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CHAPTER NOTES

Anatomy of Flowering Plants Class 11 Notes | CBSE Biology Chapter 6

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Anatomy of Flowering Plants Class 11 Notes | CBSE Biology Chapter 6

Anatomy of Flowering Plants is Chapter 6 of CBSE Class 11 Biology — the chapter that takes you *inside* the plant to study the tissues and tissue systems that root, stem, and leaf are built from. If Morphology told you what a plant looks like from outside, Anatomy is the microscope view: cells, tissues, and how they are organised.

By the end of these notes you will be able to classify any plant tissue (meristematic vs permanent, simple vs complex), distinguish a dicot root from a monocot root under a microscope, explain the tissue systems, and describe secondary growth step by step. This is a fact-heavy, high-yield chapter for NEET — every year questions come from xylem/phloem elements, dicot–monocot differences, and secondary growth.

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Key Concepts

1. The Tissue — and Two Big Categories

A **tissue** is a group of cells having a common origin and usually performing a common function. Anatomy studies how these tissues are organised inside roots, stems, and leaves.

Based on whether the cells can divide, plant tissues are of two main types: **meristematic tissue** (dividing cells) and **permanent tissue** (non-dividing, mature cells).

2. Meristematic Tissues

A **meristem** is a group of actively dividing cells. The cells are small, thin-walled, isodiametric, with dense cytoplasm, large nuclei, and few or no vacuoles and no intercellular spaces.

Classification by Position

- **Apical meristem:** present at the tips of roots and shoots; produces primary tissues and causes increase in length (primary growth).
- **Intercalary meristem:** present at the base of leaves or internodes (common in grasses); part of apical meristem left behind; helps in elongation.
- **Lateral meristem:** present along the sides (vascular cambium and cork cambium); causes increase in girth/thickness (secondary growth).

Apical and intercalary meristems are **primary meristems**; lateral meristems are **secondary meristems**.

[DIAGRAM: A shoot tip showing apical meristem at the top, intercalary meristem at the internode base, and lateral meristem (cambium) running along the sides.]

3. Permanent Tissues — Simple Tissues

Cells of permanent tissue have lost the power to divide. A **simple tissue** is made of only one type of cell. There are three simple tissues: parenchyma, collenchyma, and sclerenchyma.

Tissue	Cell Wall	Key Feature & Function
Parenchyma	Thin, cellulose	Living, isodiametric; storage, photosynthesis (chlorenchyma), secretion
Collenchyma	Thickened at corners (pectin/cellulose)	Living; mechanical support to growing parts; found below epidermis in dicot stems and petioles
Sclerenchyma	Thick, lignified; no protoplasm at maturity	Dead; provides mechanical strength. Two types — fibres (long) and sclereids (stone cells, e.g. in guava/pear)

4. Permanent Tissues — Complex Tissues

A **complex tissue** is made of more than one type of cell working together as a unit. The two complex tissues — xylem and phloem — together form the vascular bundle and conduct materials.

Xylem (conducts water and minerals, upward)

- **Tracheids** — elongated, dead, tapering cells with lignified walls; conduct water (chief water-conducting element in gymnosperms).
- **Vessels (tracheae)** — long tube-like, dead, with perforated end walls; characteristic of angiosperms; most efficient water conductors.
- **Xylem fibres** — provide mechanical support.
- **Xylem parenchyma** — living cells; store food and help in lateral conduction.

Protoxylem forms first; **metaxylem** forms later. In roots, xylem is **exarch** (protoxylem towards periphery); in stems it is **endarch** (protoxylem towards centre).

Phloem (conducts food, mostly downward)

- **Sieve tube elements** — long tube-like living cells with perforated sieve plates; lack nucleus at maturity.
- **Companion cells** — living, nucleated; control the activity of sieve tubes (connected by plasmodesmata).
- **Phloem parenchyma** — stores food; absent in most monocots.
- **Phloem fibres (bast fibres)** — the only dead component; provide support.

Protophloem has narrow sieve tubes; **metaphloem** has bigger ones.

5. The Tissue System

On the basis of structure and location, all tissues are grouped into three **tissue systems**.

- **Epidermal tissue system:** the outermost protective layer — epidermis, stomata, and epidermal appendages (root hairs, trichomes). The epidermis is usually a single layer covered by a waxy **cuticle** (absent in roots).
- **Ground tissue system:** all tissues except epidermis and vascular bundles — cortex, pericycle, pith, and medullary rays; mainly parenchyma. In leaves, the ground tissue is the **mesophyll**.
- **Vascular tissue system:** the xylem and phloem (vascular bundles).

