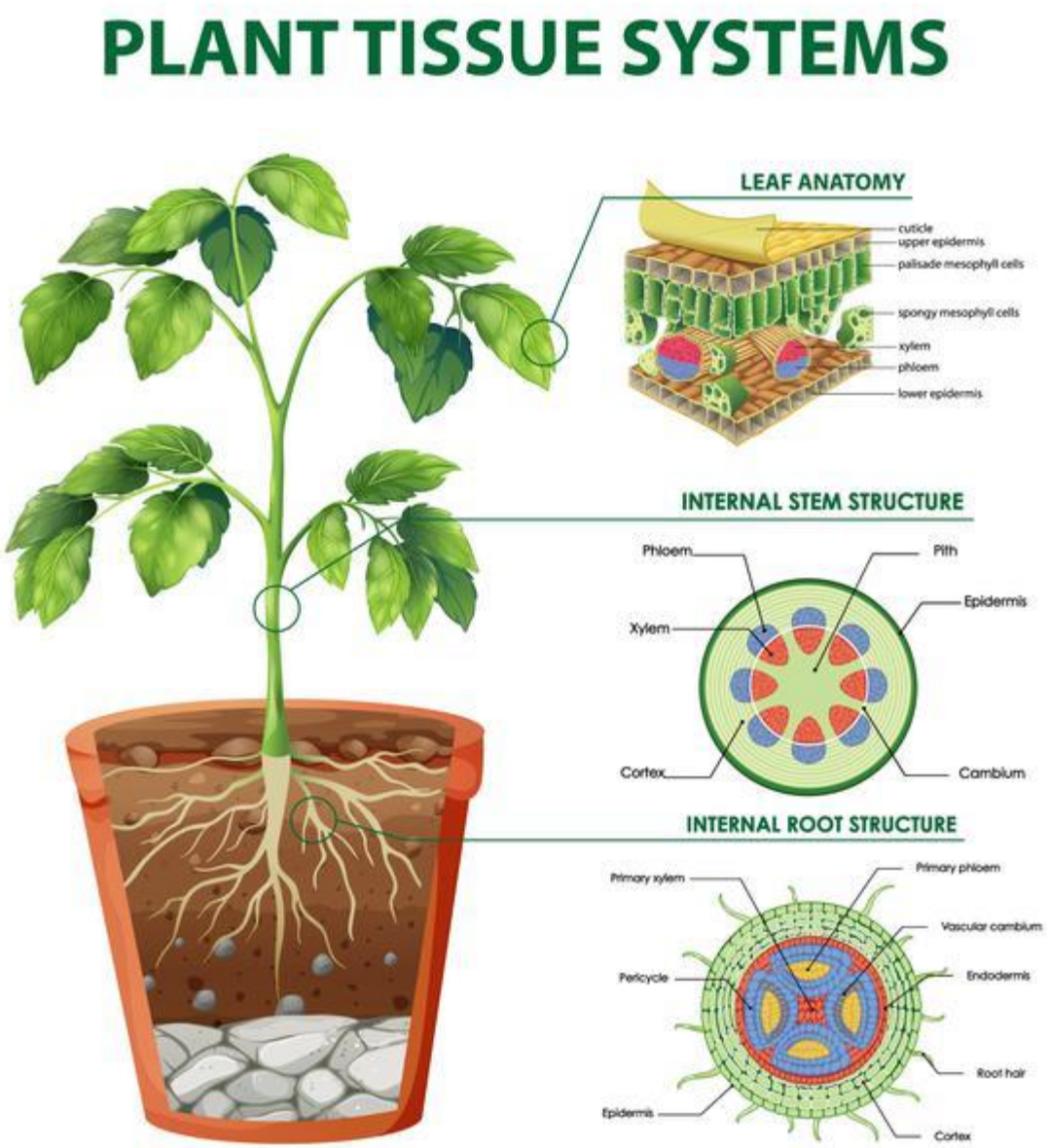
CC-4
UNIT-3

The Plant Tissues



DR. ARINDAM MANDAL
Assistant Professor in Botany
Bejoy Narayan Mahavidyalaya
Itachuna, Hooghly

The Tissues

- A Tissue is a group of cells that are alike in origin, structure and function.
- The study of tissue is called Histology.
- A plant is made up of different types of tissues.

There are two principal groups:

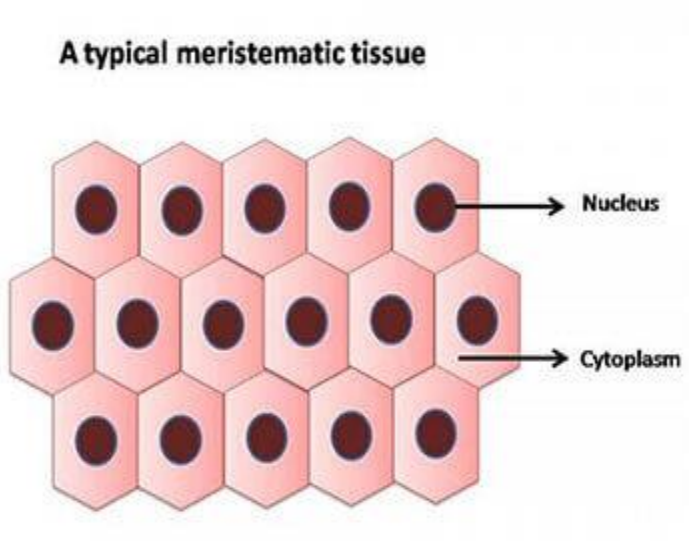
1. **Meristematic tissues**
2. **Permanent tissues**

Meristematic Tissue

The term meristem is coined by C. Nageli 1858.

The characters of meristematic tissues:

- **The meristematic cells are isodiametric and they may be, oval, spherical or polygonal in shape.**
- **They have generally dense cytoplasm with prominent nucleus.**
- **Generally the vacuoles in them are either small or absent.**
- **Their cell wall is thin, elastic and essentially made up of cellulose.**
- **These are most actively dividing cells.**
- **Meristematic cells are self-perpetuating.**



Classification of Meristem

Meristem has been classified into several types on the basis of position, origin,function and division.

A. On the basis of Position:

- **Apical meristem:- Present in apices of root and shoot. It is responsible for increase in the length of the plant, it is called as primary growth.**
- **Intercalary meristem:- Occurs between the mature tissues. It is responsible for elongation of internodes.**
- **Lateral meristem:- Occurs along the longitudinal axis of stem and root. It is responsible for secondary tissues and thickening of stem and root. Example: vascular cambium and cork cambium.**

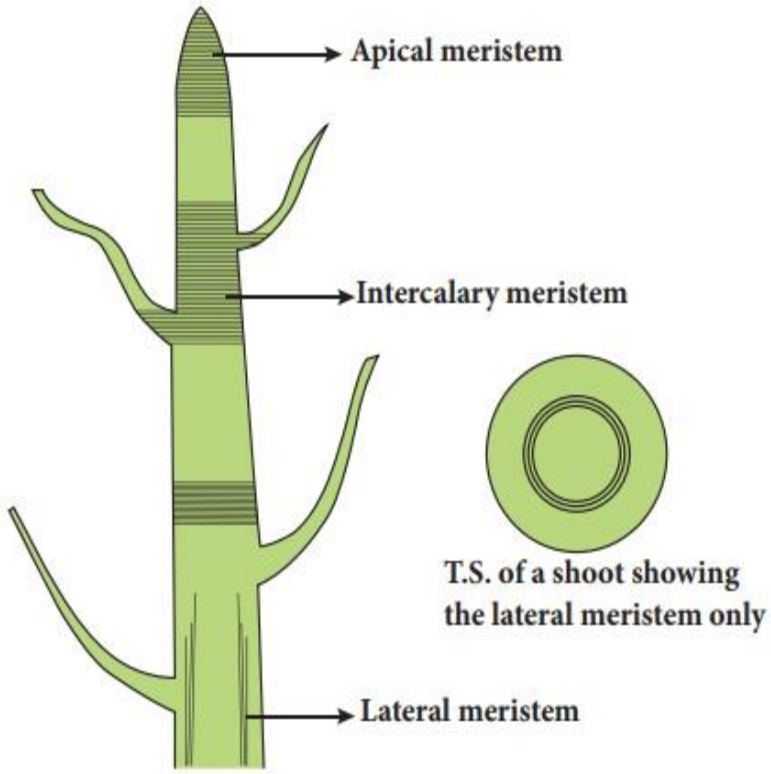


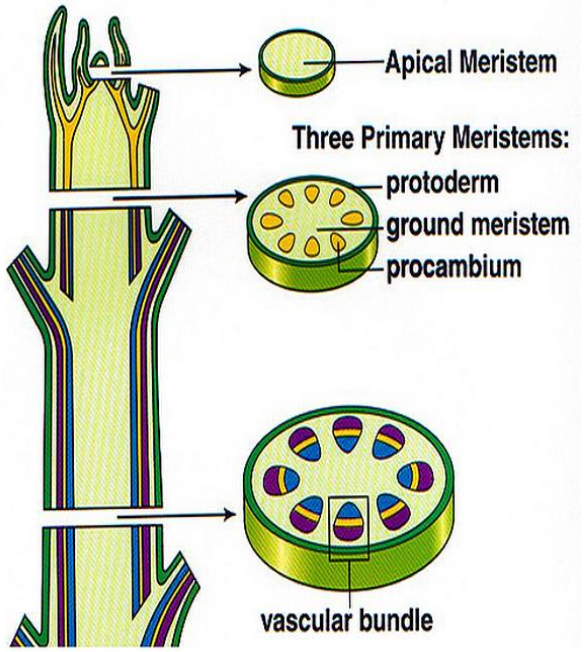
Figure 7.1 Longitudinal section of shoot apex showing location of meristems and young leaves.

