

COMPLEX PERMANENT TISSUES

Complex permanent tissues

- ❖ The complex tissues are made of more than one type of cells and these work as a unit.
- ❖ Complex tissue are heterogeneous
- ❖ Complex tissues are absent in gametophytes.

Complex permanent tissues

- Two types
 - (a) Xylem
 - (b) Phloem
- Xylem
 - The term Xylem is coined by Nageli.
 - The function of xylem is to conduct water & minerals salts upwards from the roots to stem & leaves
 - To give mechanical strength to the plant body.

Complex permanent tissues

➤ On the basis of **origin**, xylem is divided' into

➤ (1) primary xylem (2) secondary xylem.

❖ Primary xylem originates from procambium.

❖ On the basis of **development** primary xylem is divided into two parts.

(1) Protoxylem (2) Metaxylem

❖ Cells of protoxylem are small as compared to metaxylem

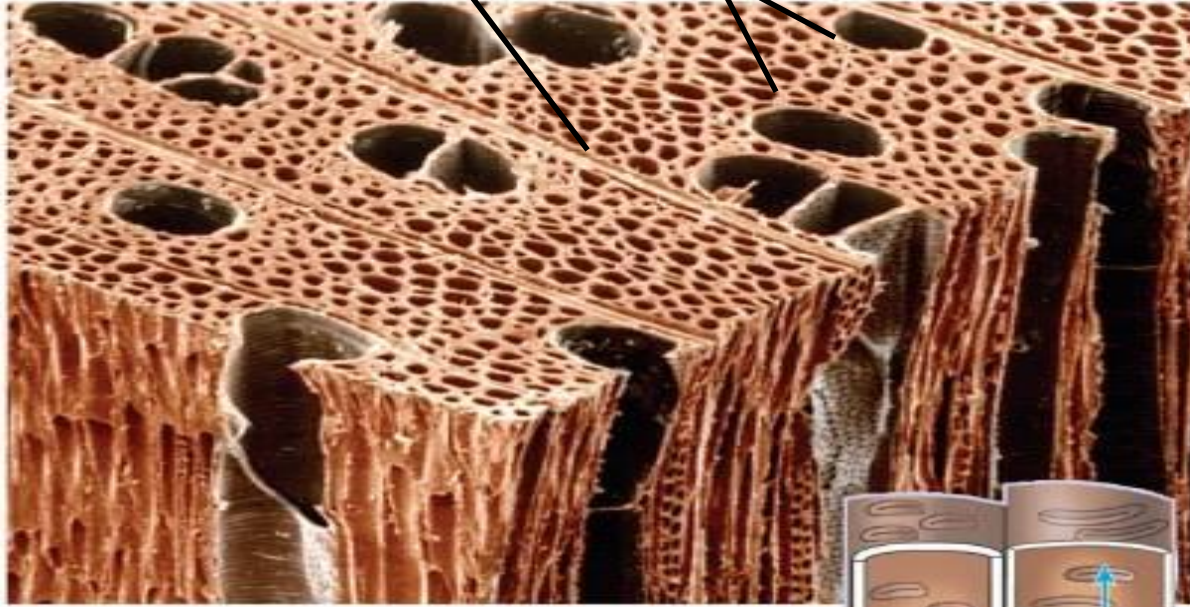
❖ Secondary xylem originates from vascular cambium.

The elements of xylem

- ❖ Xylem Tracheids
- ❖ Xylem Vessels
- ❖ Xylem Fibres
- ❖ Xylem Parenchyma

The elements of xylem

Vessel Tracheids 100 μm

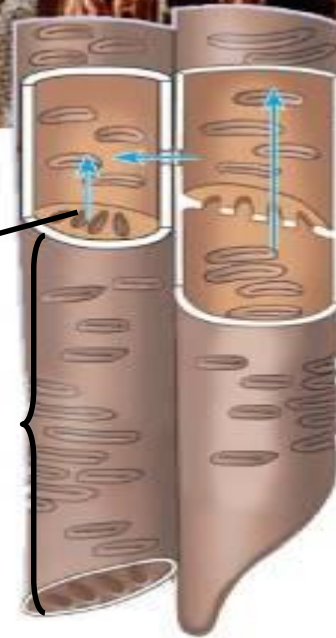


Tracheids and vessels
(colorized SEM)

