Flowering Plants

Structure and Organization

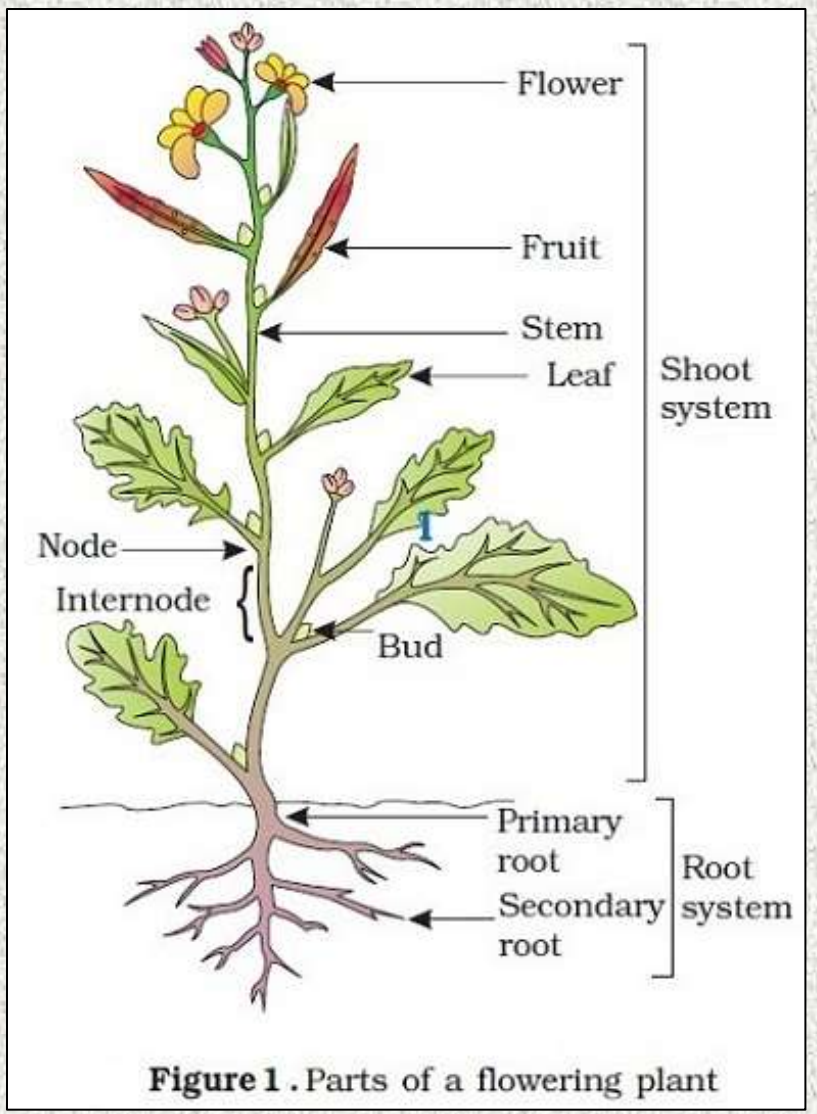
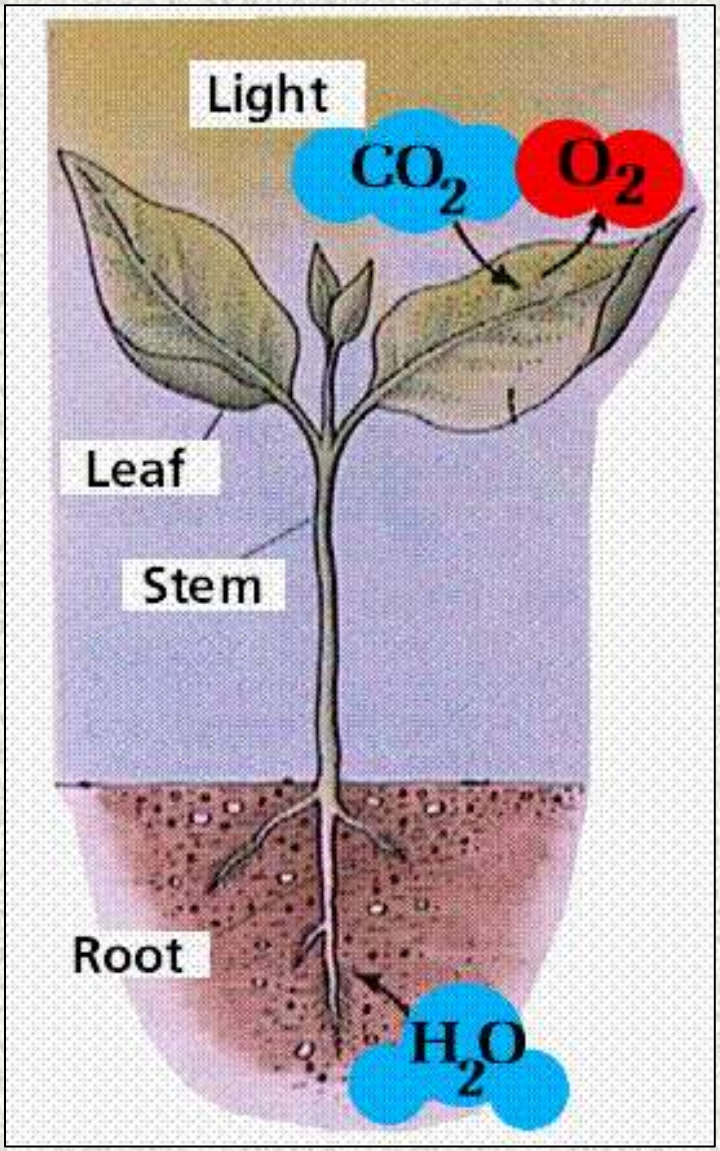


Figure 1 . Parts of a flowering plant

The Plant Body



Shoot System

Vascular System for transporting water and food up and down

Root System

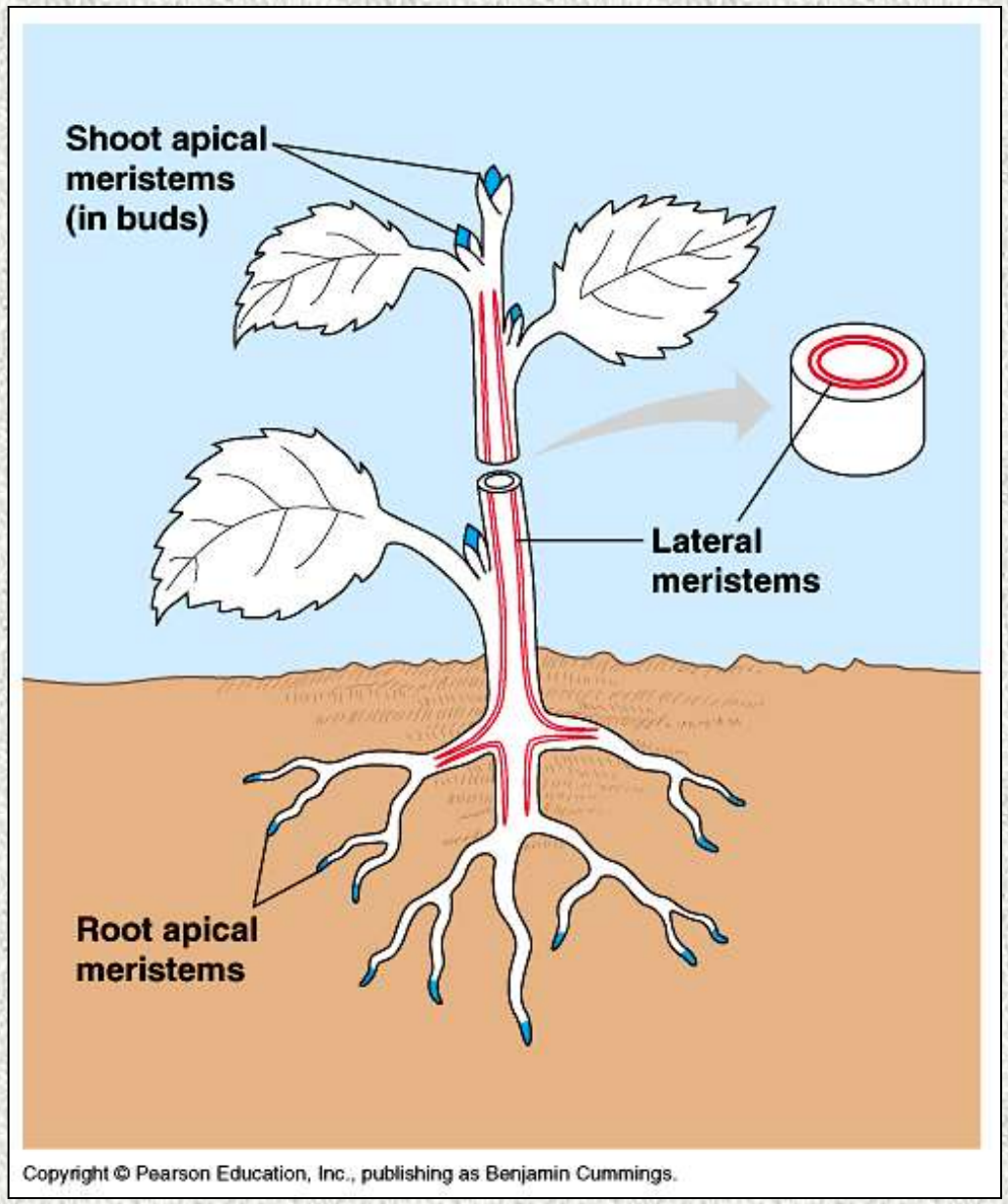
Cells and Tissues of Flowering Plants

- As in animals, a **cell** is the basic unit of life.
- A **tissue** is made of specialized cells that perform a particular function.
- An **organ** is a structure made from multiple tissues.

Plant Tissue Types

1. **Meristematic tissue** - site of growth in plant; origin of the other tissue types; apical meristems - site of primary growth; lateral meristems - site of secondary growth
2. **Dermal tissue** system - the outer protective covering of the plant
3. **Ground tissue** system - the inner supportive tissues of the plant – pith in herbaceous plants
4. **Vascular tissue** system - comprises the xylem and phloem - it is embedded within the ground tissue system – xylem forms wood in woody plants

Meristems – Growing Points

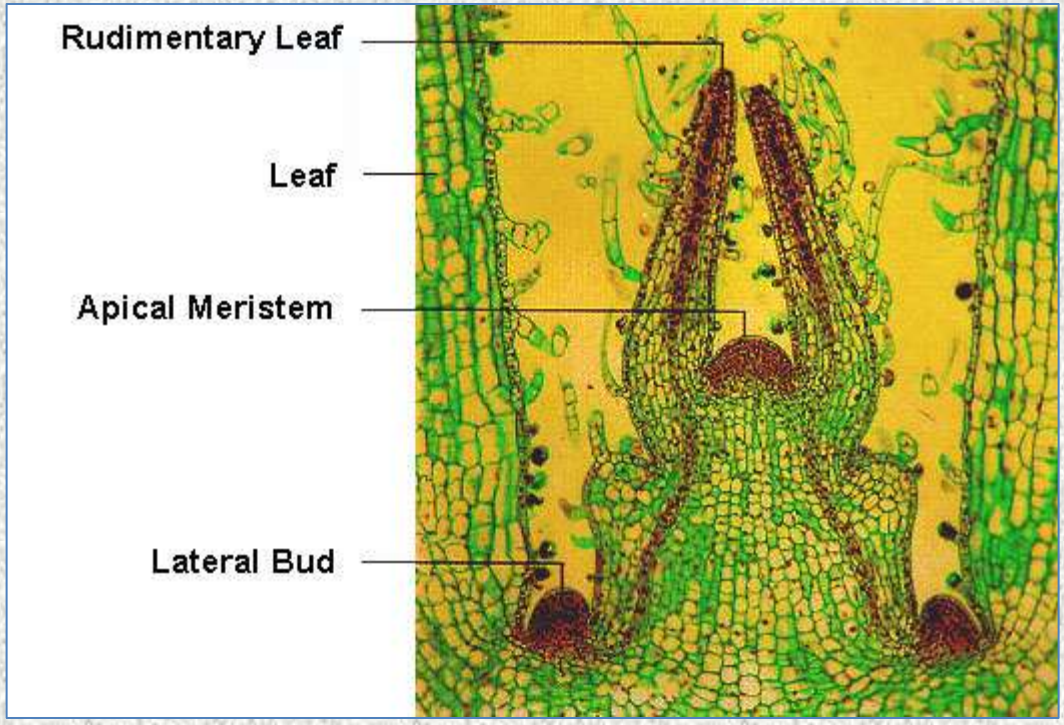


Primary Growth – Apical growth from meristems at the tips

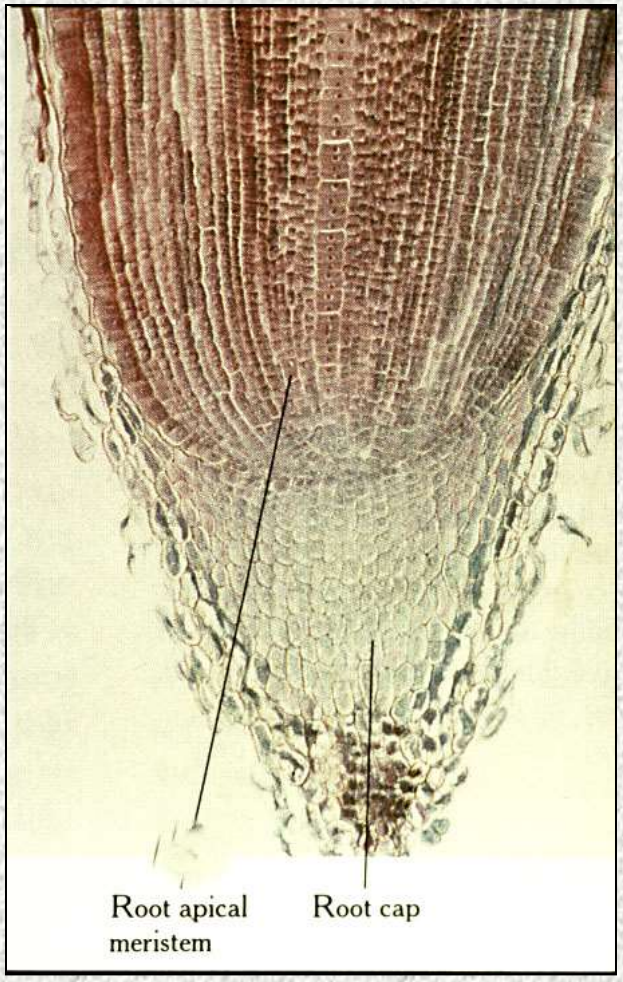
Secondary Growth – Lateral growth in width from vascular cambium meristem

1. Meristems - centers of cell division that produce new tissue of the plant body. Meristem cells divide, derivatives differentiate into other types of cells.

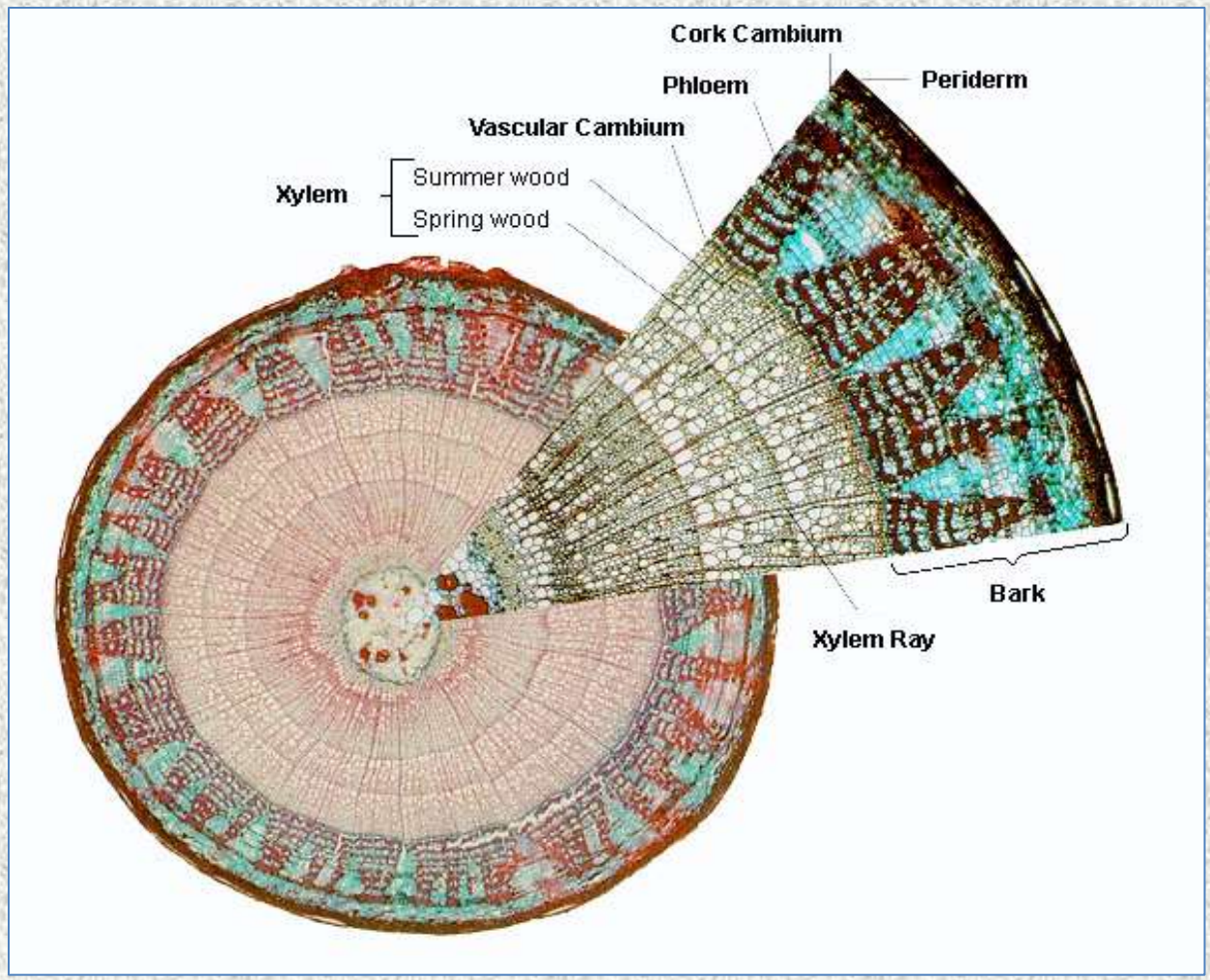
Stem Apex



Root Apex



Secondary growth - lateral growth in width
Vascular cambium



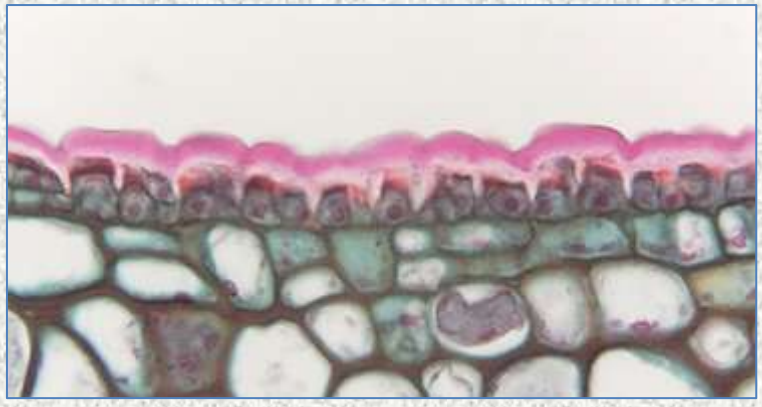
2. Dermal Tissue – outermost layers of the plant

