

(4) Conducting tissue

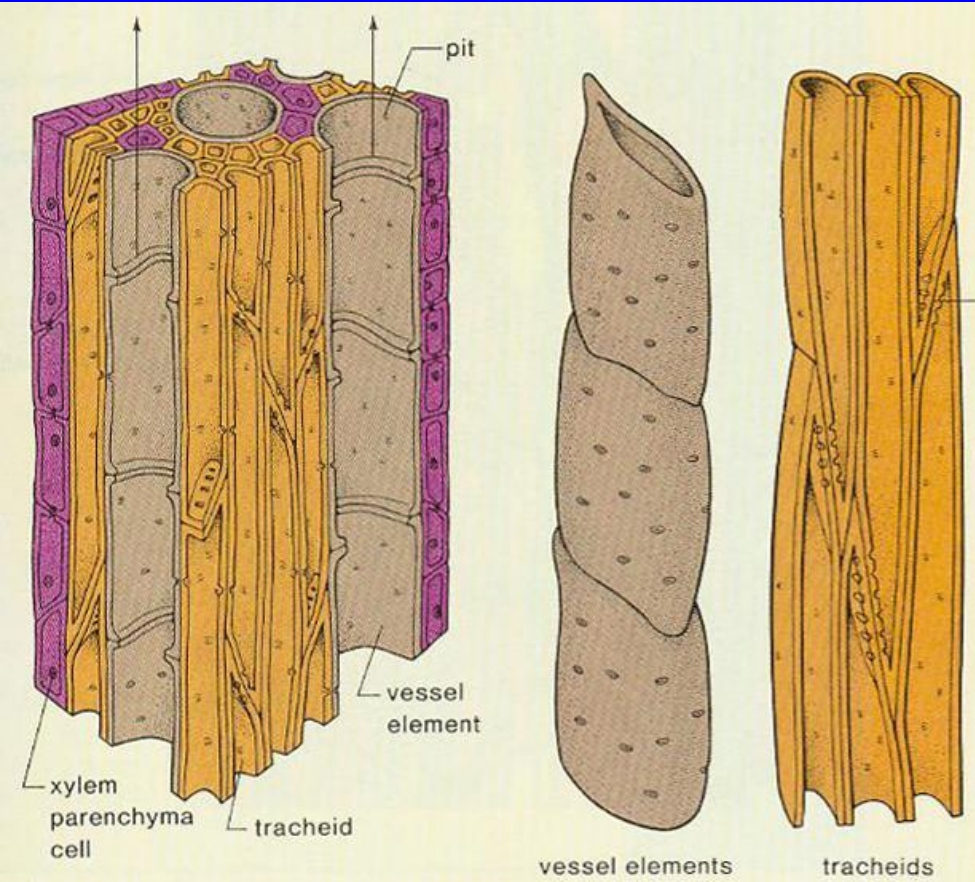
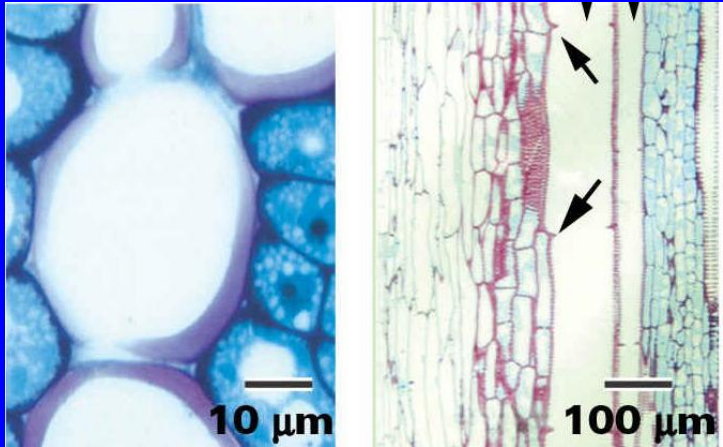
It is a major tissue undertaking long-distance transport in a plant, including the transport of water, inorganic salts and photosynthetic products. Xylem transports water and inorganic salts dissolved in water. Phloem mainly transports organic nutrient substances.

① Xylem

- ♣ A complex tissue constituted by a few kinds of cells, including tracheids, vessel elements, fibers, parenchyma cells, etc.

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- Tissues and Tissue Systems

Photomicrographs and diagrams of xylem structure.



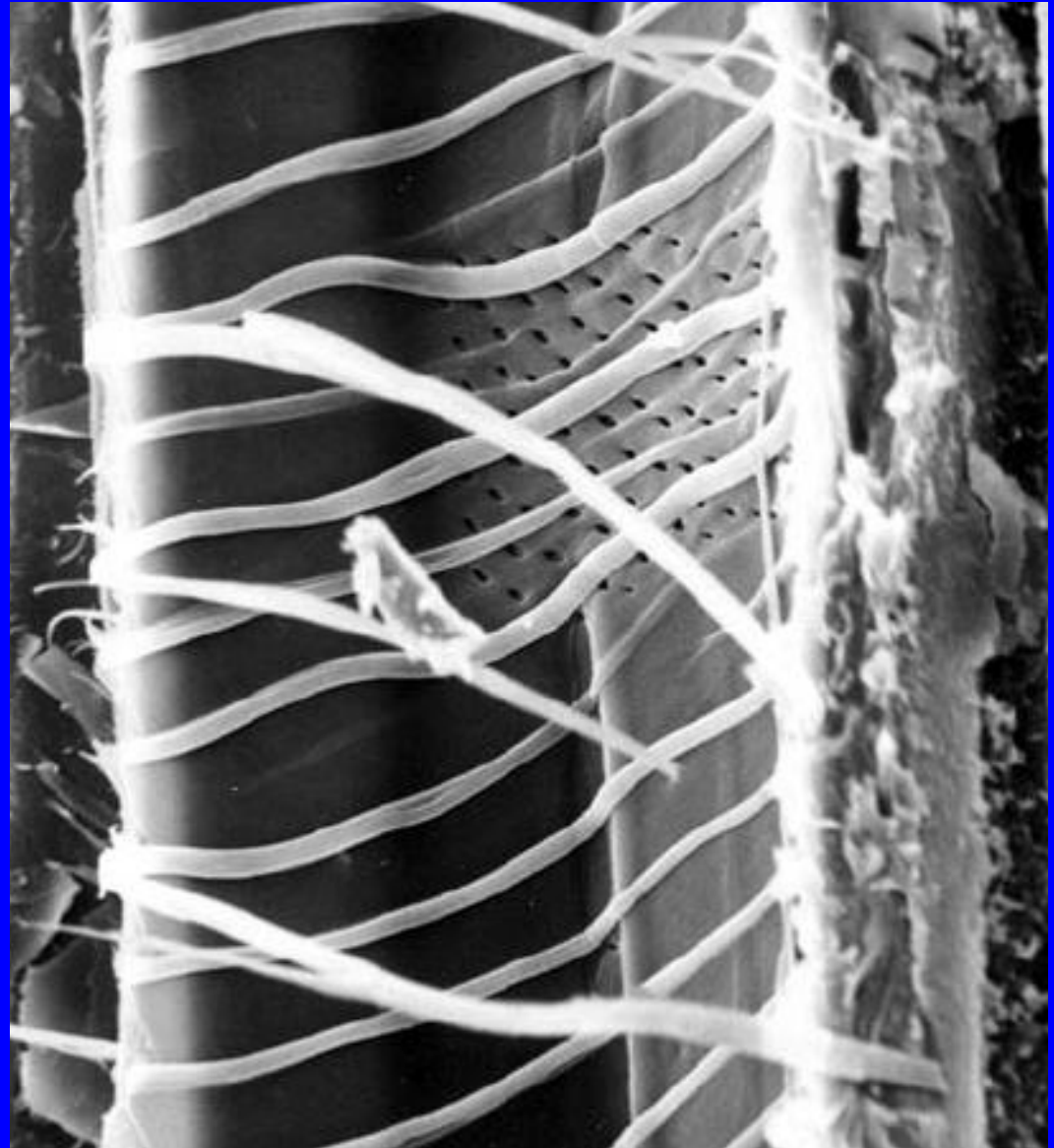
- ❖ Tracheid and vessel element: Sclerenchymatous tuncyte does not have living protoplast. The secondary wall shows diverse lignified thickening and is manifested in various forms, such as: annular, spiral, scalariform, reticulate and pitted.