Perforation
plate

Vessel
element

Vessel elements, with
perforated end walls



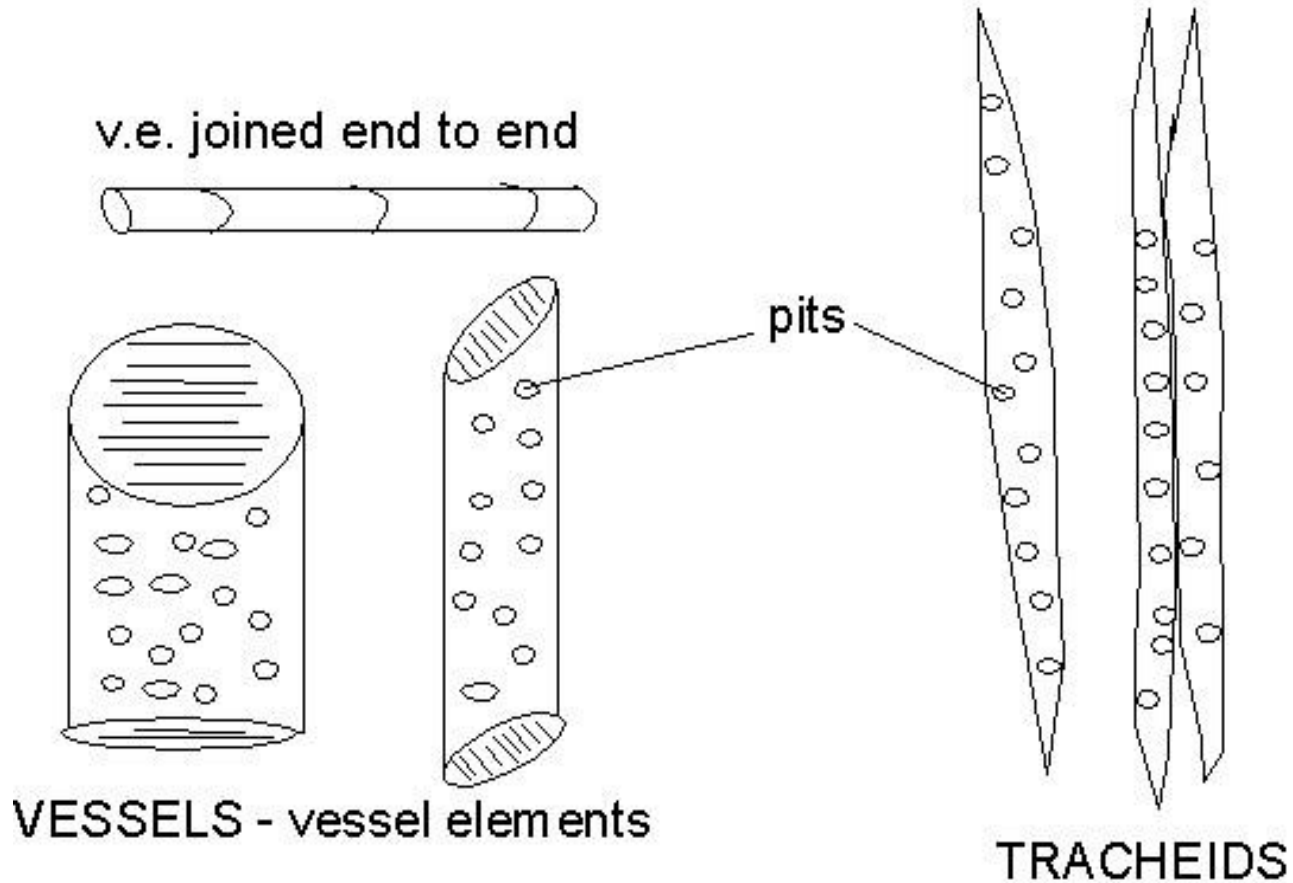
Pits



Tracheids

The elements of xylem

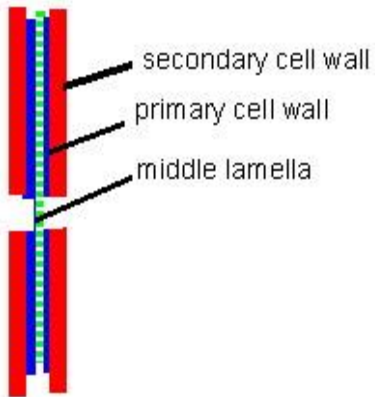
COMPONENTS OF XYLEM



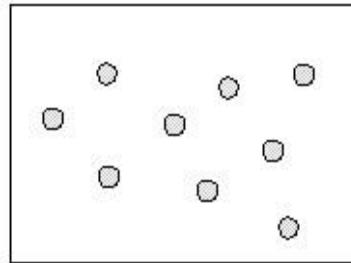
+ fibers, parenchyma, and ray cells

The elements of xylem

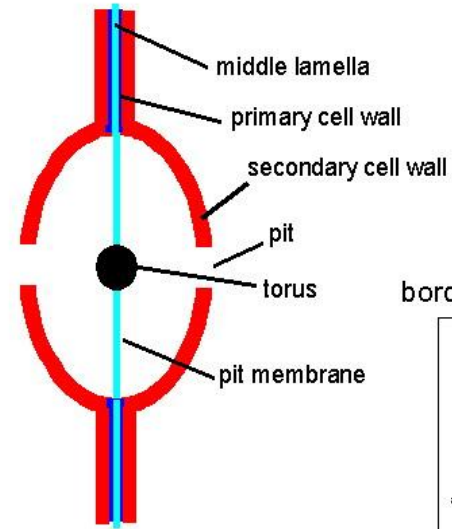
SIMPLE PITS (middle lamella + thin primary cell wall)



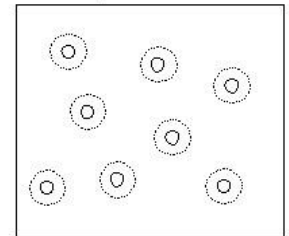
simple pits in cell wall



BORDERED PITS



bordered pits in a cell wall



The elements of xylem

- **Xylem Tracheids**
 - ❖ Tracheids are primitive conducting elements of xylem.
 - ❖ They are unicellular having narrow lumen but wider than xylem fibres
 - ❖ Tracheids join together from their ends to form a long rows.
 - ❖ These rows extending from the roots via stem to the leaves
 - ❖ A transverse septum lies between each two tracheids bearing pits.

Xylem Tracheids.....

- ❖ Water moves from one tracheid to another tracheid through these pits
- ❖ Pits are unlignified areas on lignified wall
- ❖ Due to presence of transverse septum lumen is discontinuous in tracheids.
- ❖ They are dead and lignified cells.
- ❖ The deposition of lignin on cell wall is responsible to form a different type of thickenings

