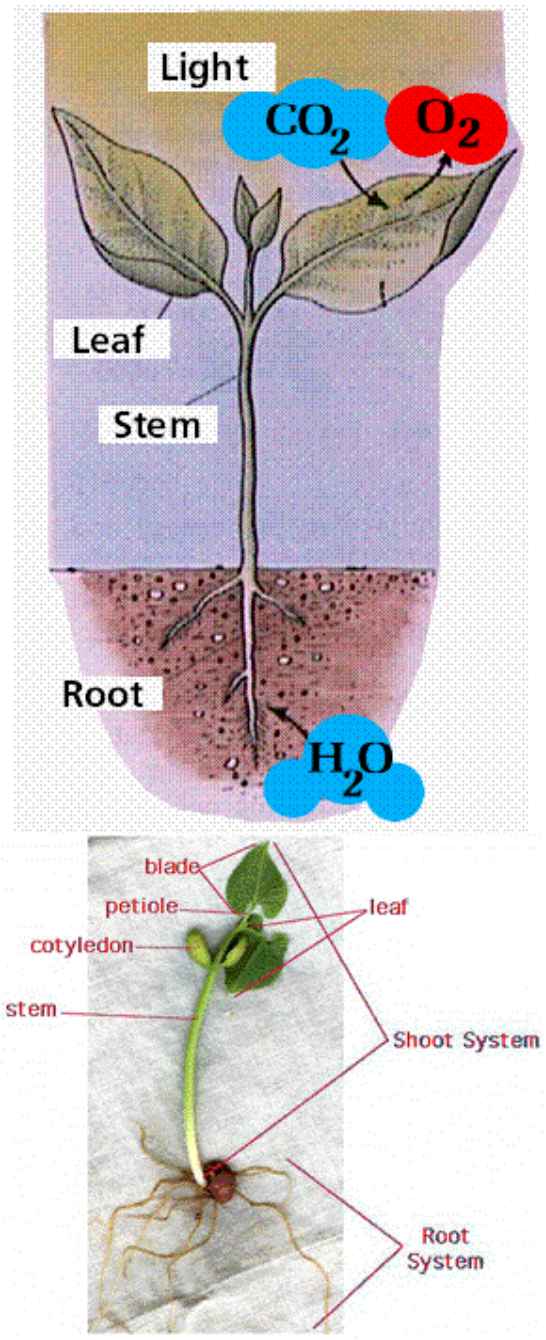
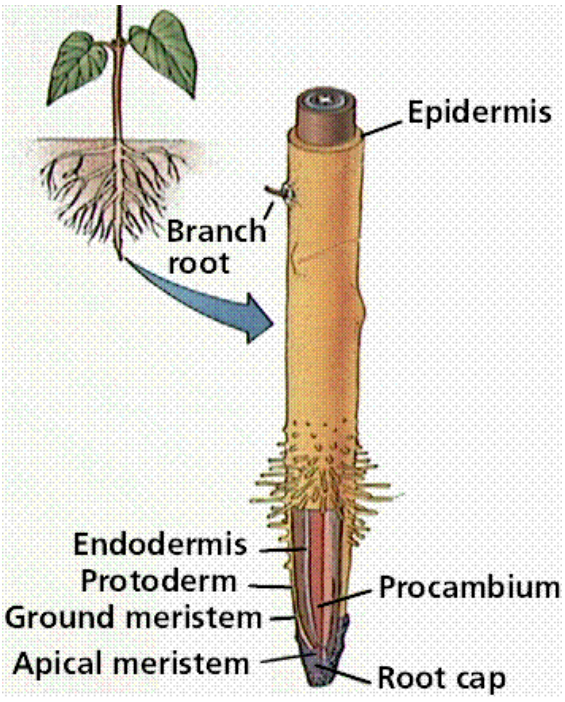
PLANTS AND THEIR STRUCTURE