Tracheid: It is a single cell with sharp terminals. During vertical connection, the terminals of upper and lower cells are closely overlapped. Water is transported via the pits on the tube cell wall. Vascular plants all have tracheids. The water transport molecules of most ferns and gymnospermae are composed of tracheids only.

During system development, tracheid 

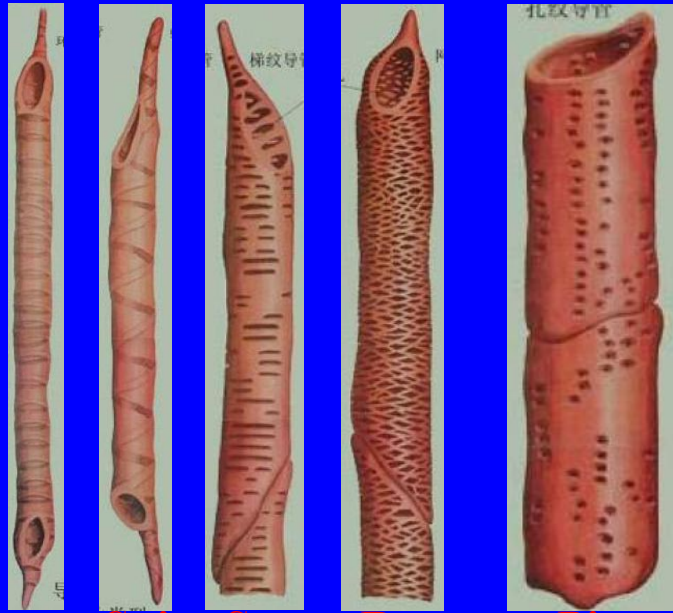


Tilia olivieri (Tiliaceae),
SEM inside surface of
vessel element showing
wall thickenings and
intervascular pitting.



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Examples of tracheids and vessel members.



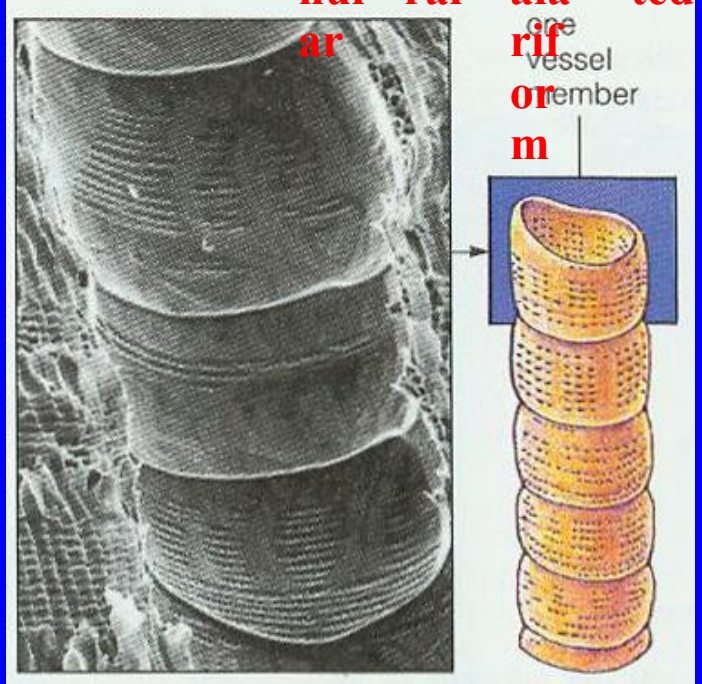
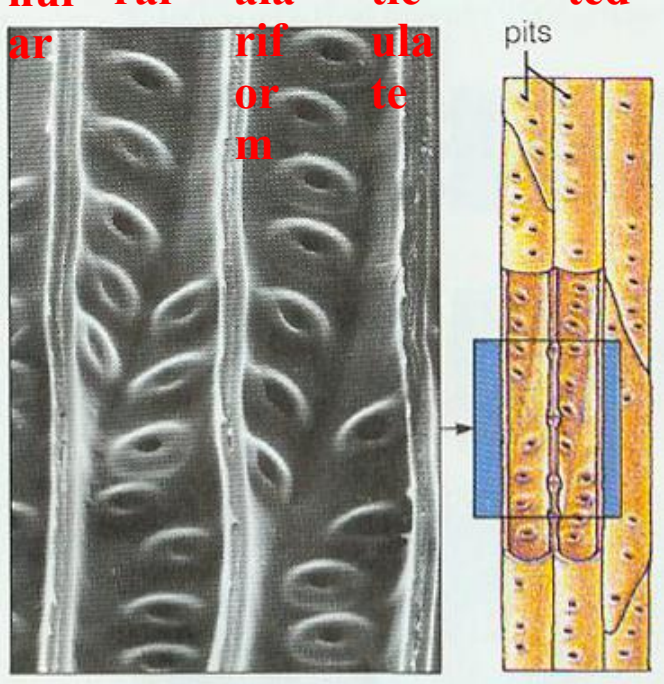
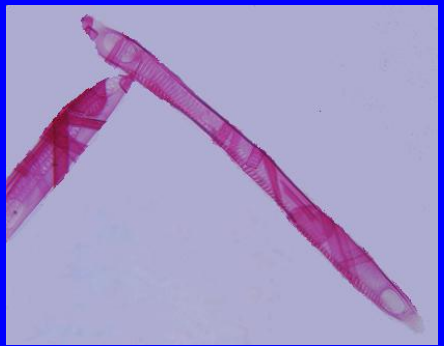
Anular Spiral Scalariform Reticulate Pitted

Vessel ←

Tracheid →

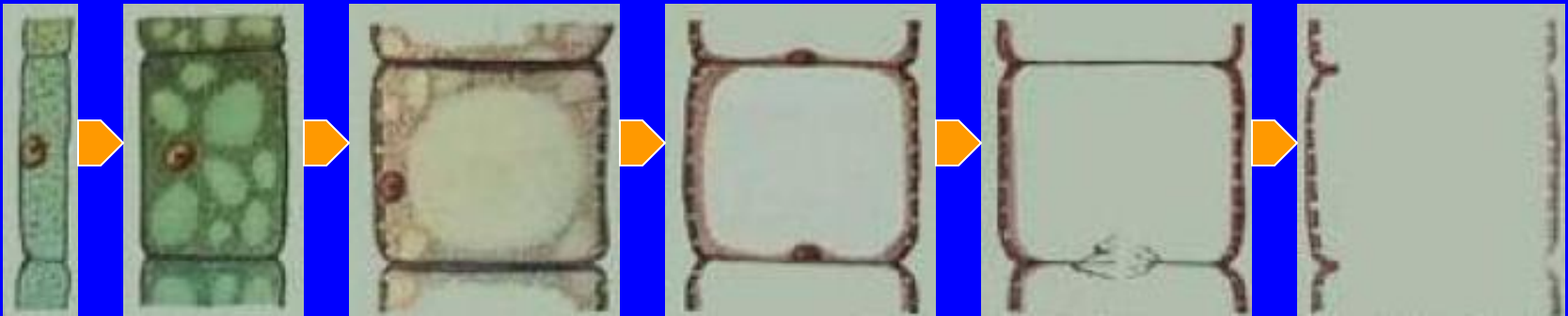


Anular Spiral Scalariform Pitted



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Vessel element: The end walls of a cell are dissolved and disappear in the development process, forming a through hole; the diameter of a vessel element is larger than that of a tracheid in general. The vessel element chain is called vessel. Compared with tracheid, vessel is more efficient in water transport. Except the most primitive types, the xylem of angiosperm mainly contains vessels.