Types of Vascular Bundles

- **Radial:** xylem and phloem on different radii, alternating (found in roots).
 - **Conjoint:** xylem and phloem on the same radius (found in stems and leaves).
 - **Open:** cambium present between xylem and phloem → secondary growth possible (dicot stems).
 - **Closed:** no cambium → no secondary growth (monocot stems).
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6. Anatomy of the Dicot Root

A transverse section of a typical dicot root (e.g. gram) shows, from outside in:

- **Epiblema** (epidermis) with unicellular root hairs; no cuticle.
 - **Cortex** of several layers of parenchyma.
 - **Endodermis** — innermost cortex layer with **Casparian strips** (suberin bands).
 - **Pericycle** — gives rise to lateral roots and part of cambium.
 - **Vascular bundle:** radial; xylem is exarch; usually 2–4 xylem patches (di- to tetrarch).
 - **Pith** — small or absent.
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7. Anatomy of the Monocot Root

Monocot root (e.g. maize) is similar to the dicot root but with key differences:

- Xylem bundles are usually **many (polyarch)** — more than six.
- **Pith is large and well developed.**
- **No secondary growth** (no cambium develops).

8. Anatomy of the Dicot Stem

A transverse section of a dicot stem (e.g. sunflower) shows:

- **Epidermis** with cuticle and trichomes.
- **Hypodermis** of collenchyma (gives support).
- **Cortex, endodermis (starch sheath), and pericycle.**
- **Vascular bundles:** conjoint, open, with cambium; arranged in a **ring**; xylem endarch.
- **Pith** large and central; medullary rays present.

9. Anatomy of the Monocot Stem

Monocot stem (e.g. maize) differs sharply from the dicot stem:

- Vascular bundles are **conjoint, closed** (no cambium), and **scattered** in the ground tissue.
- Each bundle is surrounded by a **bundle sheath** of sclerenchyma and is skull-shaped.
- A **water-containing cavity** is present in the protoxylem (lysigenous cavity).
- No distinct cortex, endodermis, pericycle, or pith; ground tissue is continuous.

10. Anatomy of the Leaf (Dicot vs Monocot)

The leaf is bounded by upper and lower epidermis (with stomata), enclosing the **mesophyll** (photosynthetic ground tissue) and vascular bundles in the veins.

Feature	Dorsiventral (Dicot) Leaf	Isobilateral (Monocot) Leaf
Mesophyll	Differentiated into palisade (upper) + spongy (lower)	Not differentiated; uniform parenchyma
Stomata	More on lower surface	Equal on both surfaces
Bulliform cells	Absent	Present (in upper epidermis; help rolling of leaf)
Guard cells	Bean/kidney-shaped	Dumb-bell-shaped

11. Secondary Growth

Secondary growth is the increase in girth (thickness) of the stem and root due to the activity of lateral meristems. It occurs in dicots and gymnosperms, not in monocots.

(a) Vascular Cambium — gives secondary vascular tissue

- In the dicot stem, the cambium between xylem and phloem (intrafascicular) joins with cells of the medullary ray (interfascicular cambium) to form a complete **cambial ring**.
- The cambium cuts off cells: **secondary xylem towards the inside** and **secondary phloem towards the outside**. More xylem is formed than phloem.
- The bulk of a tree trunk is secondary xylem (wood).

(b) Annual Rings (Growth Rings)

Cambium activity changes with seasons. In spring it is very active and forms wide vessels → **spring/early wood**. In autumn/winter it is less active and forms narrow vessels → **autumn/late wood**. One ring of early wood + late wood = one **annual ring**. Counting annual rings (dendrochronology) gives the approximate age of the tree.

[DIAGRAM: Cross-section of a woody stem showing concentric annual rings, with alternating light spring wood and dark autumn wood, plus heartwood at the centre and sapwood outside.]

Heartwood (duramen): central, dark, dead wood that gives mechanical support. **Sapwood (alburnum):** outer, lighter, living, conducts water.

(c) Cork Cambium (Phellogen) — gives the periderm

- As girth increases, the outer cortex/epidermis ruptures, so a second lateral meristem — **cork cambium (phellogen)** — develops in the cortex.
- It cuts off **cork (phellem)** towards the outside and **secondary cortex (phelloderm)** towards the inside.
- Cork cells are dead and have **suberin**, making them impervious to water and protective. Phellem + phellogen + phelloderm together form the **periderm**.
- **Lenticels** are pores in the periderm that allow gaseous exchange.

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	4–6 marks (unit: Structural Organisation)	Meristems, simple/complex tissues, dicot vs monocot anatomy, secondary growth
NEET	2–4 questions	Xylem/phloem elements, tissue systems, dicot–monocot differences, annual rings, cork cambium

[TABLE: Question-type split — VSA (1 mark): tissue/element identification; SA (2–3 marks): dicot vs monocot differences, types of vascular bundles; LA (5 marks): secondary growth in dicot stem, structure of complex tissues.]