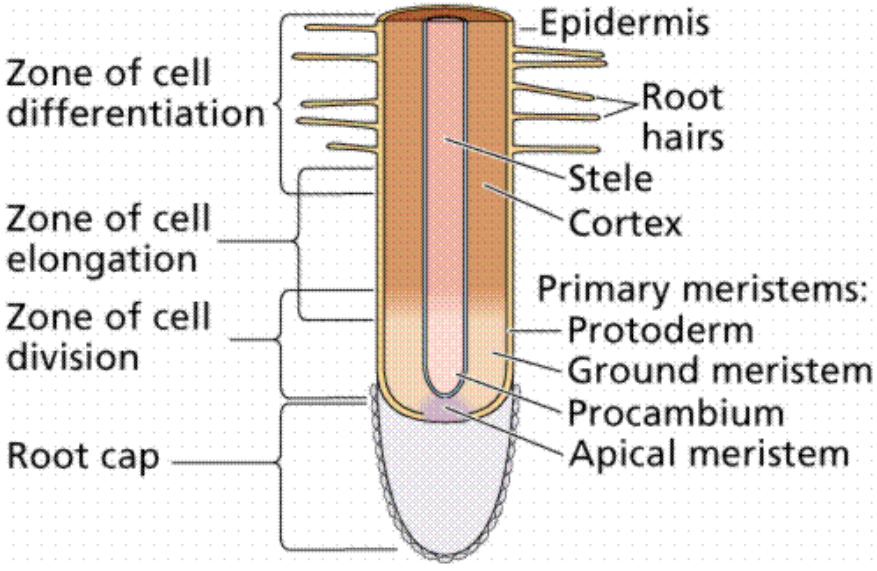
A plant has two organ systems: 1) the shoot system, and 2) the root system. The shoot system is above ground and includes the organs such as leaves, buds, stems, flowers (if the plant has any), and fruits (if the plant has any). The root system includes those parts of the plant below ground, such as the roots, tubers, and rhizomes.



Major organ systems of the plant body

Plant cells are formed at meristems, and then develop into cell types, which are grouped into tissues. Plants have only three tissue types: 1) Dermal; 2) Ground; and 3) Vascular. Dermal tissue covers the outer surface of herbaceous plants. Dermal tissue is composed of epidermal cells, closely packed cells that secrete a waxy cuticle that aids in the prevention of water loss. The ground tissue comprises the bulk of the primary plant body. Parenchyma, collenchyma, and sclerenchyma cells are common in the ground tissue. Vascular tissue transports food, water, hormones and minerals within the plant. Vascular tissue includes xylem, phloem, parenchyma, and cambium cells.





Two views of the structure of the root and root meristem

Plant cell types rise by mitosis from a meristem. A meristem may be defined as a region of localized mitosis. Meristems may be at the tip of the shoot or root (a type known as the apical meristem) or lateral, occurring in cylinders extending nearly the length of the plant. A cambium is a lateral meristem that produces (usually) secondary growth. Secondary growth produces both wood and cork (although from separate secondary meristems).

Parenchyma

A generalized plant cell type, parenchyma cells are alive at maturity. They function in storage, photosynthesis, and as the bulk of ground and vascular tissues. Palisade parenchyma cells are elogated cells located in many leaves just below the epidermal tissue. Spongy mesophyll cells occur below the one or two layers of palisade cells. Ray parenchyma cells occur in wood rays, the structures that transport materials laterally within a woody stem. Parenchyma cells also occur within the xylem and phloem of vascular bundles. The largest parenchyma cells occur in the pith region, often, as in corn (*Zea*) stems, being larger than the vascular bundles. In many prepared slides they stain green.