Cuticle – waxy outer layer

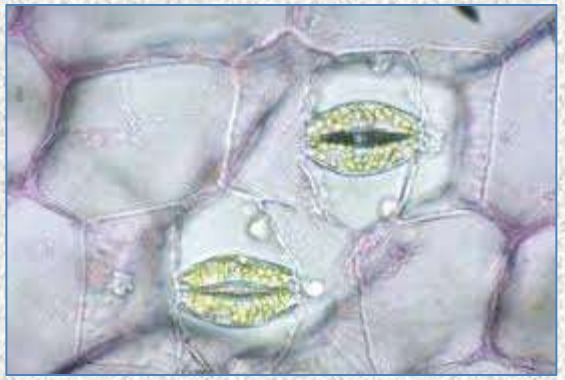
Epidermis – outer cell layer

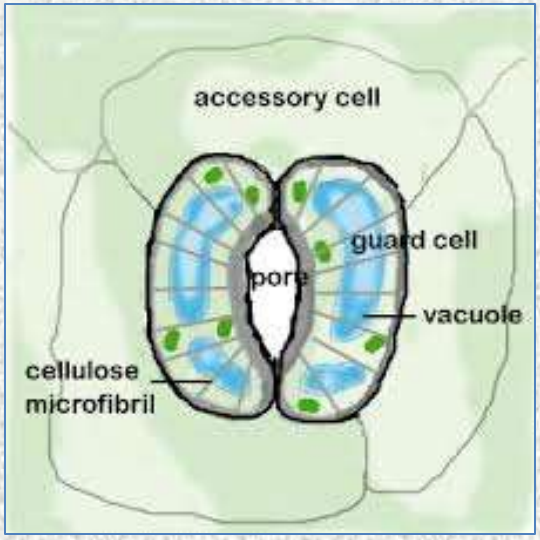
Trichomes (Hairs) and Glands

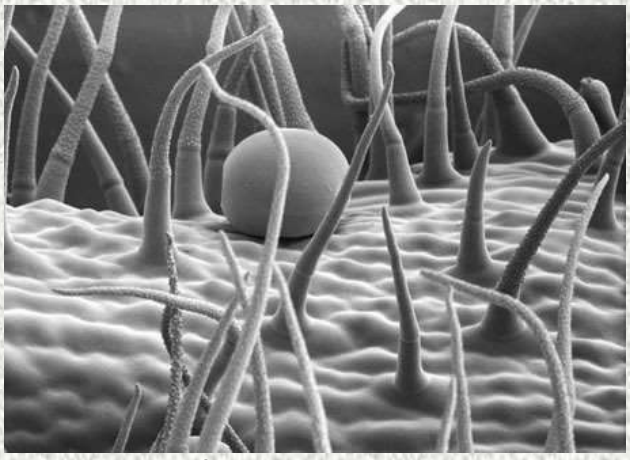
Stomata – allow air passage, open and close, how plants breathe



Cuticle



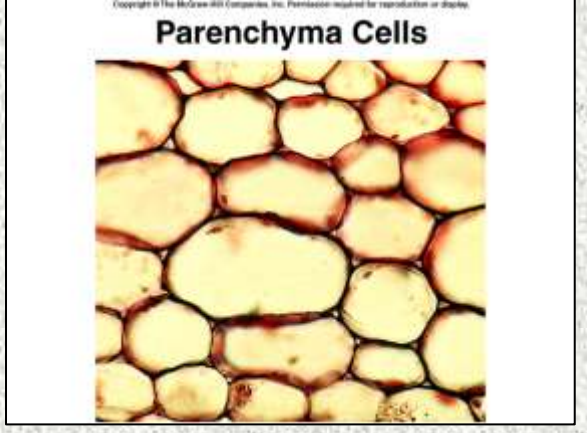




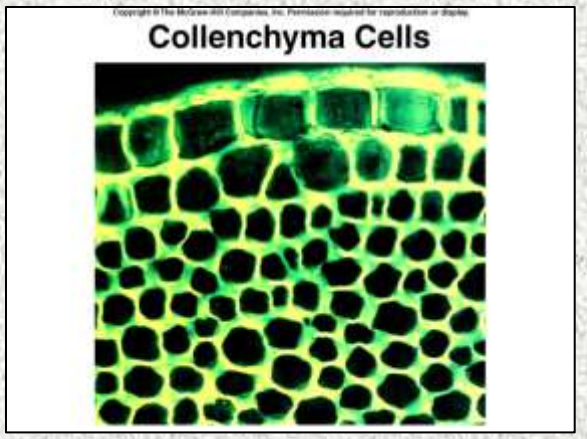
Trichomes

3. Ground Tissue – bulk of the plant, filler, storage functions

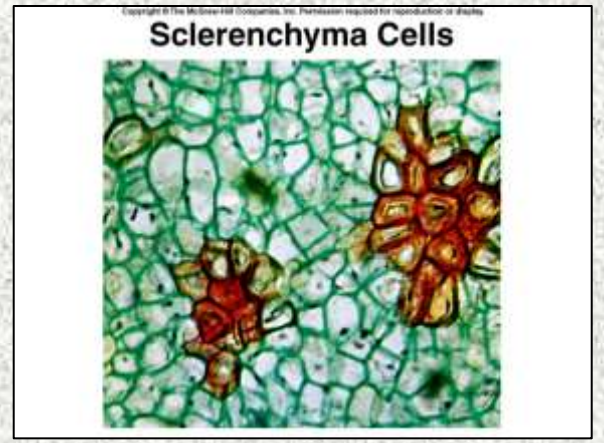
- Parenchyma – thin walled storage cells



- Collenchyma – flexible cells, in leaf petioles, bendable

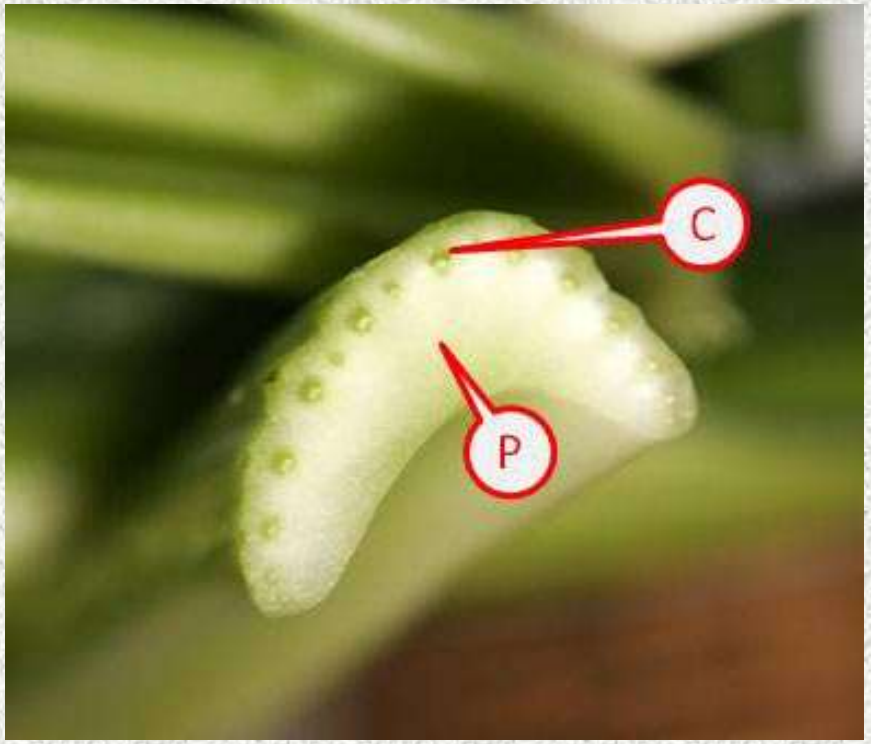


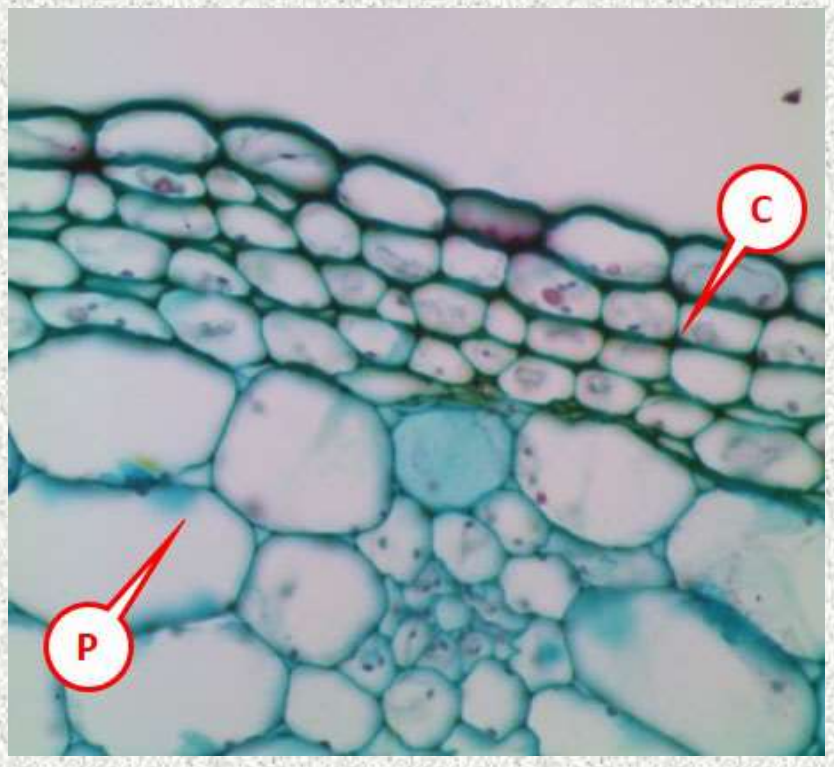
- Sclerenchyma – toughened with <u>lignin</u>, hard, strong



Parenchyma cells are large and only have thin primary cell walls. Notice the space between cells at the corners.

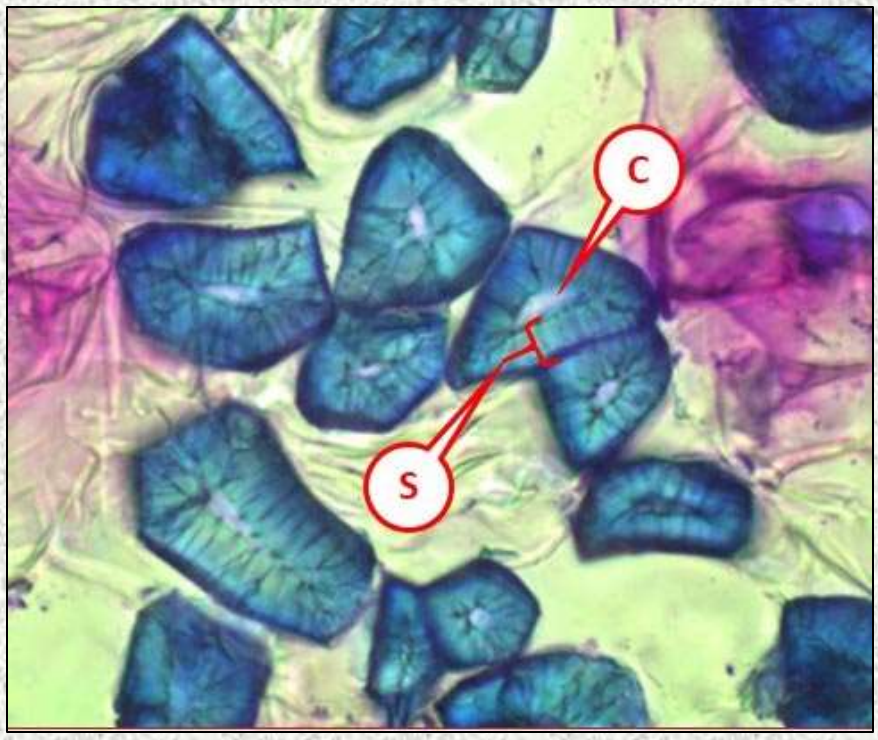
Collenchyma cells are involved in support, hick primary cell walls. These are the "strings" inside of celery

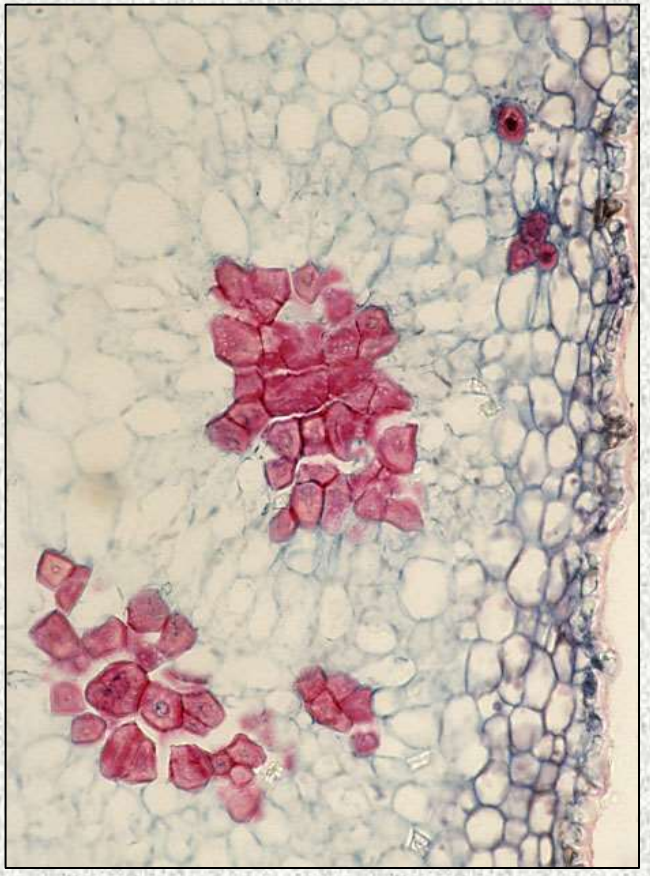




Sclerenchyma – thick secondary wall strengthened with lignin, non-living at maturity

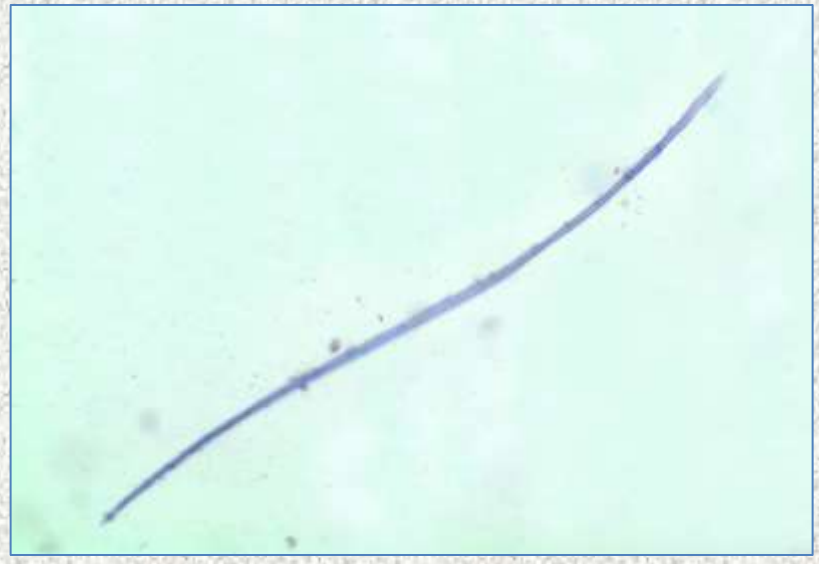
Sclereids – short compact fibers. Stone cells from a pear, the grit that we feel when we eat a fresh pear. This cell is now dead. 'C' is where the living cell was. 'S' is showing secondary cell wall.