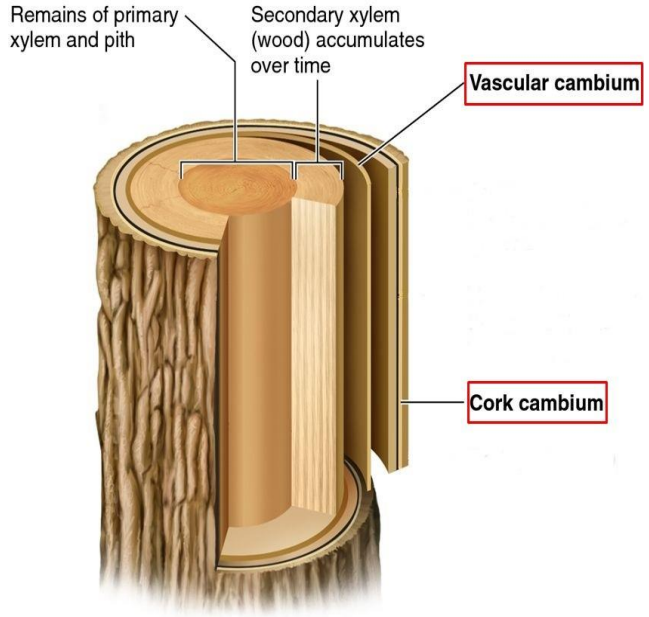
Classification of Meristem

B. On the basis of Origin

Primary Meristem:- It is derived from embryonic stages and differentiated into primary permanent tissues.

Secondary meristem It is derived during later stage of development of the plant body. It produces cork cambium and interfascicular cambium.





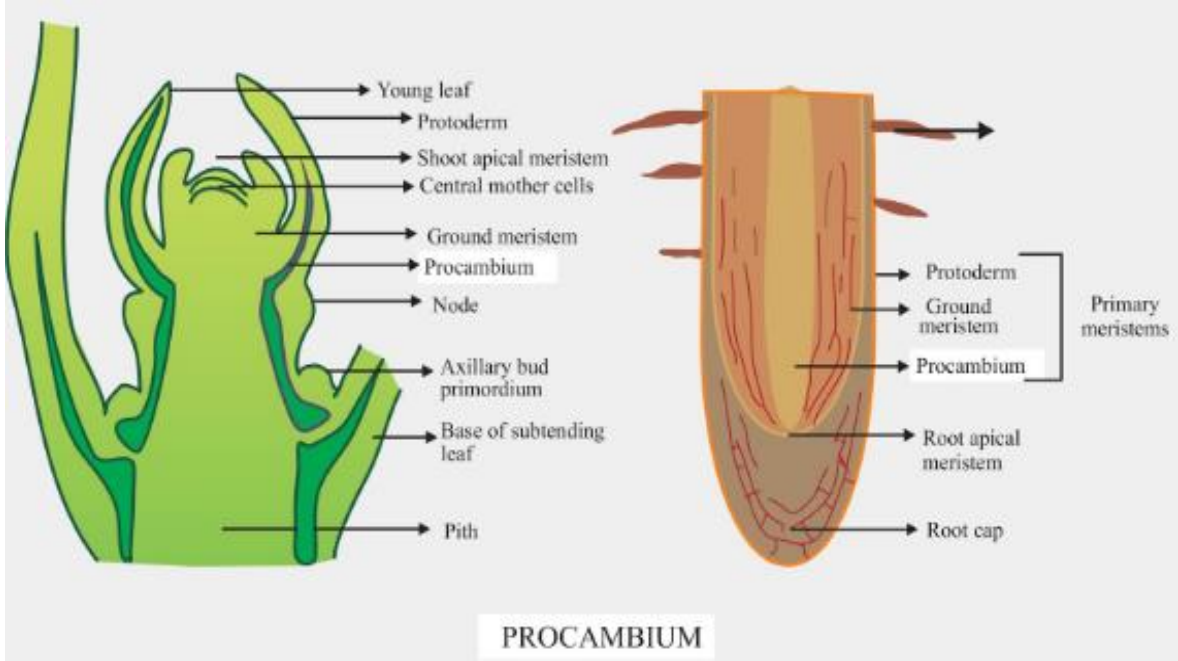
Classification of Meristem

C. On the basis of Function:

Protoderm:- It gives rise to epidermal tissue system and develops into epidermis,stomata and hairs.

Procambium:- It gives rise to primary vascular tissues. Example: xylem and phloem.

Ground Meristem:- It gives rise to all tissues except epidermis and vascular strands.



Classification of Meristem

D. On the basis of Plane of division:

Mass meristem:- It divides in all planes. Example: endosperm,young embryo and sporangium

Rib meristem or File meristem:- It divides anticlinally in one plane. Example: development of cortex and pith

Plate meristem:- It divides anticlinally in two planes. Example: development of epidermis

Permanent Tissues

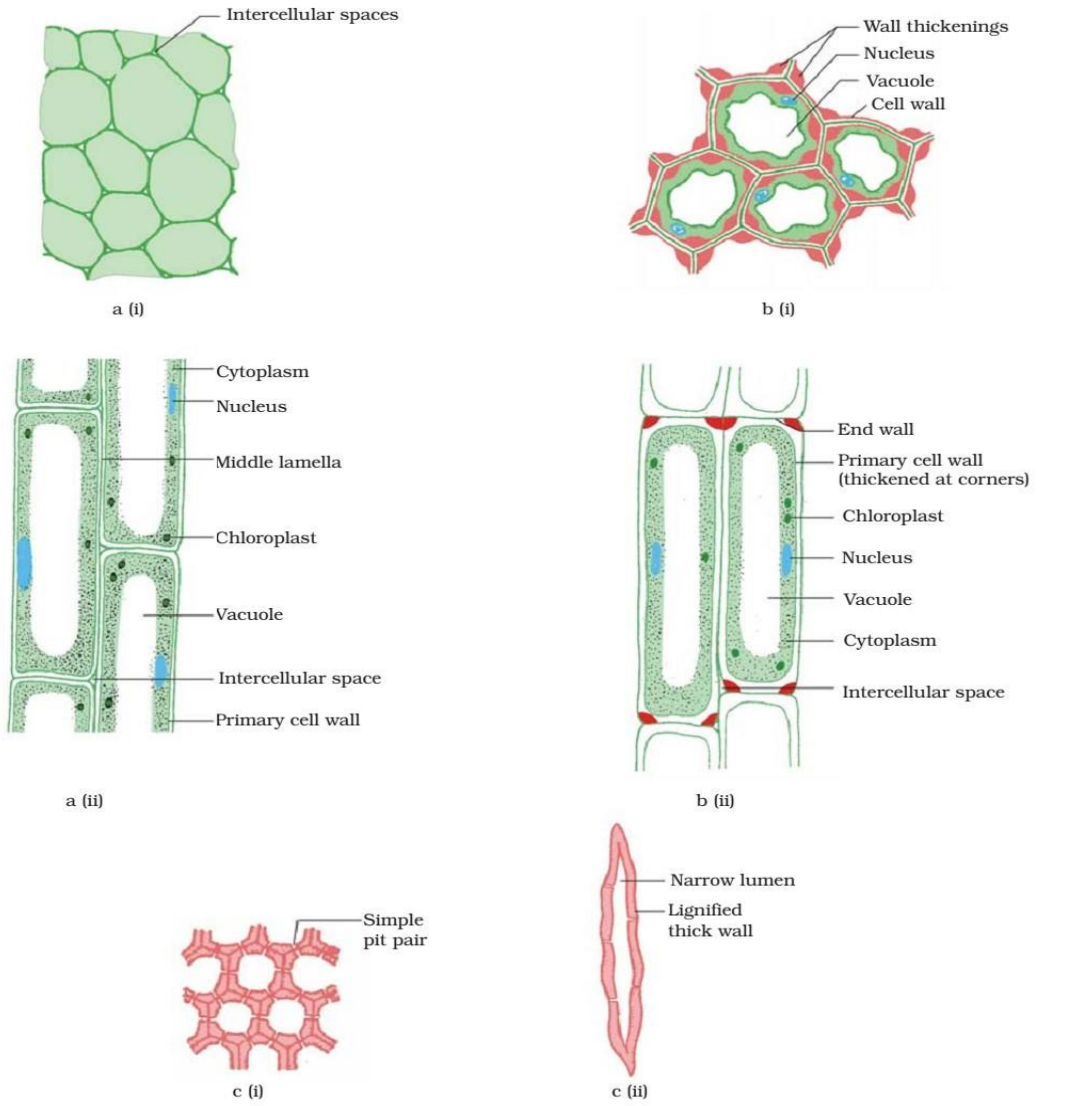
- The Permanent tissues develop from apical meristem.
- They lose the power of cell division either permanently or temporarily.
- They are classified into two types:

1. Simple permanent tissues.
2. Complex permanent tissues.

Simple Permanent Tissues

- Simple tissues are composed of one type of cells only.
- The cells are structurally and functionally similar. It is of three types.

