

ANATOMY OF FLOWERING PLANTS

I 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 division called **Meristems**.

Primary →

- Apical meristems
- Intercalary meristem

Secondary or lateral meristem

• **Apical meristems**: Occur at the tips of root and shoots

→ produces primary tissue
Root apical meristem → Tip of root's

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

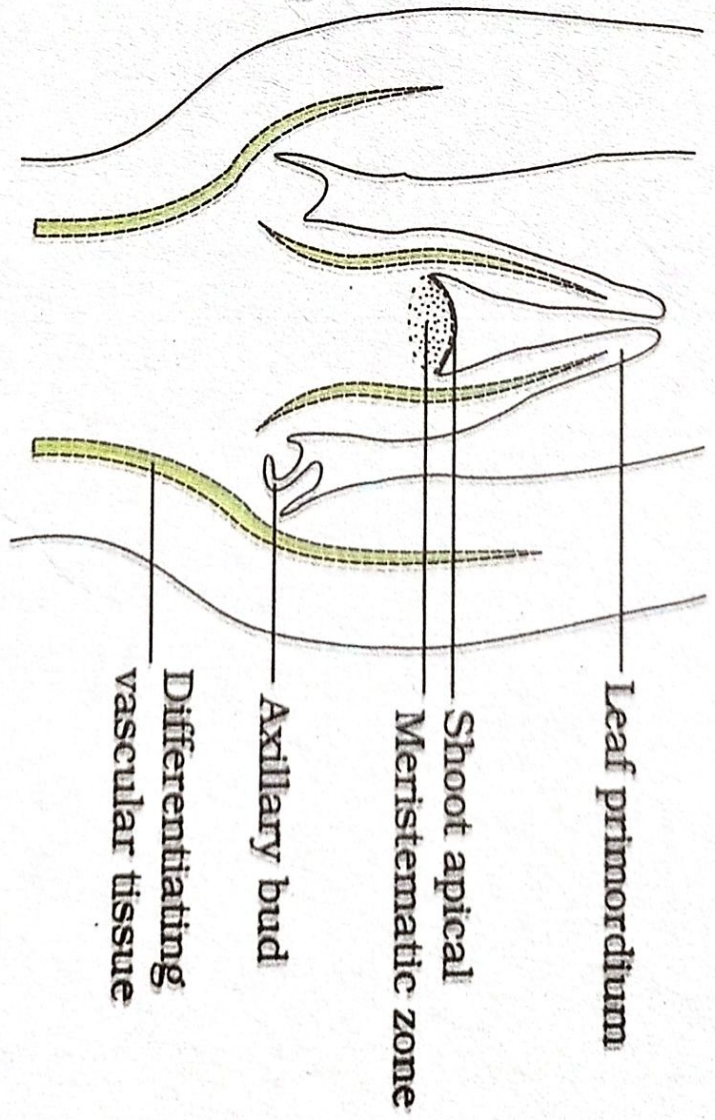
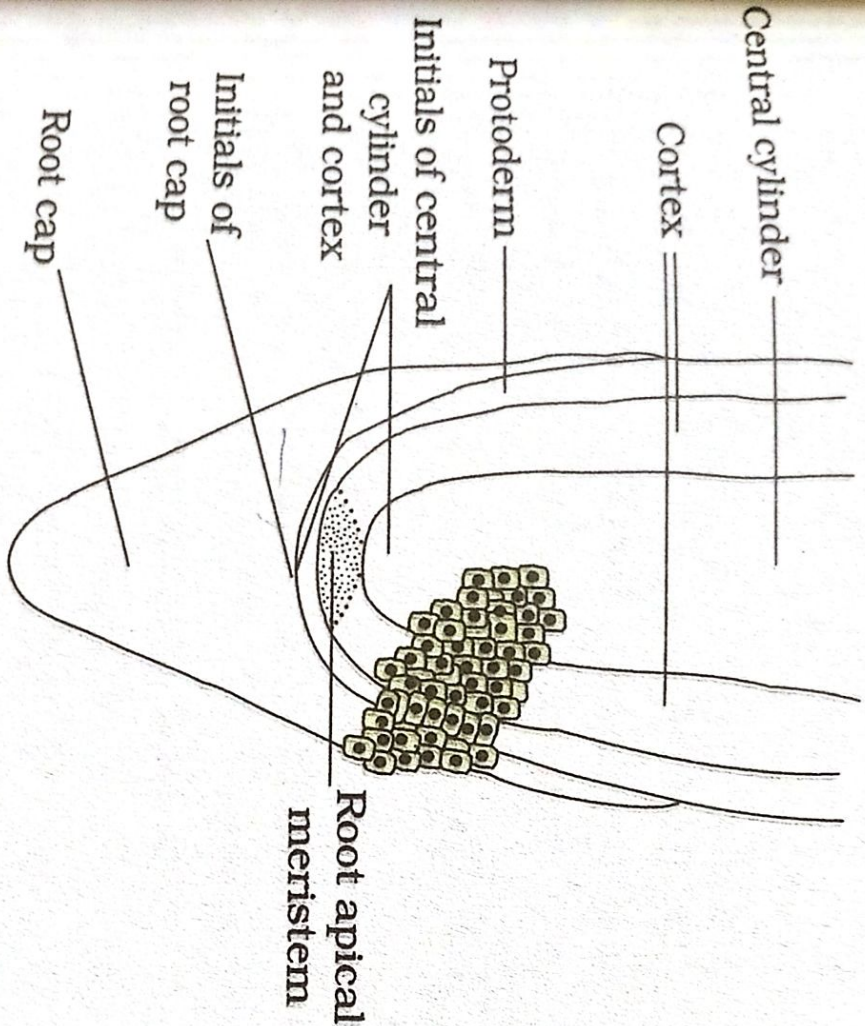


Figure 6.1 Apical meristem: (a) Root (b) Shoot

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

↓
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 meristem 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 plant's are