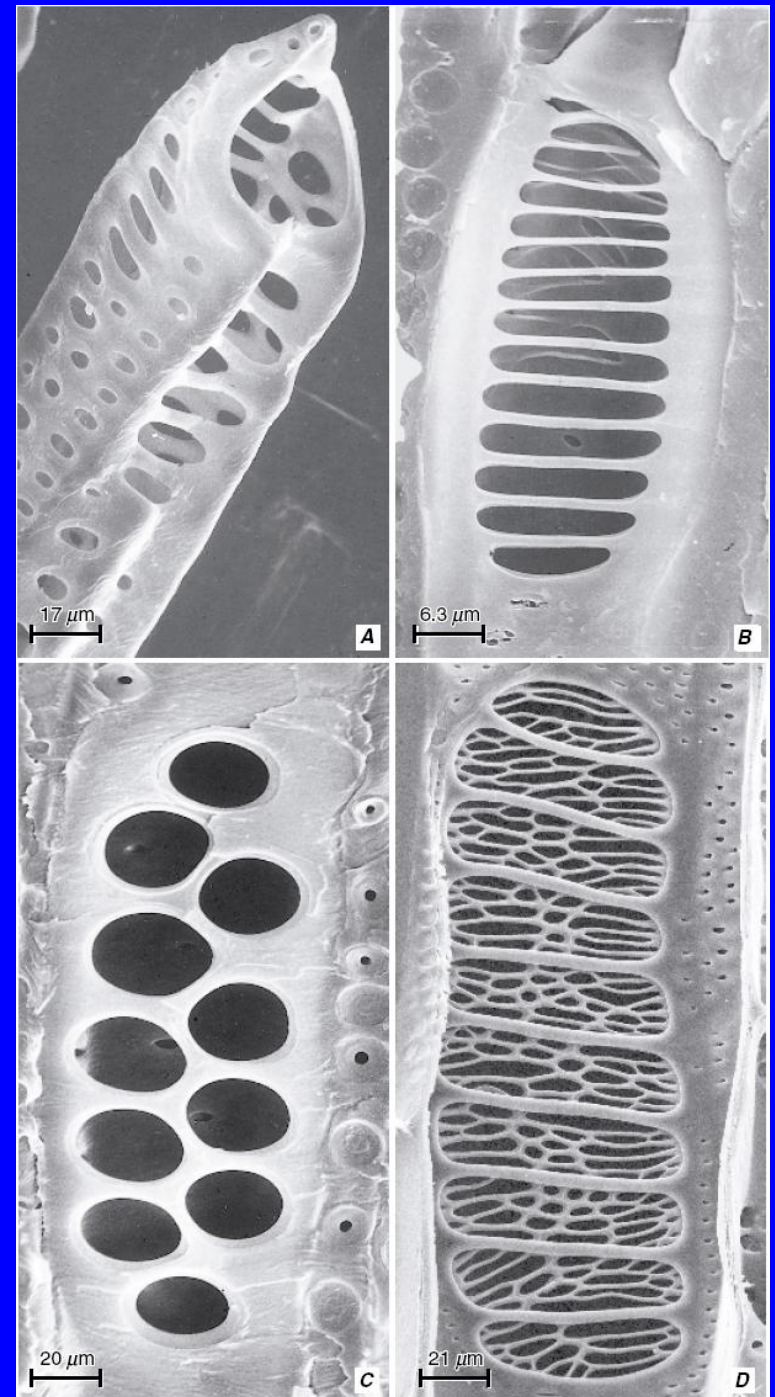
- ❖ Xylon: Fiber in xylem, with a wall thicker than that of tracheid, highly lignified and playing a role of support.
- ❖ Wood parenchyma cell: Refer to parenchyma cells living in xylem. In the later stage of development, the wall is lignified usually. The cells has a storage function.



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Perforation plates. Scanning electron micrographs of the perforated end walls of vessel elements from secondary xylem. A, a simple perforation plate, with its single large opening, in *Pelargonium* vessel element. B, the ladder-like bars of a scalariform perforation plate between vessel elements in *Rhododendron*. C, foraminiate perforation plate, with its circular perforations, in *Ephedra*. D, contiguous scalariform and reticulate perforation plates in *Knema furfuracea*. (A-C, courtesy of P. Dayanandan; D, from Ohtani et al., 1992)



② Phloem

♥ It is also a complex tissue, and contains sieve element or sieve tube cell, companion cell, parenchyma cell, fiber and other types of cells.

♥ Sieve element

The primary wall is not lignified and mainly contains pectin and cellulose.

End walls are specialized into sieve plates on which there are large sieve pores.

