FREE NOTES · NCERT + NEET LEVEL

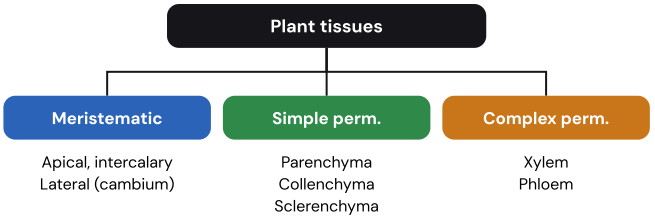
Anatomy of Flowering Plants

Meristems, simple and complex permanent tissues, the three tissue systems, internal structure of dicot and monocot root, stem and leaf, and secondary growth.

01 Meristematic tissues
02 Permanent tissues
03 Tissue systems
04 Dicot vs monocot: root and stem
05 Leaf anatomy
06 Secondary growth
07 Extra + tricks
08 Important Q&A
09 Common mistakes
10 Practice (NEET style)
11 Quick revision

01 Meristematic tissues

- **Apical**: tips of root and shoot, increase length (primary growth).
- **Intercalary**: between mature tissues (grasses), regrow after grazing.
- **Lateral** (secondary): vascular cambium, cork cambium; increase girth.
- Axillary buds come from leftover shoot apical meristem cells.



Classification of plant tissues

02 Permanent tissues

Tissue	Structure	Function
Parenchyma	Thin cellulose walls, living, isodiametric	Photosynthesis, storage, secretion
Collenchyma	Corners thickened with cellulose, hemicellulose, pectin; living; below epidermis in dicots	Mechanical support to growing parts
Sclerenchyma	Lignified thick walls, dead; fibres and sclereids (nut shells, guava, pear, tea leaves)	Mechanical support
Xylem	Tracheids, vessels (dead, lignified), xylem fibres, xylem parenchyma (only living part)	Water, minerals transport
Phloem	Sieve tubes (no nucleus, sieve plates), companion cells, phloem parenchyma, phloem fibres (bast, only dead part)	Food transport

Protoxylem first formed, metaxylem later. **Endarch** (protoxylem towards centre: stems), **exarch** (towards periphery: roots). Gymnosperms lack vessels; they have albuminous cells instead of companion cells.

03 Tissue systems

- **Epidermal**: epidermis, cuticle (absent in roots), stomata (guard cells: bean-shaped in dicots, dumbbell in grasses; with subsidiary cells), trichomes (shoot, multicellular) and root hairs (unicellular).
- **Ground**: everything except epidermis and vascular bundles: cortex, pericycle, pith, medullary rays; mesophyll in leaves.
- **Vascular**: xylem + phloem. **Radial** (xylem and phloem on different radii: roots), **conjoint** (same radius: stems, leaves). Open (cambium present: dicot stem) vs closed (no cambium: monocots).

04 Dicot vs monocot: root and stem

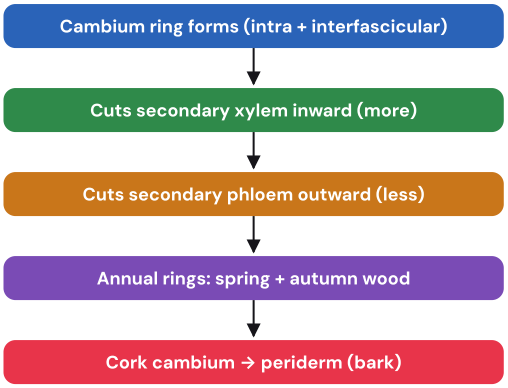
Feature	Dicot root	Monocot root	Dicot stem	Monocot stem
Vascular bundles	2–4 xylem/phloem (radial)	>6 (polyarch)	Ring, conjoint, open	Scattered, conjoint, closed
Pith	Small/absent	Large	Present	Not distinct
Special	Endodermis with Casparian strips; pericycle gives lateral roots	Same, no secondary growth	Hypodermis collenchyma; starch sheath	Sclerenchymatous bundle sheath; water cavities

05 Leaf anatomy

- **Dorsiventral** (dicot) leaf: mesophyll differentiated into **palisade** (upper, elongated) and **spongy** (lower, with spaces); more stomata on lower epidermis.
- **Isobilateral** (monocot) leaf: stomata on both surfaces, mesophyll not differentiated.
- **Bulliform cells** (grasses): large empty cells on upper epidermis; when they lose water, leaf rolls up to reduce water loss.
- Bundle sheath around veins.