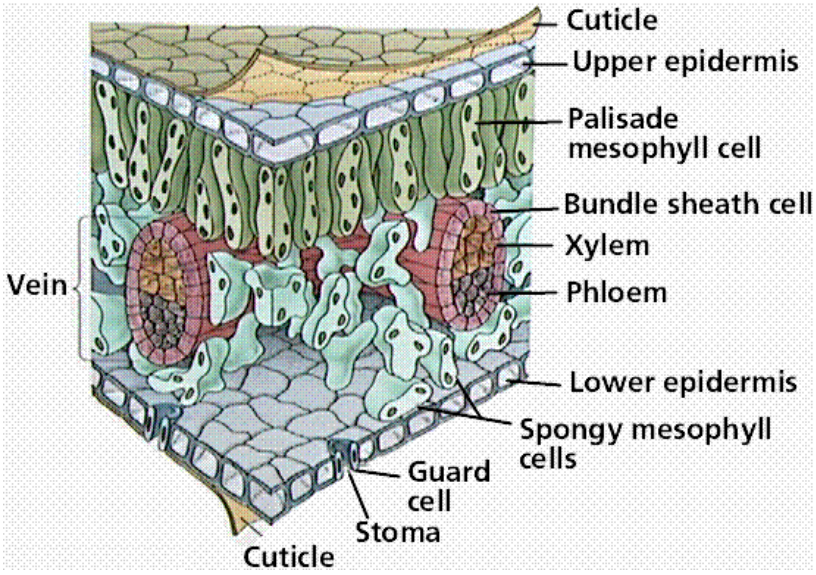
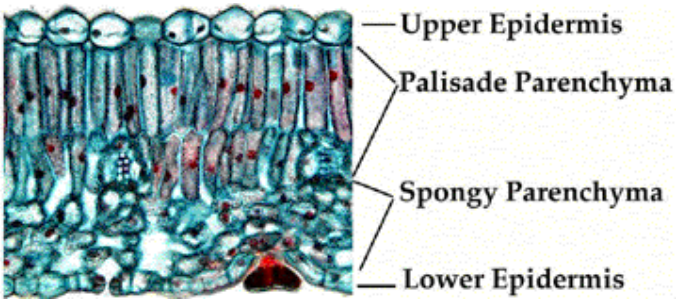
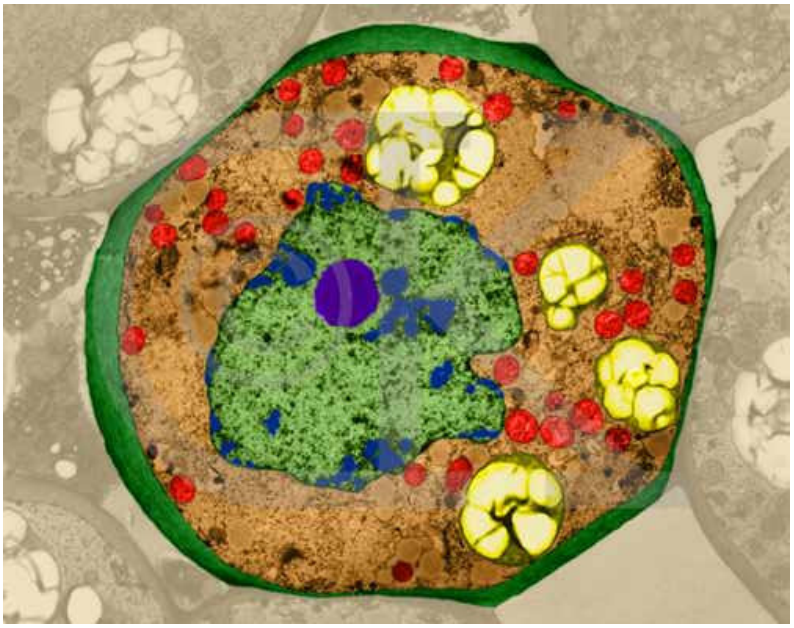


Diagram of leaf structure. Note the arrangement of tissue layers within the leaf.



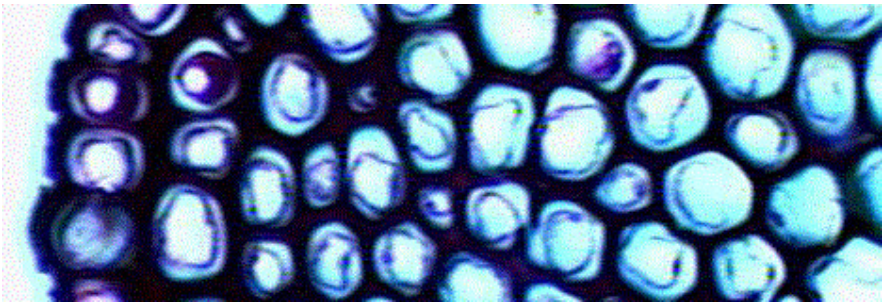
Cross-section of a stained leaf of *Syringia*



Lily Parenchyma Cell (cross-section) (TEM x7,210). Note the large nucleus and nucleolus in the center of the cell, mitochondria and plastids in the cytoplasm.