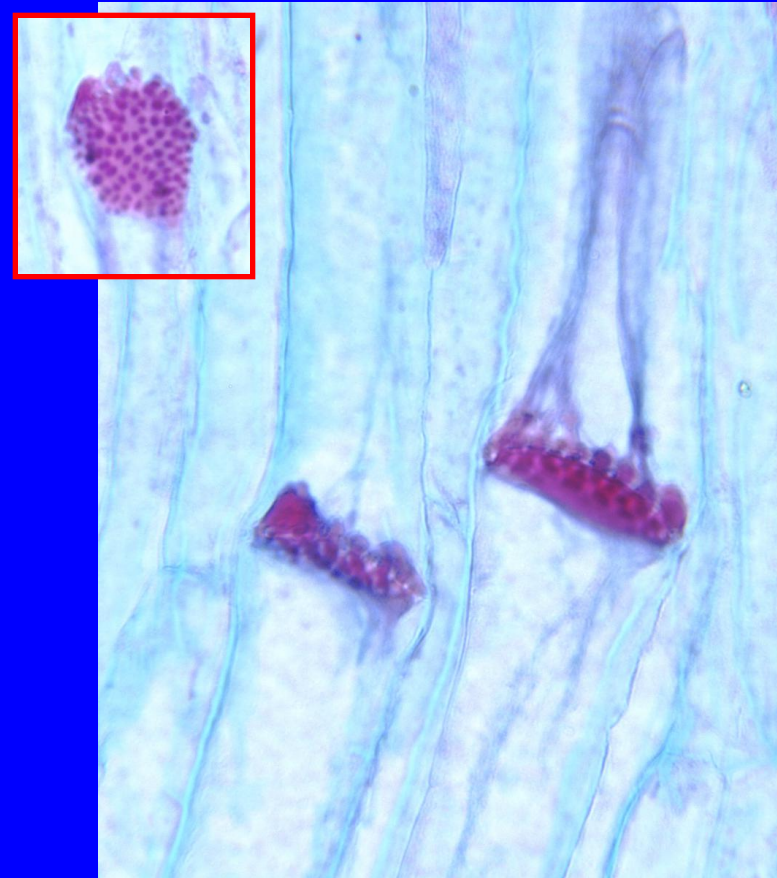
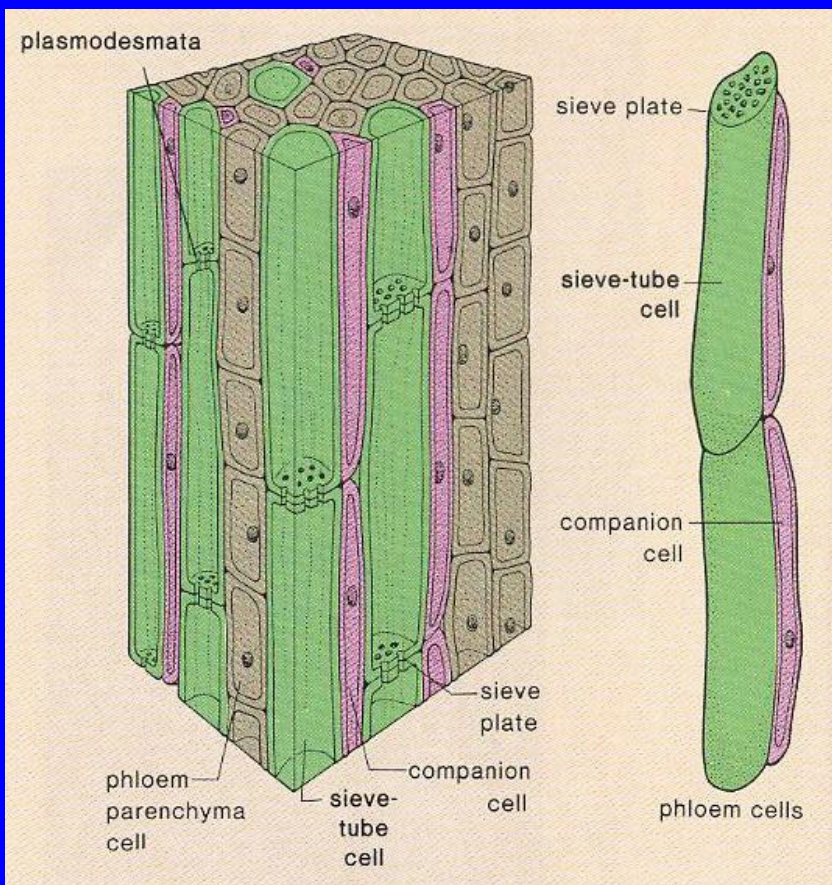
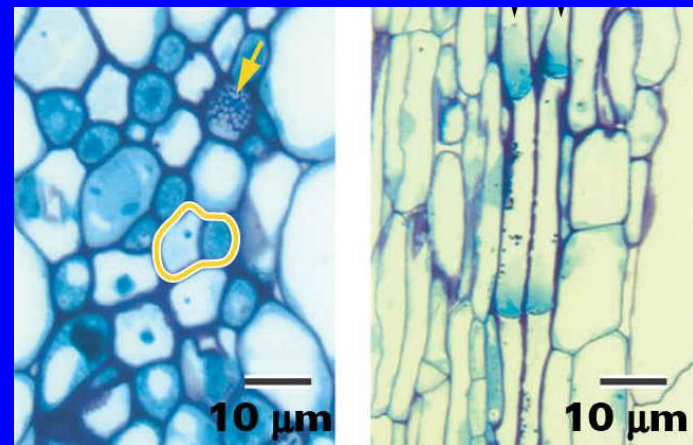
The adjacent upper and lower sieve elements have thick protoplast connecting strands, which are mutually linked via sieve pores and transport organic matters.

There is living protoplast. At the time of maturity, tonoplast and nucleus are disintegrated, organelles are degenerated, and mitochondria, plasmid, p-protein and some endoplasmic reticula constitute a special protein-containing viscous liquid.



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Photomicrographs and diagrams of phloem structure.





♥ Companion cell

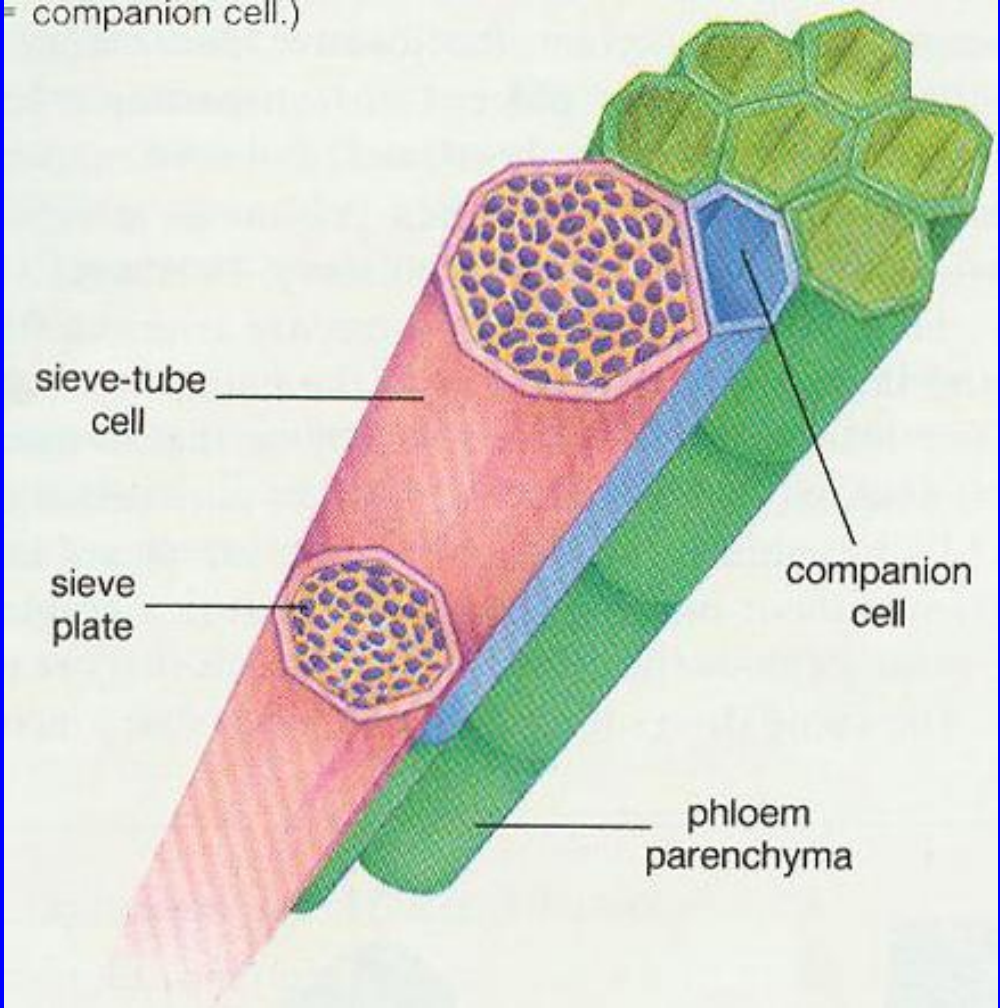
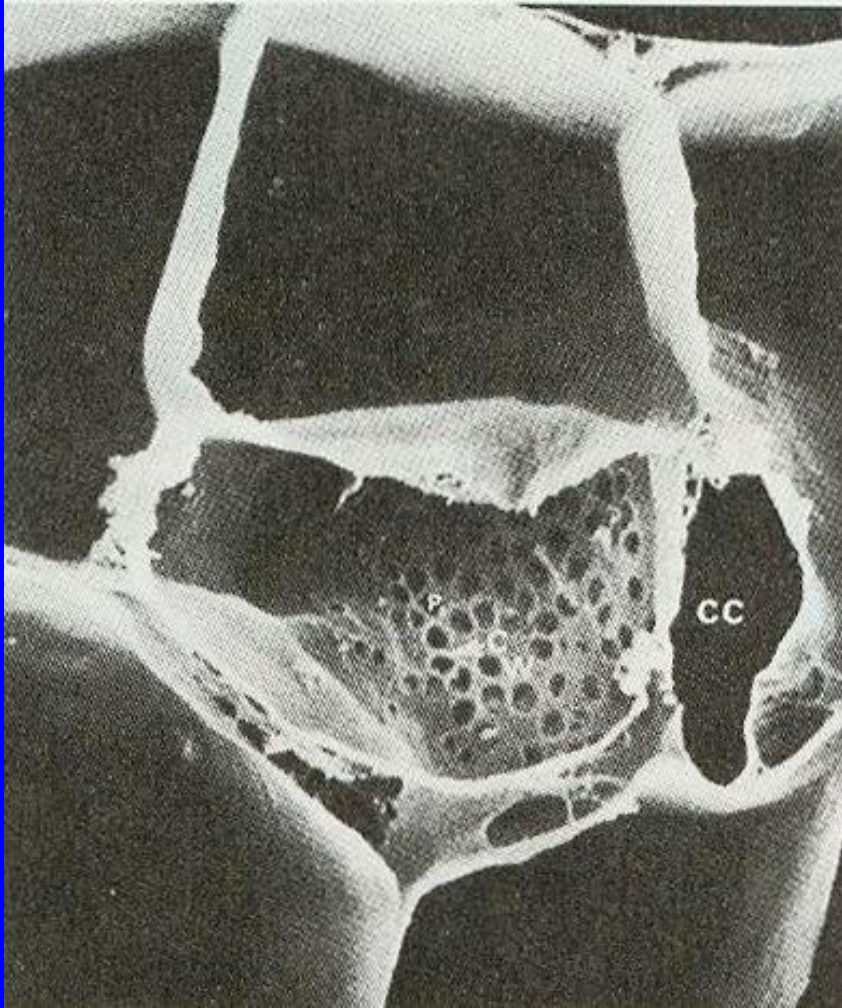
Companion cell is originated from a primary small parenchyma cell same as sieve element and has a nucleus and various kinds of organelle. Between it and sieve element, there is a dense sieve area.