(a) Parenchyma (b) Collenchyma

(c) Sclerenchyma

[a] Parenchyma tissue : Form major component within organs

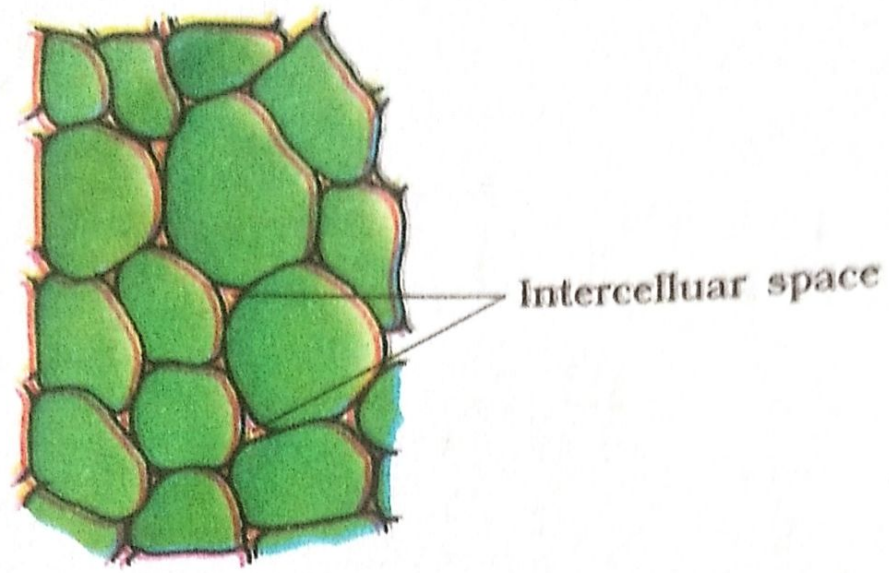
→ Cells are **isodiametric**

→ **Shape** : Spherical, Oval, Round, polygonal and Elongated.

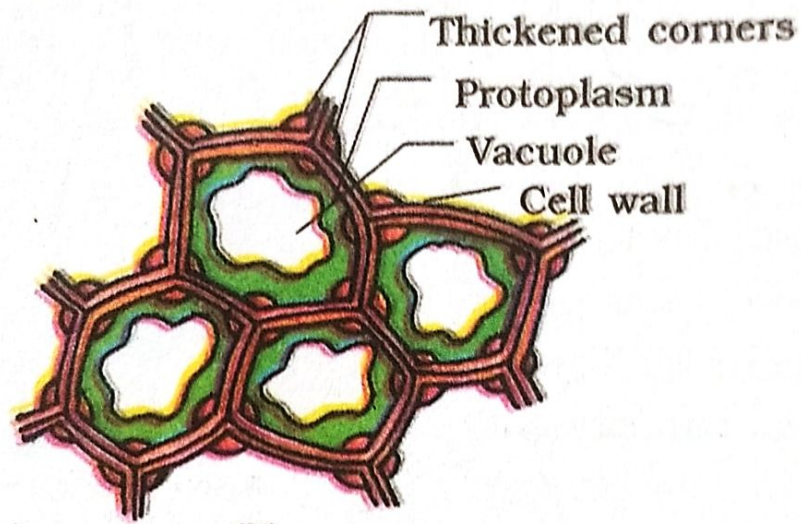
→ Made up of Cellulose

→ Have small intracellular space

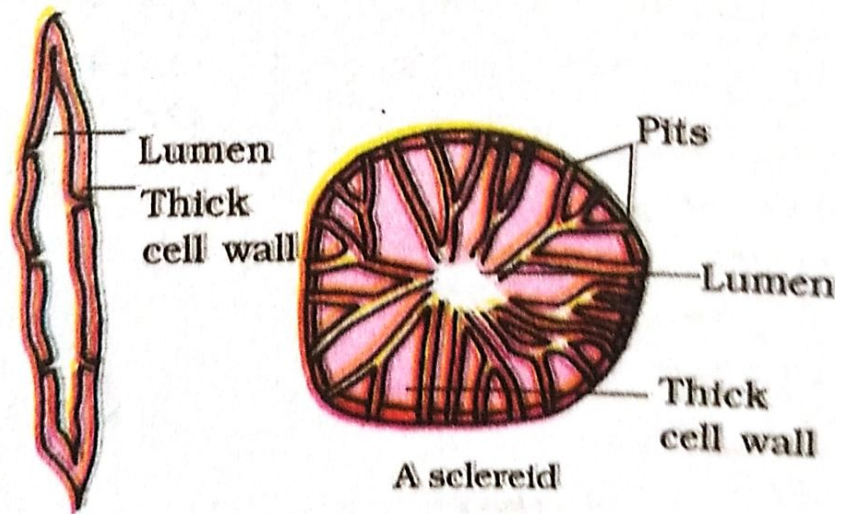
→ **function** : Photosynthesis, Storage, Secretion.



(a)



(b)



A fibre

A sclereid

(c)

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 corners 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 vary narrow cavities [lumen]
 - Provide mechanical support to organ
- found in joint walls of nuts.

~~1~~ * COMPLEX TISSUES

- Made up of more than one type of cells.
- Xylem and phloem constitute the complex tissue.

[a] Xylem : Conducting tissue for water and minerals from roots to stem and leaves.