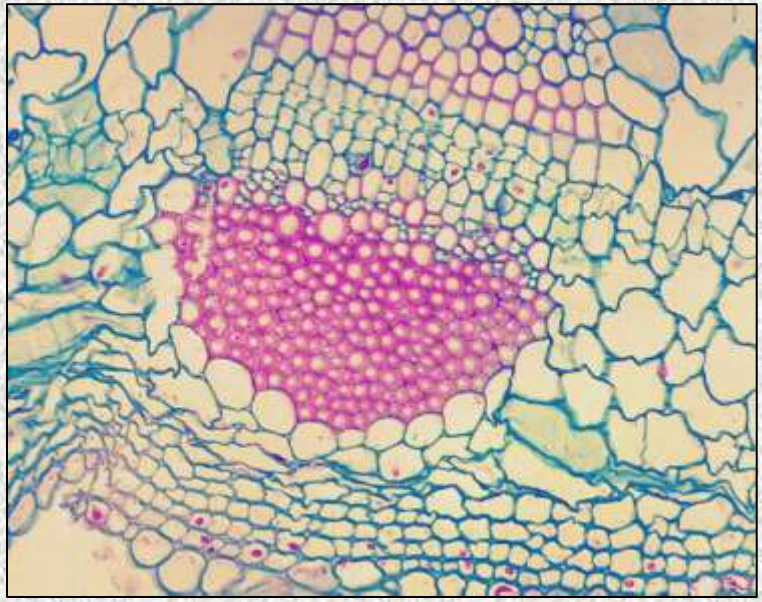


Sclerenchyma – secondary wall strengthened with lignin

Fibers - long and skinny sclerenchyma cells, tough, thick walls, dead at maturity, often grouped in bundles.



Fiber from a papyrus plant. These fibers allowed the Egyptians to make ropes, boats and paper from the papyrus plant.



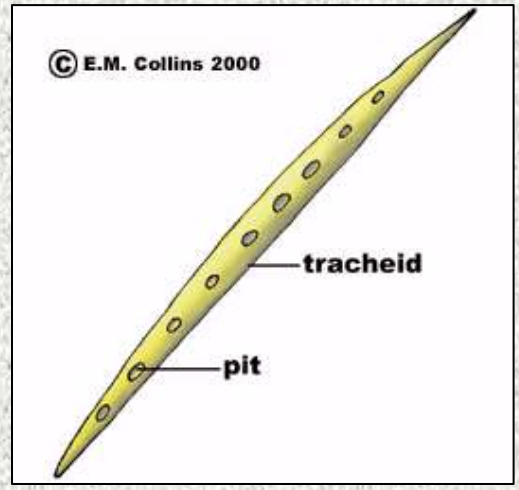
Fibers in a vascular bundle of *Helianthus* (sunflower). Not thick walls, and bright red stain. This is a cross-section.

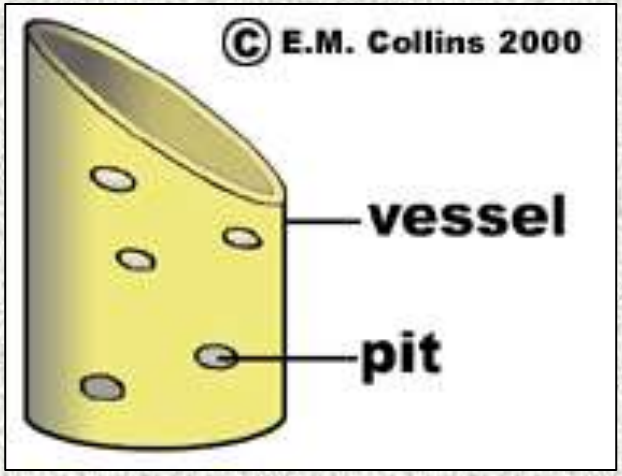
4. Vascular Tissue - conducting tissues in plants

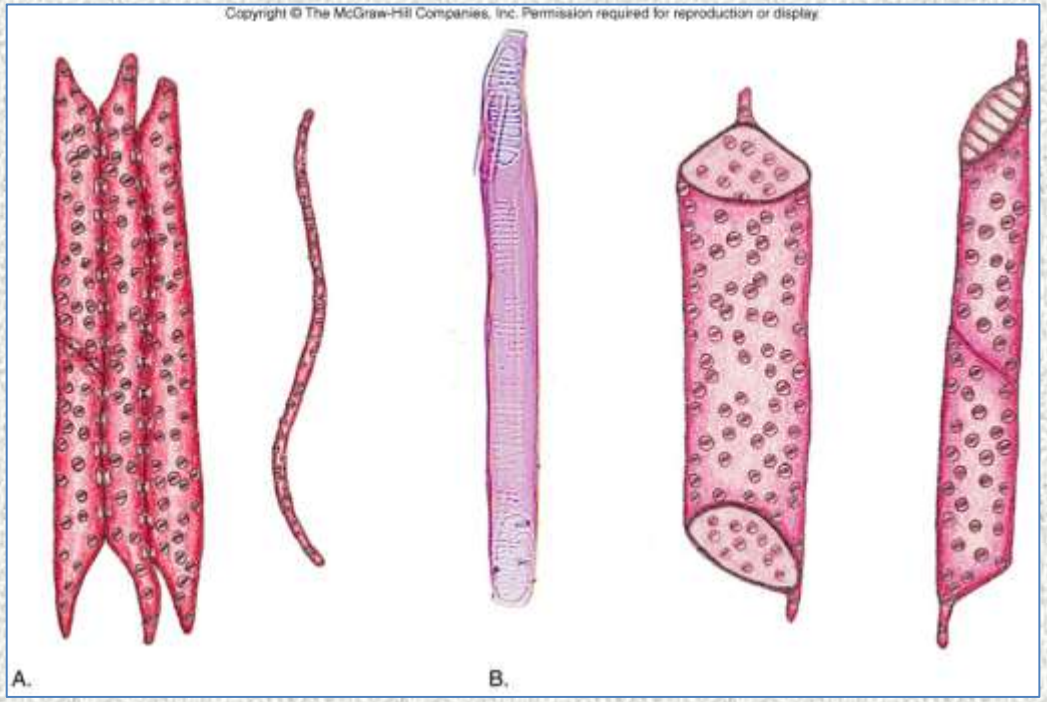
- **Xylem** – conduct water and minerals from soil throughout the plant. Wall strengthened with lignin.
  -Tracheids – long, tapered ends, pits in end walls
  -Vessel Elements – large, perforation plates in end walls
- **Phloem** – conduct sugar produced by photosynthesis in leaves throughout the plant.
  Sieve elements (tubes and companion cells)

Are to plants what veins and arteries are to animals

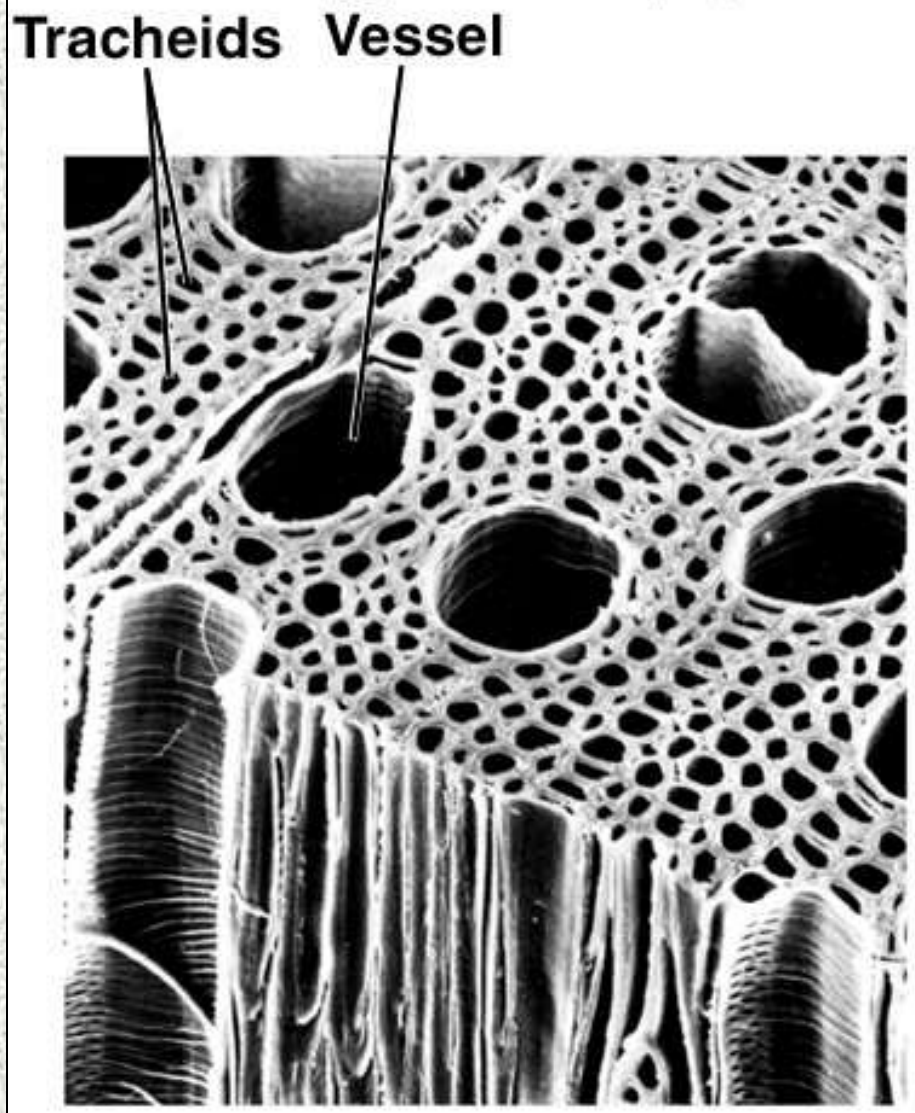
Xylem – Tracheids and Vessels conduct water