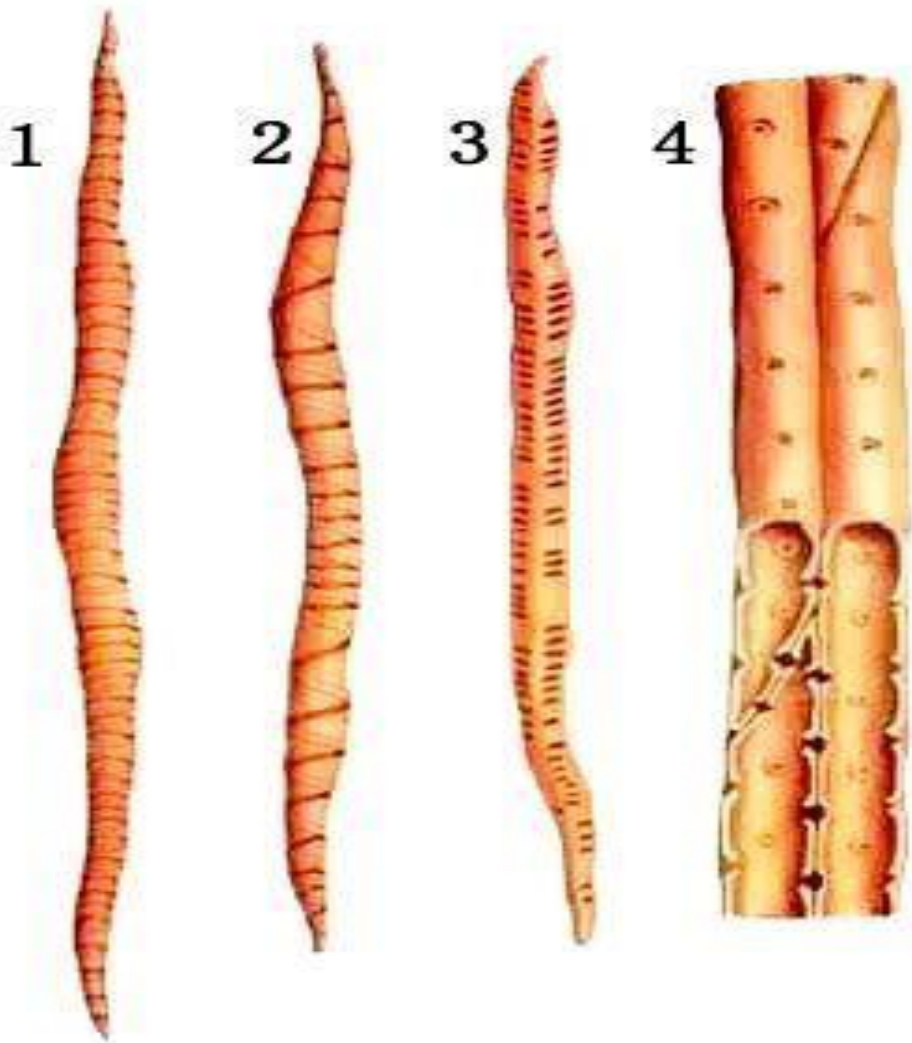
Xylem Tracheids.....

- ❖ Usually bordered pits are present at end wall of tracheids.
- ❖ The maximum bordered pits are, found in the tracheids of Gymnosperm plants.
- ❖ Maximum deposition of lignin is found in pitted type of thickening.
- ❖ Annular and Spiral type of thickening of lignin is found in protoxylem.

Xylem Tracheids.....

- ❖ Reticulate and Pitted (mainly) type of thickening of lignin is found in meta xylem.
- ❖ Tracheids of pteridophytes have long or elongated bordered pits. Such type of pits are called scalariform pits.

Type of thickenings in Tracheid



1. Annular

2. Spiral

3. Scalariform

4. Pitted

FUNCTIONS OF TRACHEIDS

1. Upward conduction of water and dissolved minerals.
2. Provide mechanical support by virtue of their hard and firm secondary walls.

Xylem Vessels

- ❖ It is **advance conducting element of xylem. The basic structure of vessels is same as tracheids**
- ❖ Vessel is multicellular.
- ❖ The lumen of vessels is **wider than tracheids** and end wall is perforated.
- ❖ Transverse septum is absent between two vessel elements.
- ❖ If present then it will be porous.
- ❖ Thus **vessels are more capable for conduction of water than tracheids.**

Xylem Vessels.....

- ❖ Due to **presence of perforated end wall**, vessels work as a pipe line during conduction of water.
- ❖ Vessels contains usually simple pits at their lateral wall.
- ❖ Thickening type-of wall is the same as tracheids.
- ❖ Vessels are only found in xylem of angiosperm but **exceptionally it is also present in some Gymnosperms like Ephedra, Gnetum and Welwitschia.**

Xylem Vessels.....

- ❖ Vessels are absent in some Angiosperm plants such as Dracaena, Yucca, Winter's bark (*Drimys winteri*) etc
- ❖ There are some angiosperm families in which vesselless angiosperms are included.
 - e.g. Winteraceae



- ❖ Vessels as a dead syncyte.
- ❖ **Syncyte**: Cell which is formed by fusion of cells is called as syncyte.
- ❖ Tracheids and vessels are, collectively known as water conducting elements or “**Hadrom**”.
- ❖ The term “Hadrom” as proposed by Haberlandt.