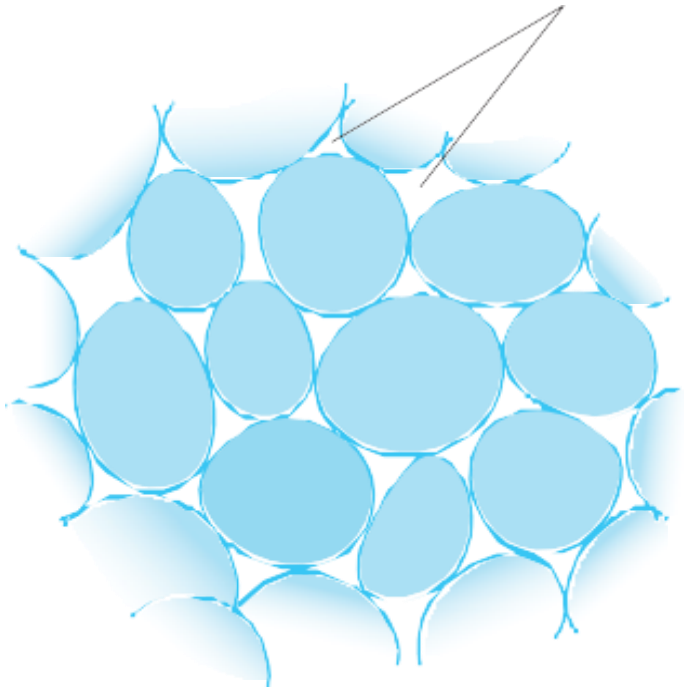
1. Parenchyma
2. Collenchyma
3. Sclerenchyma



. 6.4: *Various types of simple tissues: (a) Parenchyma (i) transverse section, (ii) longitudinal section; (b) Collenchyma (i) transverse section, (ii) longitudinal section; (c) Sclerenchyma (i) transverse section, (ii) longitudinal section.*

Parenchyma

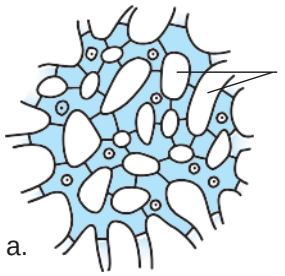
- Parenchyma is generally present in all organs of the plant.
- It forms the ground tissue in a plant. Parenchyma is a living tissue and made up of thin walled cells.
- The cell wall is made up of cellulose.
- Parenchyma cells may be oval, polyhedral, cylindrical, irregular, elongated or armed.
- Parenchyma tissue normally has prominent intercellular spaces.
- Parenchyma may store various types of materials like, water, air, ergastic substances.
- The turgid parenchyma cells help in giving rigidity to the plant body.
- Partial conduction of water is also maintained through parenchymatous cells.
- Occsionally Parenchyma cells which store resin, tannins, crystals of calcium carbonate, calcium oxalate are called idioblasts.

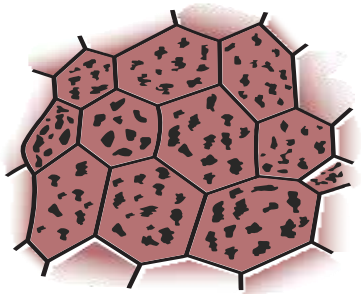


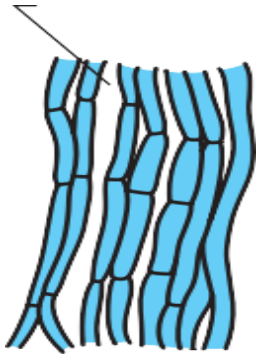
Parenchyma

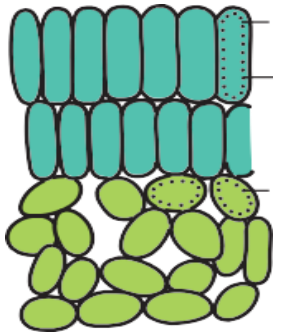
Types of Parenchyma

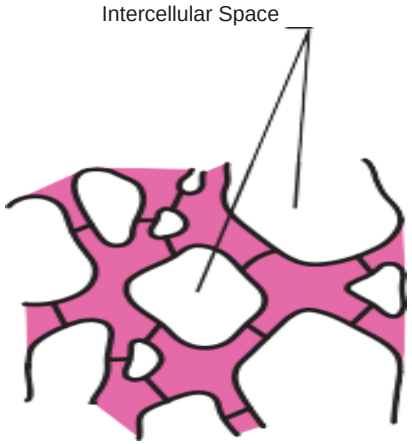
1. **Aerenchyma:** Parenchyma which contains air in its intercellular spaces. It helps in aeration and buoyancy. Example: Nymphae and Hydrilla.
2. **Storage Parenchyma:** Parenchyma stores food materials. Example: Root and stem tubers.
3. **Prosenchyma:** Parenchyma cells became elongated, pointed and slightly thick walled. It provides mechanical support.
4. **Chlorenchyma:** Parenchyma cells with chlorophyll. Function is photosynthesis. Example: Mesophyll of leaves.
5. **Stellate Parenchyma:** Star shaped parenchyma. Example: Petioles of Banana and Canna.





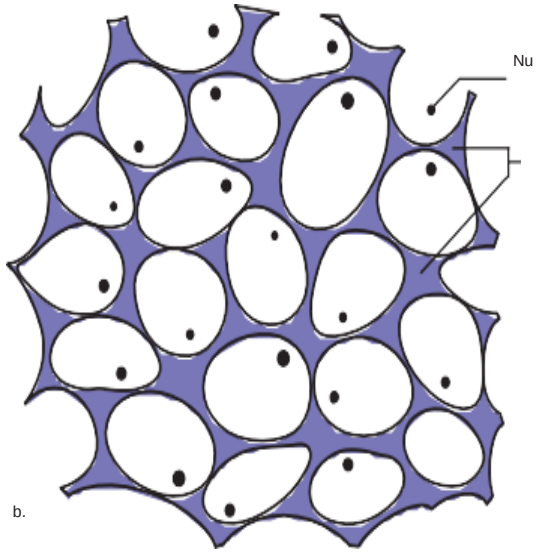






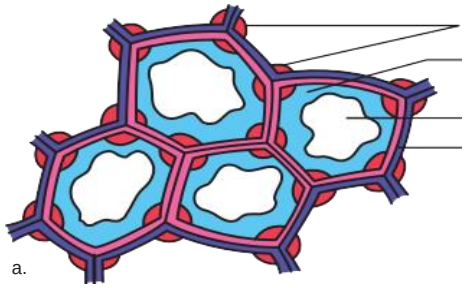
Collenchyma

- Collenchyma is a simple, living mechanical tissue.
- Collenchyma generally occurs in hypodermis of dicot stem.
- It is absent in the roots and also occurs in petioles and pedicels.
- The cells are elongated and appear polygonal in cross section.
- The cell wall is unevenly thickened.
- It contains more of hemicellulose and pectin besides cellulose.
- It provides mechanical support and elasticity to the growing parts of the plant.
- Collenchyma consists of narrow cells. It has only a few small chloroplast or none.
- Tannin maybe present in collenchyma.

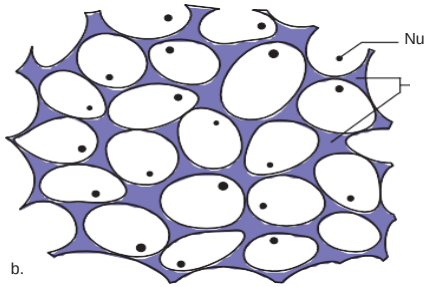


Collenchyma

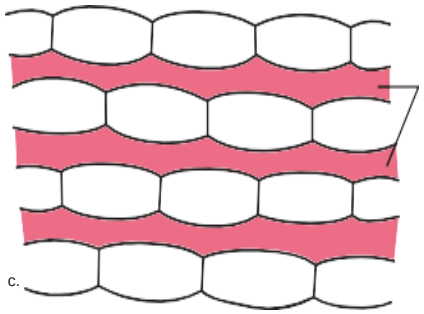
Based on pattern of pectinisation of the cell wall, there are three types of collenchyma



1. Angular collenchyma It is the most common type of collenchyma with irregular arrangement and thickening at the angles where cells meets. Example:Hypodermis of Datura and Nicotiana



2. Lacunar collenchyma The collenchyma cells are irregularly arranged. Cell wall is thickening on the walls bordering intercellular spaces. Example:Hypodermis of Ipomoea

