# ANATOMY OF FLOWERING PLANTS

## 1 THE TISSUES

→ Group of cells having a common origin and perform a common function is known as Tissues.

Types → Meristematic tissue
Permanent tissue

## * MERISTEMATIC TISSUE

→ Growth in plant is restricted to specialised region of active cell divison called Meristems.

→ Primary → Apical meristems
→ Intercalary meristem
→ Secondary or lateral meristem

- Apical meristems: Occur at the tip's of root and shoots
→ produces primary tissue

Root apical meristem → Tip of root's

Shoot apical meristem → Occupies distant most region of stem axis.

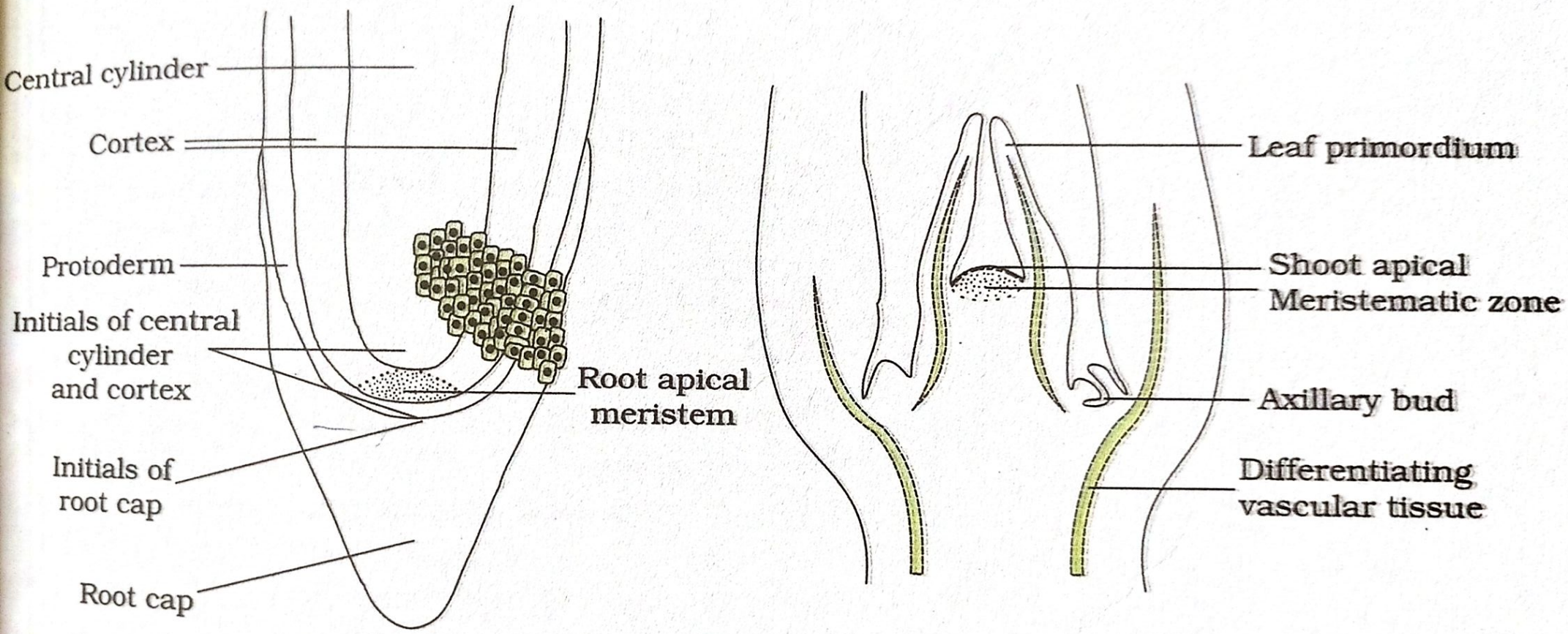


**Figure 6.1** Apical meristem: (a) Root (b) Shoot

→ During formation of leaves and elongation of stem, some cell left behind from shoot apical meristem constitute the Axillary bud.

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Capable of forming branch or flower.

- Intercalary meristem: Occur between mature tissues.
  → Occur in grasses
  → Regenerate part removed by grazing herbivores.

Q. Why apical and intercalary meristem are known as Primary meristem?

- Secondary or lateral meristem:
  → Occur in mature regions of root's and shoot's of plant's
  → appear later than primary meristem

  eg: Cork - Cambium, Cylindrical meristems etc.

## * Permanent Tissues

→ Cells of permanent do not grow further.

→ Permanent tissue ⟶ Simple tissue

↓

Complex Tissue

(i) Simple tissue : Made up of only one type of cells.

Simple tissue in plants are
(a) Parenchyma (b) Collenchyma
[c] Sclerenchyma

[a] Parenchyma tissue : Form major component within Organs

→ Cells are isodiametric
→ Shape : Spherical, Oval, round, polygonal and Elongated.
→ Made up of Cellulose
→ Have small intracellular space
→ function : Photosynthesis, Storage, Secretion.