Types of vessel thickenings

1- xylem parenchyma

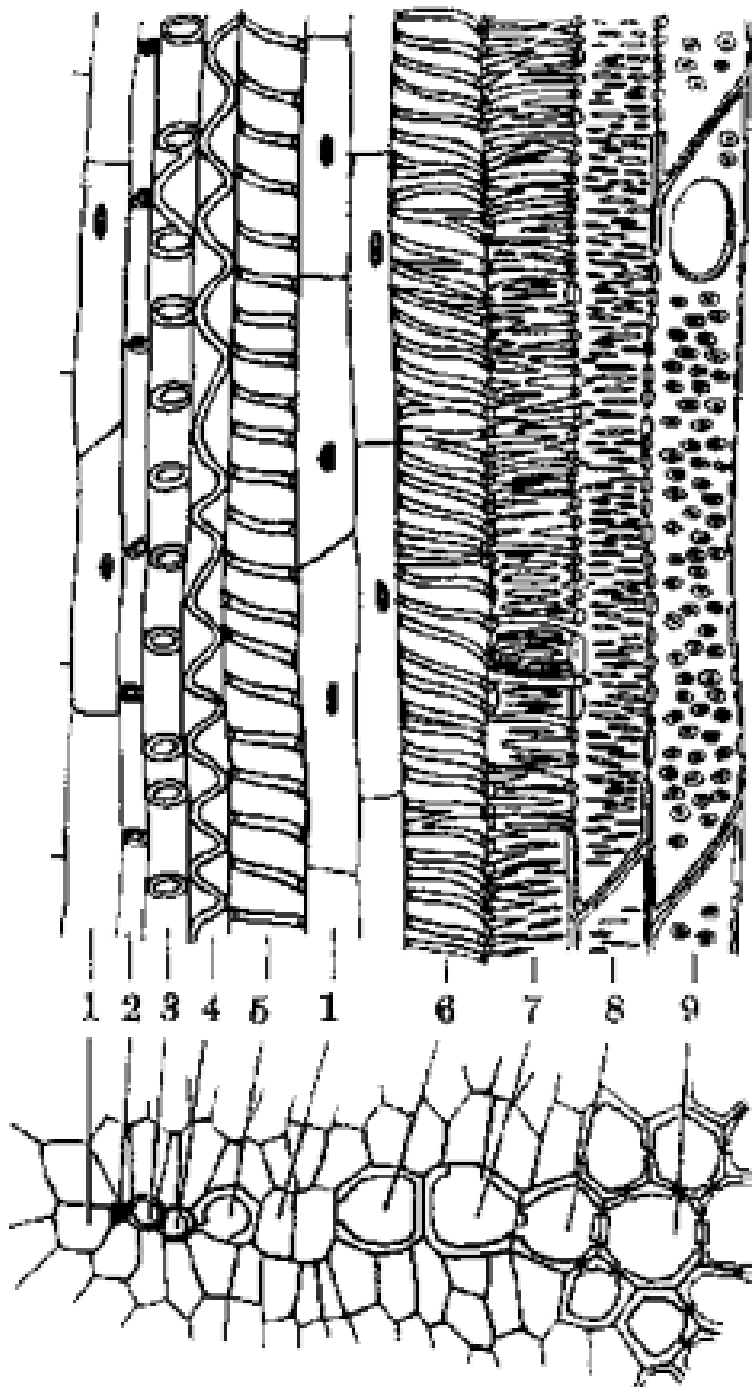
2 & 3-annular vessel

4, 5 & 6 -spiral vessel

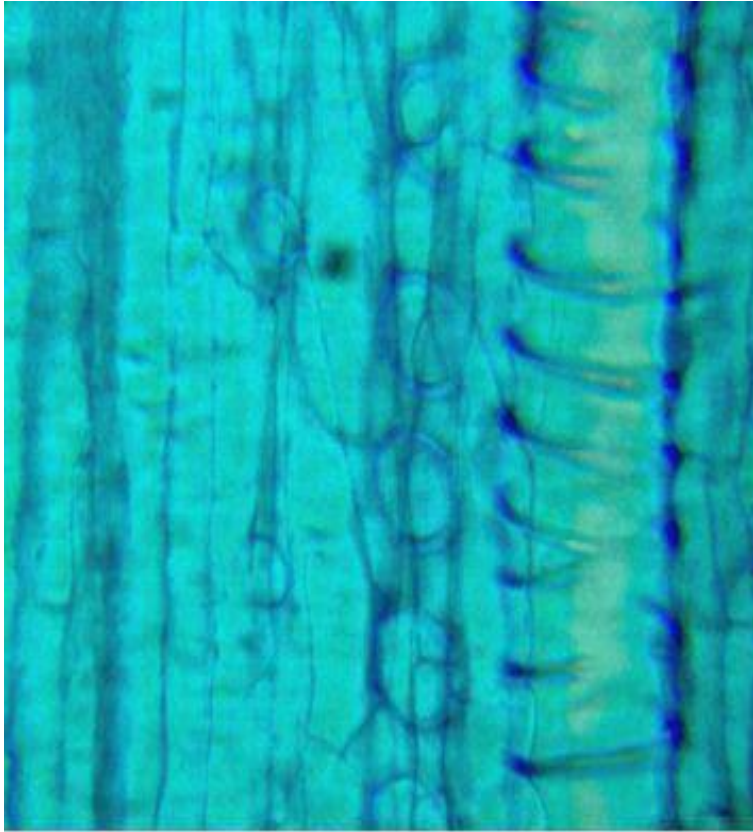
7-scalariform vessel

8-reticulate vessel

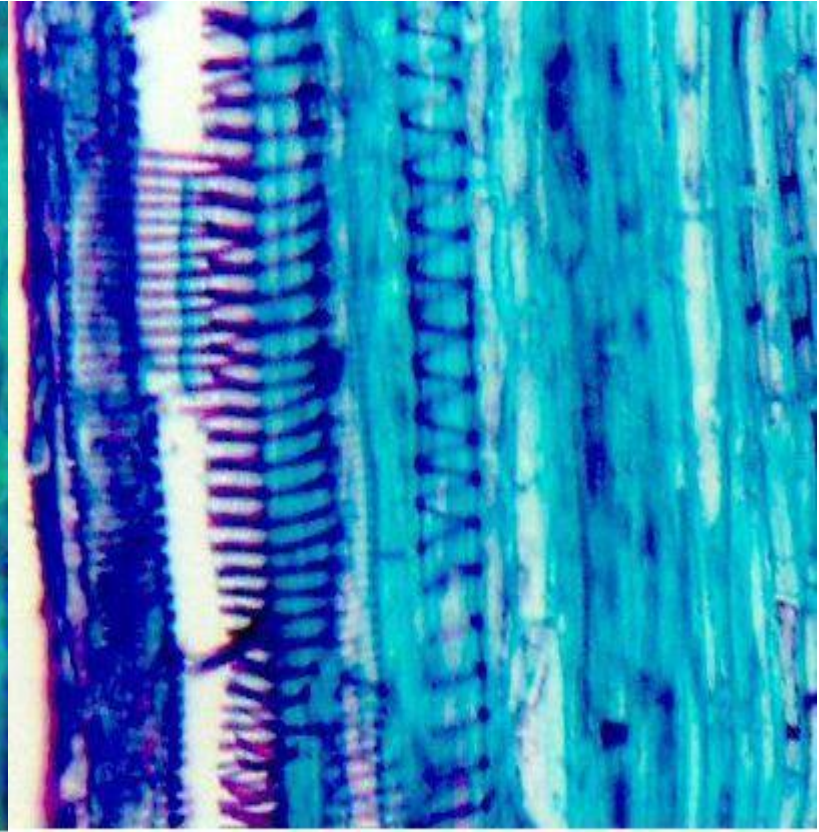
9- pitted vessel



Types of vessel thickenings



Annular Vessel

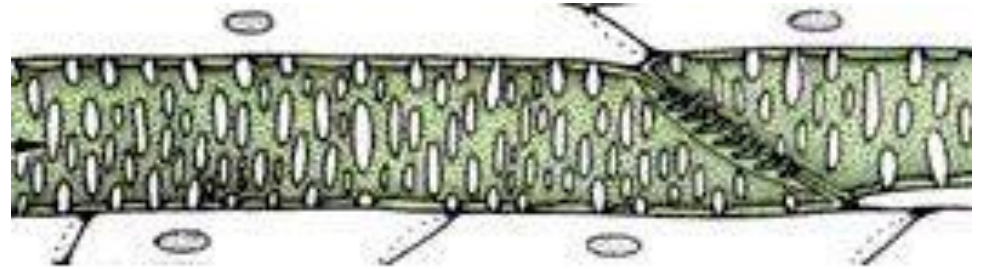


Spiral Vessel

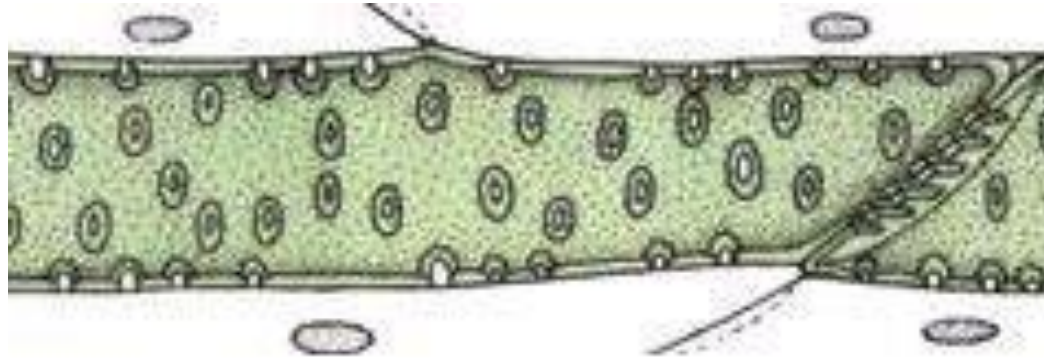
Types of vessel thickenings



Scalariform Vessel



Reticulate Vessel



Pitted Vessel

FUNCTIONS OF VESSELS

- Chief conducting elements of vascular plants, particularly in angiosperms. They conduct water & dissolved mineral nutrients.