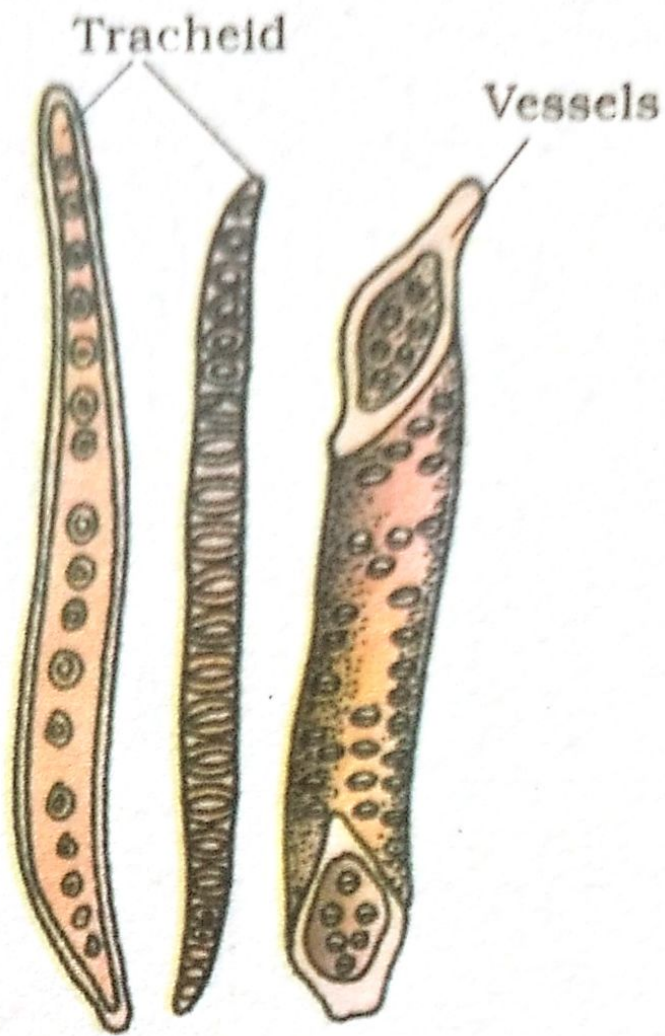
→ It is composed of

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

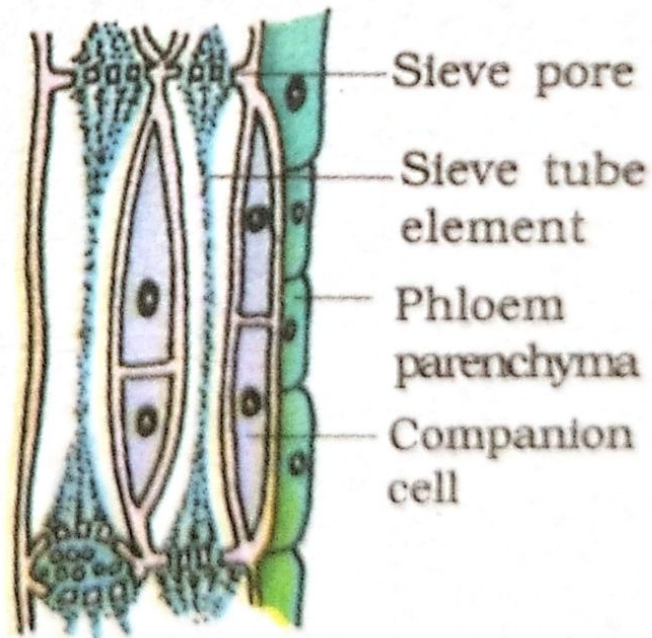
→ Gymnosperm lack vessel in xylem

[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, possesses 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 fields

→ Help in maintaining pressure gradient in Sieve tubes.

[C] Phloem Parenchyma : Made of Elongated, Cylindrical 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, ~~un~~ unbranched and have pointed needle like apices

→ Cell wall is thick.

→ at maturity, fibre lose their protoplast and become dead.

⊙ Protoxylem: 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.

→ Cells are parenchymatous with a small amount of cytoplasm lining the cell wall and a large vacuole.

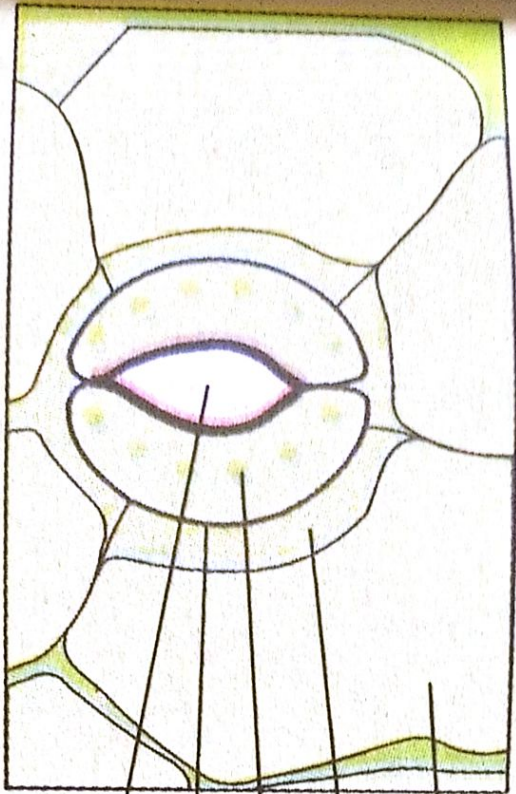
→ Outside of epidermis covered with a waxy thick layer called cuticles.

↓
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



Epidermal cells
Subsidiary cells
Chloroplast
Guard cells
Stomatal pore

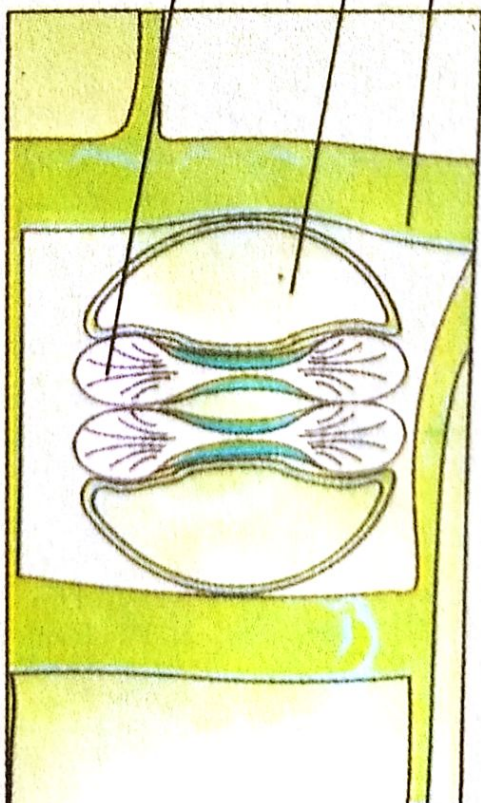


Figure 6.4 Diagrammatic representation: (a) stomata with bean-shaped guard cells
(b) stomata with dumb-bell shaped guard cell

→ 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 bears 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 roots.

→ 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**.

→ ~~But~~ **Cambium** posses the ability to form **secondary Xylem** and **phloem**.