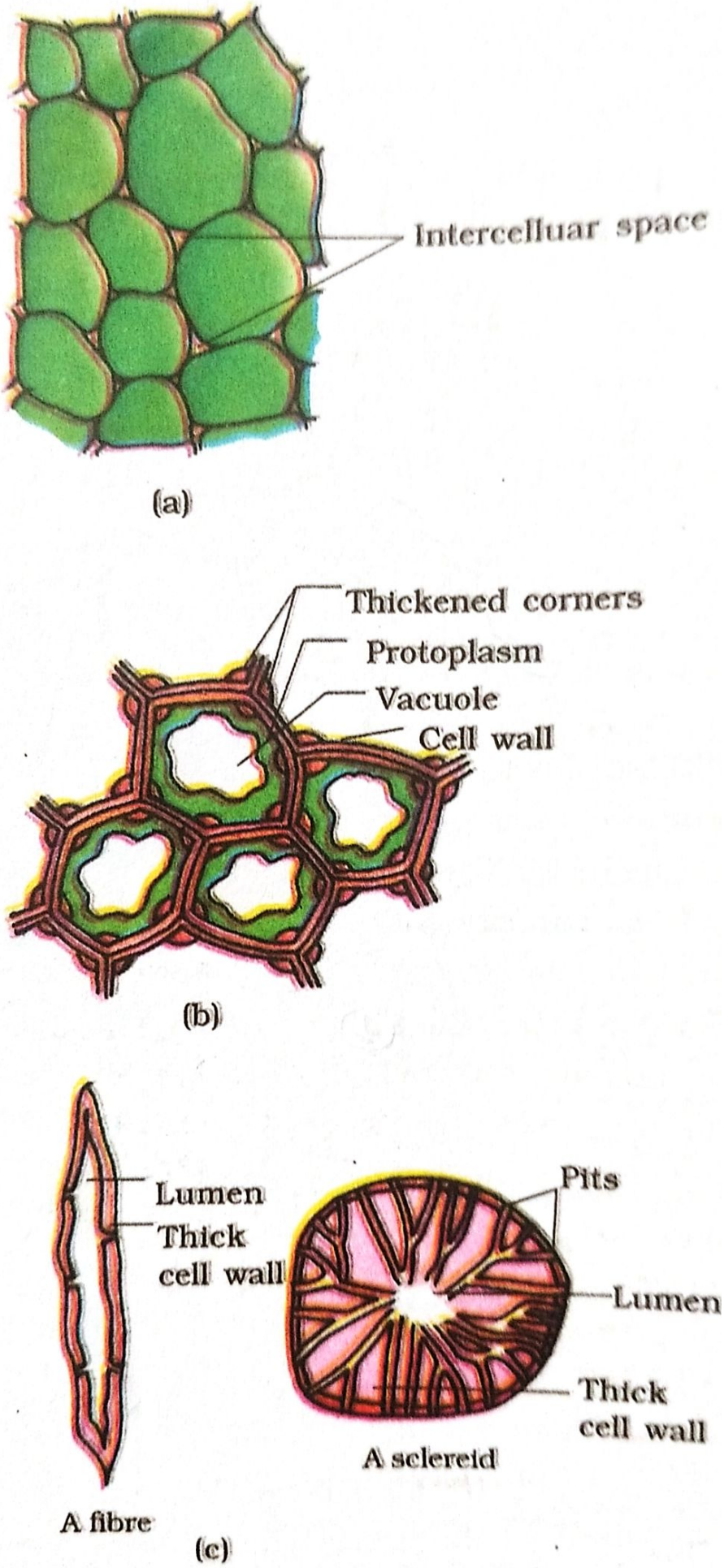



**Figure 6.2** Simple tissues :
(a) Parenchyma
(b) Collenchyma
(c) Sclerenchyma

[b] Collenchyma: Occur in layer below epidermis in dicotyledonous plants

→ Consist of Cells which are thickened at the Corner due to deposition of Cellulose, hemicellulose and pectin.

→ Shape: Oval, Spherical or polygonal.

→ Contain Chloroplast and assimilate food when they Contain Chloroplast.

→ Intercellular Space Absent.

→ Provide Support to growing part of plant.

[C] Sclerenchyma: Consist long narrow Cells with thick and lignified cell walls

→ Dead and without protoplast.

→ May be Fibres or Sclereids.

- Fibres: Thick walled, elongated and pointed cells
  → Occur in groups

- Sclereids: Spherical, Oval or Cylindrical.
  → highly thickened dead Cell with Very narrow Cavities [lumen]
  → Provide mechanicals Support to Organs

→ found in fruit walls of nuts.

## ✱ COMPLEX TISSUES

→ Made up of more than one type of cells.

→ Xylem and phloem constitute the complex tissue

[a.i] Xylem: Conducting tissue for water and Minerals from root's to stem and leaves.

→ It is composed of

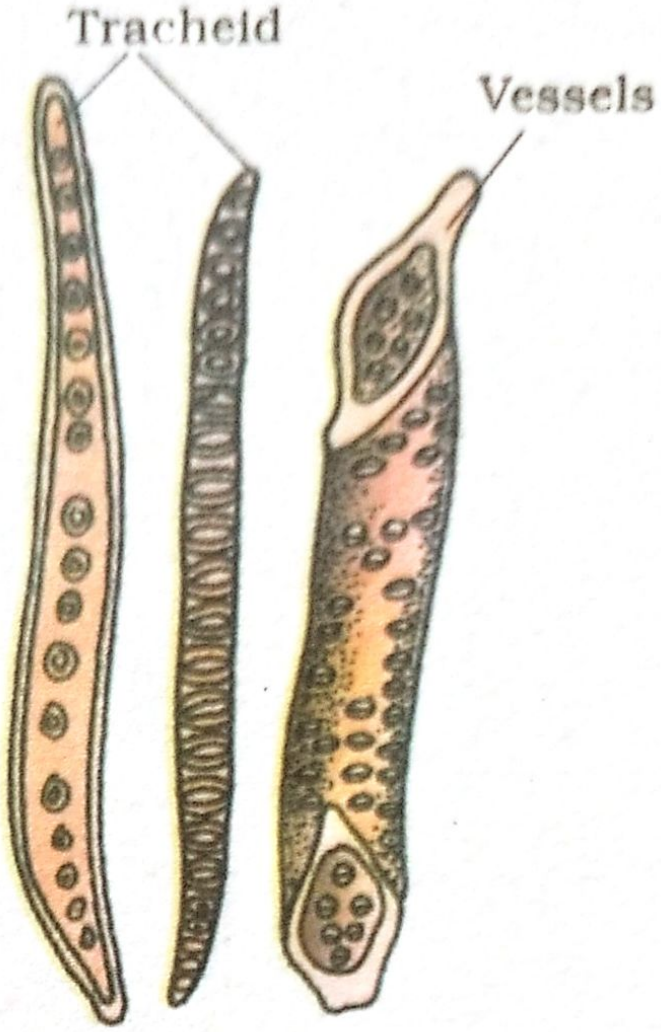
[a] Tracheids [b] Vessels
[c] Xylem fibres [d] Xylem parenchyma.