- They provide mechanical support to the plants.

DIFFERENCES

TRACHIIDS

1. Tubular cells with tapering ends.
2. Polygonal or somewhat rounded in cross section.
3. End walls with bordered pits and without perforation plate.
4. Present in all vascular plants.

VESSELS

- Cylindrical cells without tapering ends.
- Circular in cross section.
- End walls absent, or with simple or multiple perforation plate.
- Common in angiosperms

Xylem fibres

- ❖ Xylem fibres provides strength to the tracheids and vessels.
- ❖ Mainly these fibres provide strength to the vessels.
- ❖ They are present more abundant in secondary xylem.
- ❖ Wood fibres
- ❖ Present in primary as well as secondary xylem.
- ❖ 2 types : fibre tracheids & libriform fibres

Xylem fibres

Fibre-tracheids

- Neither true fibres nor true tracheids but are intermediate between them.
- Develop from tracheids by increasing the thickness of wall and decreasing the lumen diameter and cell length

Libriform fibres

- True fibres
- Provide mechanical support

Xylem Parenchyma

- ❖ It's cell wall is made up of cellulose.
- ❖ It store starch, fats and tannin etc.
- ❖ The radial conduction of water is the function of xylem parenchyma.
- ❖ It conducts water to peripheral part of plant organ
- ❖ Their walls possess pits