Its activity extremely influences the transport function and other physiological activities of the sieve element.

It and the sieve element exist in angiospermae only.

- ♥ Sieve cell: Angiosperma and fern don't contain sieve tubes. On the sieve cell wall, there is only a sieve area. Protoplast does not contain P-proteoplast.
- ♥ Fiber: Cell wall is slightly lignified or not lignified, is tough and has strong flexural ability.
- ♥ Parenchyma cell: It is for storage and transverse transport and often contains crystal and reserve substances.

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(5) Secretory tissue

- ★ Secretory phenomenon: Refer to a phenomenon of discharging synthesized special organic matters or inorganic matters out of body or cells, or accumulating them inside cells.
- ★ Secretory structure: The plant cells that generate secreta have different origins, forms and distribution modes. They are either scattered or concentrated or specialized into a specific structure and collectively called secretory structure, which is classified into two categories: internal and external structures.



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Euphorbia helioscopiae



Plants with a secretory structure



Nepenthes distillatoria

Urtica fissa



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Nerium indicum

Lavandula angustifolia



Eucommia ulmoides

① External secretory structure: It can secrete matters to plant surface

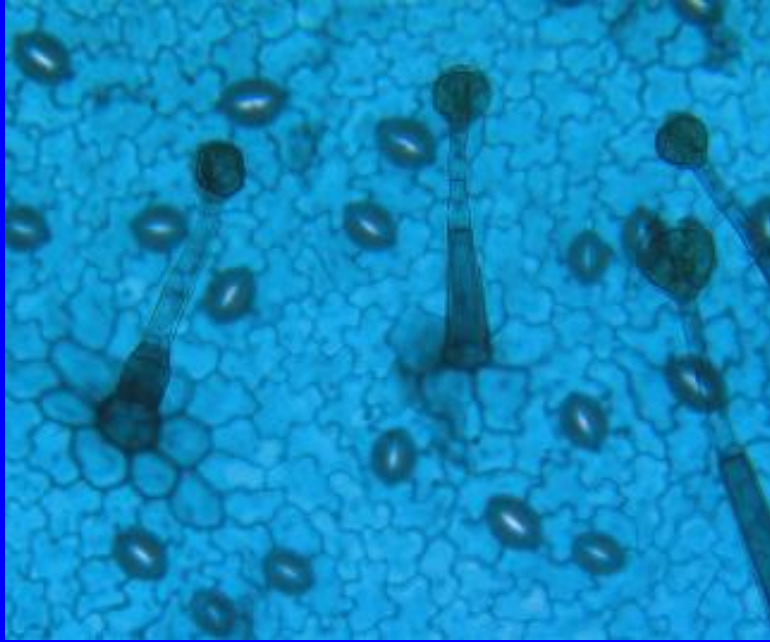
Glandularepidermis: The epidermal cells at some locations are glandular and have a secretory function.

Glandular hair: Refer to various kinds of epidermal hairy appendages of different complexities with a secretory function. In general, it has a head and a handle.

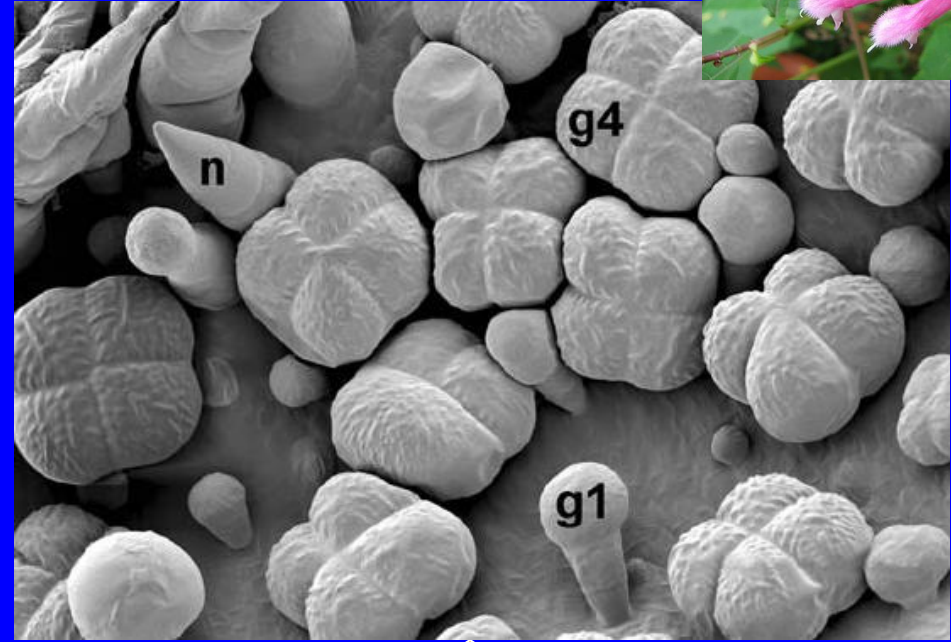
Hydathode: Refer to a structure that discharges excess water in plant out of the body. It is located on leaf apex or margin and has waterstoma and epithem.