Collenchyma

Collenchyma cells support the plant. These cells are charcterized by thickenings of the wall, they are alive at maturity. They tend to occur as part of vascular bundles or on the corners of angular stems. In many prepared slides they stain red.

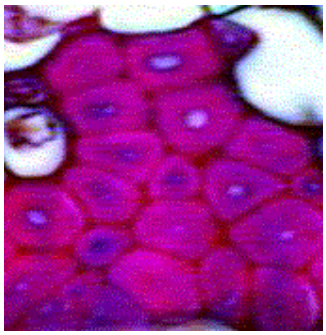


Collenchyma cells. Note the thick walls on the collenchyma cells occurring at the edges of the *Medicago* stem cross section.

Sclerenchyma

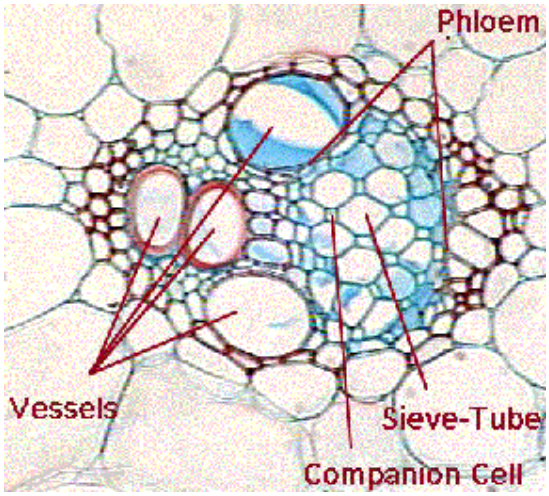
Sclerenchyma cells support the plant. They often occur as bundle cap fibers. Sclerenchyma cells are characterized by thickenings in their secondary walls. They are dead at maturity. They, like collenchyma, stain red in many commonly used prepared slides.

A common type of schlerenchyma cell is the fiber



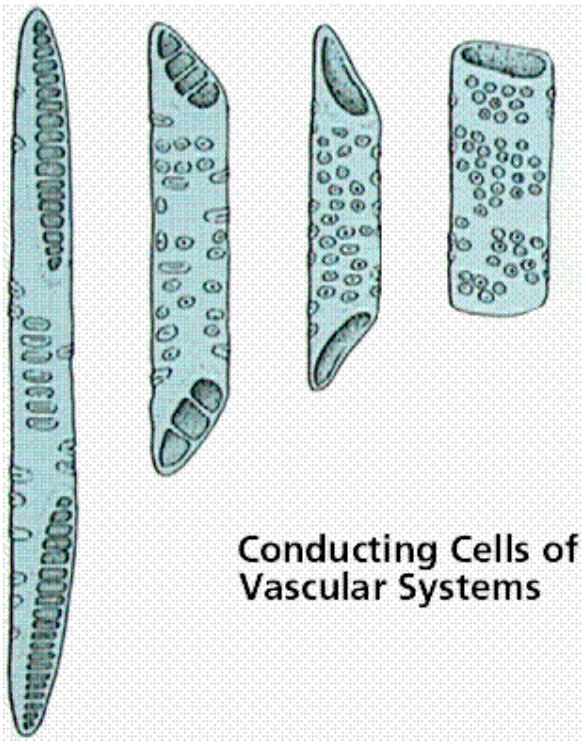
Xylem

Xylem is a term applied to woody (lignin-impregnated) walls of certain cells of plants. Xylem cells tend to conduct water and minerals from roots to leaves. While parenchyma cells do occur within what is commonly termed the "xylem" the more identifiable cells, tracheids and vessel elements, tend to stain red with Safranin-O. Tracheids are the more primitive of the two cell types, occurring in the earliest vascular plants. Tracheids are long and tapered, with angled end-plates that connect cell to cell. Vessel elements are shorter, much wider, and lack end plates. They occur only in angiosperms, the most recently evolved large group of plants.