→ Gymnosperm lack Vessel in Xylem

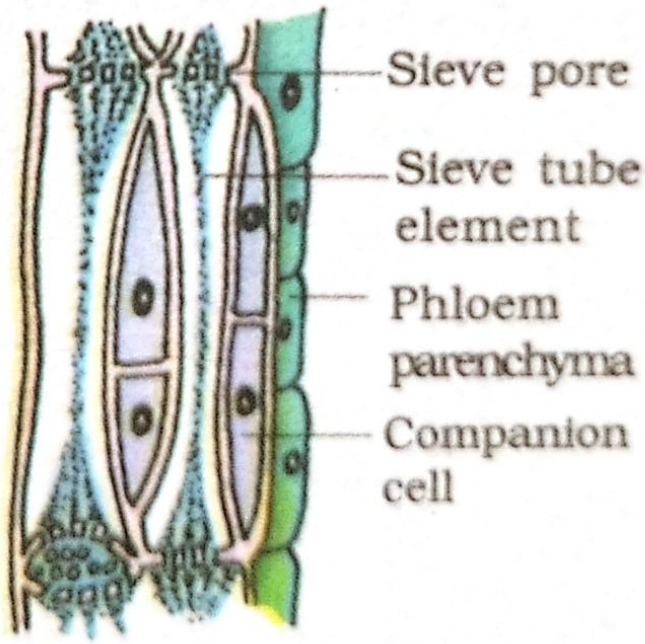
### [a] Tracheids:

→ Elongated or tube like cells with thick and lignified walls and tapering ends.
→ Dead cells and are without protoplasm

→ In flowering plants, tracheids and Vessels are main water transporting canals.




(a)




(b)

**Figure 6.3** (a) Xylem
(b) Phloem

[b] Vessel: long Cylindrical tube like structure made up of many Cells called Vessel members

→ Have large Central Cavity.
→ Devoids of protoplasm
→ Presence of Vessel is Characteristic features of angiosperm.

[c] Xylem fibres: highly thickened walls and obligatory Central lumens
→ May be Septate or Aseptate

[d] Xylem Parenchyma: living Cell with thin walled
→ Cell wall is made up of Cellulose
→ Store food in form of Starch, Fat, and tannins
→ Radial Conduction of water take place by the ray Parenchymatous Cells

⊙ Primary Xylem is of two type
→ Protoxylem: First formed Xylem
→ Metaxylem: later formed Xylem

⊙ Endarch: Protoxylem lie towards Centre and metaxylem lie towards periphery of Organ. This type of primary Xylem is Called Endarch. In Stem.

⊙ Exarch: Protoxylem lie towards periphery and Metaxylem lie toward Centre of Organ. This type of arrangement of primary xylem is Called Exarch.

[ii] Phloem:

→ Transport Food material, from leaves to other part of plant's

→ In angiosperm is Composed of Sieve tube Elements, Companion Cell, phloem parenchyma and phloem fibres.

→ Gymnosperm have albuminous Cells and Sieve Cells. They lack Sieve tubes and Companion Cells

[a] Sieve tube Elements: long tube like structure

→ arranged longitudinal and associated with the Companion Cells.

→ Mature Sieve Element's posseses a peripheral Cytoplasm and large Vacuole but lacks a Nucleus

→ function of Sieve tube is Controlled by nucleus of Companion Cells

[b] Companion cells : Specialised parenchymatous cell.

→ ~~Com~~ Connected by Sieve tube with the help of pit field's

→ Help in maintaining pressure gradient in Sieve tubes.

[C] Phloem Parenchyma : Made of Elongated, Cyclindrical Cells.

→ Have dense Cytoplasm and Nucleus

→ Cell wall is Composed of Cellulose.

→ Store food material and other substance like Resins and mucilage.

→ Absent in Monocotyledons.

[d] Phloem fibres: also known as Bast fibres.

→ Made up of Sclerenchymatous Cells
→ Absent in primary phloem but found in secondary phloem.
→ Elongated, Unbranched and have pointed needle like apices
→ Cell wall is thick.
→ at maturity, fibre loose their protoplast and become dead.

⊙ Protoploem: formed primary phloem Consist of narrow sieve tubes.

⊙ Metaphloem: Later formed phloem has bigger sieve tube.

## 2. THE TISSUE SYSTEM

→ On the basis of structure and location there are three type of tissue System.

[i] Epidermal Tissue System
[ii] The Ground Tissue System
[iii] Vascular or Conducting Tissue System

## Epidermal Tissue System:

→ Outermost Covering of whole plant body

→ Comprises epidermal cells, stomata and the epidermal appendages → The trichomes and hairs.

[i] Epidermis: Outermost layer

→ Made up of Elongated, Compactly arranged Cells.

→ Single layered.

→ Cell are parenchymatous with a small amount of Cytoplasm lining the Cell wall and a large Vacuole.

→ Outside of Epidermis Covered with a waxy thick layer called Cuticles.
↓
prevent loss of Water.

[ii] Stomata: It is a structure present on Epidermis of leaves.

→ Regulate the process of transpiration and gaseous exchange.