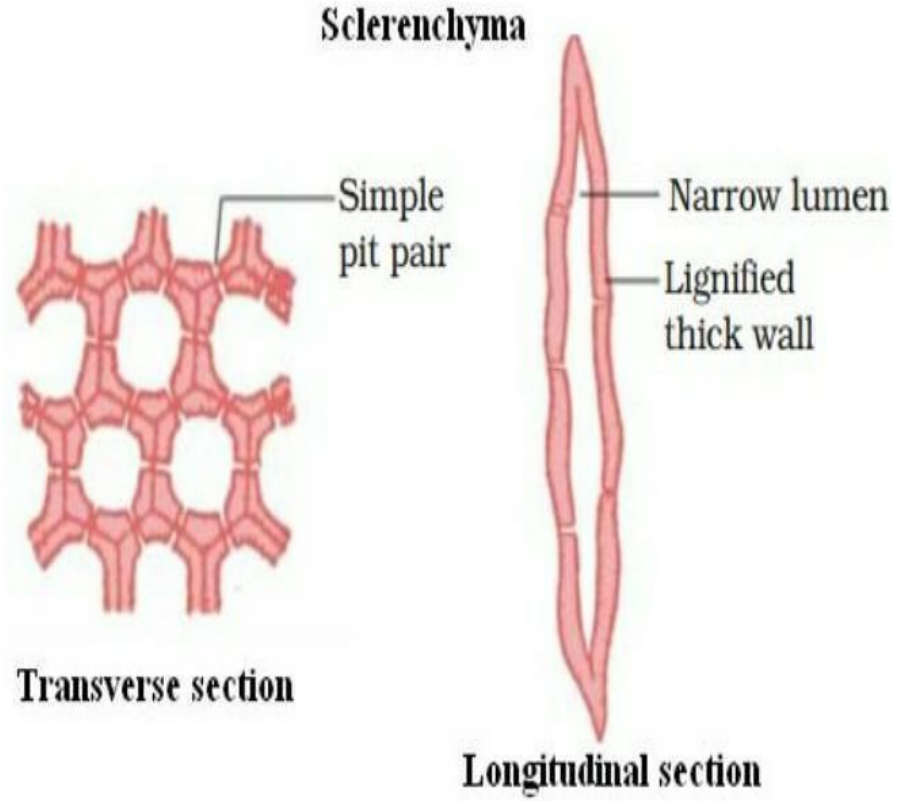


3. Lamellar collenchyma The collenchyma cells are arranged compactly in layers(rows). The Cell wall is thickening is at tangential walls.These thickening appear as successsive tangential layers. Example:Hypodermis of Helianthus

Sclerenchyma

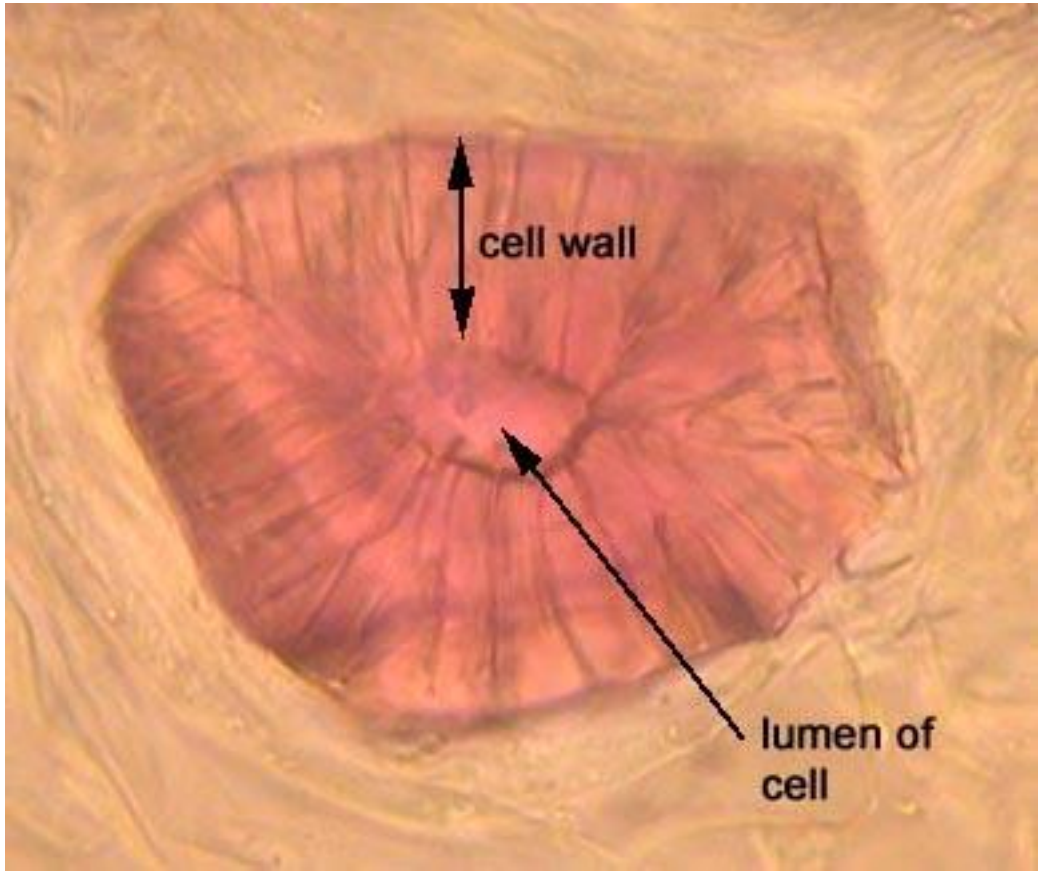
- The sclerenchyma is dead cell and lacks protoplasm.
- The cells are long or short, narrow thick walled and lignified secondary walls.
- The cell walls of these cells are uniformly and strongly thickened.
- The sclerenchymatous cells are of two types:

1. Sclereids
2. Fibres



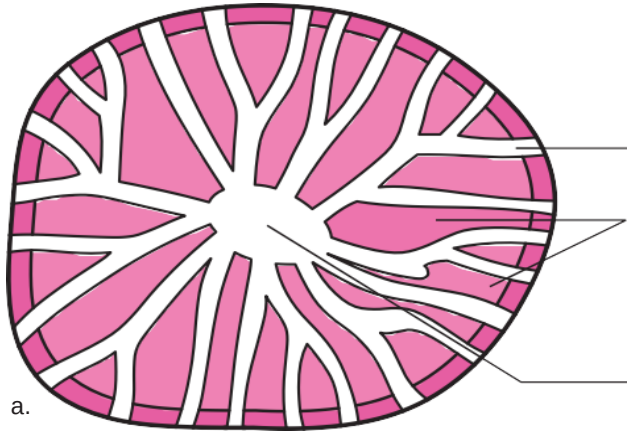
Sclereids

- Sclereids are dead cells, usually these are isodiametric but some are elongated too.
- The cell wall is very thick due to lignification.
- Lumen is very much reduced.
- The pits may simple or branched.
- Sclereids are mechanical in function.
- They give hard texture to the seed coats, endosperms etc.,

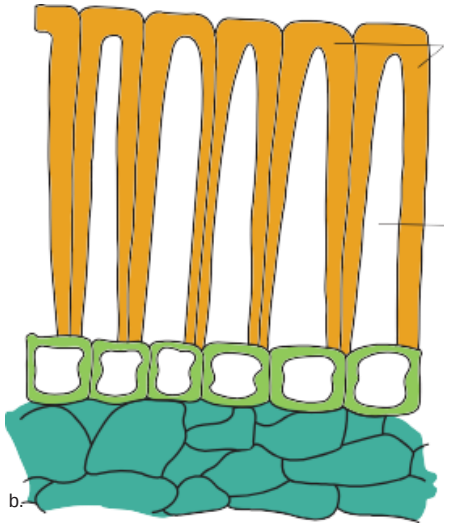


Sclereids (Stone Cells)

Sclereids are classified into the following types:-


a.

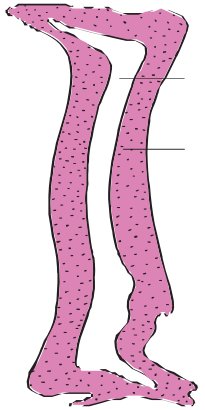
1. Branchysclereids or Stone cells: Isodiametric sclereids, with hard cell wall. It is found in bark, pith cortex, hard endosperm and fleshy portion of some fruits. Example: - Pulp of *Pyrus*.


b.

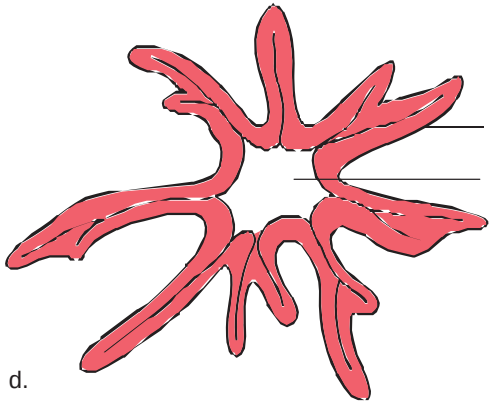
2. Macrosclereids: Elongated and rod shaped cells, found in the outer seed coat of leguminous plants. Example: *Crotalaria* and *Pisum sativum*.

Sclereids (Stone Cells)

3. Osteosclereids (Bone cells): Rod shaped with dilated ends. They occur in leaves and seed coats. Example: seed coat of *Pisum* and *Hakea*

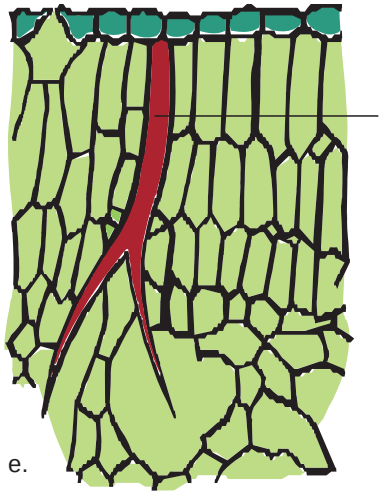


4. Astrosclereids: Star cells with lobes or arms diverging form a central body. They occur in petioles and leaves. Example: Tea, *Nymphaea* and *Trochodendron*.



d.