Nectary: It is an external structure secreting liquid glucose. In some cases, it is only a glandularepidermis type. In some cases, it is differentiated into a special structure with specific appearance, including floral nectary and extra-floral nectary. The internal structure includes parenchyma cells of epidermis and a few layers under epidermis. The cells are characterized by high mass concentration and large nucleus and have developed endoplasmic reticulum and dictyosome.





Glandular hair out of the epidermis surface of pelargonium leaf.



Salvia involucrata (Lamiaceae), trichomes on petal surface. n=non-glandular trichome, g1=glandular trichome with unicellular head, g4=glandular trichome with four-celled head. Scale =50 μm.



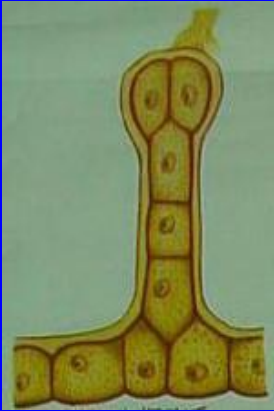


Drops of guttation water on the edges of a strawberry leaf.

Droplets of guttation water at the tips of leaves of young barley plants.



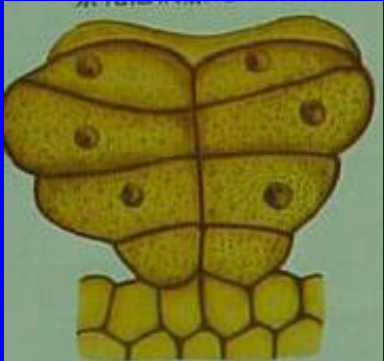
Various external secretory structures



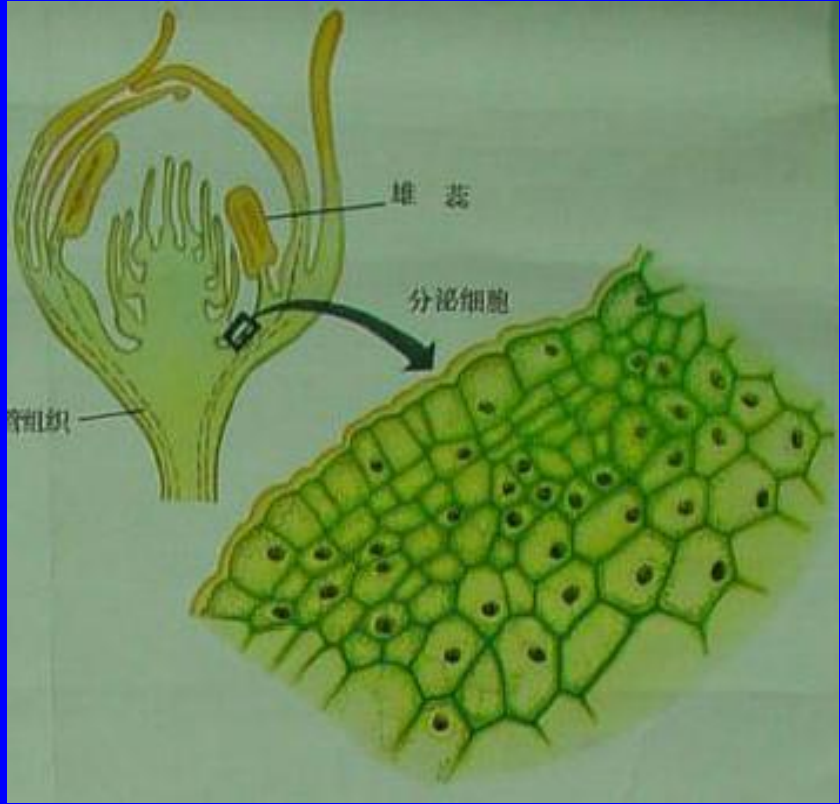
Glandular hair of Paulownia



Tobacco glandular hair



Menthol squamous gland



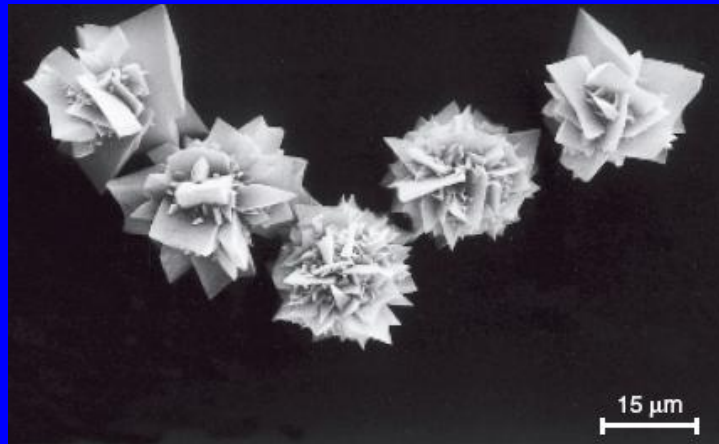
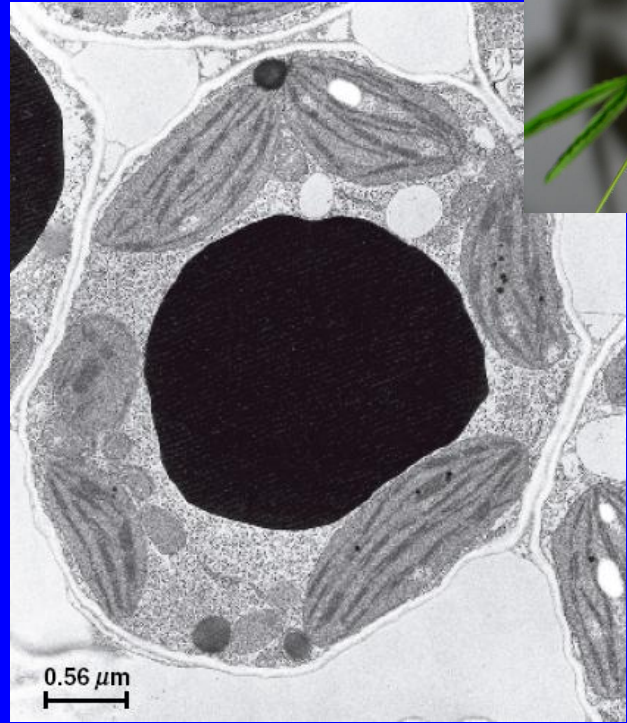
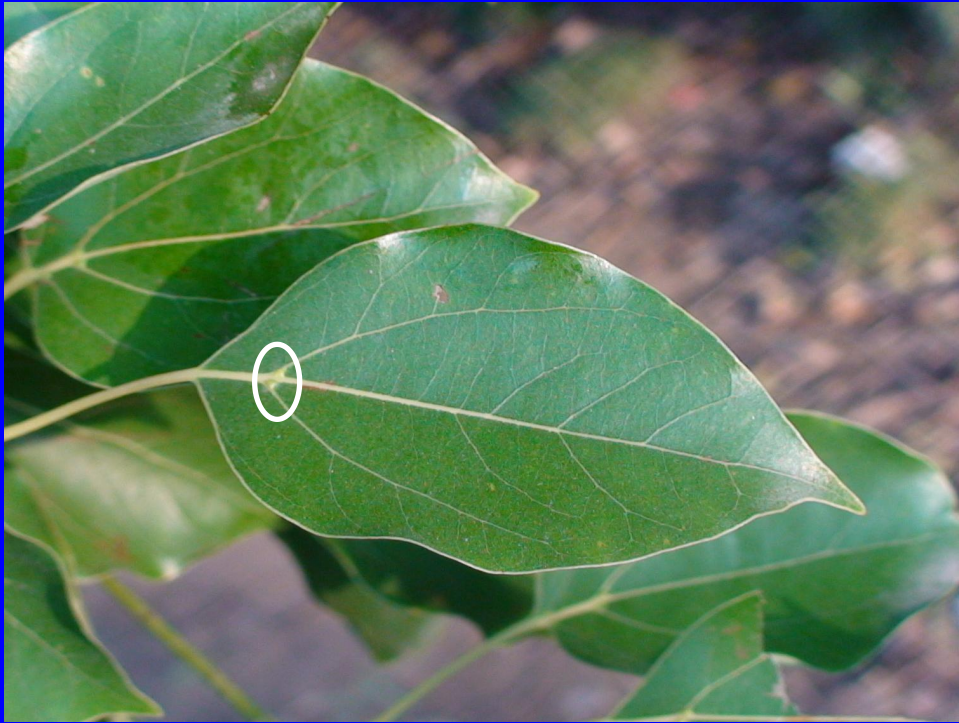
Nectary on strawberry flower