Q. what is **Open** and **Close Vascular bundle**.

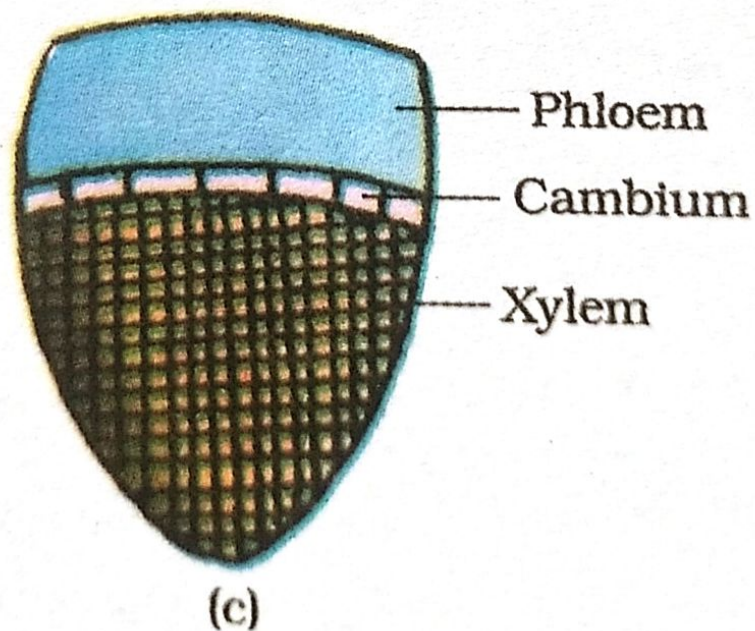
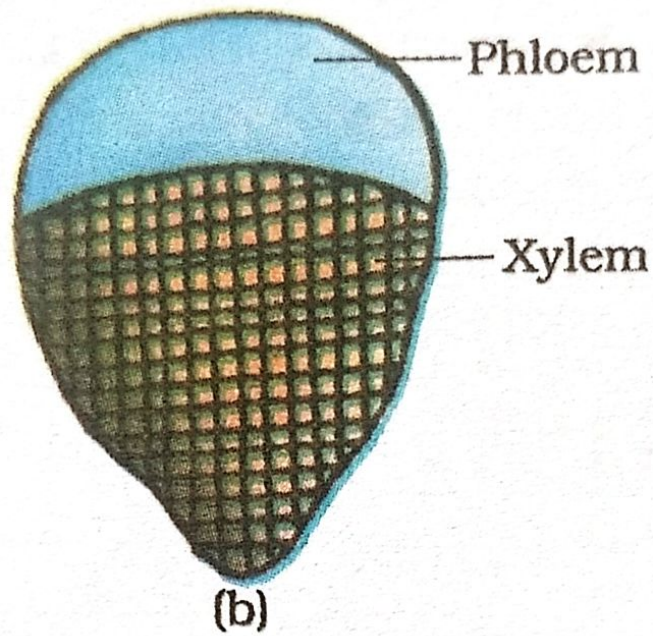
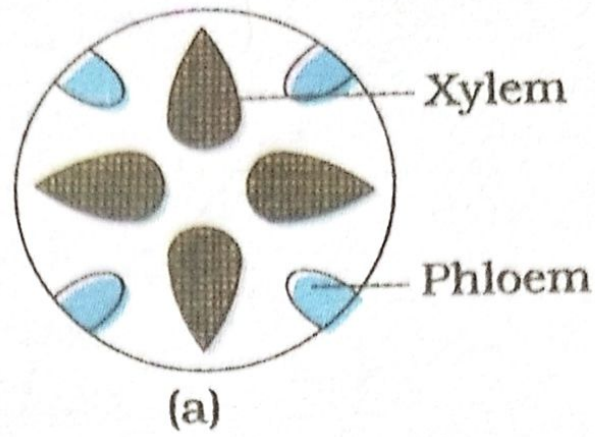


Figure 6.5 Various types of vascular bundles :
 (a) radial (b) conjoint closed
 (c) conjoint open

→ 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 layers 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 roots and Vascular Cambium during secondary growth.

→ The pith is small or inconspicuous.

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

→ There are two - four Xylem and phloem patches.

- Stele: All tissue on inner side 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 large and well developed.

→ Do not undergo any secondary growth.