→ Composed of two bean shaped cells known as guard cells → Enclose Stomatal pore

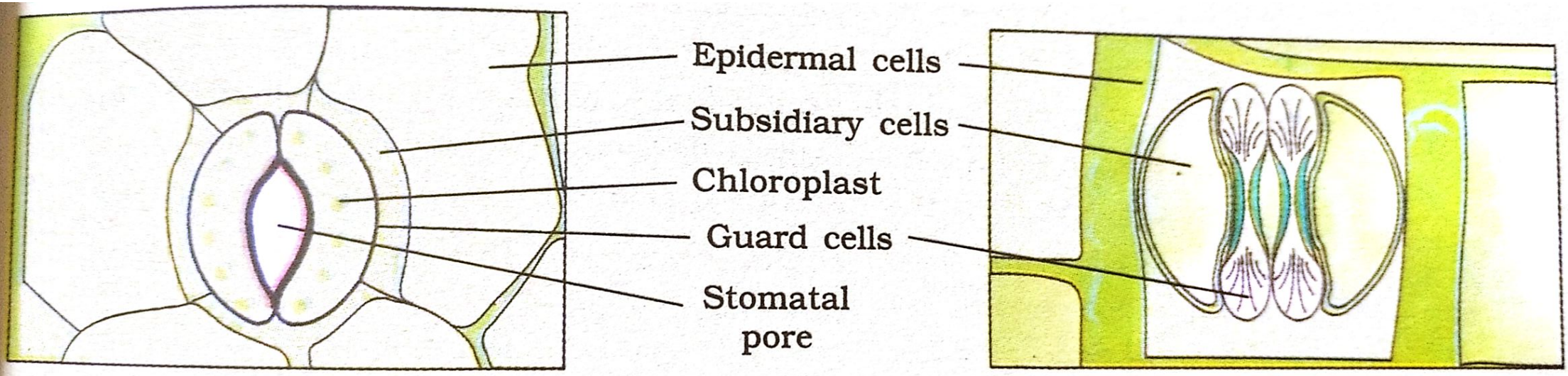



**Figure 6.4** Diagrammatic representation: (a) stomata with bean-shaped guard cells (b) stomata with dumb-bell shaped guard cell

→ In grass guard cell are dumb bell shaped.

→ Guard cell posses Chloroplast and regulate the opening and closing of stomata.

- Subsidiary Cell: Few epidermal cell in the vicinity of guard cell become specialised in their shape and size.

- Stomatal apparatus: Stomatal aperture guard cell and subsidiary cell are together called stomatal apparatus.

[iii] Hairs: Cell of epidermis bear a no. of hairs

→ Root hair: Unicellular and help in absorption of water and minerals

→ Trichomes: epidermal hair on stem.
→ Multicellular
→ May be branched or Unbranched.
→ Help in preventing water loss due to transpiration.

## * THE GROUND TISSUE SYSTEM

- All tissue Except Epidermis and Vascular bundles.
- Consist of simple tissue such as parenchyma, Collenchyma and Sclerenchyma.

→ Cell's are present in Cortex, pericycle pith and medullary rays in primary stems and root's

→ In leaves the ground tissue consist of thin-walled chloroplast containing cells and is called Mesophyll.

## * THE VASCULAR TISSUE SYSTEM.

→ Consist the phloem and Xylem.
→ In Dicotyledonous stem, Cambium is present b/w phloem and xylem.
→ Cambium posses the ability to form secondary Xylem and phloem.

Q. What is Open and Close Vascular bundle.

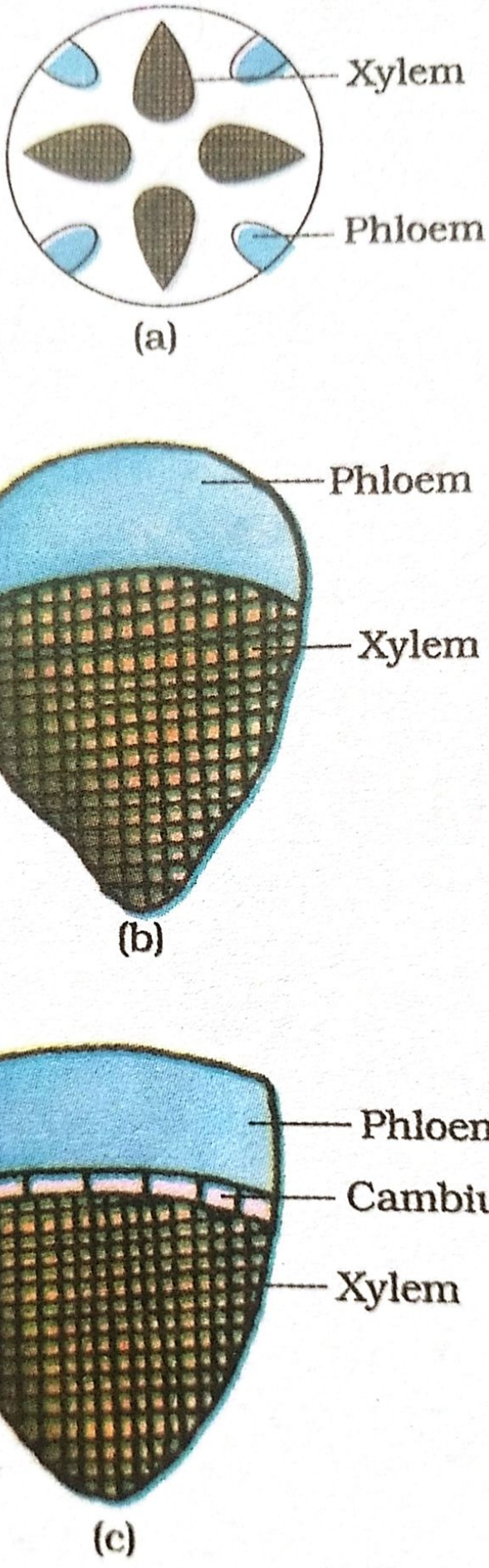



**Figure 6.5** Various types of vascular bundles : (a) radial (b) conjoint closed (c) conjoint open

→ When Xylem and phloem within a Vascular bundle are arranged in an alternate manner on different radii the arrangement is called radial.

→ Conjoint: Xylem and phloem are situated at the same radius of Vascular bundle.
→ Common in leaves and stem.

## 3. DICOTYLEDONOUS ROOT

→ Outermost layer is Epidermis
→ Cortex: Consist several layer of thin walled walled parenchyma cells with intracellular space.

- Innermost layer of Cortex is Endodermis.
- Consist single layer of barrel-shaped cell without any intracellular space.

- The Endodermal cells have a deposition of water impermeable, waxy material-Suberin in form of Casparian strips.

→ Pericycle: Next to endodermis
- few layer of thick walled parenchymatous cells.

- Initiation of lateral root's and Vascular Cambium during secondary growth.

→ The pith is small or inconspicuous.

- Conjuctive tissue: Parenchymatous cells which lie b/w Xylem and phloem.

→ There are two - four Xylem and phloem patches.

- Stele: All tissue on innerside of Endodermis such as pith and pericycle Constitute the stele.

## * MONOCOTYLEDONOUS ROOT

→ Anatomy is similar to Dicotyledonous
→ Has epidermis, Cortex, Endodermis, pericycle Vascular bundle and pith.