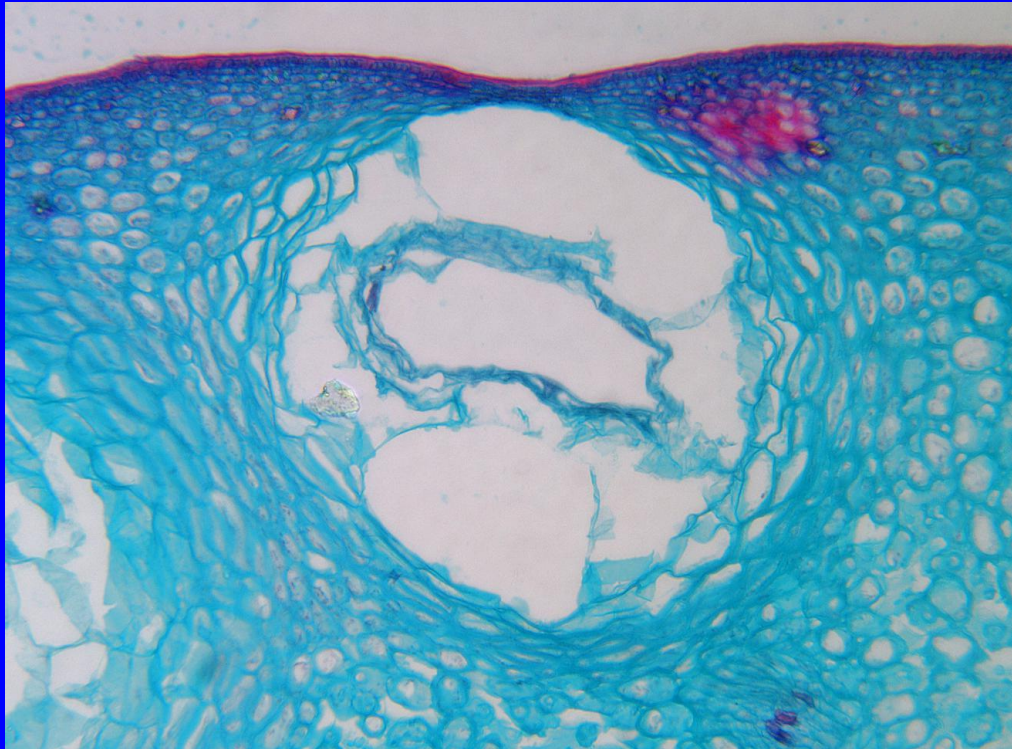


- ② Internal secretory structure: A secretory structure where secreta is not discharged out of the body.
- ⊙ Secretory cells: Refer to living or non-living cells inside which special secreta is accumulated. They are parenchyma cells and individually live in other cells, but the volume is large (eleocyte, mucous cell, crystalliferous cell, tannin cell and myrosin cell).
 - ⊙ Secretory cavity and secretory canal: Refer to the cavity or canal that stores secreta in the plant.
 - Dissolving type: Formed after disintegration of some cells (citrus).
 - Cleavage type: Formed after the middle layer of the cell is dissolved, resulting in split of the cell (pine, cypress and lacquer tree).
 - Cleavage and dissolving type: Formed after combination of the above two types (mango).

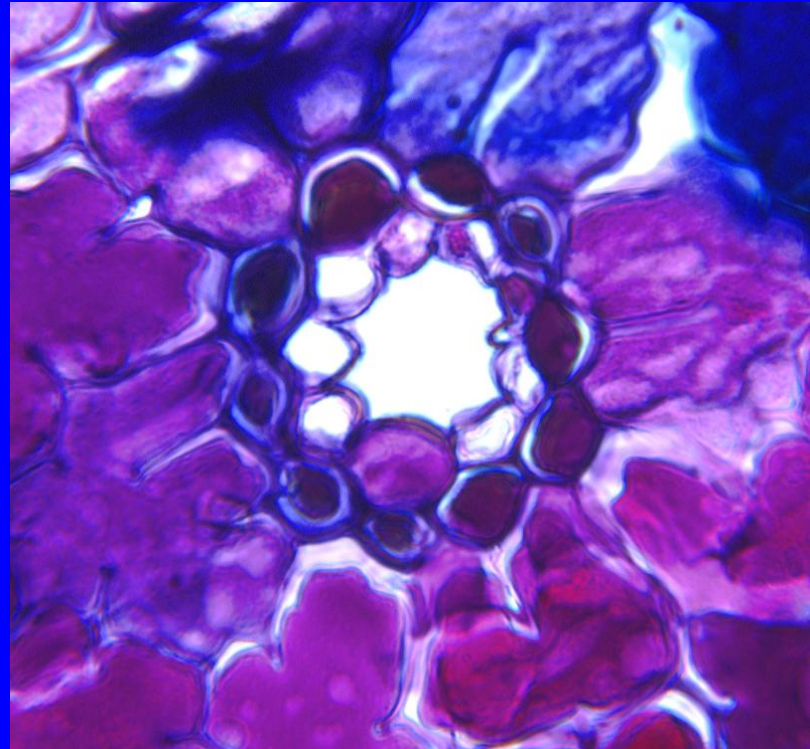


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Lysigenous secretory cavity in the pericarp of orange fruit.



Schizogenous resin canal in the leaf of pine plant.



- © Laticifer: Refer to the tubular cells that secrete latex. The primary wall is not lignified. There are multiple nuclei at the time of maturity. There isn't a clear boundary between vacuole and cytoplasm. The protoplast encircles latex and has extremely complex composition.

