomata are equally distributed on upper and lower epidermis.
 - o Mesophyll cells are not differentiated into palisade and spongy.

- In grasses, certain adaxial epidermal cells along the veins modified themselves into large, empty, colourless cells called **bulliform cells**.
- Causes rolling of leaves to reduce transpiration during water stress.

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