ANATOMY OF FLOWERING Plants

TISSUES

GROUP OF CELLS HAVING COMMON ORIGIN & USUALLY PERFORM COMMON FUNCTION

1 Meristematic tissue
Actively dividing cells, growth is restricted to meristems areas

Apical meristem

Present at root/shoot apex, & shoot apical meristem left behind constitute axillary meristem

Intercalary meristem

Occur b/w mature tissues & occur in grasses & regenerate parts removed by grazing animals.

Lateral meristem

Occur in parts which produce woody axis, appear later & mature regions of shoots/ roots. Eg-fascicular vascular cambium, interfascicular cambium, cork cambium

Newly formed cells —(Specialisation)→ Mature/Permanent cells

During primary growth, specific regions of apical meristems produce dermal tissue, ground tissue & vascular tissue which are permanent.

2 Permanent tissue
Lost ability to divide

SIMPLE TISSUE
MADE OF SINGLE TYPE OF CELLS

Parenchyma
Isodiametric(spherical, oval, round polygonal, elongated), thin cell wall of cellulose, small intercellular space, performs photosynthesis, storage, secretion.

Collenchyma
Found in layers or patches below epidermis in most dicots, thickened at corners due to deposition of cellulose, hemicellulose And pectin thick cell (oval, spherical & polygonal), no intercellular space, chloroplast present, provides mechanical support to young stem & growing parts.

Schlerenchyma
Long narrow cells. lignified cell wall with pits, dead cells without protoplast, mechanical support.

- **Fibres:** Thick walled, elongated/ pointed cells in form of groups
- **Sclereids:** Spherical, oval, thickened, dead cells, narrow cavity called lumen is present. Found in nuts walls, pulp of fruits like guava, pear and sapota

COMPLEX TISSUE
MADE OF MANY TYPES OF CELLS

- Xylem
- Phloem

XYLEM

Conducts water & minerals & gives mechanical strength. • **Trachieds-**elongated, tube-like structure, lignified, dead cells with tapering ends, without protoplosm • **Vessels**-long cylindrical tube like, made of many vessel members connected via perforations; lignified walls; large central cavity; dead cells. Their presence marks plant as angiosperm & gymnosperm. do not have it • **Fibres-**obliterated central lumen; maybe septate or aseptate• **Parenchyma-**living; thin walled.(store starch, fat, tannins). The radial conduction of water takes place by ray parenchymatous cells. **Primary xylem is of 2 types- PROTOXYLEM-**first formed **METAXYLEM-**later formed. Endarch-protoxylem is towards pith & metaxylem towards periphery. Eg. Stem and Exarch-opposite, Eg-roots

PHLOEM

Transports food. Gymnosperms lacks sieve tube but have sieve cells & albuminous cells in place of companion cells

Sieve tube elements- long, longitudinally arranged: perforated end walls(sieve plates), mature sieve element possess peripheral cytoplasm, large vacuole but lacks nucleus.
Companion cells-specialised parenchymatous cells. Sieve tube elements & these are connected via pit fields & help in maintaining pressure gradient in sieve tubes.
Parenchyma-long, tapering cylindrical cells, dense cytoplasm & nucleus, have pits for plasmodesmata, stores food & resins, latex, mucilage. It is absent in most monocots.
Fibres/bast fibres-generally absent in primary phloem, have pointed needle like apices, thick cell wall & at maturity they loose protoplasm. Phloem fibres of jute, flax & hemp are commercially used.
PROTOPHLOEM -first formed, narrow sieve tube.
METAPHLOEM-later formed, bigger sieve tube.

THE TISSUE SYSTEM (BASED ON LOCATION)

Epidermal T.S.
"Forms outer covering. "comprises cells stomata + epidermal appendages(trichome /hair)" epidermis is usually single layered (elongated, compactly placed parenchymatous cells.
• Cuticle (wax) prevents transpiration.
• Guard cells of monocot > dumb bell
• Guard cells of Dicot > Bean shaped
• Guard cells have outer wall thin & inner wall thick. & sometimes epidermal cells form subsidiary cells. (stomatal apparatus aperture + guardcell + subsidiary cell)
• Root hairs are unicellular elongations, on stem epidermal hairs are called trichome usually multicellular (branched/ unbranched).

Ground T.S.
"Constitute all tissues except epidermis & vascular bundles. Eg. parenchyma, collenchyma & sclerenchyma Parenchyma cells are present in cortex, pericycle, pith & medullary rays in primary stem & roots.
In leaves ground tissue consist of thin walled chloroplast containing cells & is called mesophyll.

Vascular T.S.
• Consist of xylem & phloem in dicot, cambium is found in b/w vascular bundles & form sec. phloem & xylem (open vascular bundles)
• In monocot they are closed
• If xylem & phloem are arranged in alternate manner in diff. Radii it is called radial (as in roots). *conjoint-> X & P are along same radii. (Common in stem & leaves)
• Conjoint vascular bundles usually have phloem located on the outer side of xylem

ANATOMY OF DICOT & MONOCOT PLANTS

DICOT ROOT

Outer- Epiblema protrude (unicellular root hairs) & then parenchymatous cortex [inner layer is endodermis comprising barrel shaped cells without intercellular space with casparian strips (suberin)]. Next is pericycle from which lateral roots & vascular cambium (Secondary growth).