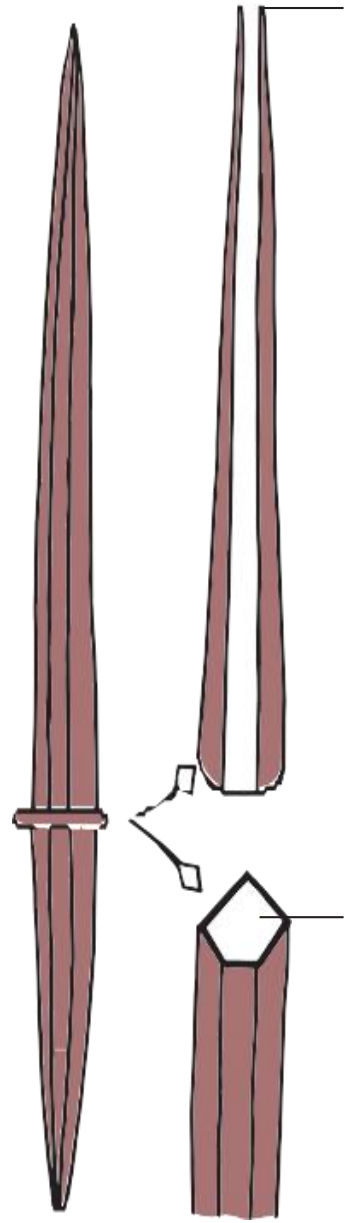
5. Trichosclereids: Hair like thin walled sclereids. Numerous small angular crystals are embedded in the wall of these sclereids, present in stems and leaves of hydrophytes. Example: *Nymphaea* leaf and Aerial roots of *Monstera*.



e.

Fibres

- Fibres are very much elongated sclerenchyma cells with pointed tips.
- Fibres are dead cells and have lignified walls with narrow lumen.
- They have simple pits.
- They provide mechanical strength and protect them from the strong wind. It is also called supporting tissues.
- Fibres have a great commercial value in cottage and textile industries.



Fibres

Fibres are of five types:-

A. Wood Fibres or Xylary Fibres:

- These fibres are associated with the secondary xylem tissue.
- They are also called xylary fibres.
- These fibres are derived from the vascular cambium.
- These fibres are characteristic of tension wood which is formed in the underside of leaning stems and branches.
- These are of four types.

a. Libriform fibres b. Fibre tracheids c. Septate fibres d. Gelatinous fibres.

Fibres

B. Bastfibres or Extra Xylary Fibres: These fibres are present in the phloem. Natural Bast fibres are strong and cellulosic. Fibres obtaining from the phloem or outer bark of jute, kenaf,flax and hemp plants. The so called pericyclic fibres are actually phloem fibres.

C. Surface Fibres: These fibres are produced from the surface of the plant organs. Cotton and silk cotton are the examples. They occur in the testa of seeds.

D. Mesocarp Fibres: Fibres obtained from the mesocarp of drupes like Coconut.

E. Leaf Fibres: Fibres obtained from the leaf of *Musa*, *Agave* and *Sensciveria*.

Complex Tissues

A complex tissue is a tissue with several types of cells but all of them function together as a single unit. It is of two types – xylem and phloem.

Xylem

- The xylem is the principal water conducting tissue in a vascular plant.
- The term xylem was introduced by Nageli(1858) and is derived from the Gk. Xylos – wood.
- The xylem which is derived from Procambium is called primary xylem and the xylem which is derived from vascular cambium is called secondary xylem.
- Early formed primary xylem elements are called protoxylem, whereas the later formed primary xylem elements are called metaxylem.

Xylem

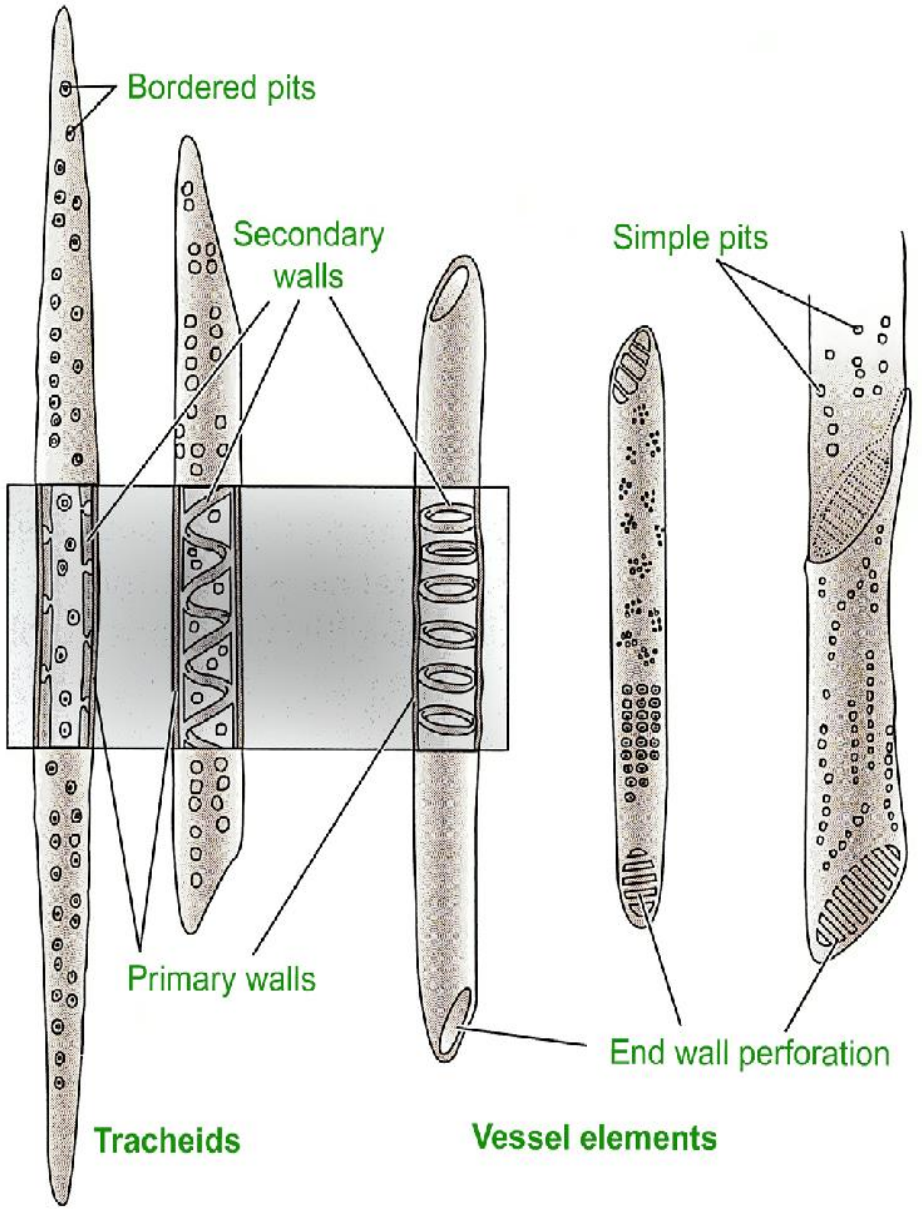
Xylem Consists of Four Types of Cells

1. Tracheids
2. Vessels or Trachea
3. Xylem Parenchyma
4. Xylem Fibres

Xylem

Tracheids

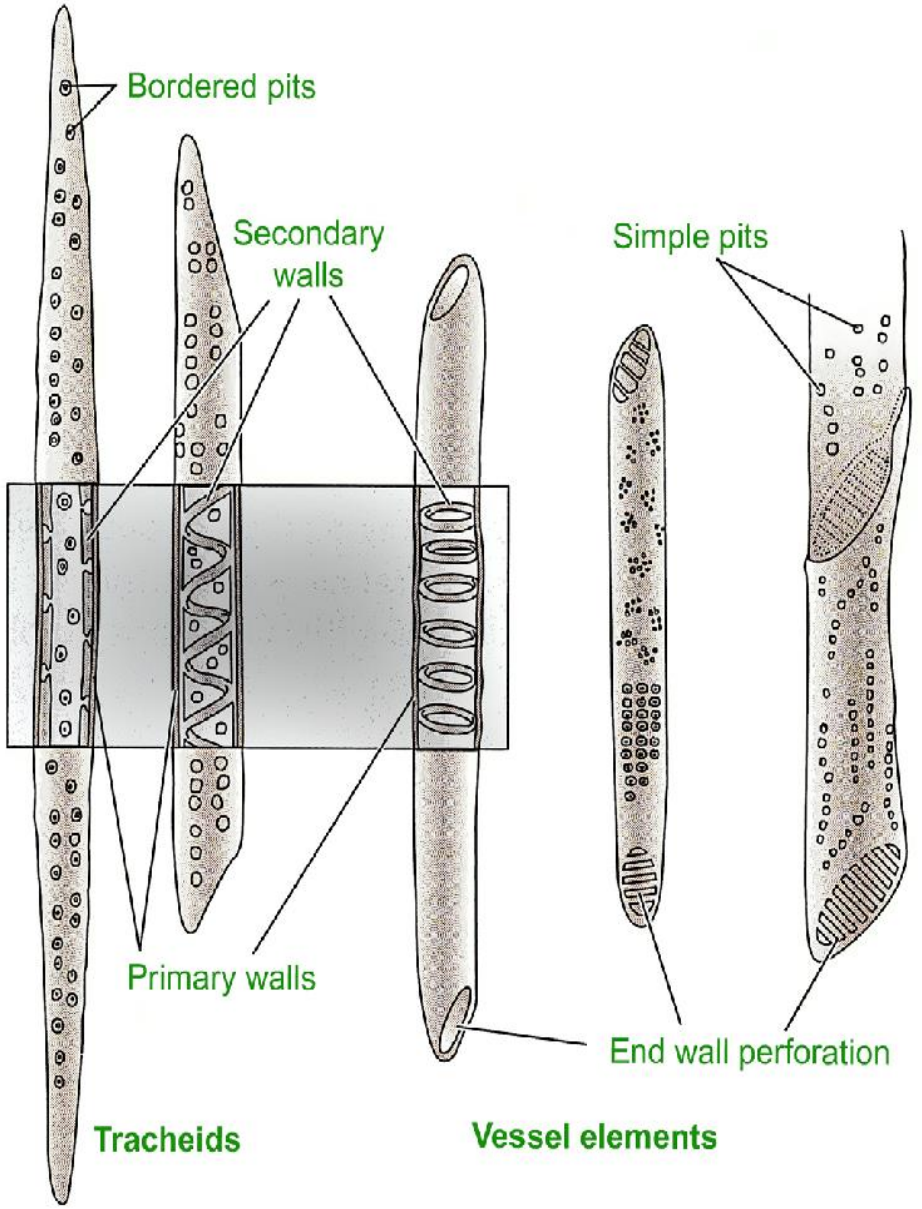
- Tracheids are dead, lignified and elongated cells with tapering ends.
- Its lumen is broader than that of fibres.
- In cross section, the tracheids are polygonal.