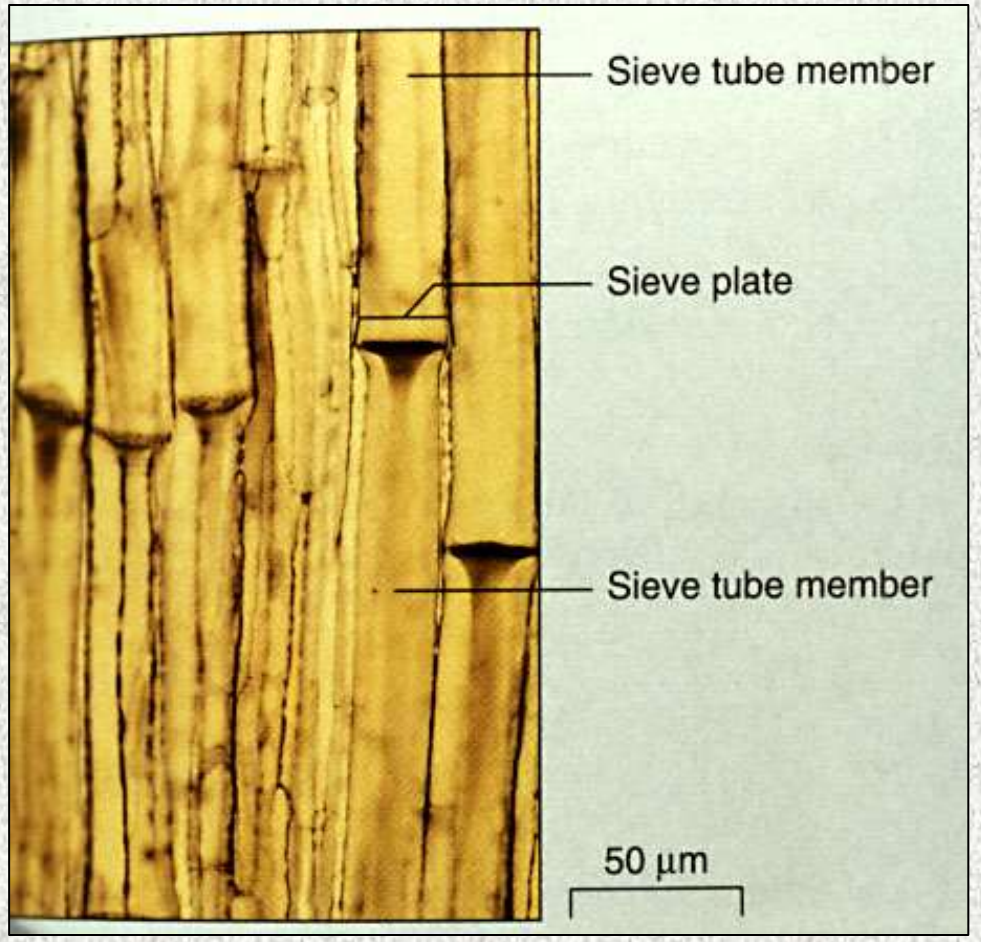
Vessels and Tracheids in Wood

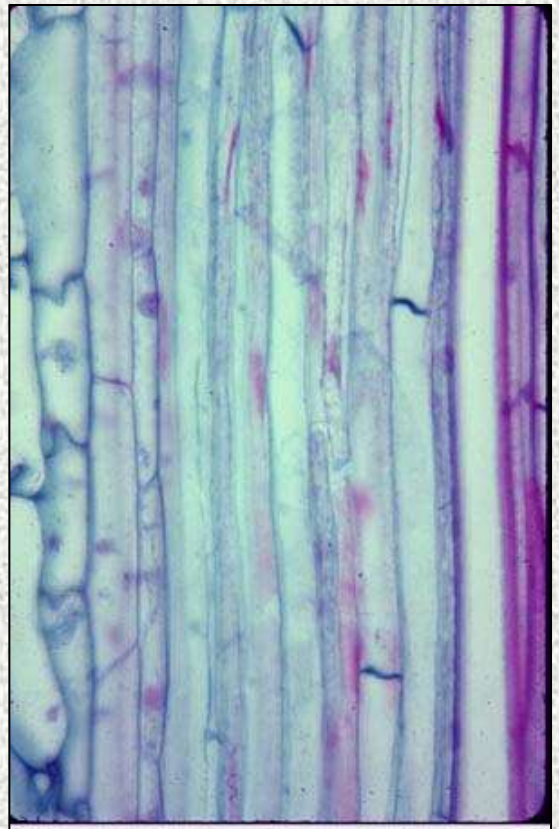


Wood of Red Maple

Phloem

conduct sugars up and down

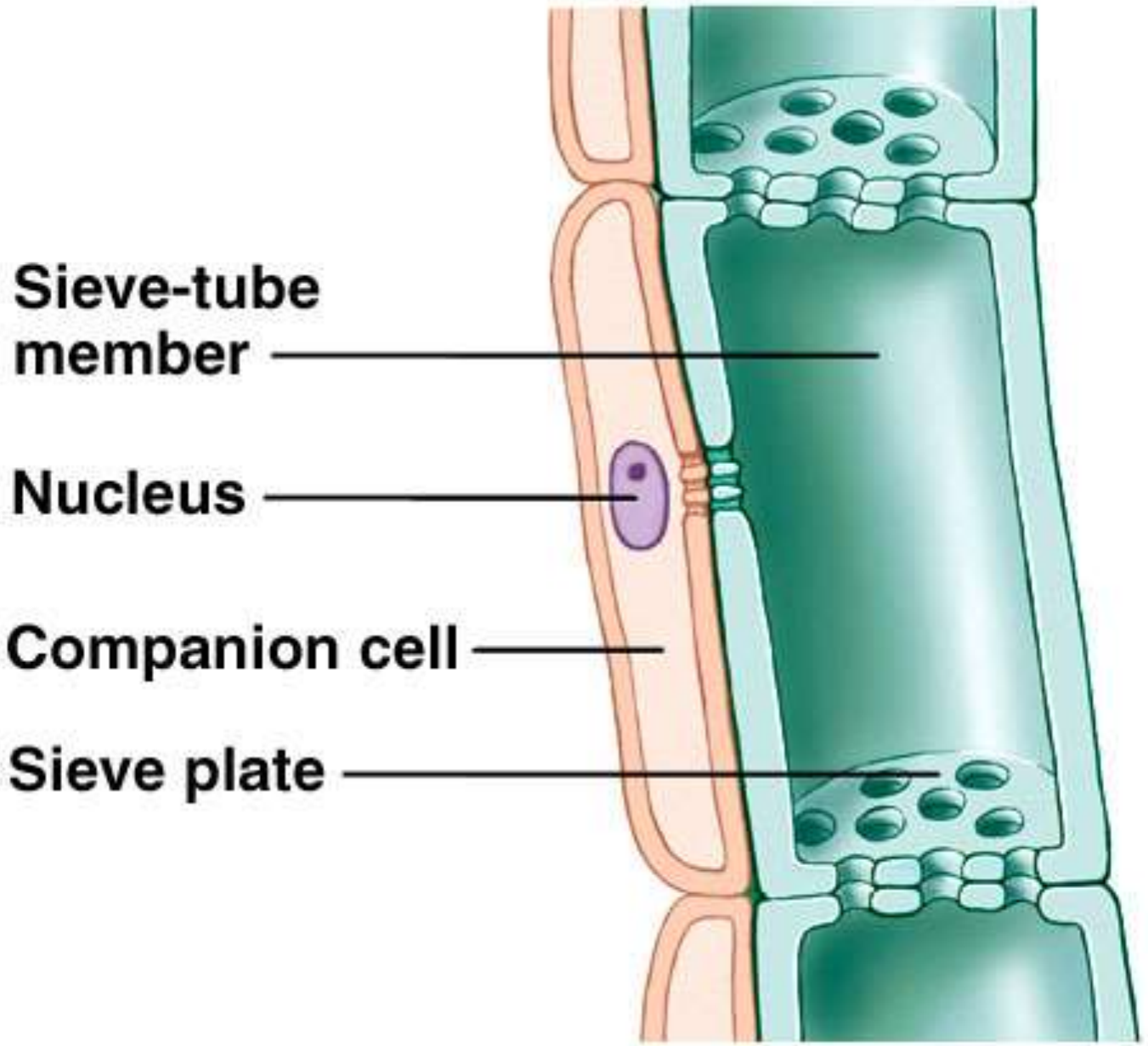




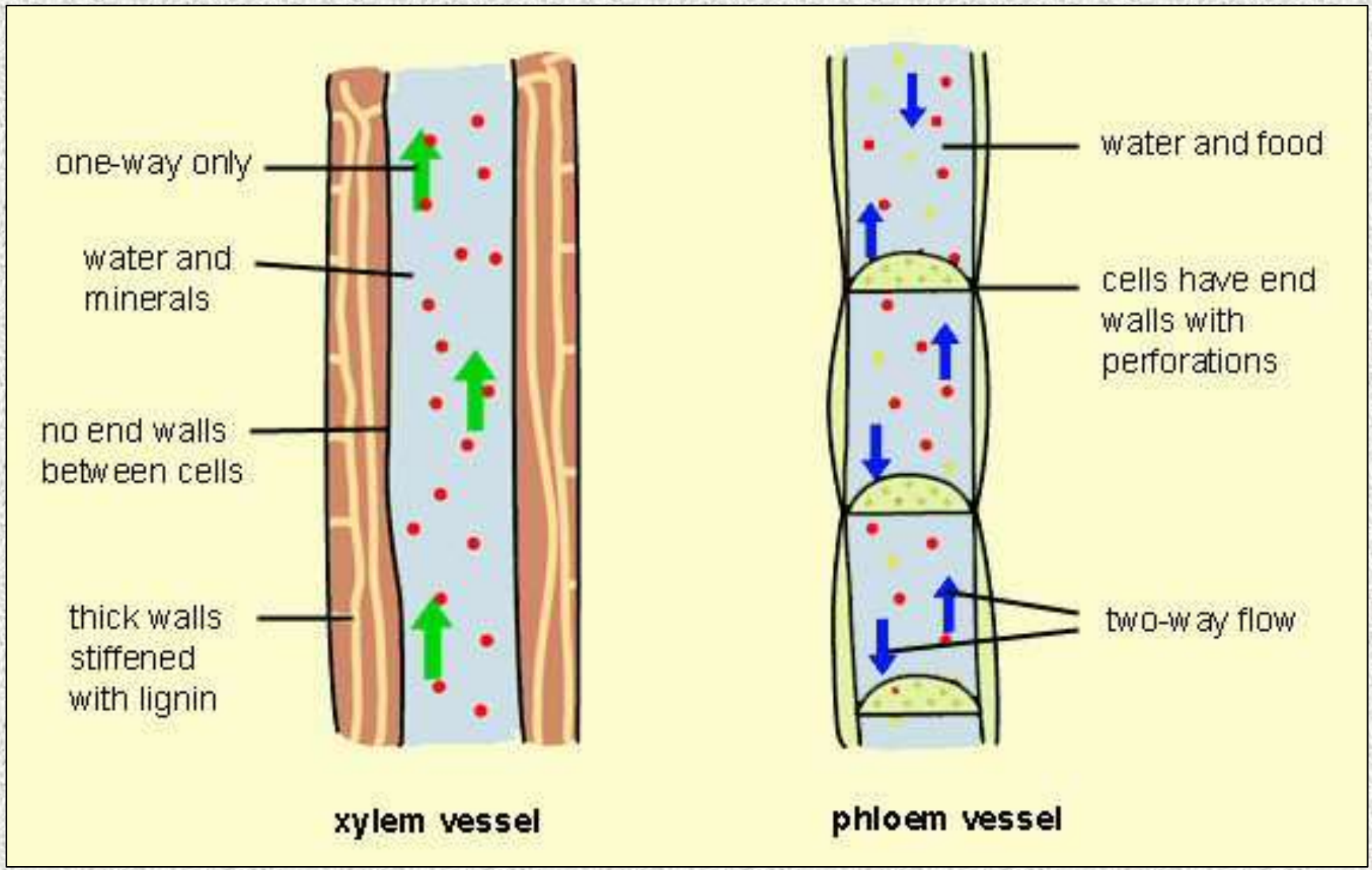
Zea stem longisection with sieve tube members, companion cells and sieve plates.

Fig. 38.14b

Sieve-Tube Member



Xylem and Phloem



Xylem and Phloem in a Vascular Bundle

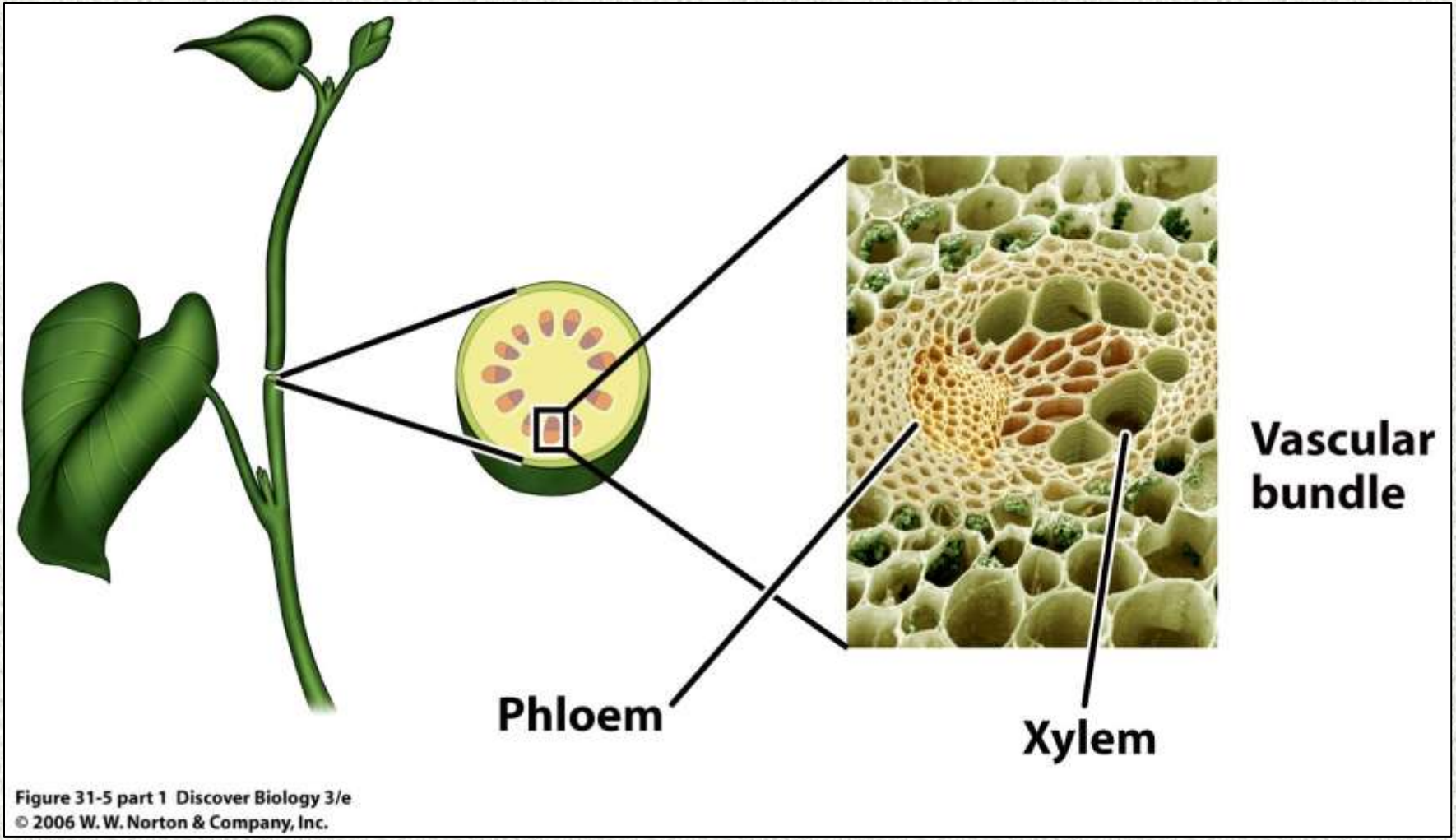
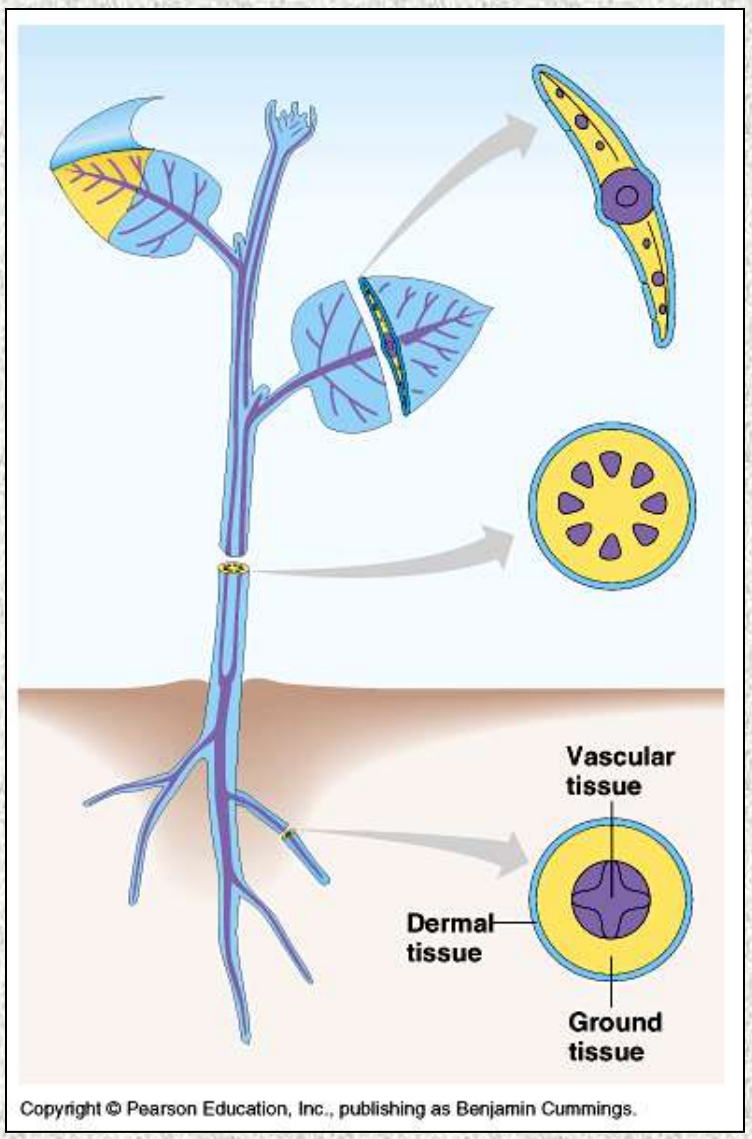