→ They have more Six Xylem bundles than Dicotyledonous.

→ Pith is larged and well developed.
→ Do not undergo any secondary growth.

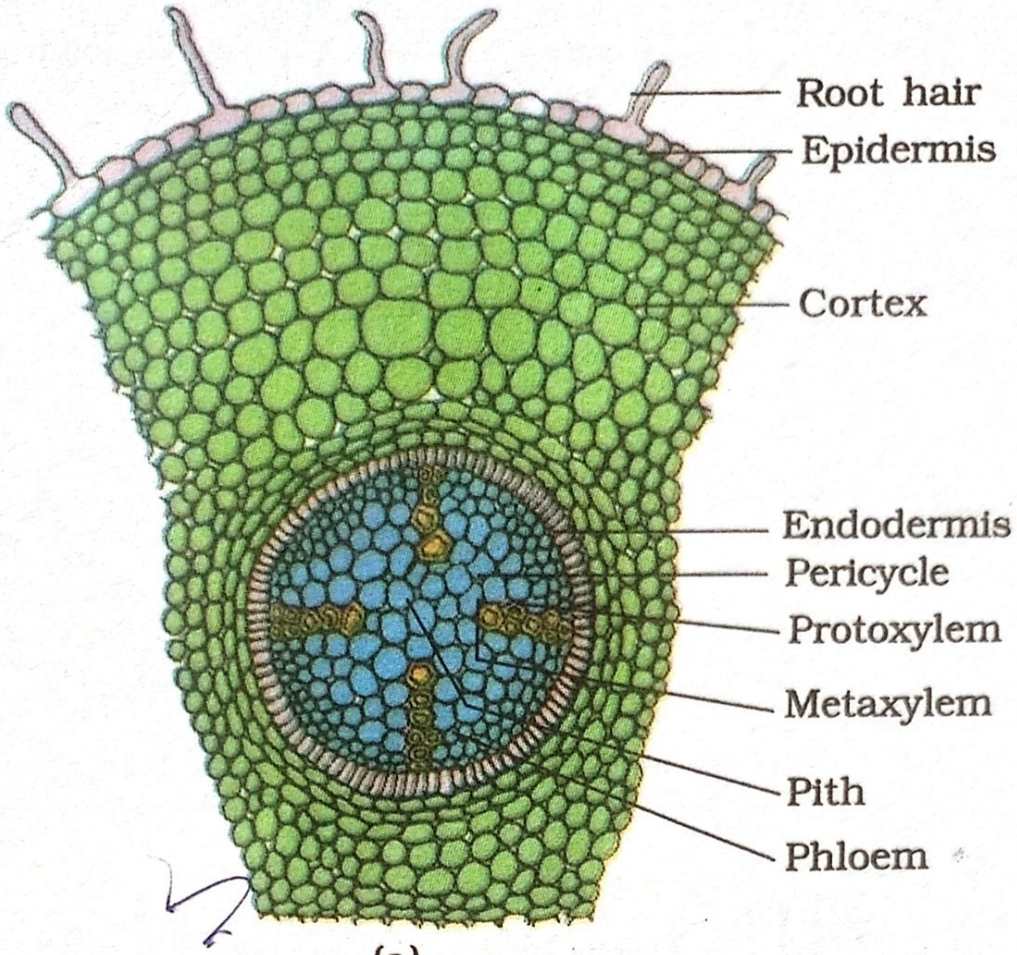



**Figure 6.6** T.S. : (a) Dicot root (Primary)
(b) Monocot root

# * DICOTYLEDONOUS ROOT

→ Epidermis is Outermost protective layer of stem.
- Covered with a thin layer of Cuticle
- May bear trichomes and a few stomata.

→ Consist three sub-zones:
- Hypodermis: Consist few layer of Collenchymatous cell just below Epidermis.

→ provide mechanical strength to young stem.

- Cortical layer: below hypodermis consist of round thin walled parenchyamatous cell with intercellular space.

- Endodermis: Innermost layer

→ Rich in starch grain and the layer is also referred to as starch sheath.

* Pericycle present on inner side of endodermis and above phloem.

→ Between the Vascular bundles; few layer of radially placed parenchymatous cell's Constitute Medullary rays.