Xylem

Tracheids

- Tracheids are imperforated cells with bordered pits on their side walls.
- They are arranged one above the other.
- Tracheids are chief water conducting elements in Gymnosperms and Pteridophytes. They also offer mechanical support to the plants.



Xylem

Tracheids

There are different types of cell wall thickenings due to the deposition of secondary wall substances. They are annular (ring like), spiral (spring like), scalariform (ladder like) reticulate (net like) and pitted (uniformly thick except at pits).

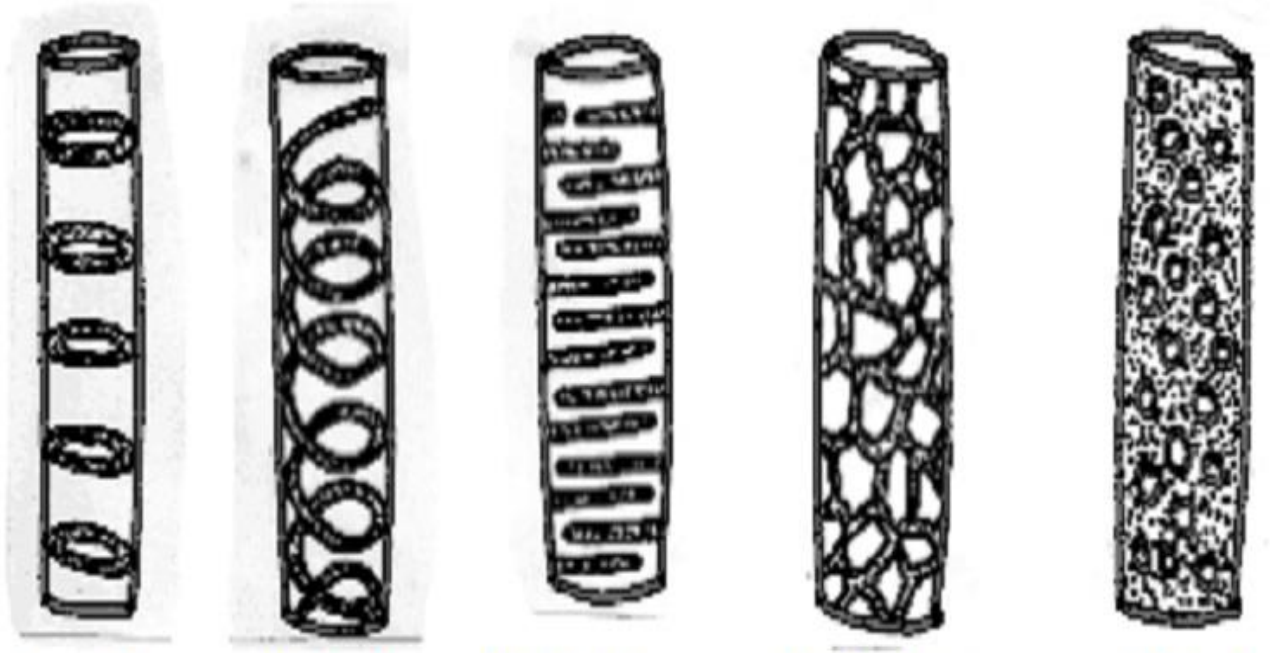
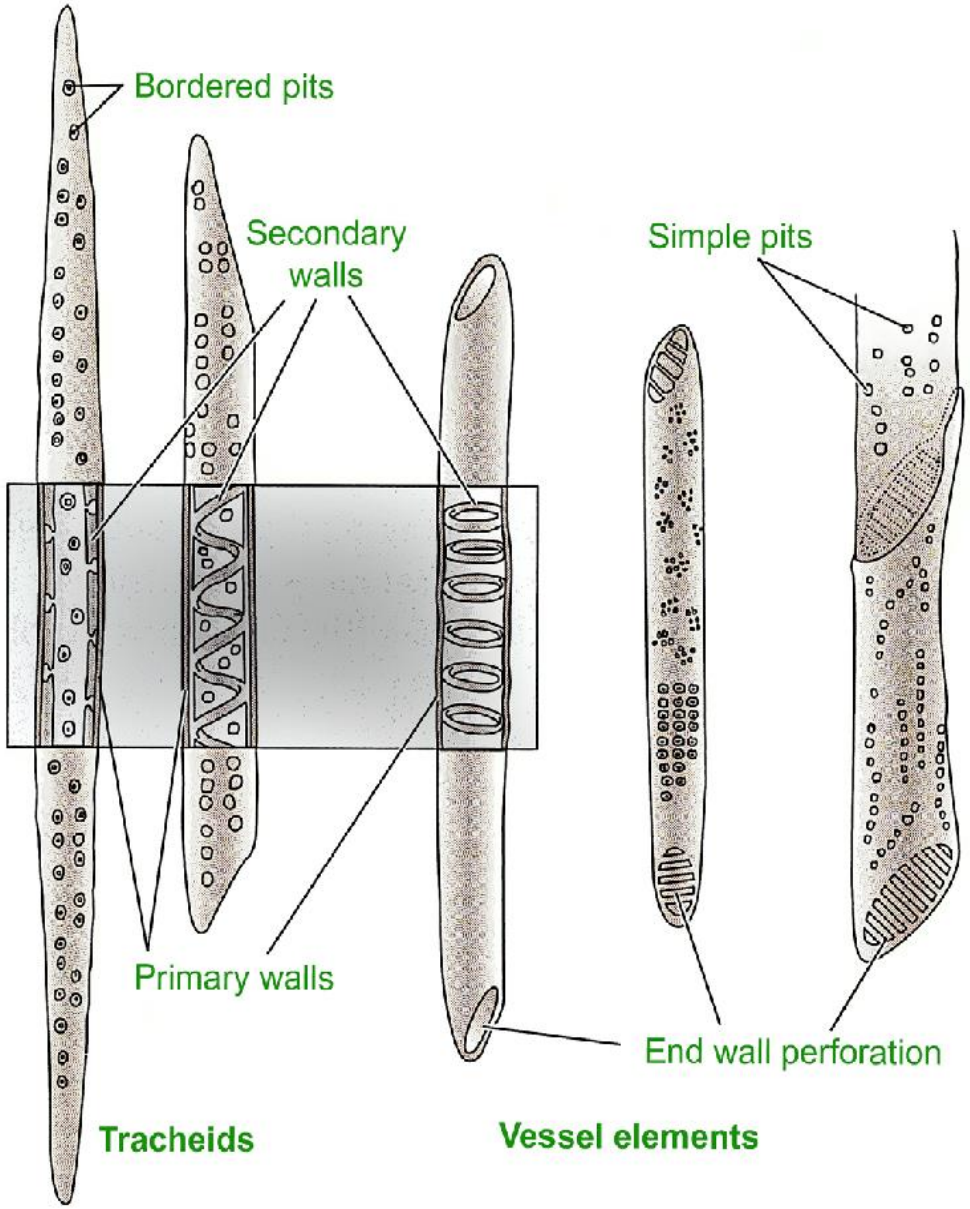