Figure 31-5 part 1 Discover Biology 3/e

Vegetative Organs

- Roots
- Stems
- Leaves

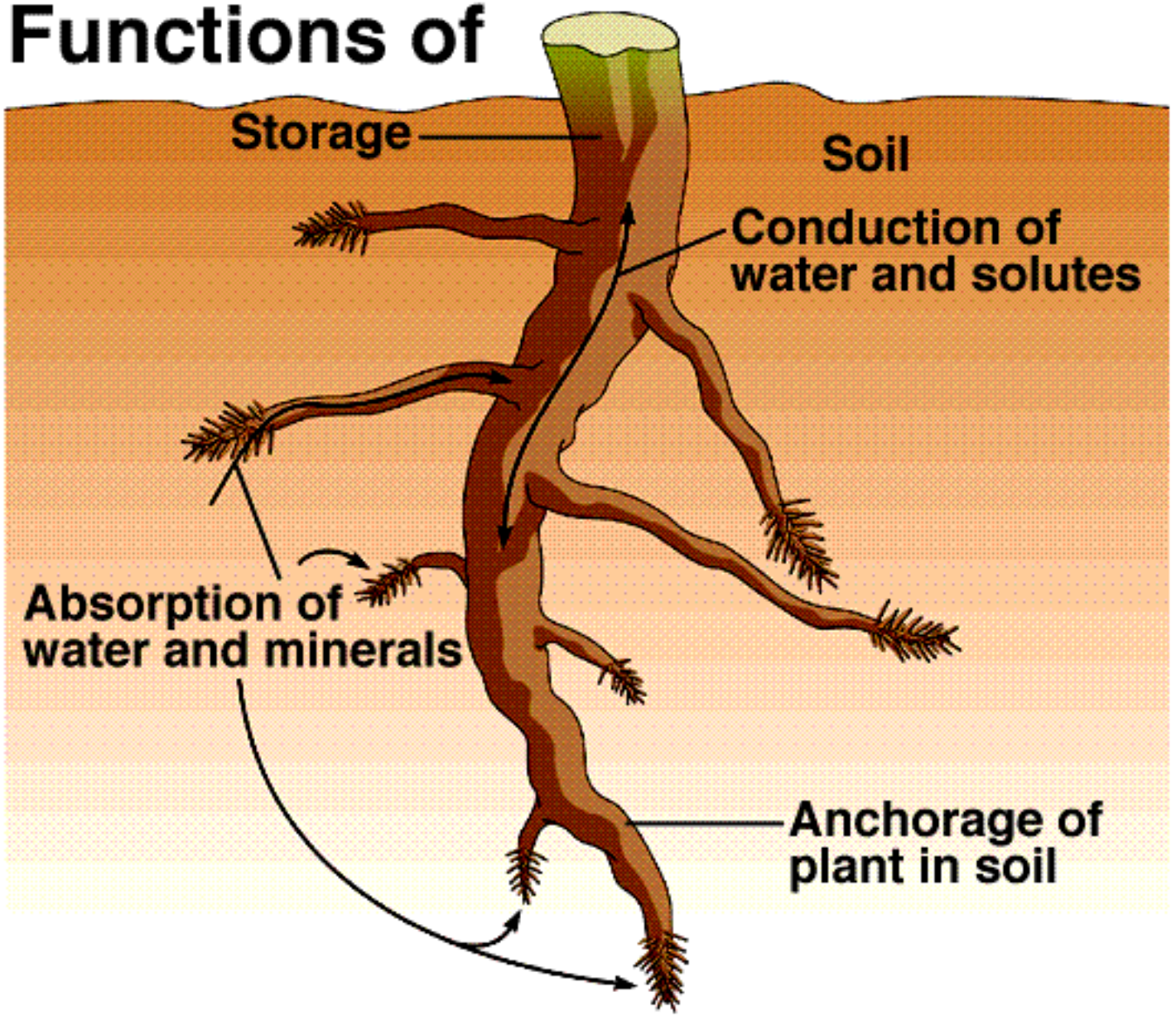


Roots

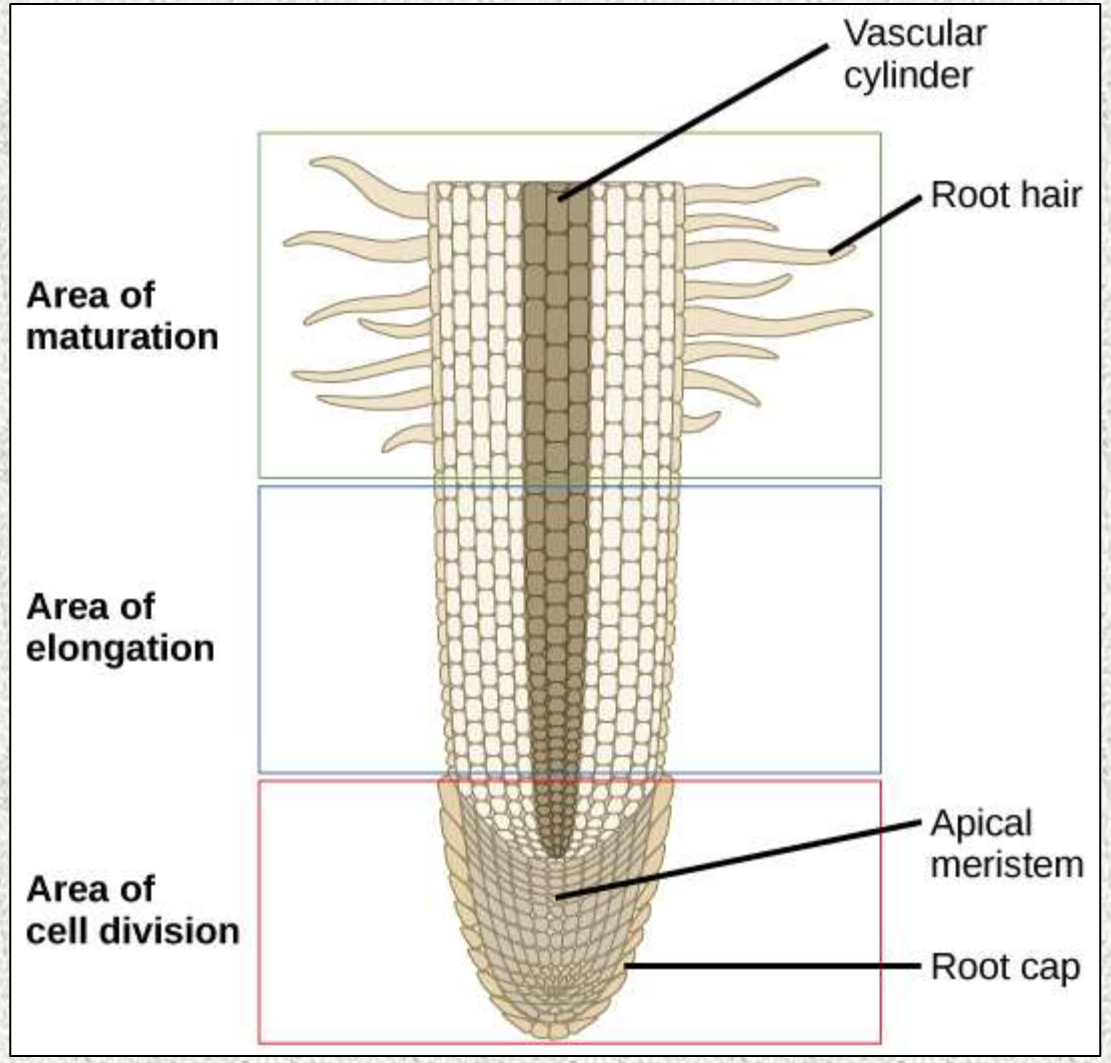
Taproot - dicots

Fibrous Roots - monocots

Major Functions of Roots

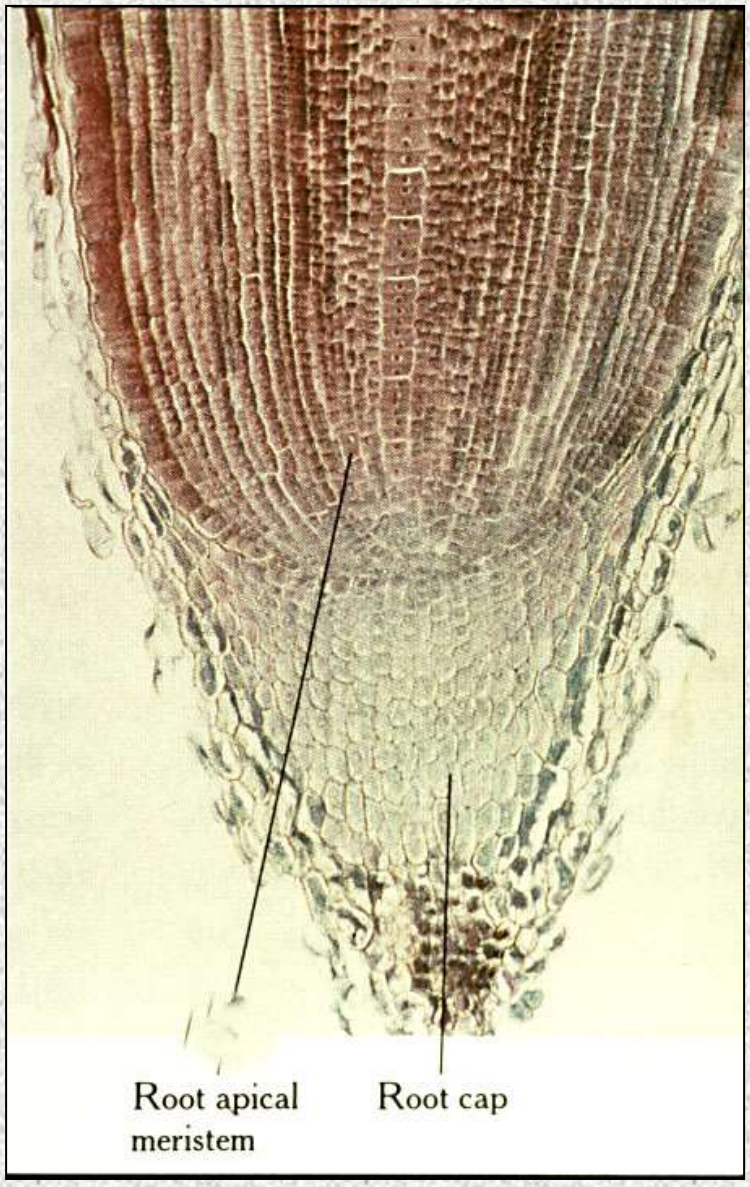


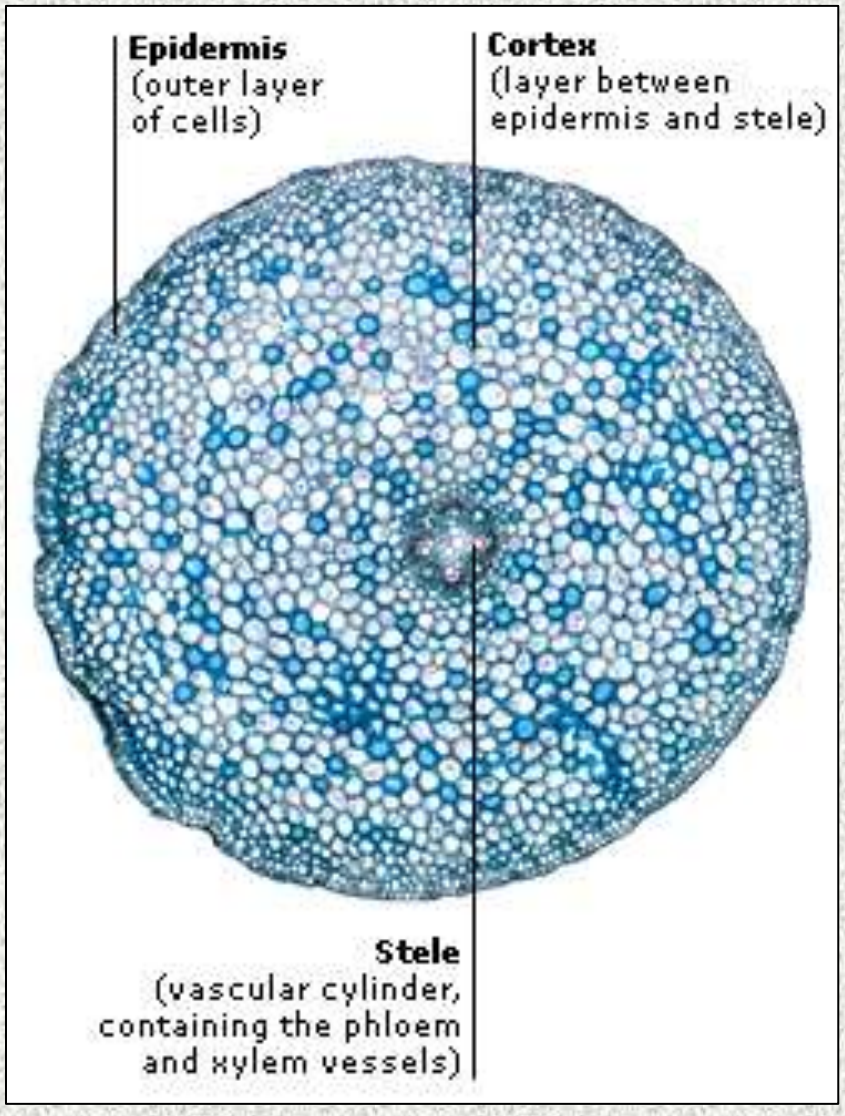
Root Structure



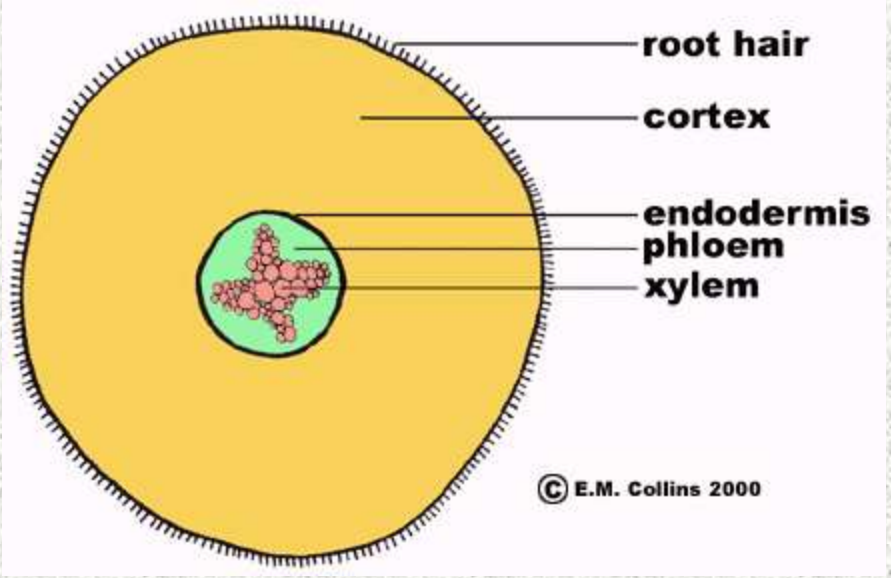
Root Hairs

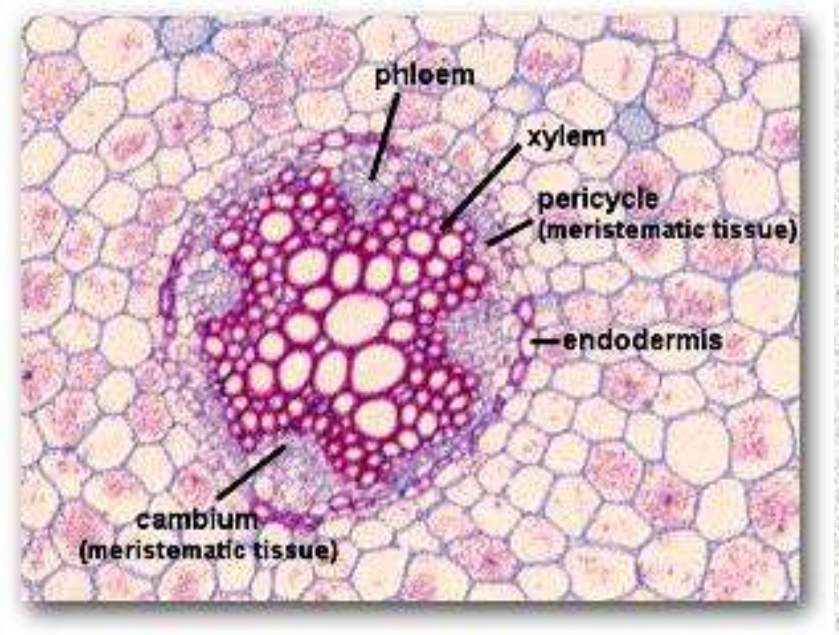
Root Anatomy

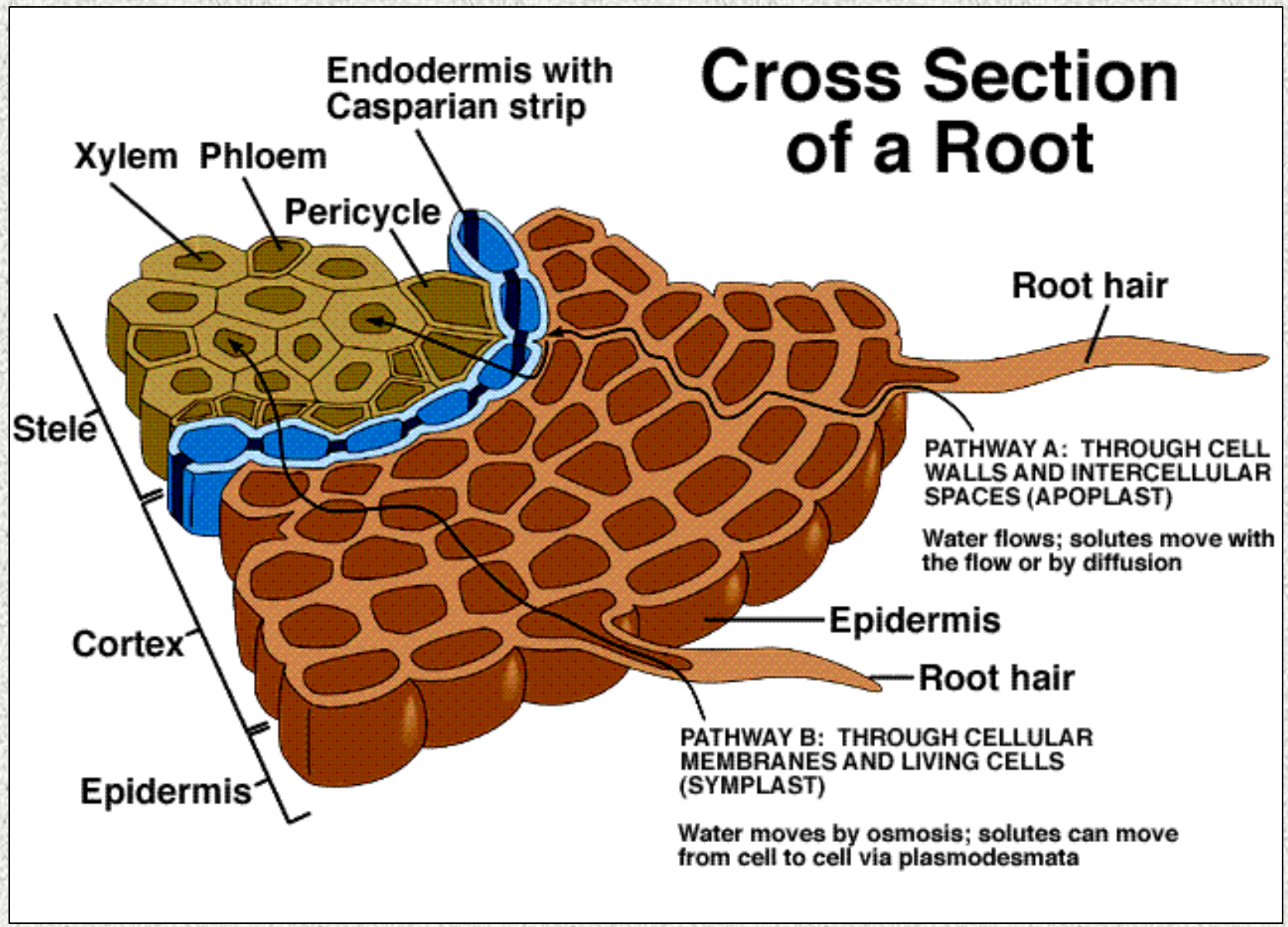




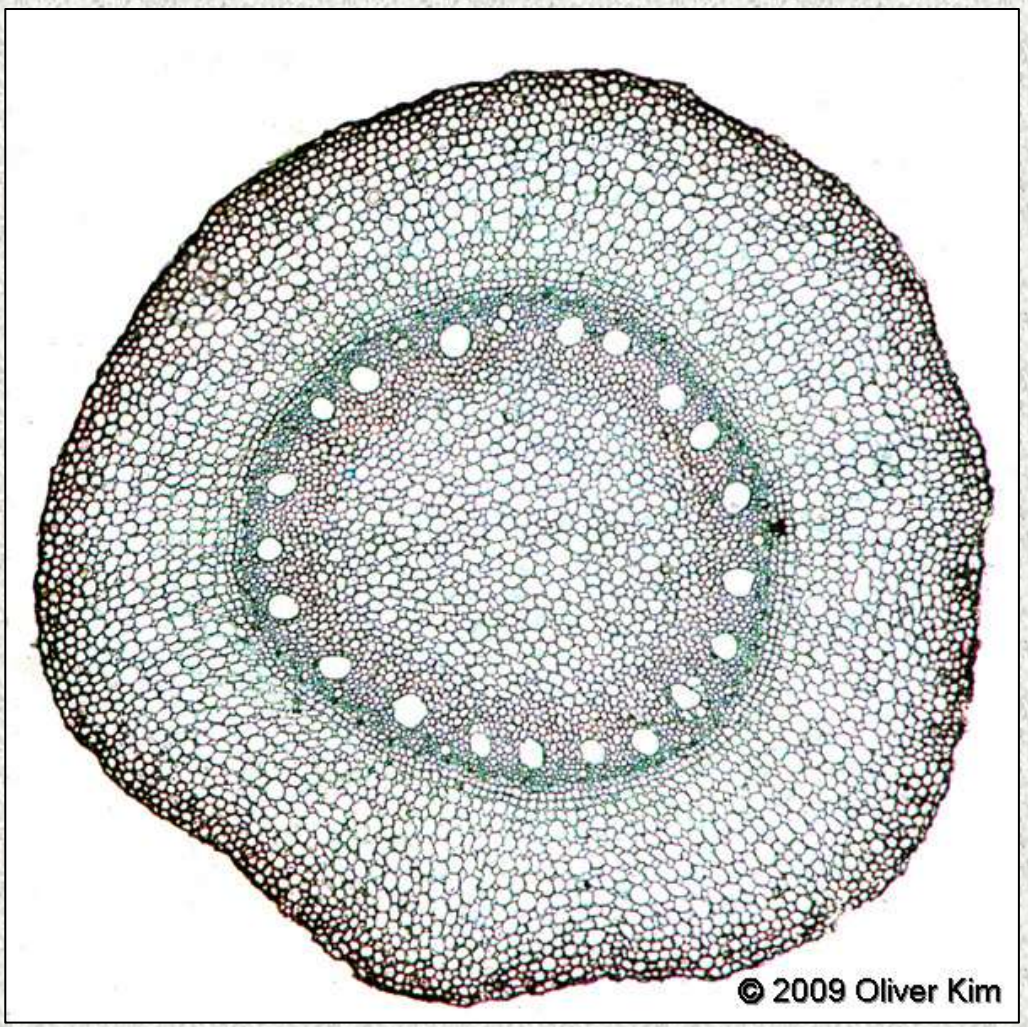
- Tissues of a eudicot root:
  - **Epidermis –** Outer layer of root
  - **Cortex –** Composed of parenchyma cells, allowing water and minerals movement
  - **Endodermis –** Forms a boundary between cortex and inner vascular cylinder
    - **Casparian strip**
  - **Vascular Tissue –** Contains xylem and phloem
    - **Pericycle –** Mitotically active and is the starting point for development of branch or lateral roots