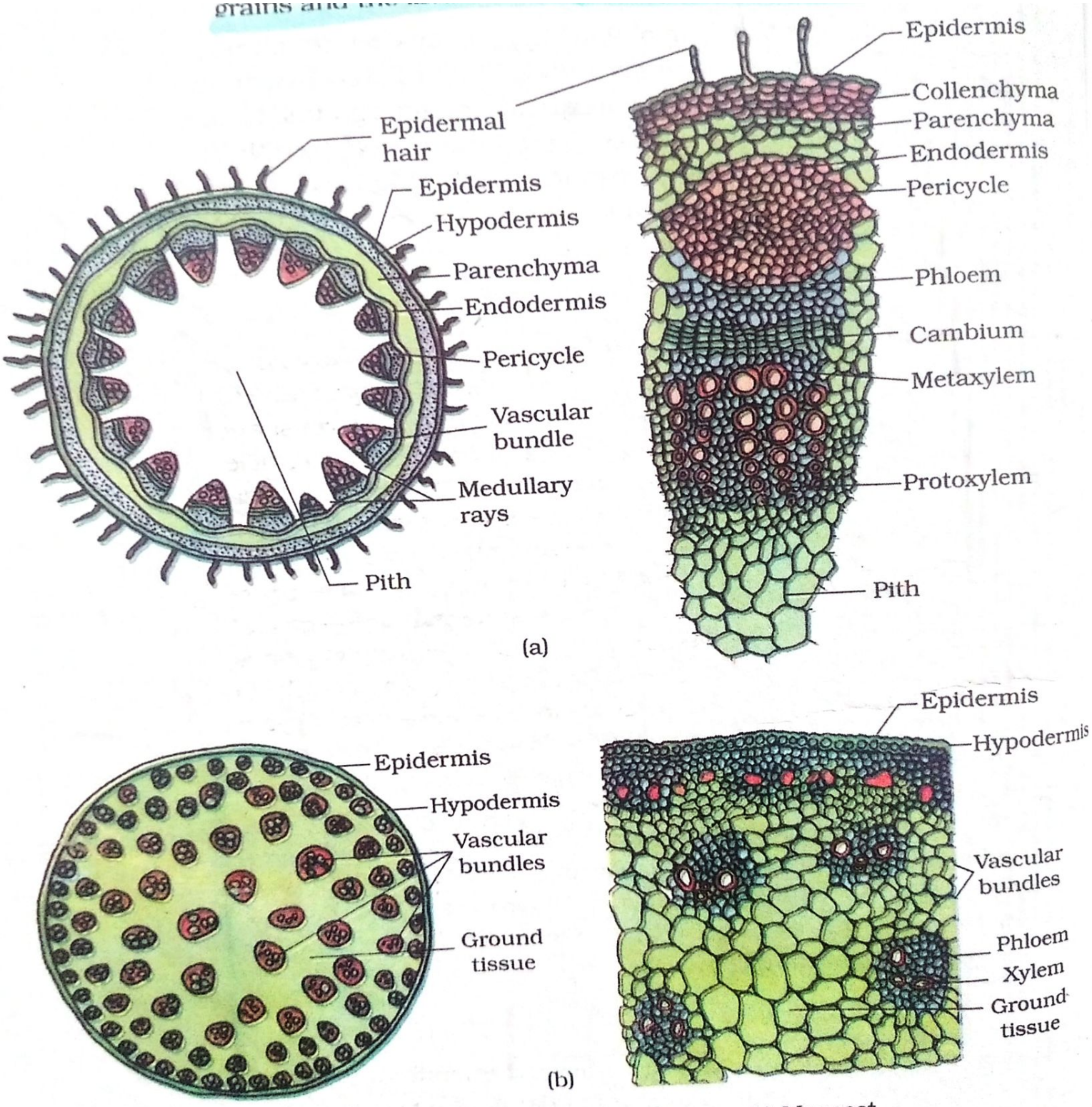



**Figure 6.7** T.S. of stem : (a) Dicot (b) Monocot

* Vascular bundle : arranged in a ring.
→ Each Vascular bundle is conjoint, open with endarch protoxylem.

* Pith: They are round, parenchymatous cell's with large intercellular space.
→ Occupy central portion of stem.

## * MONOCOTYLEDONOUS STEM

→ Has a Sclerenchymatous hypodermis.
→ Vascular bundle is surrounded by Sclerenchymatous bundle sheath and large parenchymatous ground tissue.

→ Vascular bundle are conjoint and closed
→ phloem parenchyma is absent.
→ Water - Containing Cavities are present within the Vascular bundles.

## * DORSIVENTRAL [DICOTYLEDONS] LEAF

• Epidermis: Cover both upper surface [adaxial epidermis] and lower surface [abaxial epidermis]

→ abaxial epidermis bear more stomata than adoxial.

* Mesophyll : Tissue b/w upper and lower epidermis.
→ Have chloroplast and carry out photosynthesis
→ Made up of parenchyma.
→ Has two type of cells

[i] palisade parenchyma : [ii] Spongy parenchyma

→ There are air cavities b/w these cells.

* Vascular System : includes Vascular bundle

→ Size of Vascular bundle are depend on size of Veins.

→ Vascular bundle are surrounded by layer of thick walled Bundle sheath cell's.

## * ISOBILATERAL [MONOCOTYLEDONOUS] LEAF

→ In Isobilateral, leaf, stomata present on both surface.
→ In grass, adaxial epidermis cell along the Veins modify themselves into large, empty and colourless cell. These are called bulliform cell
→ When they are flaccid, make leaves curl inwards to minimise water loss.