Important Definitions

Term	Definition
Tissue	A group of cells with a common origin performing a common function
Meristem	A group of actively dividing cells responsible for plant growth
Parenchyma	Living, thin-walled simple tissue for storage and photosynthesis
Sclerenchyma	Dead, lignified simple tissue (fibres and sclereids) giving mechanical strength
Xylem	Complex tissue conducting water and minerals; tracheids, vessels, fibres, parenchyma
Phloem	Complex tissue conducting food; sieve tubes, companion cells, parenchyma, fibres
Casparian strip	Suberin band in the endodermis that blocks the apoplast pathway
Secondary growth	Increase in girth due to lateral meristems (vascular and cork cambium)
Annual ring	One ring of spring wood + autumn wood, formed in a year; indicates tree age
Lenticel	Pore in the periderm allowing exchange of gases

Solved Examples

Example 1

Which meristem is responsible for the increase in girth of a plant, and name its two types.

Answer: The **lateral meristem** increases girth (secondary growth). Its two types are the **vascular cambium** and the **cork cambium (phellogen)**.

Example 2

Give two anatomical features that help you identify a transverse section as a monocot root rather than a dicot root.

Answer: A monocot root has (i) **polyarch** xylem (many xylem bundles, usually more than six) and (ii) a **large, well-developed pith**; it also shows no secondary growth.

Example 3

Why are vessels considered more efficient than tracheids in conducting water?

Answer: Vessels are wide tube-like structures formed of many cells joined end to end with their **end walls perforated (dissolved)**, forming a continuous channel; tracheids are single tapering cells, so water must cross pit membranes. Hence vessels conduct water faster and are characteristic of angiosperms.

Example 4

A companion cell has a nucleus but the sieve tube element it serves does not. Explain the significance.

Answer: The mature sieve tube element loses its nucleus, so it cannot control its own metabolism. The adjacent **companion cell**, connected by plasmodesmata, retains its nucleus and **regulates the loading, unloading, and activity** of the sieve tube. The two function as a unit.

Example 5

Distinguish between heartwood and sapwood.

Answer: Heartwood (duramen) is the central, dark, dead secondary xylem filled with tannins and resins; it gives mechanical support but does not conduct water. **Sapwood (alburnum)** is the outer, lighter, living wood that actively conducts water and minerals.

Example 6

How does the cork cambium contribute to the protection of an old dicot stem?

Answer: Cork cambium (phellogen) cuts off **cork (phellem)** outwards; cork cells are dead and contain **suberin**, making them impervious to water and resistant to mechanical injury and microbes. Together with phelloderm it forms the periderm, replacing the ruptured epidermis as a protective covering, with lenticels for gas exchange.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Name the meristem present at the base of internodes in grasses.
2. Which is the only living component of phloem that lacks a nucleus at maturity?
3. What is the function of the Casparian strip in the endodermis?
4. Name the tissue that forms the bulk of a tree trunk.
5. What are bulliform cells and where are they found?

2–3-Mark Questions (SA)

1. Differentiate between a dicot stem and a monocot stem with respect to vascular bundles.
2. Describe the four types of cells found in xylem and state their functions.
3. Distinguish between collenchyma and sclerenchyma on the basis of structure and function.
4. Explain the terms exarch and endarch with examples.

5-Mark Questions (LA)

1. Describe secondary growth in a dicot stem due to the activity of the vascular cambium. How are annual rings formed?
 2. Explain the three tissue systems of a flowering plant, naming the tissues in each.
 3. With a labelled-diagram description, compare the internal structure of a dorsiventral (dicot) leaf and an isobilateral (monocot) leaf.
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Quick Revision Points

- Tissues = meristematic (dividing) + permanent (non-dividing)
 - Meristems: apical (length), intercalary (length, in grasses), lateral (girth)
 - Simple tissues: parenchyma (storage), collenchyma (support, living), sclerenchyma (support, dead)
 - Complex tissues: xylem (water, upward) + phloem (food, downward)
 - Xylem = tracheids + vessels + fibres + parenchyma; vessels are angiosperm-specific
 - Phloem = sieve tubes + companion cells + parenchyma + fibres (fibres are the only dead part)
 - Root xylem exarch + radial bundles; stem xylem endarch + conjoint bundles
 - Dicot root: di–tetrarch, small pith; Monocot root: polyarch, large pith
 - Dicot stem: bundles in a ring, open (cambium); Monocot stem: scattered bundles, closed
 - Secondary growth: vascular cambium (2° xylem inside, 2° phloem outside) + cork cambium (periderm)
 - Annual ring = spring wood + autumn wood; heartwood (dead) vs sapwood (living); lenticels for gas exchange
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Next Chapter: Chapter 7 — Structural Organisation in Animals



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