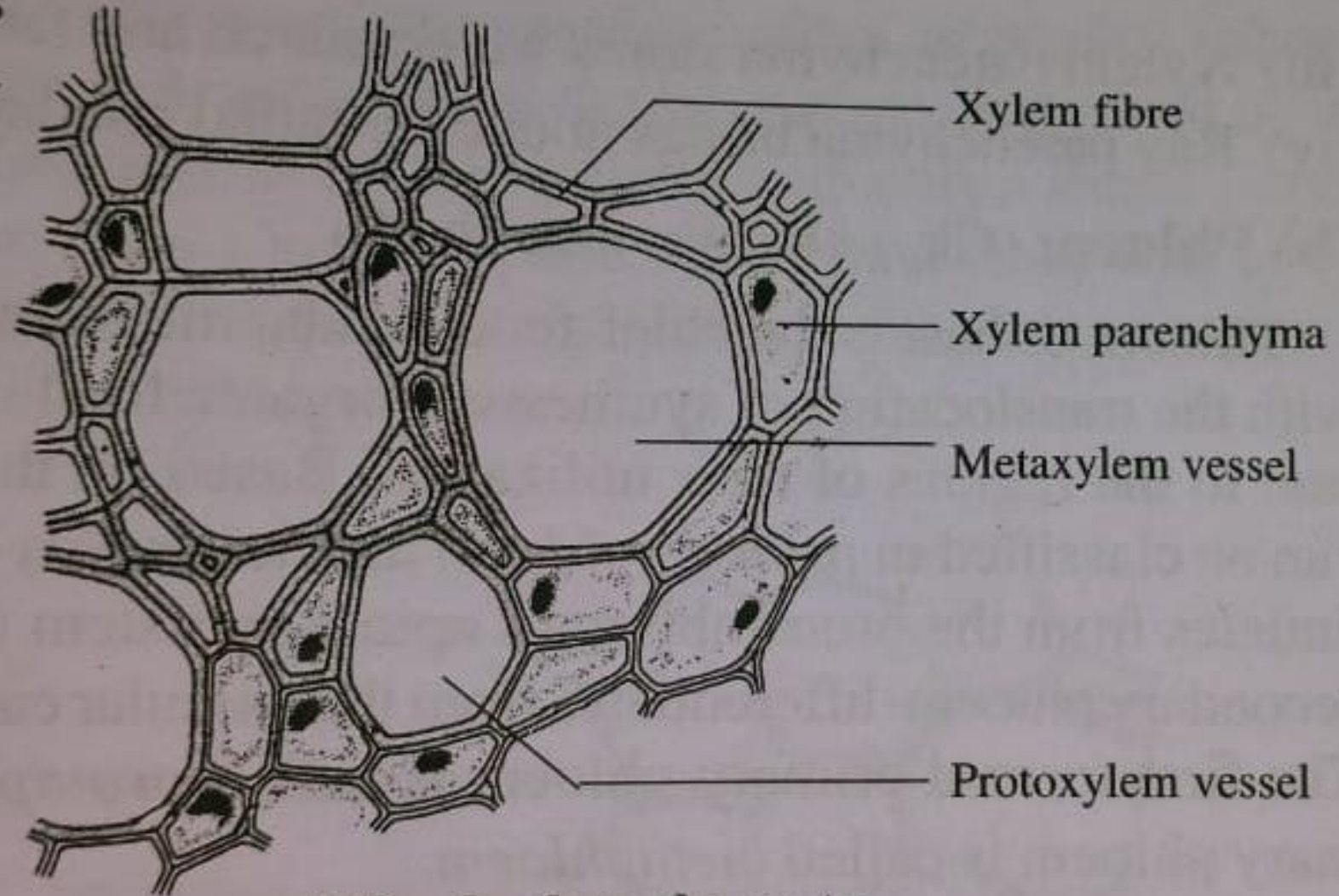
Xylem parenchyma

- Present in primary as well as secondary xylem
- Cells are thin walled & non-lignified in primary xylem, but slightly lignified in secondary xylem.
- Medullary rays or radial parenchyma – **helps in radial conduction.**
- Parenchyma present in secondary xylem is of two types:
 - **Wood parenchyma & ray parenchyma**
 - Wood parenchyma – fusiform cambial initials
 - Ray parenchyma – ray initials of cambium.
 - Both cells are living & have thin walls.

PROTOXYLEM & METAXYLEM

Differences between protoxylem and metaxylem

Protoxylem	Metaxylem
1. Small-sized and first-formed primary xylem.	1. Large-sized and later-formed primary xylem.
2. Appears first and matures before the organ completes its elongation.	2. Appears only after the protoxylem has completed its differentiation.
3. Tracheids and vessels commonly have annular or spiral thickenings.	3. Tracheids and vessels have scalariform, reticulate, or pitted thickenings.
4. Tracheary elements are usually narrow.	4. Tracheary elements are complex and wide.
5. Has more parenchyma and less tracheary elements.	5. Has less parenchyma and more tracheary elements.
6. Tyloses absent	6. Tyloses present
7. Gets destroyed due to compression and stretching.	7. Does not get destroyed by compression and stretching.



T.S. of xylem elements

XYLEM ARRANGEMENT

- Endarch – plant stems - Centrifugal
- Exarch – plant roots - Centripetal
- Mesarch – ferns & cycads

FUNCTIONS OF XYLEM

- Conducts water & solutes from roots to leaves through tracheids and vessels.
- Serves as a supporting mechanical tissues by virtue of the wall thickenings.
- Xylem parenchyma stores water, starch & fat.
- Ray parenchyma brings about the radial conduction of water & solutes.