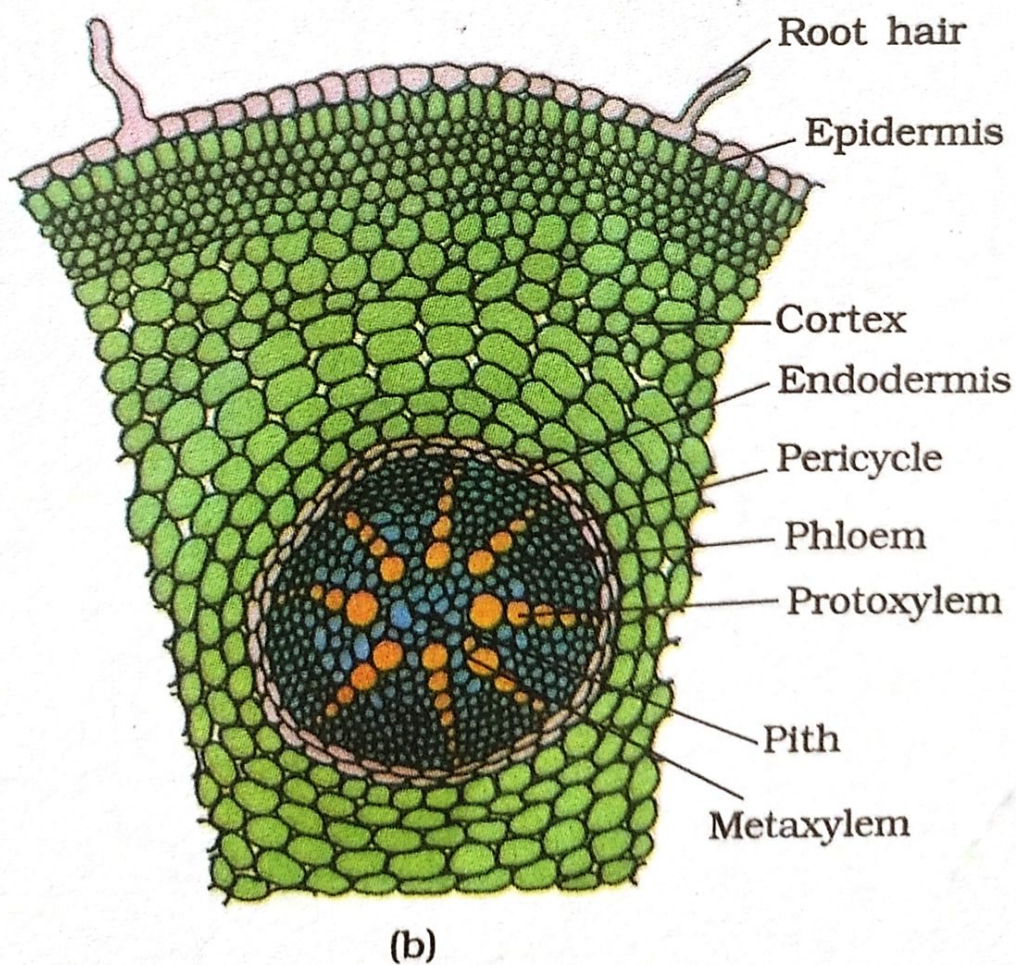
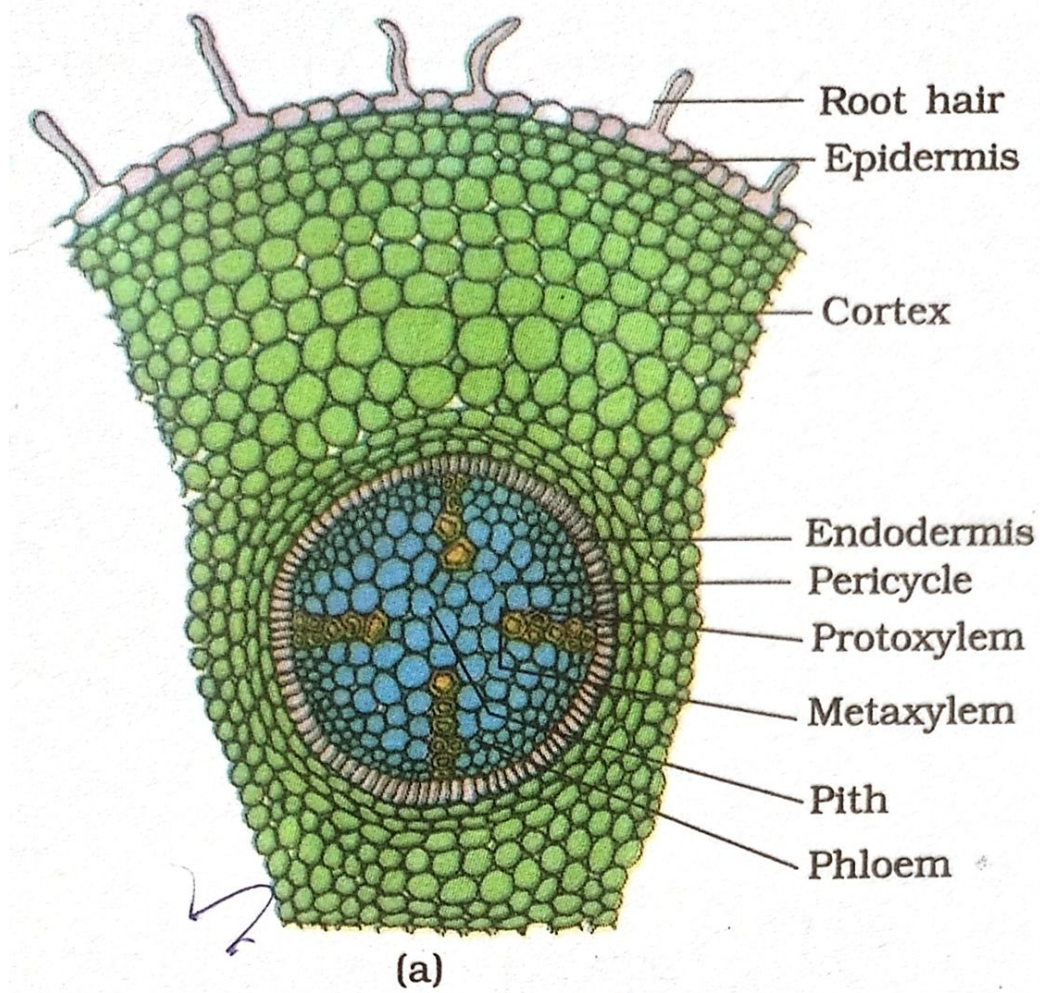


Figure 6.6 T.S. : (a) Dicot root (Primary)
(b) Monocot root

* 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 layers of Collenchymatous cell just below Epidermis.

→ provide mechanical strength to young stem.

- Cortical layer: below hypodermis consist of ground thin walled parenchymatous 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 layers of radially placed parenchymatous cells constitute Medullary rays.