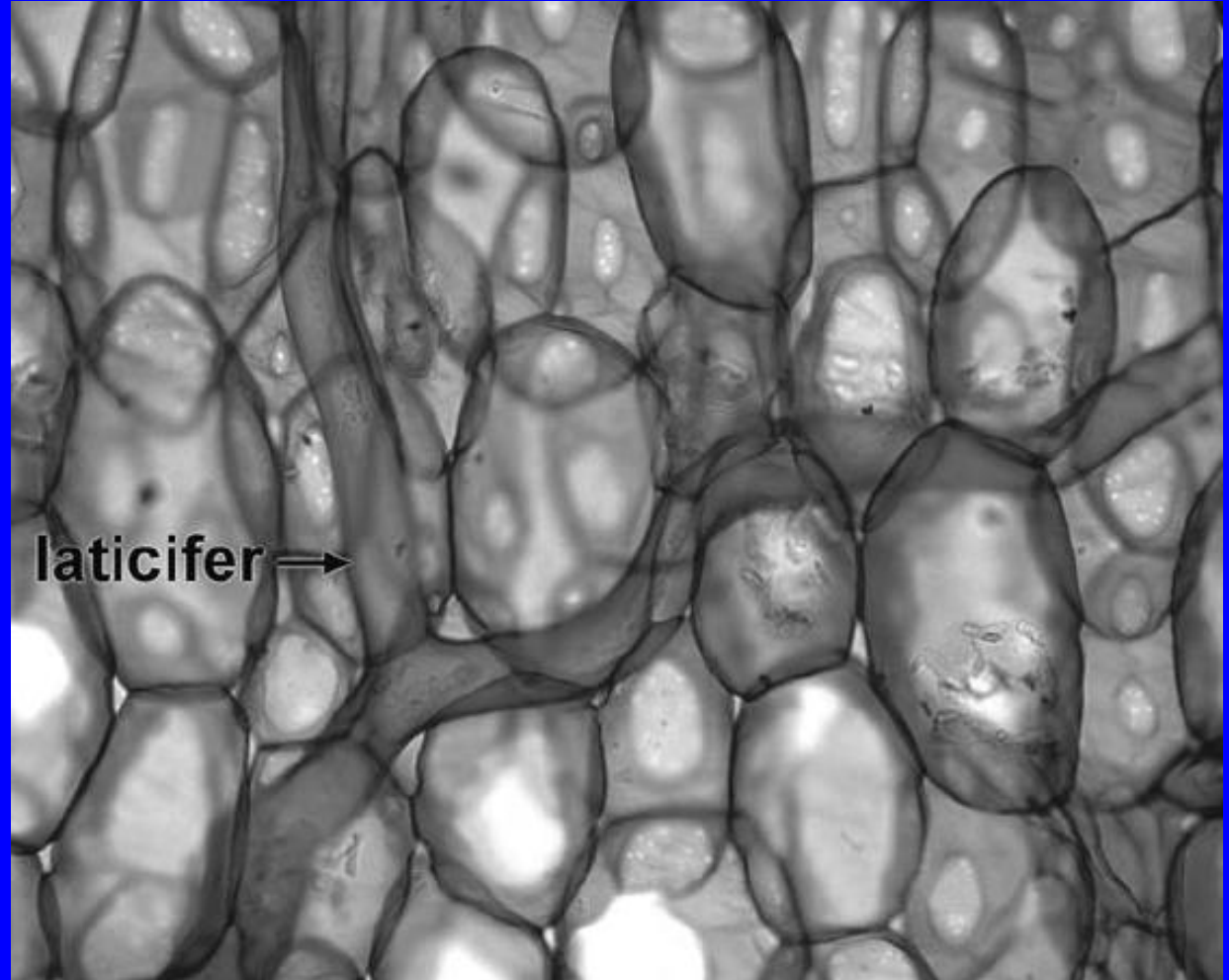
Unarticulated: Formed after a cell is elongated and branched continuously along with the growth of the plant (oleander and Moraceae).

Articulated: Formed after thawing and disappearance of connecting walls of many tubular cells, which are connected to each other in the development process (Asteraceae, Papaveraceae and Convolvulaceae).





Euphorbia eyassiana
(Euphorbiaceae),
longitudinal section
of stem showing
branched non-
articulated laticifers
in parenchyma.
Scale=50 μm .

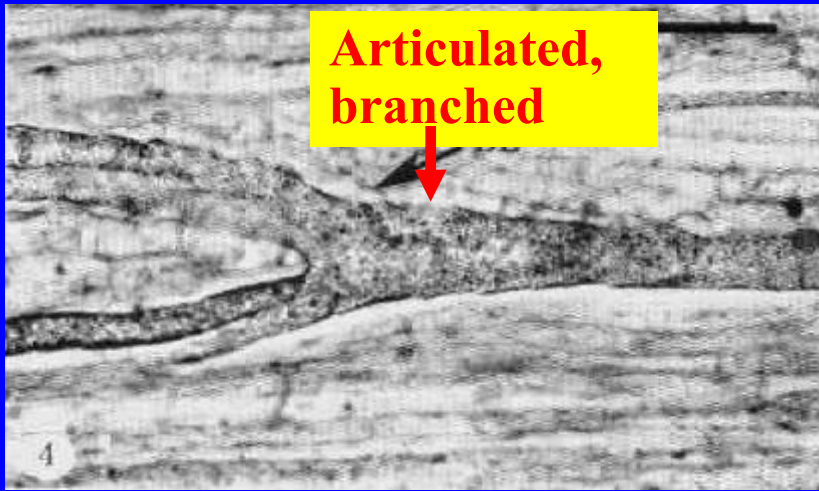


Laticifer of Jatropha curcas L. (Liu Huanfang et al, 2006)

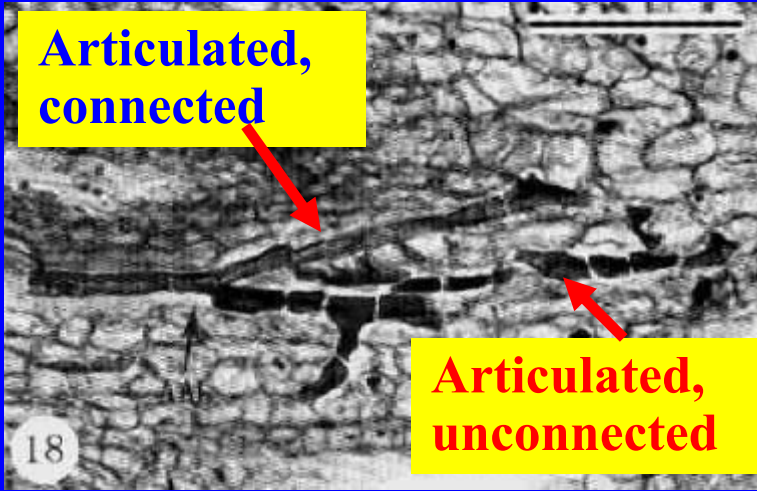


Articulated, unconnected

Unarticulated, unbranched



Articulated, branched



Articulated, connected

Articulated, unconnected

III. Tissue System

1. Concept: A or a few tissues on a plant or an organ form a structural and functional unit. This unit is called a tissue system.
2. Type:

Dermal tissue system: It covers the surface of every organ of a plant, forms a complete continuous protective layer and consists of epidermis and periderm.

Vascular tissue system: It continuously runs through a whole plant, connects the growing region and development region with the organic nutriment production and storage region and consists of xylem and phloem.

Fundamental tissue system: It is a basic component of every part of a plant and consists of all kinds of parenchyma tissues, collenchyma tissues and sclerenchyma tissues.