• Pith is small/ inconspicuous, parenchyma b/w vascular bundles is called as conjuctive tissue. Usually 2-4 xylem & phloem patches are found. Cambium ring develops blw xylem & phloem. All tissues inner to endodermis (pith + pericycle + vascular Bundles) constitutes stele.

MONOCOT ROOT

It is similar to dicot root but have more than 6 polyarch xylem bundles & pith is large and well developed.

MONOCOT STEM

Has schlerenchymatous hypodermis, scattered vascular bundles(each surrounded by schlerenchymatous bundle sheath & large parenchyma ground tissue).

• Vascular bundle are conjoint, closed with peripheral bundles smaller than central.

• Phloem parenchyma is absent & water containing cavity are present within the vascular bundles.

DICOT STEM

Epidermis (cuticle trichome + stomata), then cortical cells b/w epidermis & pericycle and consist of 3 sub-zones→hypodermis (collenchyma),cortical layers (parenchyma), endodermis(rich in starch grain hence called starch sheath).

• Pericycle inner to endodermis & above phloem in form of semilunar patches of schlerenchyma.

• B/w vascular. Bundles few layers of radially placed parenchyma constitute medullary rays. Large no. of vascular bundles are arranged in a ring with conjoint open & endarch characteristic of dicot stem.

• Rounded parenchyma with large intercellular spaces constitute pith.

DICOT LEAF (DORSIVENTRAL)

• Consist of epidermis(covers both adaxial/upper surface & abaxial/ lower surface) + mesophyll + vascular system.

• Veins vary in thickness cause of reticulate venation.

• Abaxial have more stomata than adaxial. Tissue in b/w both epidermis is called mesophyll.

• Vascular system→seen in veins & midrib(size of bundles depend on size of veins.

• Vascular bundles are surrounded by layer of thick walled bundle sheath cells.

MONOCOT LEAF (Isobilateral)

Similar to dicot but stomata on both the surface of epidermis side are same; mesophyll is not differentiated in 2 types. In grasses, some adaxial epidermal cells along the veins get modified into large, empty, colourless bulliform cells which gets turgid to make leaf surface exposed & become flaccid (leaf curl) to minimise H_2O loss. Parallel venation means same size veins, same size vascular bundle except in main veins seen in vertical section of leaf.

Secondary growth (Increase in girth)

Tissues involved (lateral meristem) are vascular cambium and cork cambium

Vascular cambium

Meristematic layer which cuts off vascular tissue

• **Formation of cambial ring:** Cambium b/w vascular Bundle (intrafascicular cambium) and cells of medullary rays become meristematic & form interfascicular cambium & in total continuous cambial ring is formed.

• **Activity of cambial ring:** It cut off new cells(sec. xylem towards pith, sec. phloem towards periphery). Cambium is more active on inner side than outer hence amount of sec. xylem is more than secondary phloem. Primary & secondary phloem get crushed due to continued formation & accumulation of secondary xylem; however primary xylem remains more or less intact in or around centre. At some places cambium forms narrow band of parenchyma (passes through secondary xylem & sec. phloem in radial direction which is called secondary medullary rays.

• **SPRING/EARLY WOOD-**produced during spring, cambium is more active, produces more xylary element with vessels (large cavities), light in colour with low density.

• **AUTUMN/LATE WOOD-**produced during autumn, cambium is less active, produce less xylary element with narrow vessels, darker in colour with high density.

HEARTWOOD: Comprises dead elements with high lignified walls(give mechanical Strength to stem from centre)

• **SAPWOOD-**comprises conducting tissue (periphery of sec. xylem), lighter in colour. H_2O & mineral transport. In older trees, greater part of sec. xylem is dark brown due to deposition of tannin, resin, oil, gum, aromatics, essential oils in central (innermost stem).

Cork combium

• Due to vascular cambium, cortex & epidermis got broken & need to be replaced (new protective layers). Hence cork cambium/ phellogen develops from cortex(a meristem) & cut cells in outer cork/phellem & inner in sec. cortex (phelloderm).

• Cork has suberin deposition (impervious);sec. cortex is parenchymatous. Phellem, phellogen & phelloderm are collectively known as periderm.

• Cork cambium builds pressure upon the remaining layers peripheral to phellogen which die & slough off. Bark is a non technical term used for all tissues exterior to vascular cambium i.e. periderm with secondary phloem.

EARLY/SOFT BARK- formed early in season
LATE/HARD BARK-formed at end of season

• At certain regions, phellogen cuts off closely arranged parenchyma cells which soon rupture epidermis, forming lens shaped openings called lenticles(gaseous exchange & occur in most woody trees)

Sec. growth in roots

• In dicot root, vascular cambium is completely sec. in origin (originates from tissue located just below the phloem bundles, a portion of pericycle tissue, above the protoxylem forming a complete & continuous wavy ring, which later becomes circular. Further events are similar as in dicot stem.