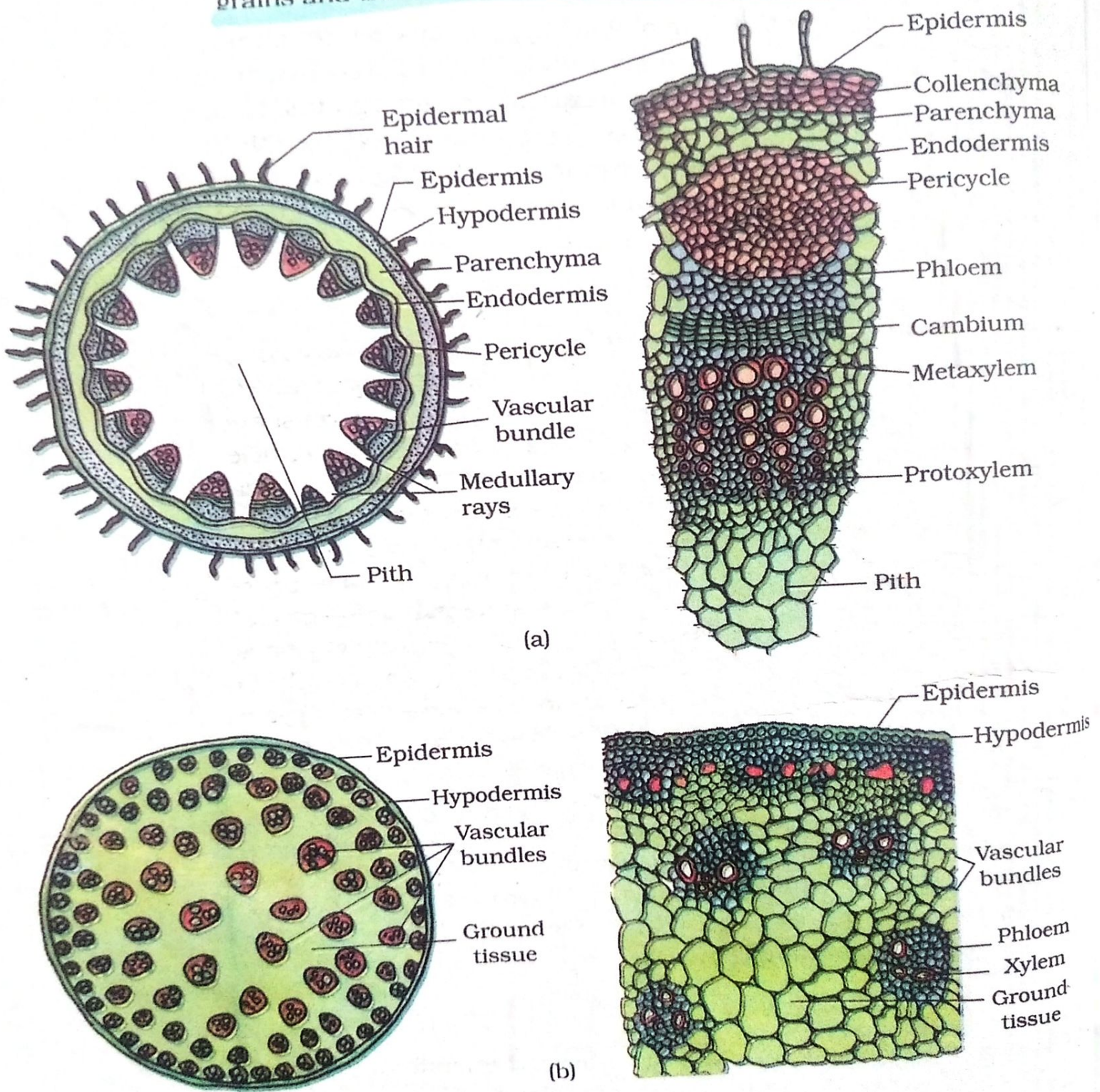


Figure 6.7 T.S. of stem : (a) Dicot (b) Monocot

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

* Pith : They are ground, parenchymatous cells with large intercellular space.
→ Occupy central position 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 bears more stomata than adaxial.

* 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

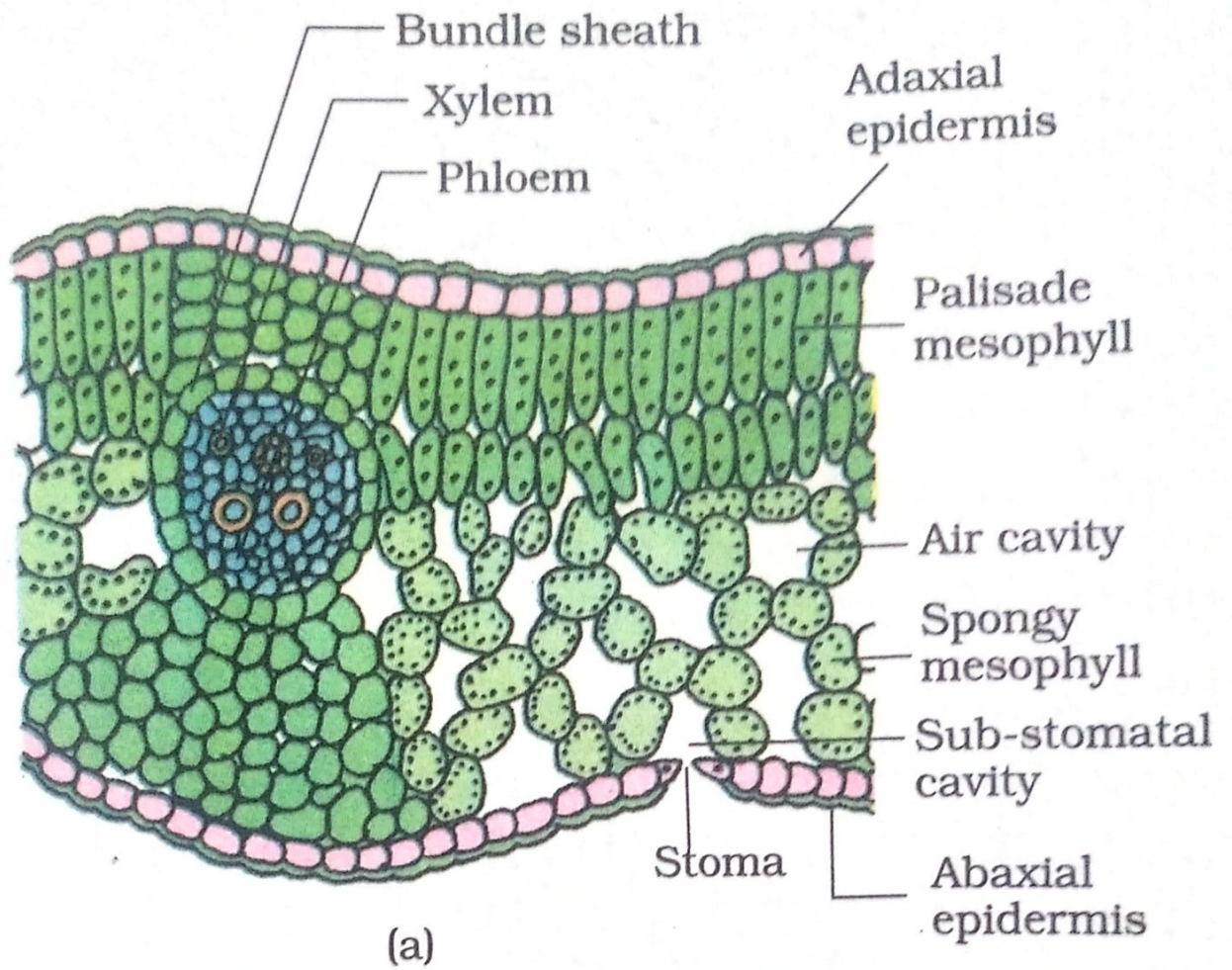
- There are air cavities b/w these cells.