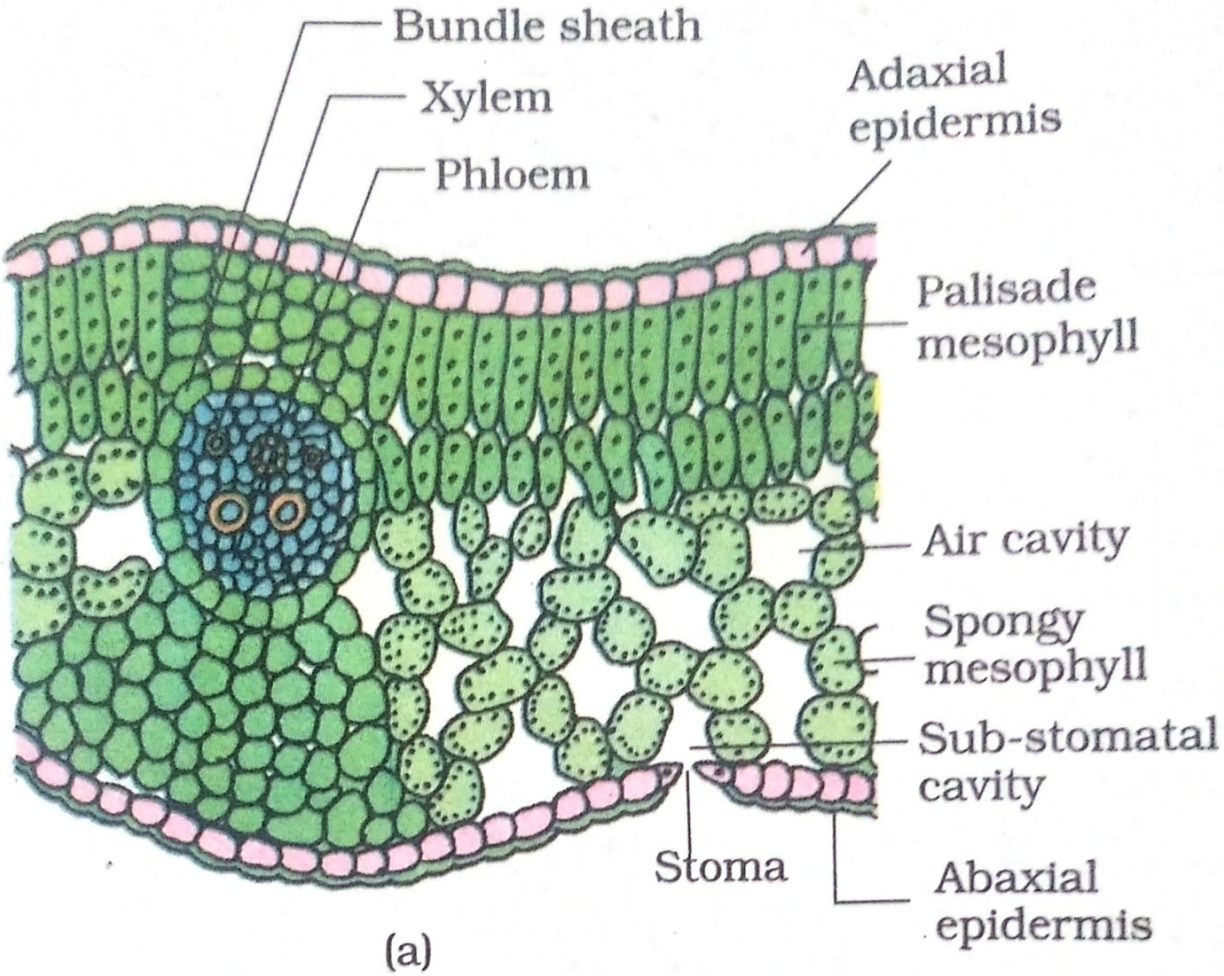



**Figure 6.8** T.S. of leaf : (a) Dicot (b) Monocot

# * SECONDARY GROWTH

→ Most dicotyledons plant's exhibit an increase in girth. This increase is Called Secondary growth.

→ Tissue involved in secondary growth is Vascular Cambium and Cork Cambium.

# * VASCULAR CAMBIUM.

→ Responsible for Cutting of Vascular tissue

→ In young stem present in patches as single layer b/w xylem and phloem.

⊙ formation of Cambium ring.

→ The cell's of Cambium present b/w primary xylem and primary phloem is infrasicular Cambium.

→ Cells of Medullary ray's adjoining infrasicular Cambium become meristematic and form the interfasicular Cambium.

Date

## ⊙ Activity of Cambial ring:

→ Cambial ring active and become to cut off new cells.

→ Cell's cut off toward pith mature into Secondary Xylem.

→ Cell's cut off toward periphery mature into Secondary phloem.

→ Amount of Secondary Xylem produce is more than Secondary phloem.

→ At some place Cambium form's a narrow band of parenchyma, which passes through the Secondary Xylem and phloem in radial direction. These are Secondary Medullary rays.

* Spring Wood: In spring Cambium is very active and produce large no of Xylary Element. The wood formed during this season is Spring wood or early wood.

* AUTUMN WOOD: In winter Cambium is less active and formed fewer Xylary Elements that have narrow Vessel. This wood is Autumn wood.

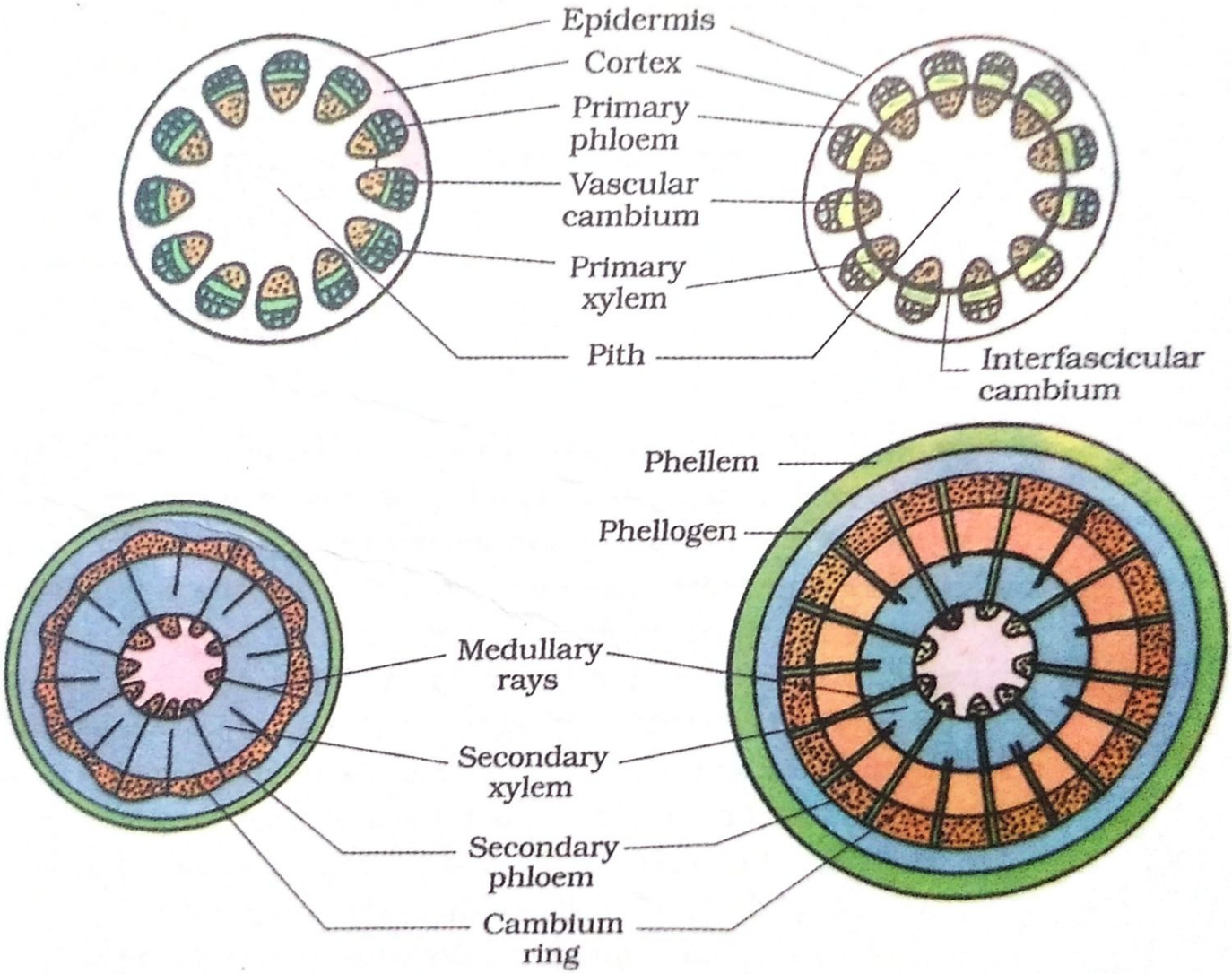



**Figure 6.9** Secondary growth in a dicot stem (diagrammatic) – stages in transverse views

→ Spring wood is lighter in colour and has lower density.