Fig. Types of secondary wall thickenings in tracheids

Xylem

Vessels or Trachea

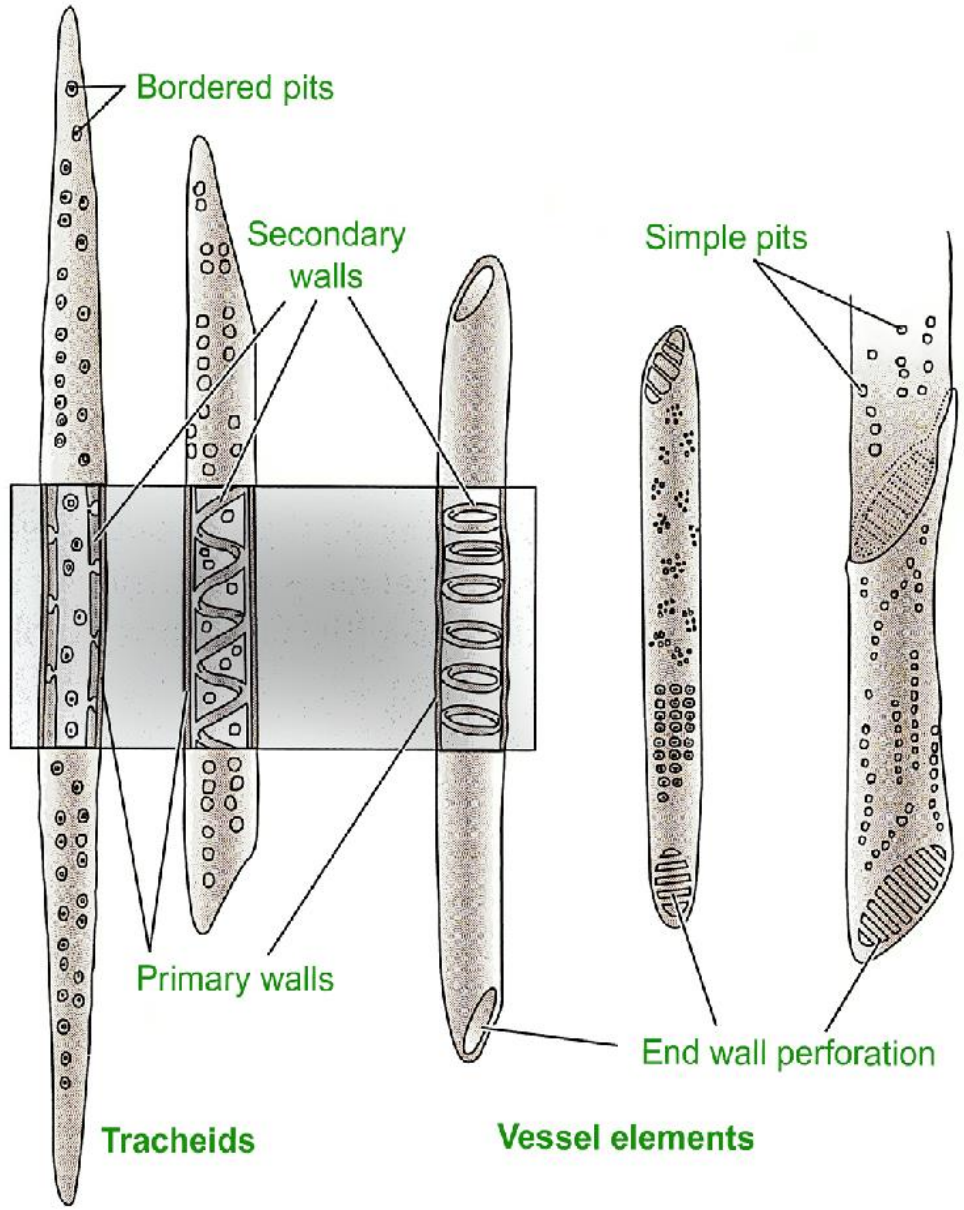
- Vessels are elongated tube like structure.
- They are dead cells formed from a row of vessel elements placed end to end.
- They are perforated at the end walls.
- Their lumen is wider than Tracheids.
- Due to the dissolution of entire cell wall, a single pore is formed at the perforation plate. It is called simple perforation plate, Example: Mangifera. If the perforation plate has many pores, it is called multiple perforation plate. Example Liriodendron.



Xylem

Vessels or Trachea

- The secondary wall thickening of vessels are annular, spiral, scalariform, reticulate, or pitted as in tracheids.
- Vessels are chief water conducting elements in Angiosperms and absent in Pteridophytes and Gymnosperms,(except-Gnetales).
- The main function is conduction of water, minerals and also offers mechanical strength.

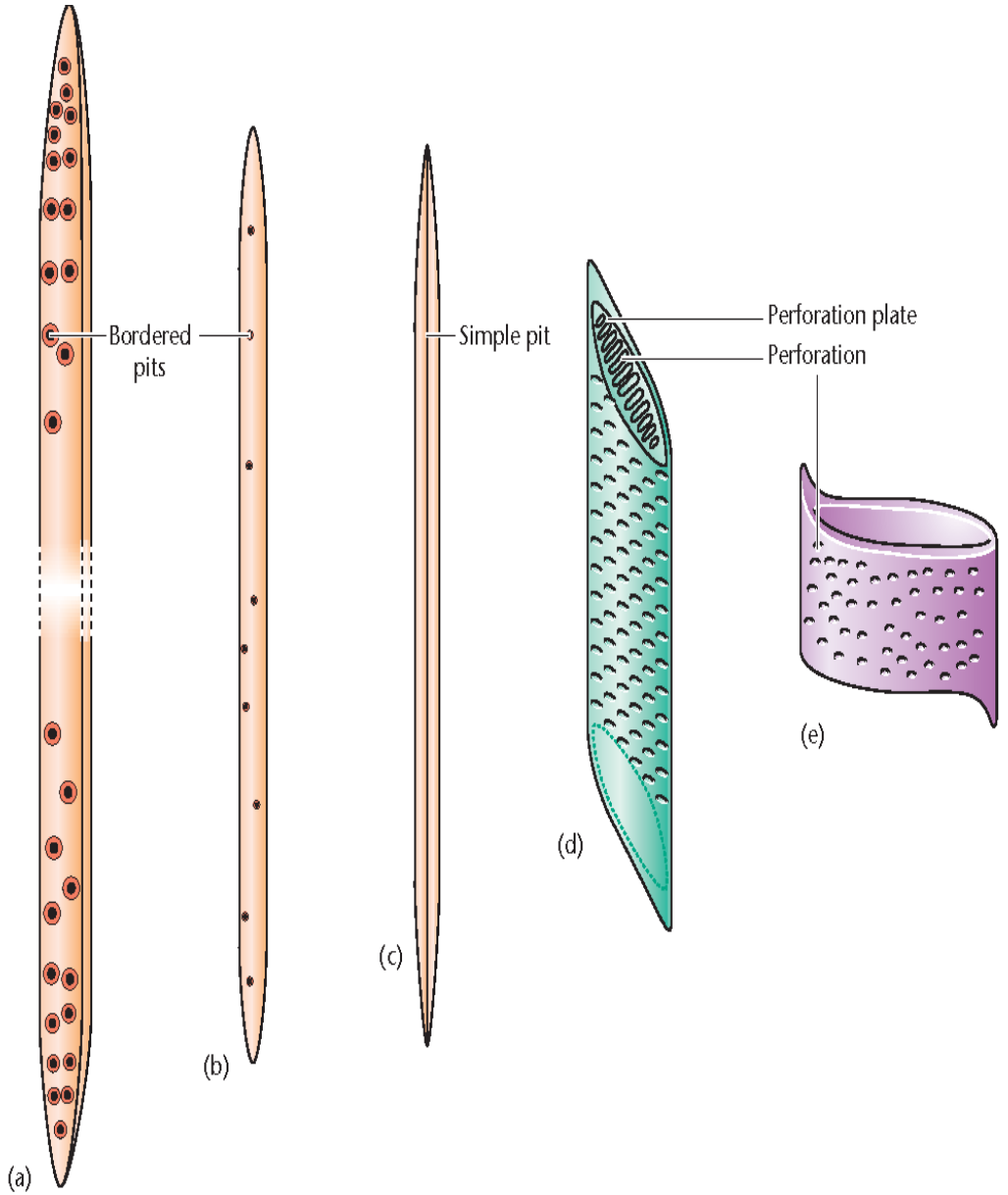


Xylem

Xylem Fibre

- The fibres of sclerenchyma associated with the xylem are known as xylem fibres.
- Xylem fibres are dead cells and have lignified walls with narrow lumen.
- They cannot conduct water but being stronger provide mechanical strength.
- They are present in both primary and secondary xylem. Xylem fibres are also called libriform fibres.
- They occur in patches, in continuous bands and sometimes singly among other cells.

Between fibres and tracheids, there are many transitional forms which are neither typical fibres nor typical tracheids. The transitional types are designated as fibre-tracheids. The pits of fibre-tracheids are smaller than those of vessels and typical tracheids.



Xylem

Xylem Parernchyma

- The parenchyma cells associated with the xylem are known as xylem parenchyma. These are the only living cells in xylem tissue.
- The cell wall is thin and made up of cellulose.
- Parenchyma arranged longitudinally along the long axis is called axial parenchyma. Ray parenchyma is arranged in radial rows.
- Secondary xylem consists of both axial and ray parenchyma.
- Parenchyma stores food materials and also helps in conduction of water.

Phloem

- Phloem is the food conducting complex tissues of vascular plants.
- The term phloem was coined by C. Nageli (1858).
- The Phloem which is derived from procambium is called primary phloem and the phloem which is derived from vascular cambium is called secondary phloem.
- Protophloem is short lived. It gets crushed by the developing metaphloem.