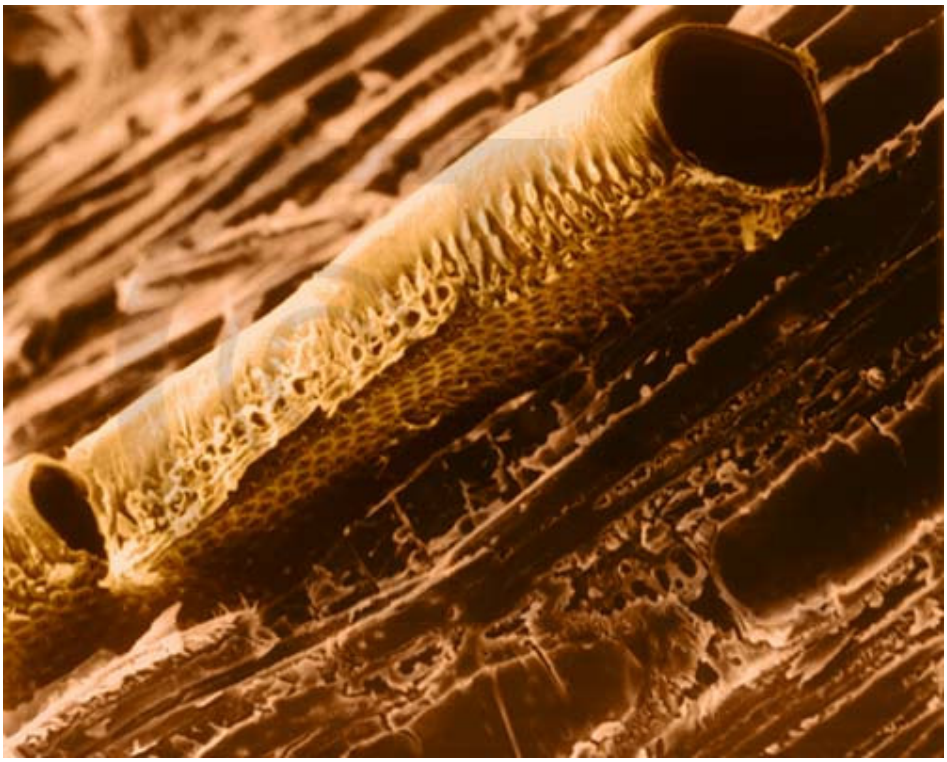


Xylem cells

Tracheids, longer, and narrower than most vessels, appear first in the fossil record. Vessels occur later. Tracheids have obliquely-angled endwalls cut across by bars. The evolutionary trend in vessels is for shorter cells, with no bars on the endwalls.



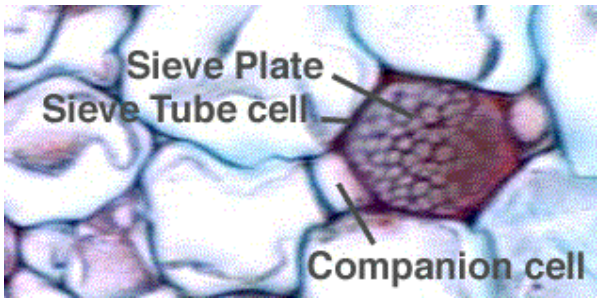
Conducting cells of the xylem; tracheids (left) are more primitive, while the various types of vessels (the other three) are more advanced.