* Vascular System: includes vascular bundle.

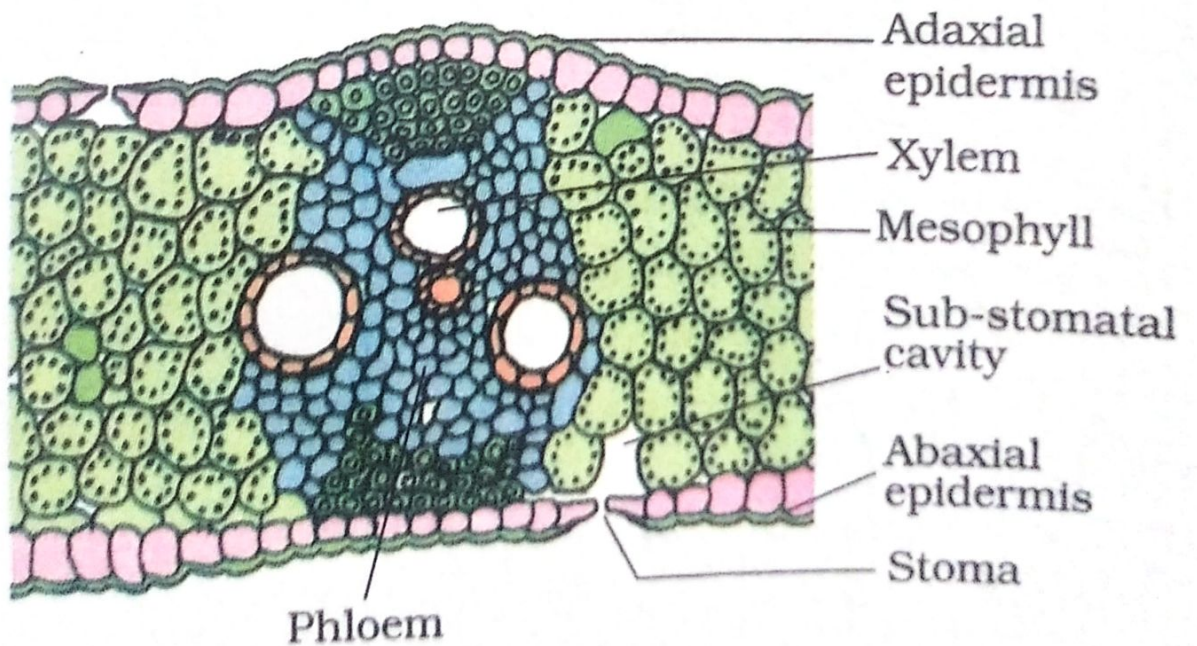
- size of vascular bundle are depend on size of veins.
- Vascular bundle are surrounded by layer of thick walled Bundle sheath cells.

* 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.



(a)



(b)

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

* SECONDARY GROWTH

→ Most dicotyledonous plants 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 cells of Cambium present b/w primary xylem and primary phloem is **intrafascicular Cambium**.

→ Cells of Medullary ray's adjoining **intrafascicular Cambium** become meristematic and form the **interfascicular Cambium**.

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 Xylem element. The wood formed during this season is Spring wood or early wood.

* **AUTUMN Wood**: In winter Cambium is less active and formed fewer Xylem elements that have narrow vessel. This wood is Autumn wood.