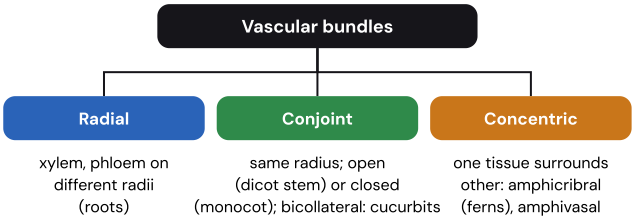
06 Secondary growth

- Occurs in dicots and gymnosperms. Intrafascicular + interfascicular cambium form a complete ring.
- **Spring wood** (early wood): more active cambium, wide vessels, light, low density. **Autumn wood** (late wood): narrow vessels, dark, dense. Together form an **annual ring** (age of tree).
- **Heartwood**: dark, non-conducting, tannins and resins, durable. **Sapwood**: light, conducts water.
- **Phellogen** (cork cambium) forms phellem (cork) outside, phelloderm (secondary cortex) inside: together periderm. **Lenticels** allow gas exchange. Bark = all tissues outside vascular cambium.



Steps of secondary growth in dicot stem

07 Extra + tricks



Types of vascular bundles

- Simple tissue trick: **P–C–S** → Parenchyma (living, thin), Collenchyma (living, corners thick), Sclerenchyma (dead, lignified).
- Phloem in angiosperms: sieve tube + companion cell connected by **pit fields**; gymnosperms lack sieve tubes and companion cells (have sieve cells and albuminous cells).
- Root vs stem: root hairs and exarch xylem in roots; stem hairs (trichomes) and endarch xylem in stems; pericycle gives lateral roots in root.
- Bark (non-technical) = all tissues outside vascular cambium; early (soft) bark and late (hard) bark.
- Spring wood (light, wide vessels) vs autumn wood (dark, narrow): annual rings are not distinct in tropical trees with no seasonal change.

08 Important Q&A

Q1. Why is phloem parenchyma absent in most monocots?

It is a recorded anatomical feature: monocot phloem lacks phloem parenchyma (exam fact; dicots have it).

Q2. How can you tell the age of a tree?

Count annual rings (one light spring band + one dark autumn band = one year). This is dendrochronology.

Q3. Why do grass leaves roll in dry weather?

Bulliform cells lose water and become flaccid, so the leaf rolls inward, reducing transpiration.

09 Common mistakes

- Saying xylem parenchyma is dead (it is the only living xylem element).
- Mixing endarch (stem) and exarch (root).
- Calling monocot bundles open (they are closed, no cambium).
- Thinking heartwood conducts water.

10 Practice (NEET style)

1. Casparian strips are made of?
2. Only dead part of phloem?
3. Meristem responsible for grass regrowth?
4. Cork cambium is also called?
5. Leaf with stomata on both surfaces?

ANSWERS

1) Suberin · 2) Phloem fibres · 3) Intercalary · 4) Phellogen · 5) Isobilateral (monocot)

11 Quick revision: 5 minutes before the exam

TISSUES

- Collenchyma: corners thick
- Sclerenchyma: dead, lignified
- Xylem parenchyma living

BUNDLES

- Root: radial, exarch
- Dicot stem: ring, open
- Monocot: scattered, closed

LEAF

- Dicot: palisade + spongy
- Monocot: isobilateral
- Bulliform: rolling

SECONDARY

- Spring light, autumn dark
- Heartwood non-conducting
- Periderm = phellem+phellogen+phelloderm

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.