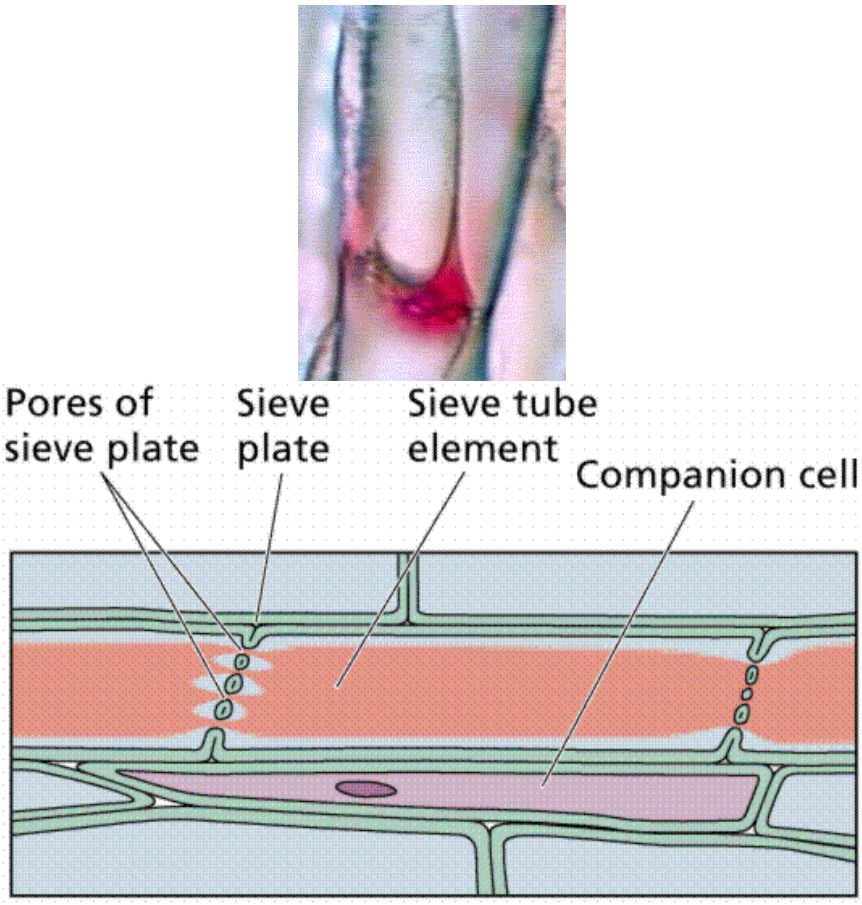
Conductive Vessel Element in Mountain Mahogany Wood (SEM x750).

Phloem

Phloem cells conduct food from leaves to rest of the plant. They are alive at maturity and tend to stain green (with the stain fast green). Phloem cells are usually located outside the xylem. The two most common cells in the phloem are the companion cells and sieve cells. Companion cells retain their nucleus and control the adjacent sieve cells. Dissolved food, as sucrose, flows through the sieve cells.



Phloem cells



Phloem cells as seen in longitudinal section. Note the longitudinal view of the sieve plate inside the large sieve tube cell. Right image is a diagram of the longitudinal view of phloem cells.