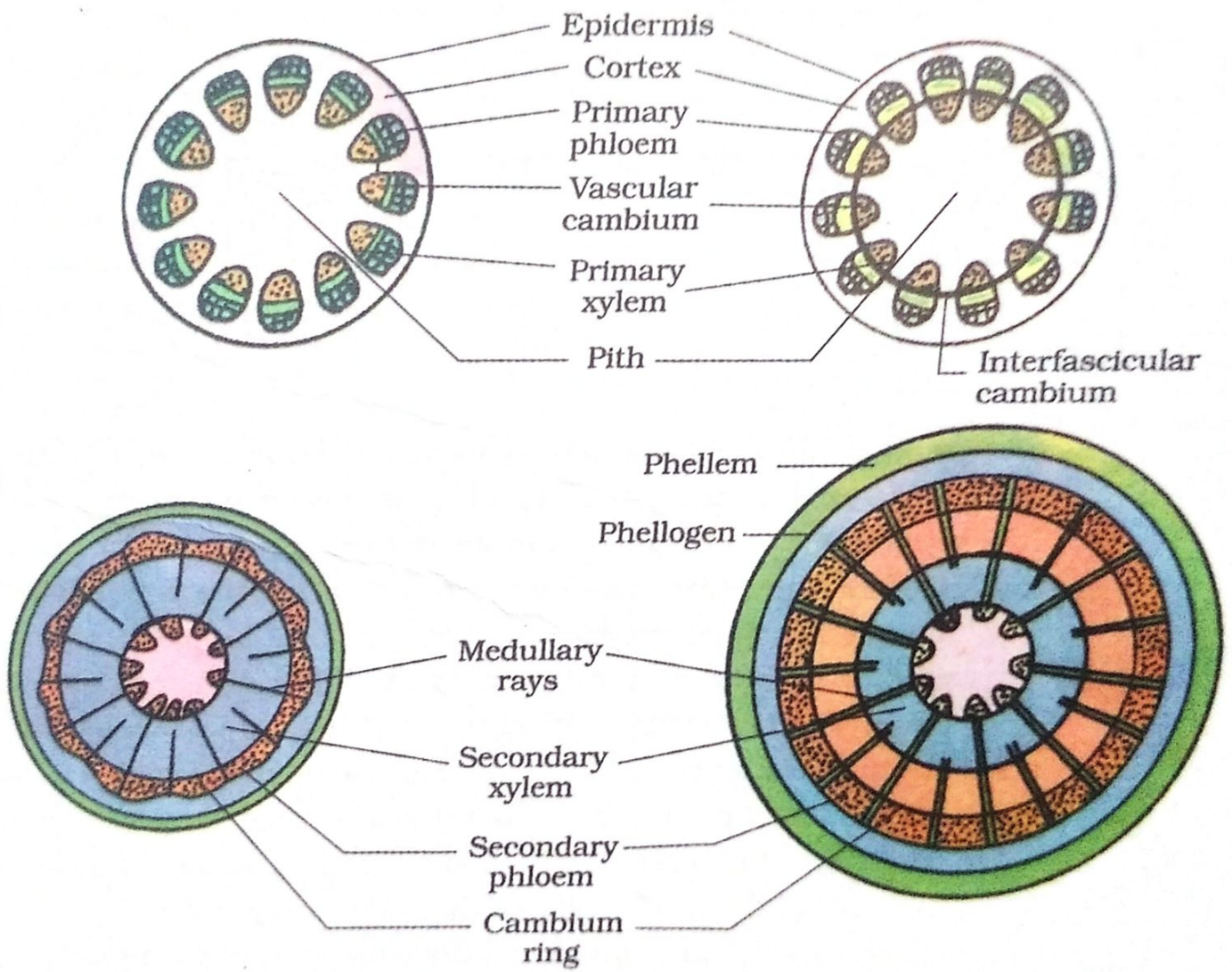


Figure 6.9 Secondary growth in a dicot stem (diagrammatic) – stages in transverse views

→ 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.

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

→ Involved in conduction of water and Minerals.

* CORK CAMBIUM

→ Cork cambium or phellogen develops in the cortex region.

→ Couple of layers thick of 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.



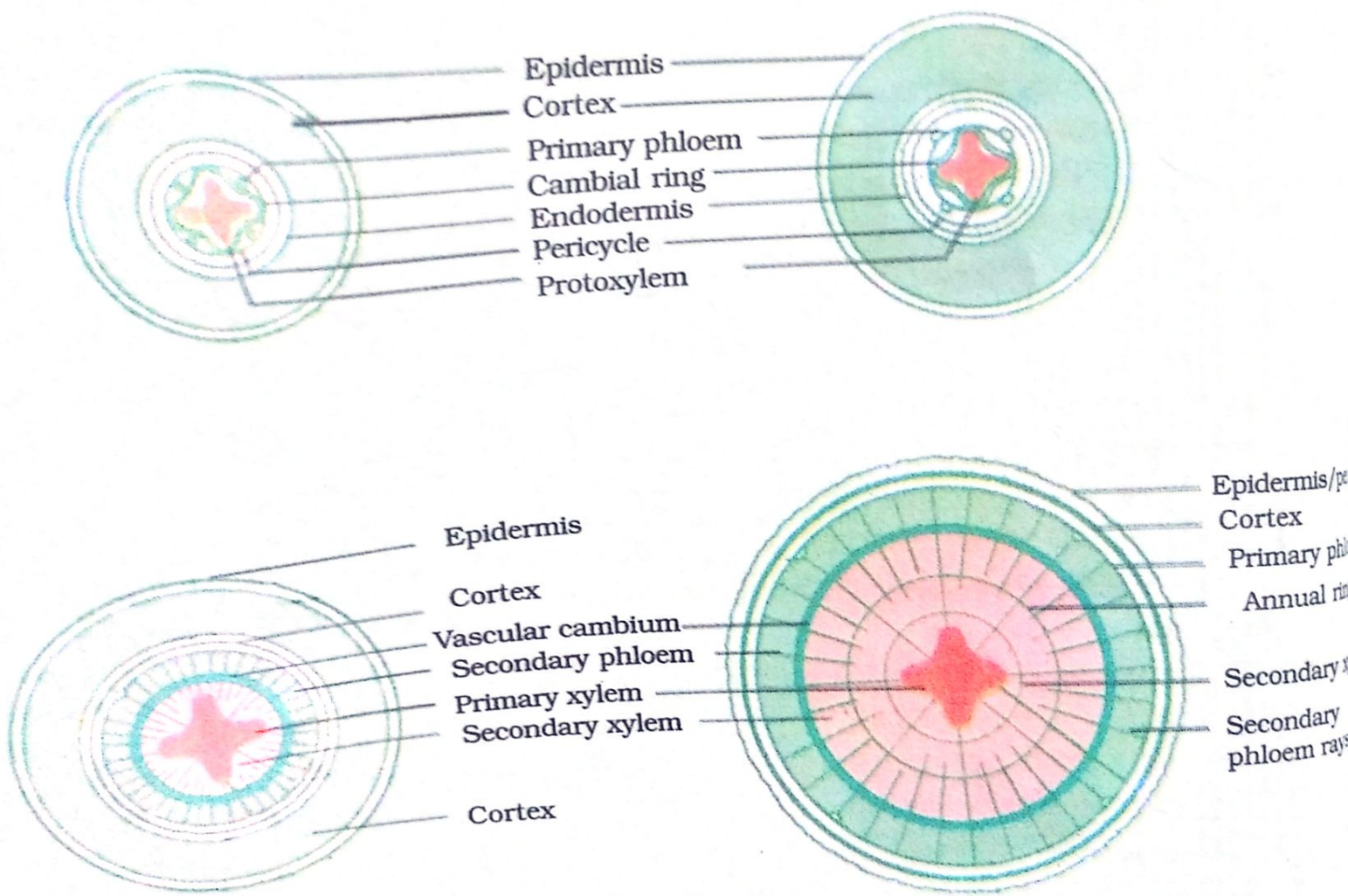


Figure 6.11 Different stages of the secondary growth in a typical dicot root

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

SUMMARY