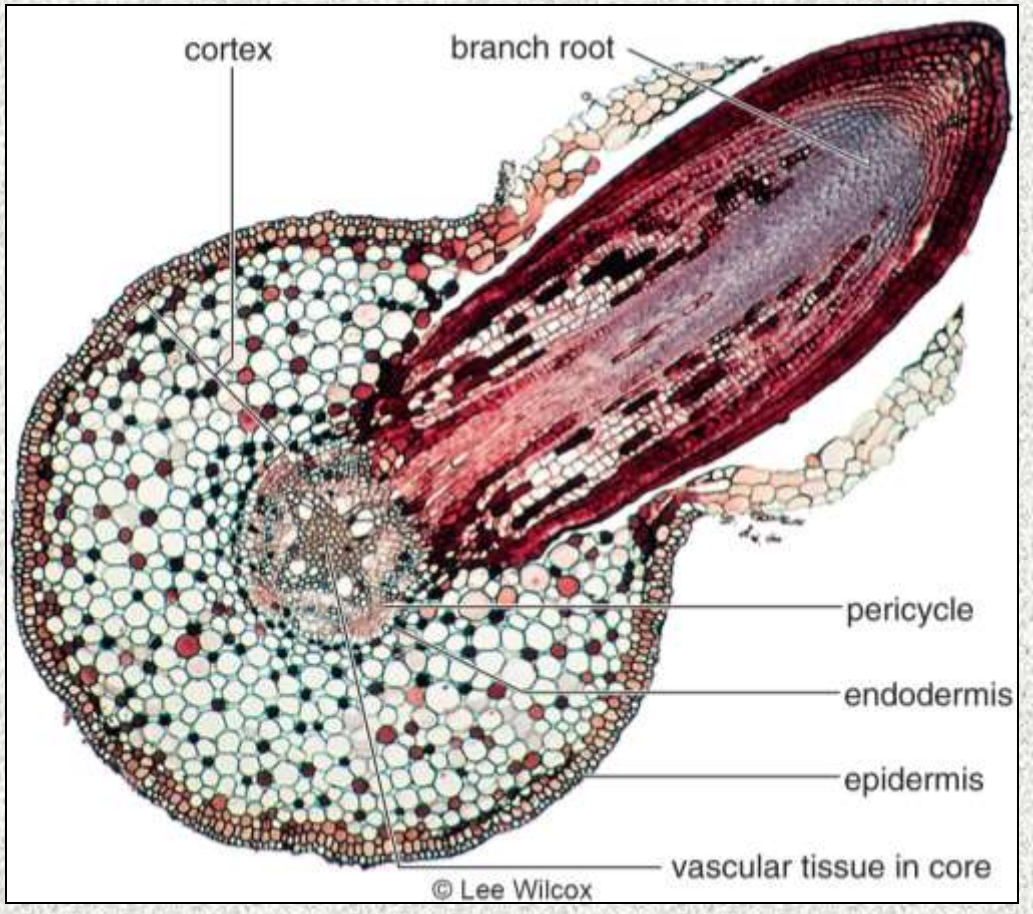

Cross Section of a Root
Endodermis with Casparian strip
Xylem
Phloem
Pericycle
Root hair
Stele
PATHWAY A: THROUGH CELL WALLS AND INTERCELLULAR SPACES (APOPLAST)
Water flows; solutes move with the flow or by diffusion
Epidermis
Cortex
Root hair
Epidermis
PATHWAY B: THROUGH CELLULAR MEMBRANES AND LIVING CELLS (SYMPLAST)
Water moves by osmosis; solutes can move from cell to cell via plasmodesmata

- Monocot roots:
  - Ground tissue of root's **pith** is surrounded by vascular ring.
  - Do not undergo secondary growth.
  - They have pericycle, endodermis, cortex, and epidermis.



Branching of Eudicot Root

New branch root originates from an inner layer, the pericycle



Root Crops

Radish

Carrots

Beets

Root Specializations

Food Storage

sweet potato

Prop roots

corn

Breathing, pneumatophores

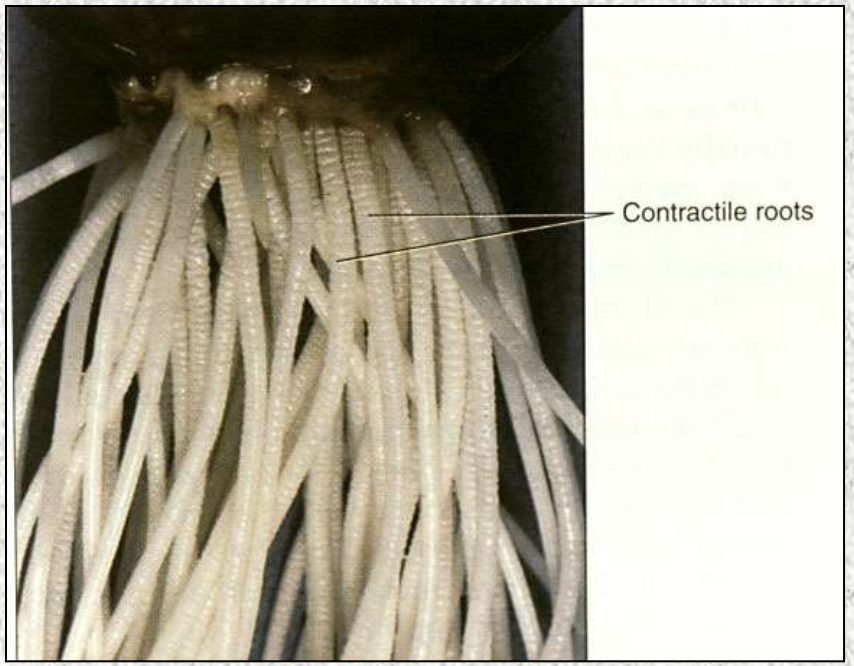
Bald cypress

Epiphytes on trees, climbing

Orchids

a: © Martin Harvey/Photodisc/Getty RF; b: © NokHoOkNoi/iStock/360/Getty RF; c: © FLPA/Mark Newman/agefotostock; d: © DEA/S Montanari/agefotostock

Root Specialization



Nodules
Rhizobium
N-fixarion

Climbing
Roots

Mycorrhizae

Vegetative Organs

- Roots
- Stems
- Leaves

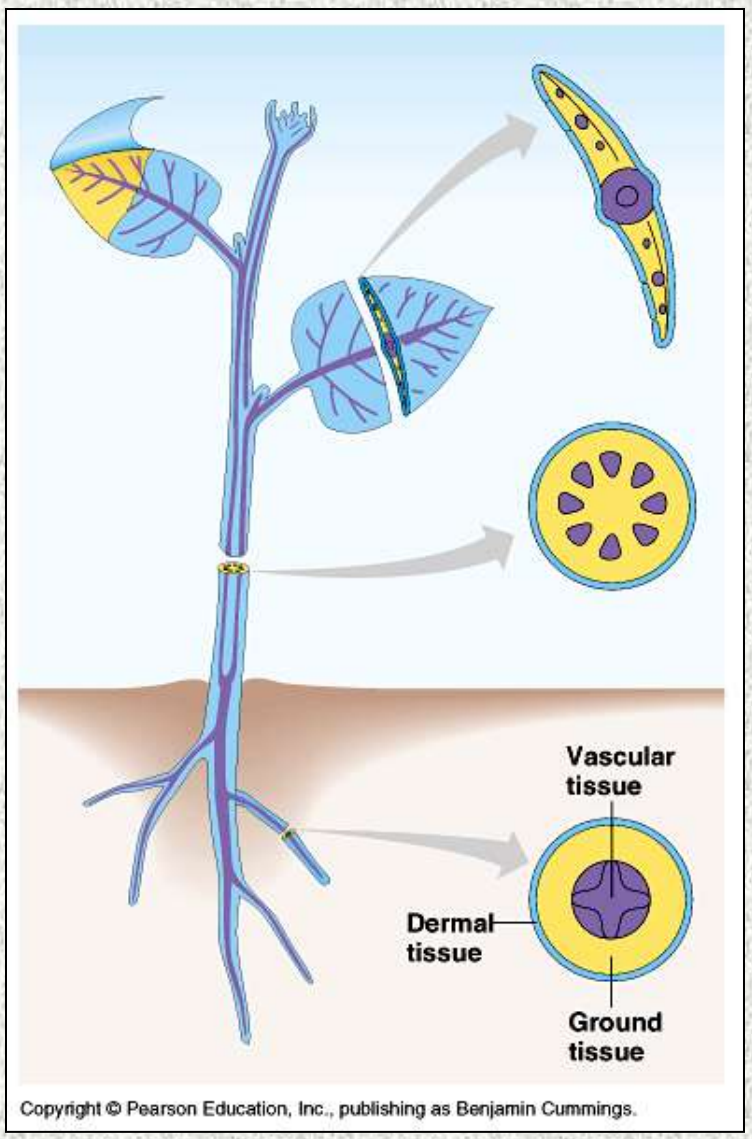
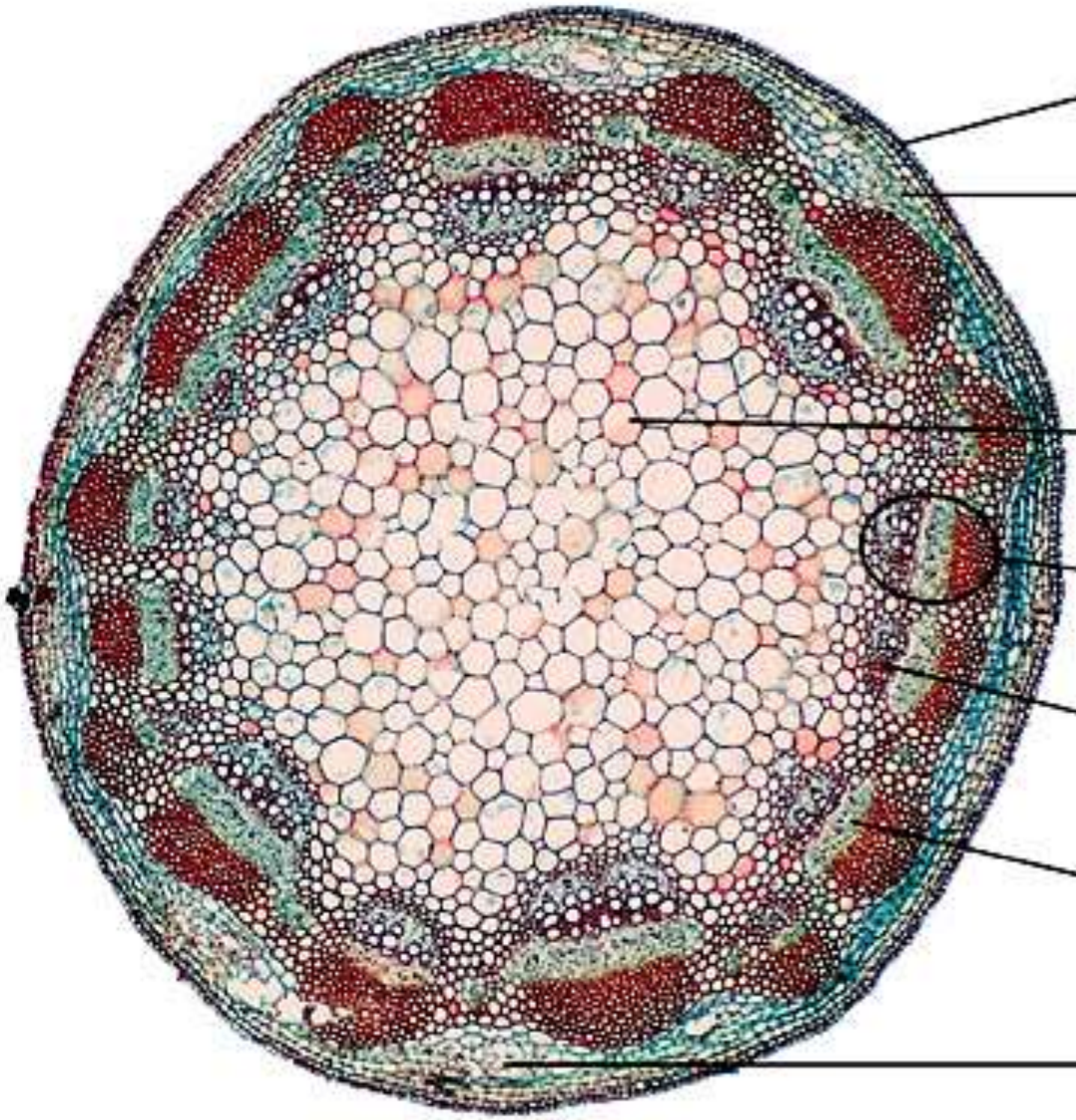


Fig. 38.25a

Dicot Stem



Epidermis (outer layer)

Collenchyma (layers below epidermis)