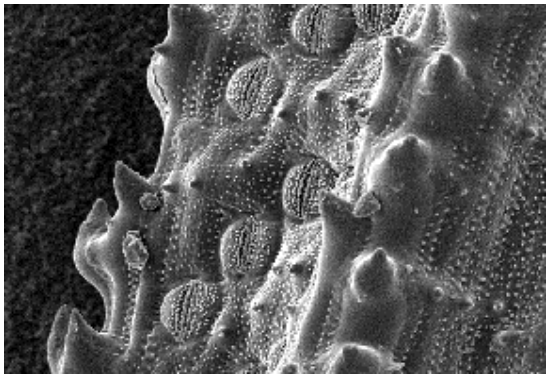
Epidermal Cells

Epidermis

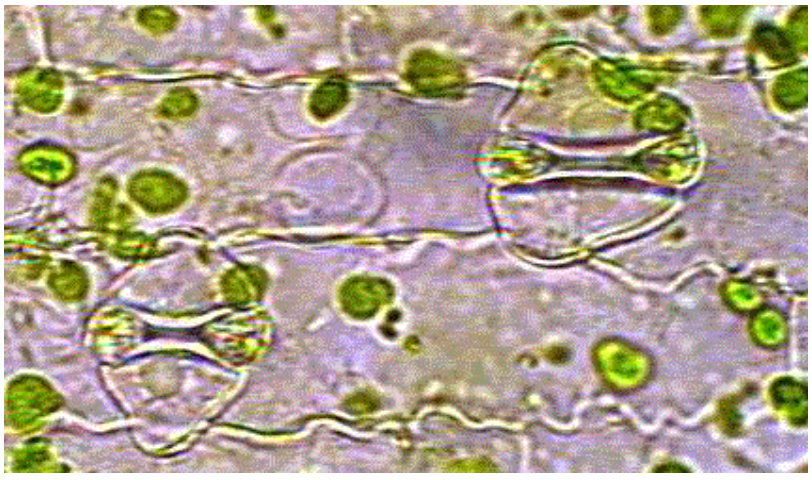
The epidermal tissue functions in prevention of water loss and acts as a barrier to fungi and other invaders. Thus, epidermal cells are closely packed, with little intercellular space. To further cut down on water loss, many plants have a waxy cuticle layer deposited on top of the epidermal cells.

Guard Cells

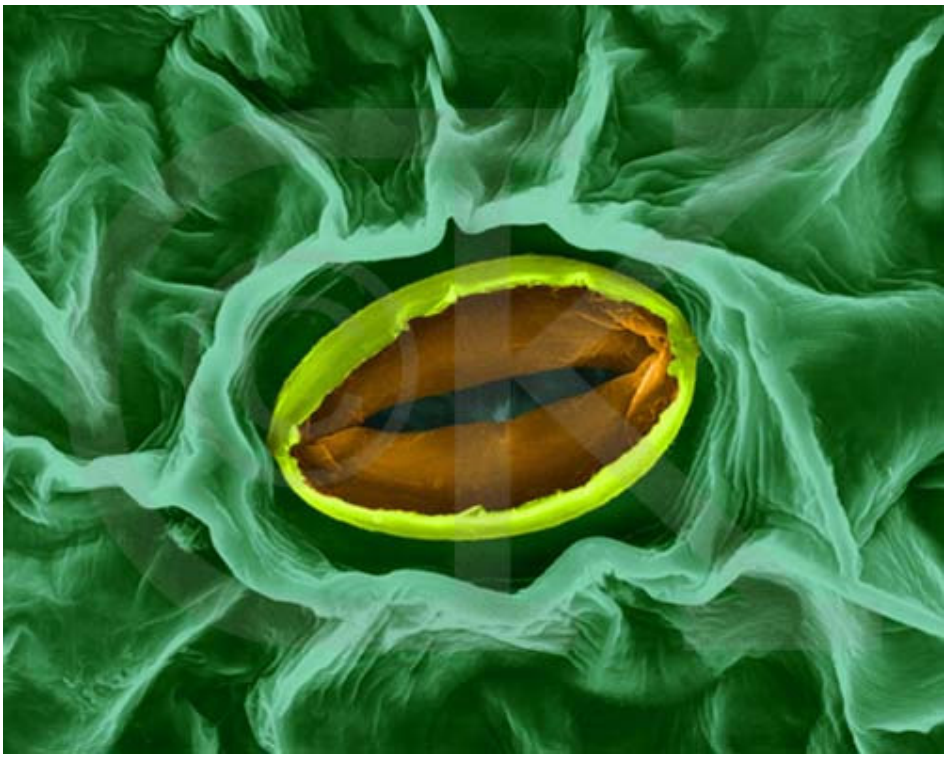
To facilitate gas exchange between the inner parts of leaves, stems, and fruits, plants have a series of openings known as stomata (singular stoma). Obviously these openings would allow gas exchange, but at a cost of water loss. Guard cells are bean-shaped cells covering the stomata opening. They regulate exchange of water vapor, oxygen and carbon dioxide through the stoma.



Scanning electron micrograph of *Equisetum* (horsetail or scouring rush) epidermis. Note the oval stomatal apparatuses in the center of the stem.



Epidermal cells, including guard cells, of corn.



Pea Leaf Stoma, *Vicea* sp. (SEM x3,520).