→ Autumn wood is darker and has a higher density.

→ Annual ring estimate the age of tree.

* Heartwood: Region of stem comprises dead element with lignified walls and is called Heartwood.

→ Does not conduct water.

* Sapewood: The peripheral region of secondary xylem is lighter in colour and known as Sapewood.

→ Involved in Conduction of water and Minerals.

* CORK CAMBIUM

→ Cork cambium or phellogen develops in the cortex region.

→ Couple of layers thick off cells on both sides

→ Outer cells differentiate into cork

or phellem while the inner cells differentiate into secondary cortex or phelloderm.

→ Phellogen, phellem, and phelloderm are collectively known as periderm.

→ ~~Due To~~

→ Bark is a non-technical term refer to all tissues exterior to vascular cambium, therefore including secondary phloem.

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

→ Formed early in the season is called early or soft bark.

→ The end of the season, late or hard bark is formed

→ At certain regions the phellogen cut off closely arranged parenchymatous cells on the outer side instead of cork cells.

→ These parenchymatous cells soon rupture the epidermis, forming

a lens-shaped openings called lenticels.

→ Permit the exchange of gases between the outer atmosphere and the internal tissue of the stem.

## ✱ Secondary Growth in Roots

→ In dicot root, Vascular cambium is completely secondary origin.

→ Originates from the tissue located just below the phloem bundles. a portion of pericycle tissue, forming a complete and continuous wavy ring, which later becomes circular.

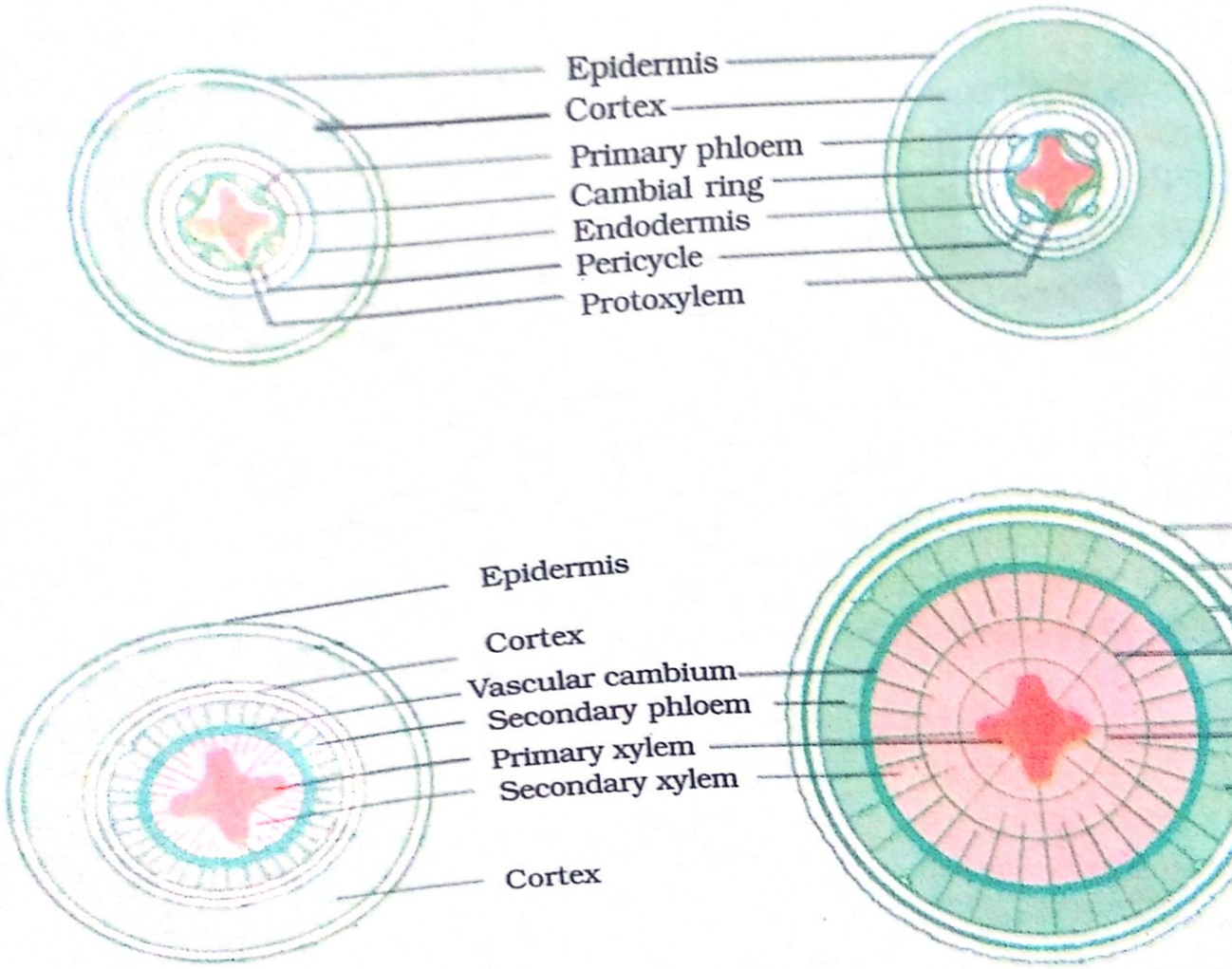



**Figure 6.11** Different stages of the secondary growth in a typical dicot root

Secondary growth also occurs in stems and roots of gymnos
However, secondary growth does not occur in monocotyledons.

## Summary