Pith

Vascular bundle

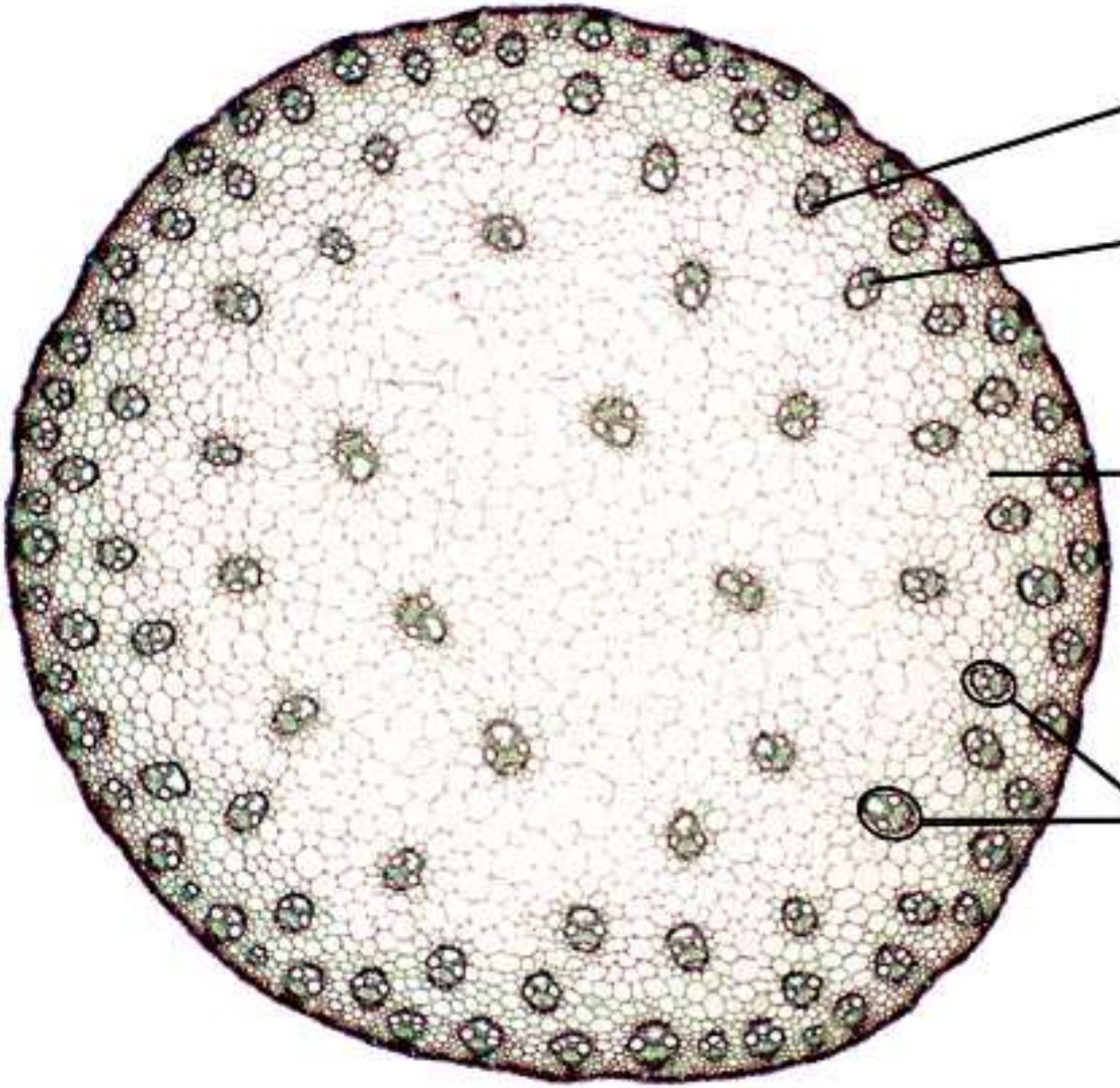
Xylem

Phloem

Cortex

Fig. 38.25b

Monocot Stem



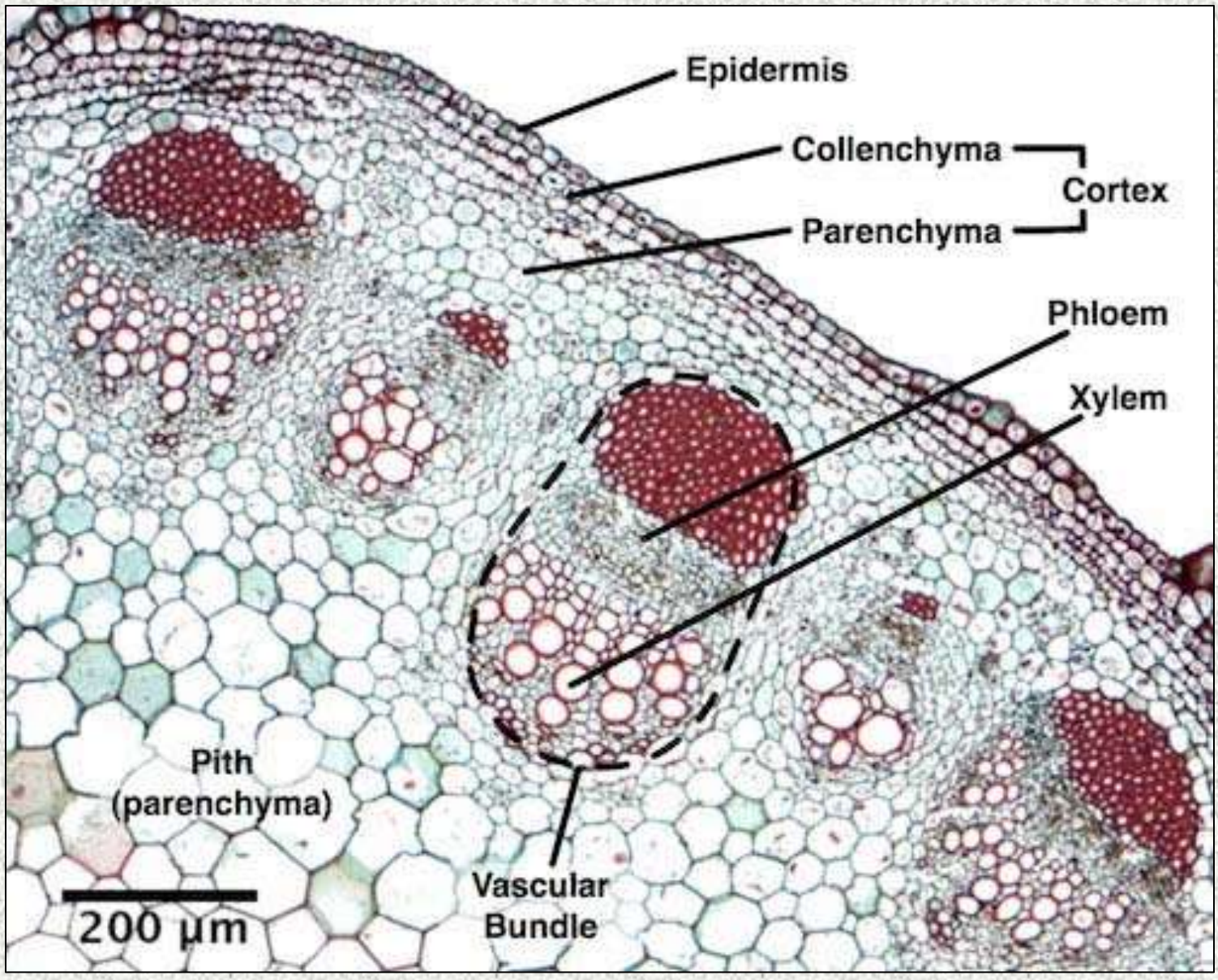
Xylem

Phloem

Ground tissue

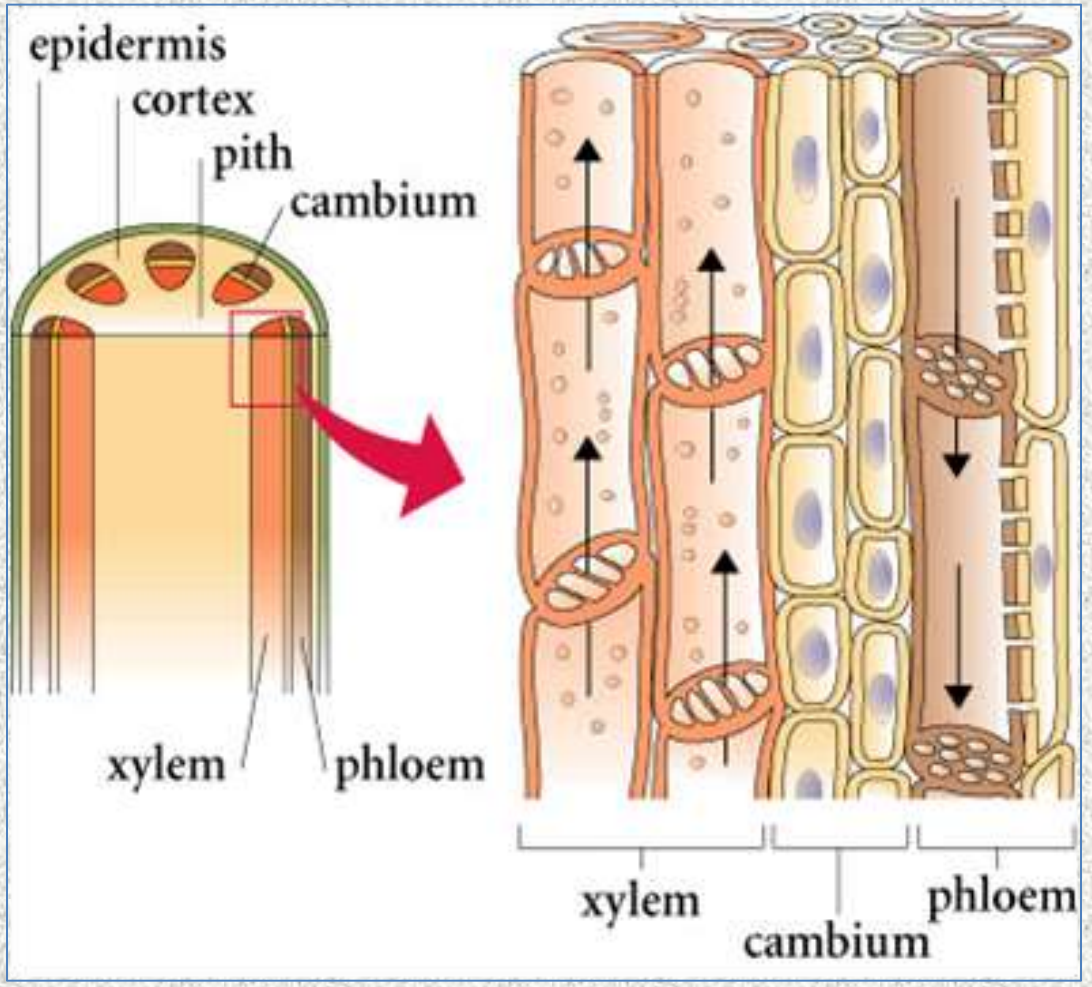
Vascular bundles

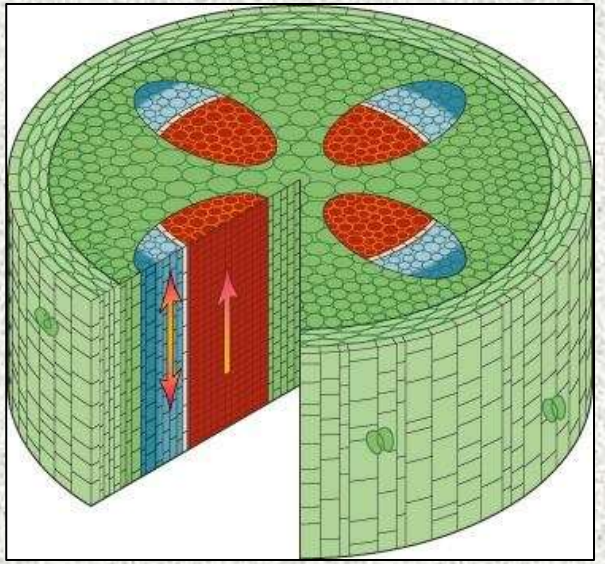
Vascular Bundle – xylem, phloem, fibers



Vascular Bundles

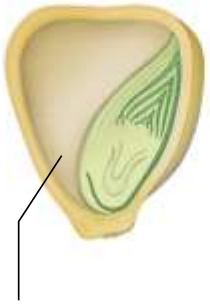
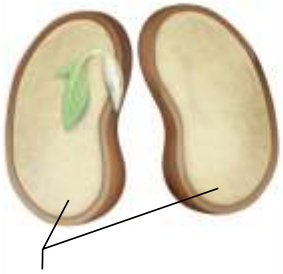
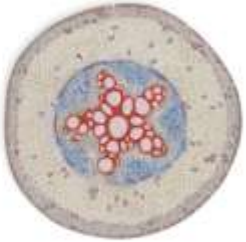
- Water and minerals transported up in xylem
- Sugars transported down to roots or to fruits in phloem



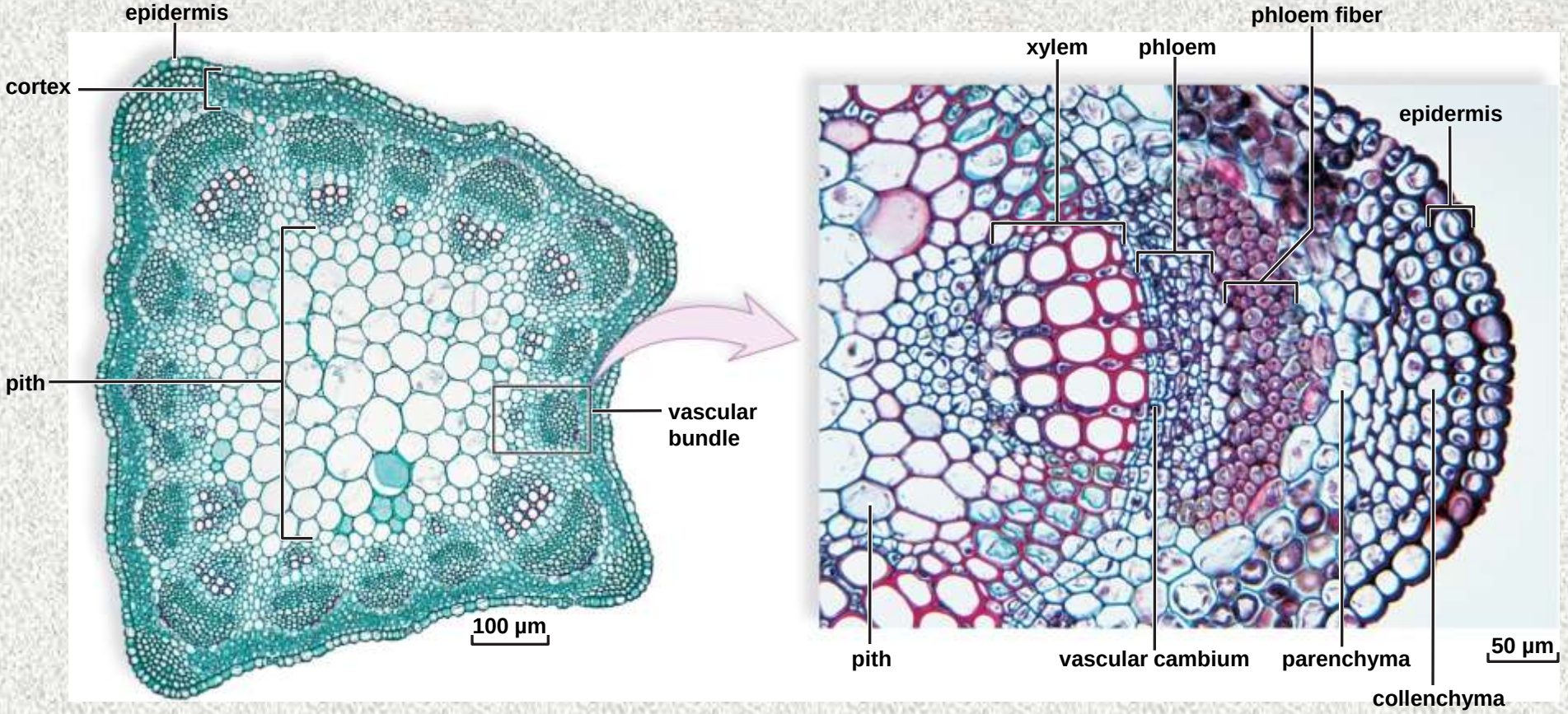


Monocots and Eudicots

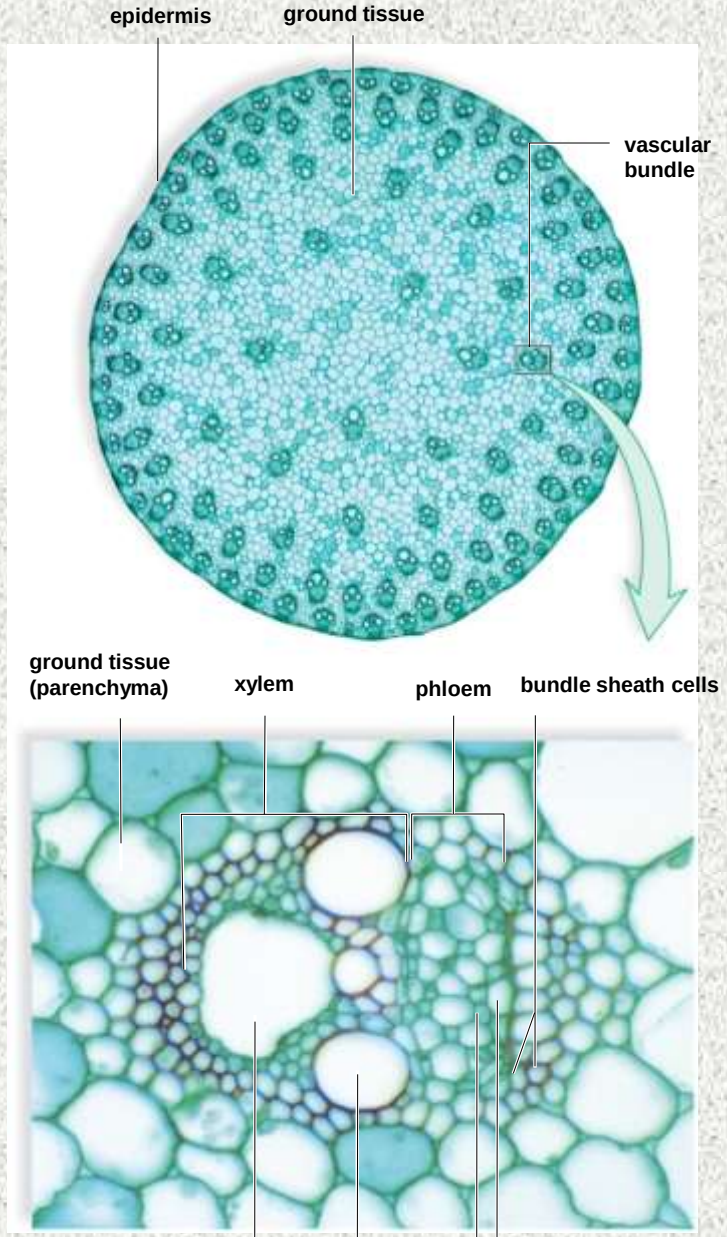
Arrangement of bundles in the stem

	Seed	Root	Stem	Leaf	Flower
Monocots	 One cotyledon in seed	 Root xylem and phloem in a ring	 Vascular bundles scattered in stem	 Leaf veins form a parallel pattern	 Flower parts in threes and multiples of three
Eudicots	 Two cotyledons in seed	 Root phloem between arms of xylem	 Vascular bundles in a distinct ring	 Leaf veins form a net pattern	 Flower parts in fours or fives and their multiples