Phloem Consists of Four Types of Cells-

1. Sieve elements
2. Companion cells
3. Phloem parenchyma
4. Phloem fibres

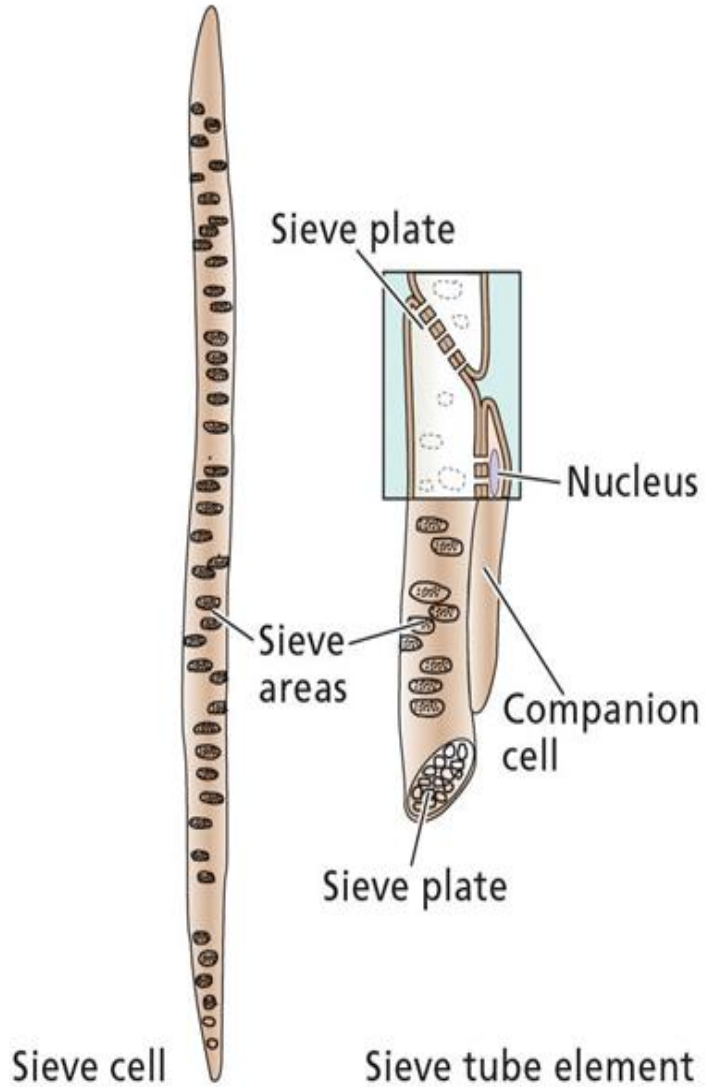
Phloem

Sieve Elements

- Sieve elements are the conducting elements of the phloem.
- They are of two types, namely sieve cells and sieve tubes.

Sieve Cells

- Sieve cells, which may be compared to the tracheids, are narrow elongated cells without conspicuous sieve areas.
- They usually have greatly inclined walls, which overlap in the tissue, sieve areas being more numerous in the ends.
- Sieve cells are more primitive than the sieve tubes.
- They occur in lower vascular plants and gymnosperms.

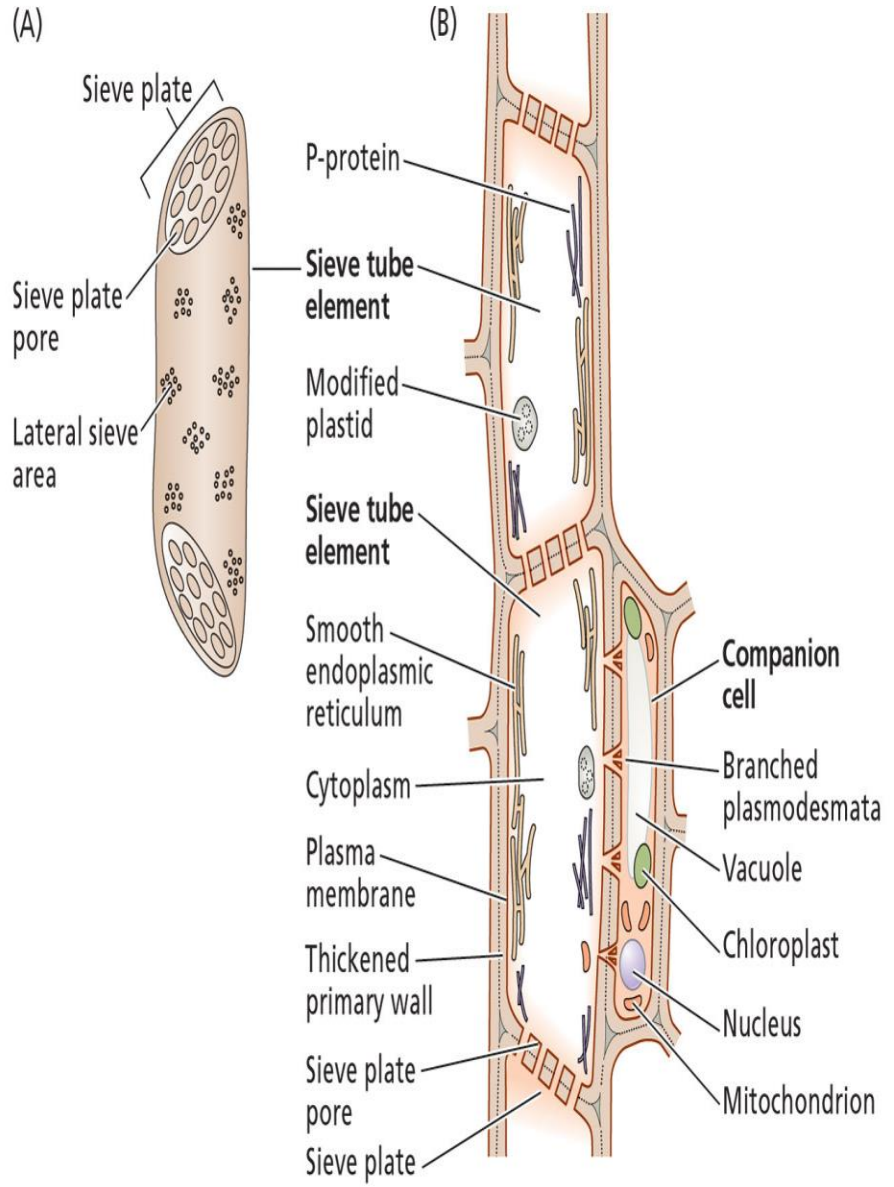


Phloem

Phloem

Sieve tubes

- Sieve tubes are long tube-like bodies formed from a row of cells arranged in longitudinal series where the end-walls are perforated in a sieve-like manner.
- The perforated end-walls are called the sieve plates, through which cytoplasmic connections are established between adjacent cells.
- The perforations or sieve areas, as they are called, may be compared to the pit fields of the primary wall with plasmodesmata connections.



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Phloem

Sieve tubes

- A sieve area in surface view looks like a depression on the wall having a pretty good number of dots. Each dot represents a connecting strand in cross-section and remains surrounded by a case of callose.
- The sieve plate or the perforated end-wall is really the primary walls of two cells with the middle lamella in between them. The end-walls may be obliquely inclined or transverse.
- A sieve plate is called simple, if it has only one sieve area, whereas the plate may be compound with several sieve areas arranged in scalariform, reticulate or other manners.

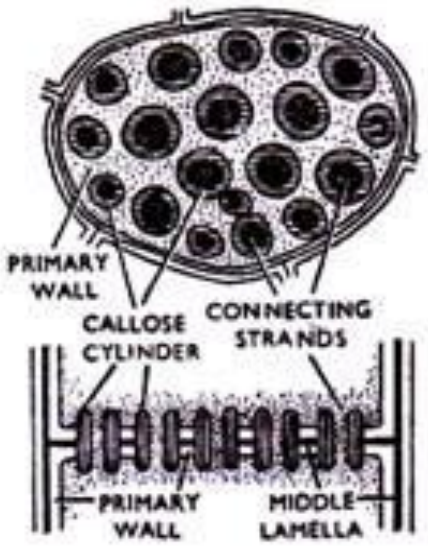

Fig. 543. Sieve tube. Structure of sieve area of an angiosperm in surface (upper) and sectional (lower) views (diagrammatic).

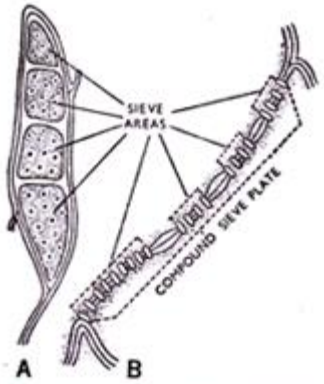

Fig. 544. Sieve tube. Compound sieve plate. A. Surface view. B. Sectional view.

Phloem

Companion Cells:

- Companion cells remain associated with the sieve tubes of angiosperms, both ontogenetically and physiologically.
- These are smaller elongate cells, having dense cytoplasm and prominent nuclei.
- They occur along the lateral walls of the sieve tubes.
- The wall between the sieve tube and companion cell is thin and provided with primary pit fields.
- The companion cells are so firmly attached to the sieve tubes that they cannot be normally separated by maceration.
- In transverse section it appears as a small triangular, rectangular or polyhedral cell with dense protoplast.
- In pteridophytes and gymnosperms some small parenchymatous cells remain associated with sieve cells, which are known as albuminous cells.

Phloem

In pteridophytes and gymnosperms some small parenchymatous cells remain associated with sieve cells, which are known as albuminous cells.

Companion cells occur abundantly in angiosperms, particularly in the monocotyledons. They are absent in some primitive dicotyledons and also in the primary phloem of some angiosperms.

Phloem

Phloem Parenchyma:

- Besides companion cells and albuminous cells, a good number of parenchyma cells remain associated with sieve elements. These are living cells with cellulose walls having primary pit fields. They are mainly concerned with storage of organic food matters. Tannins, crystals and other materials may also be present.
- The parenchyma cells of primary phloem are somewhat elongate and occur with the sieve elements along the long axis. In secondary phloem they may be of two types.