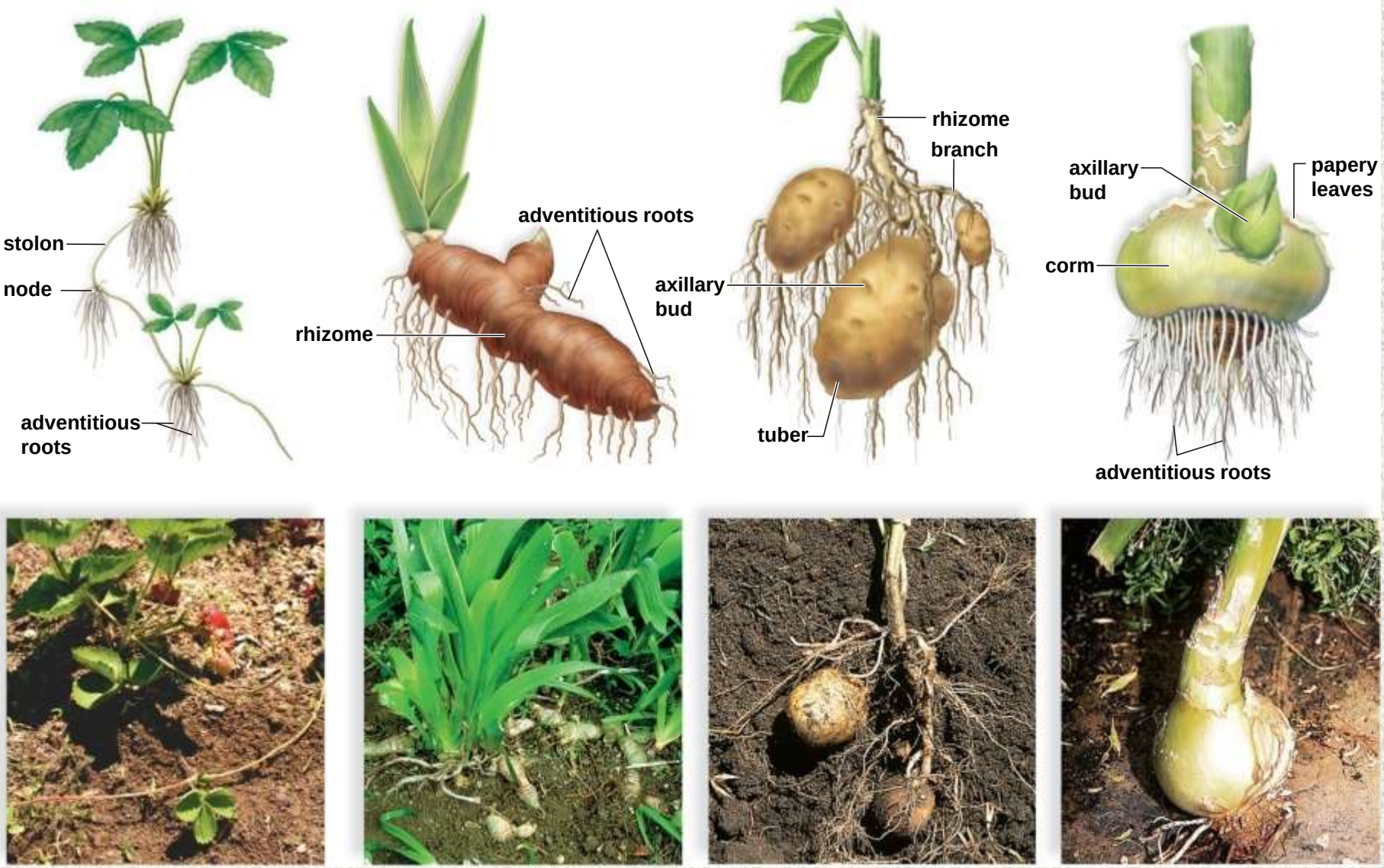
Herbaceous Eudicot Stem



Monocot Stem



Stem Modifications



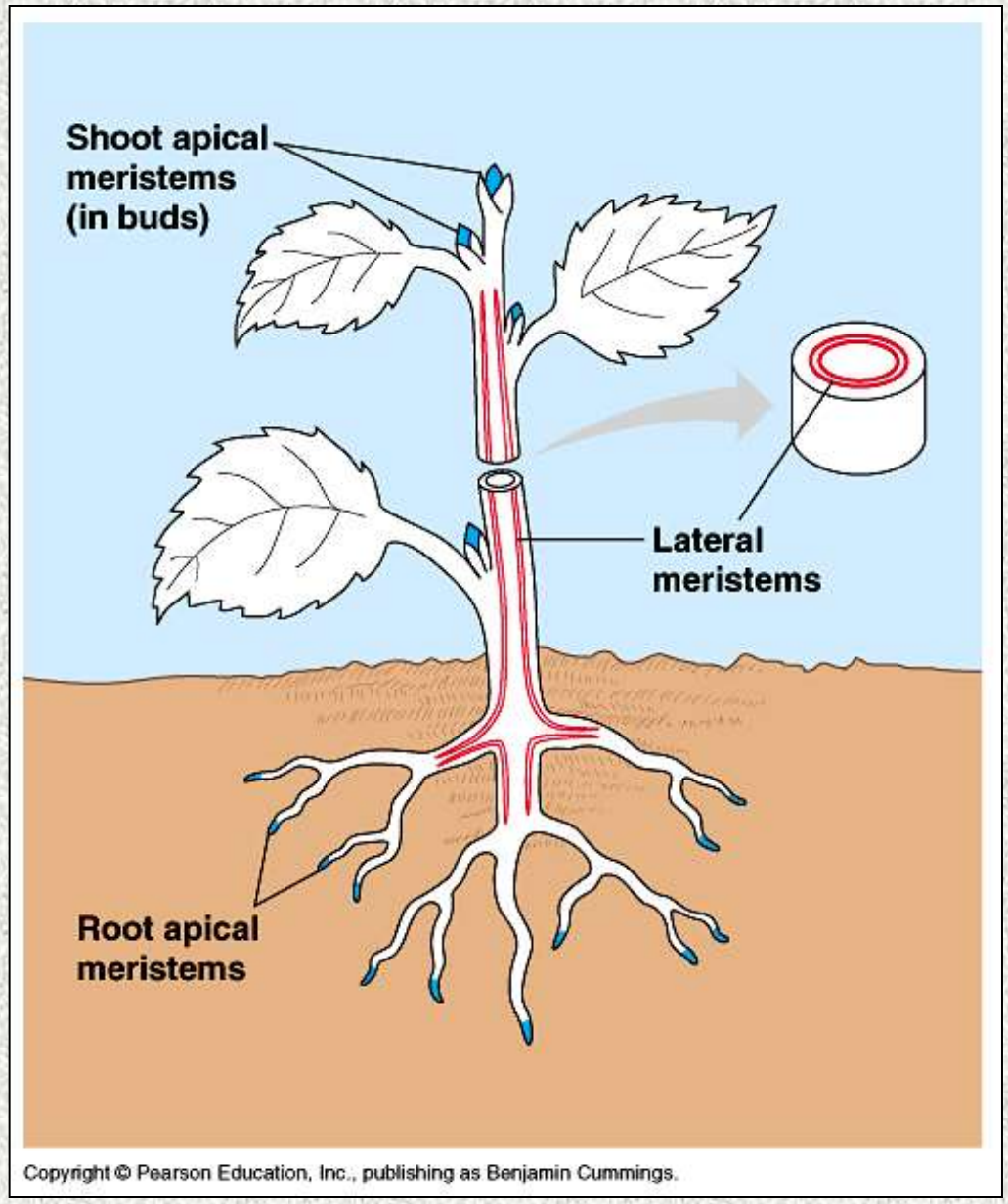
a. Stolon

b. Rhizome

c. Tuber

d. Corm

Growth in Stems – Primary and Secondary



Primary Growth – Apical growth from shoot meristems at the tips

Secondary Growth – Lateral growth in width from vascular cambium meristem

Stems: Secondary growth

- Vascular cambium – meristem for lateral growth
- Vascular tissue (xylem) makes up the bulk of the stem
- Form tree rings

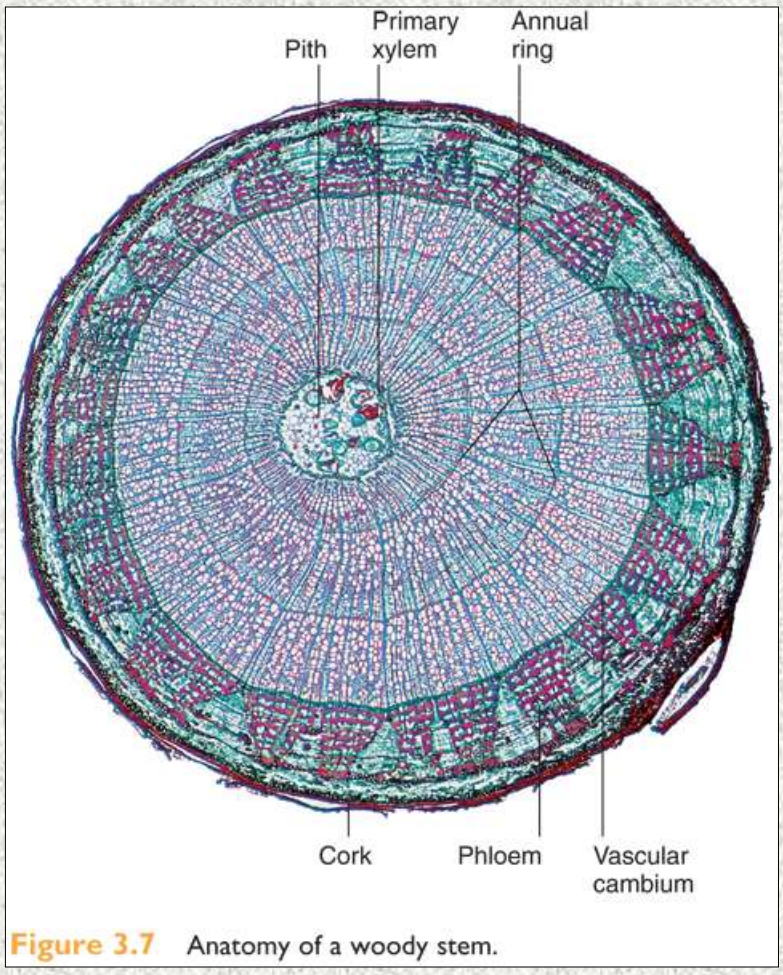
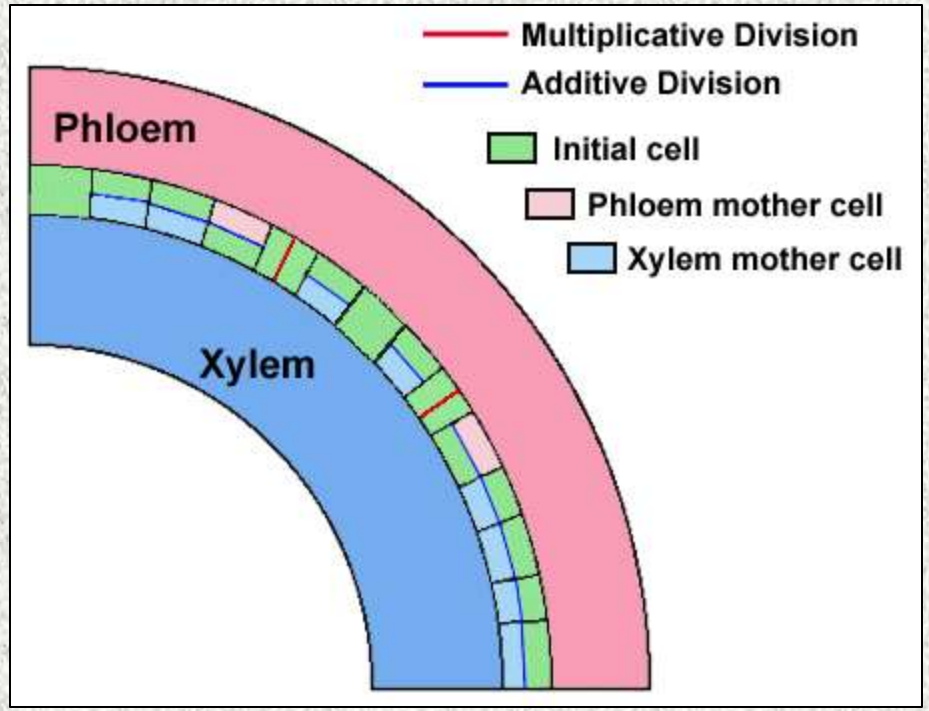
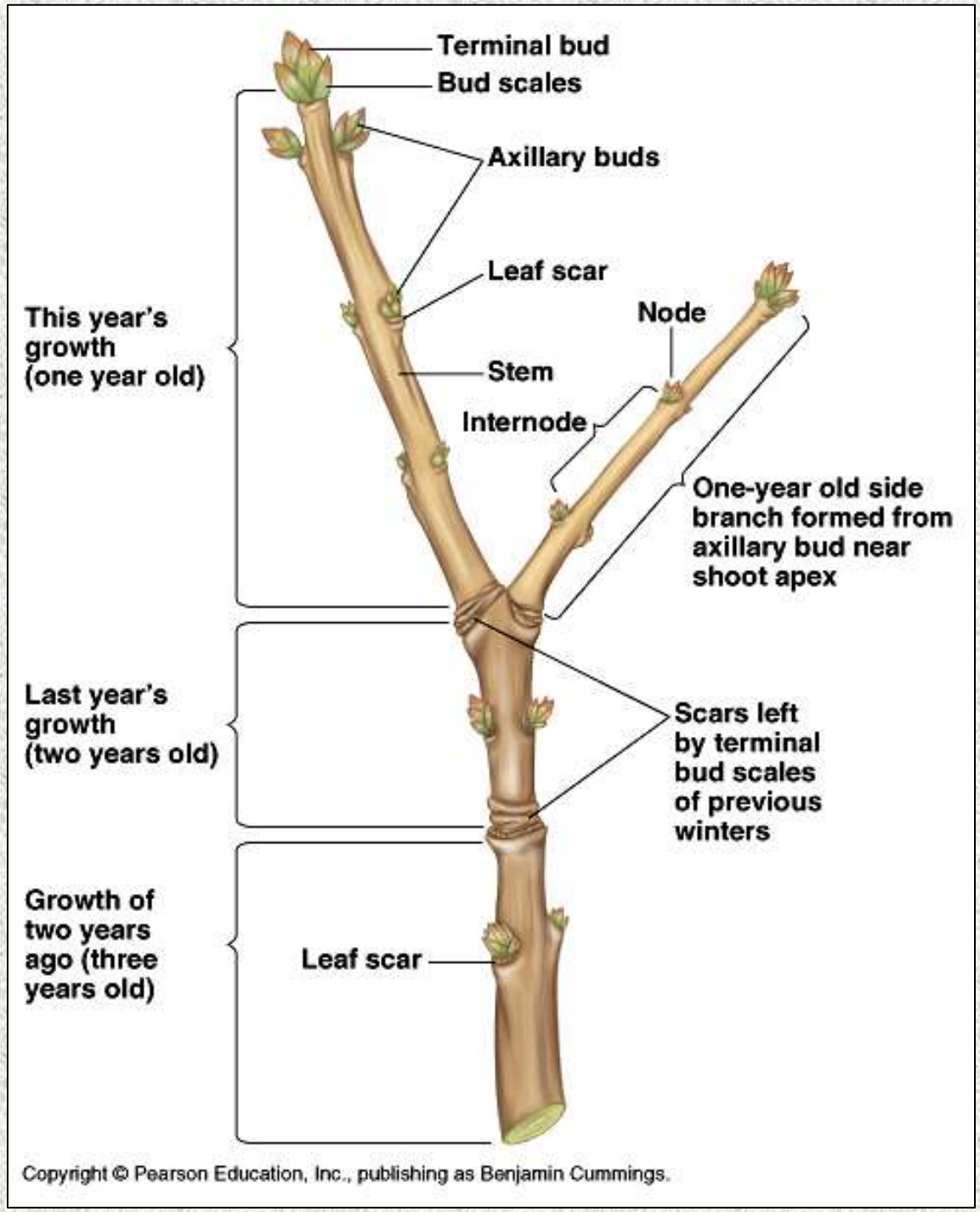


Figure 3.7 Anatomy of a woody stem.

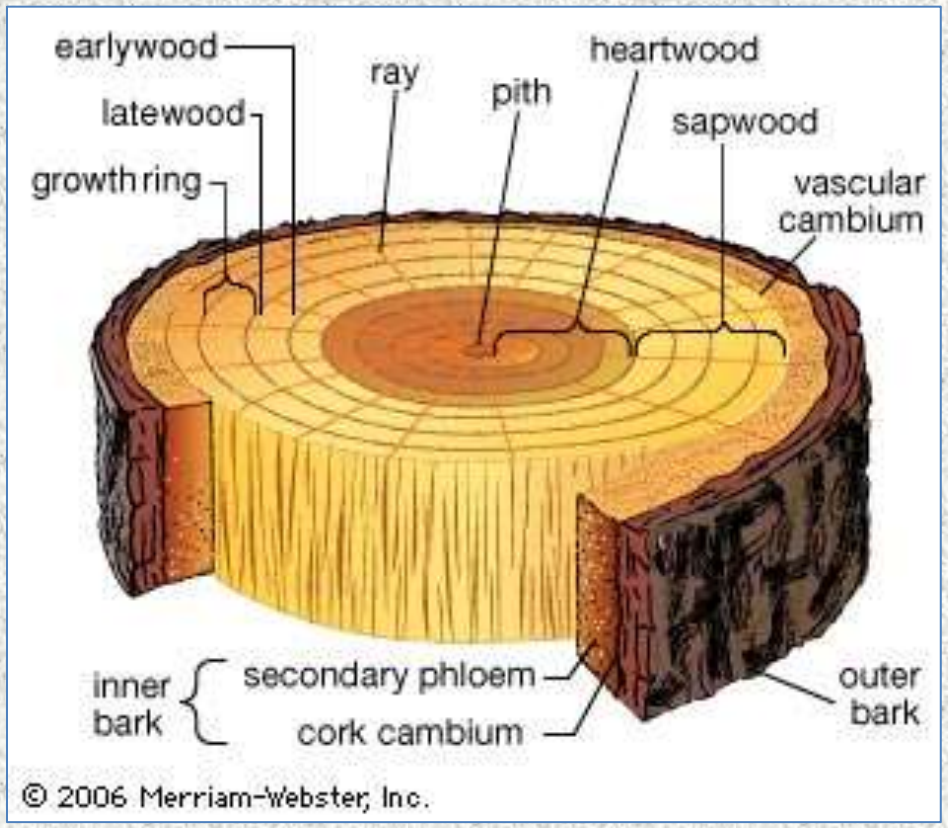


Cambium produces xylem to inside, phloem to outside

Winter Twig External Structure



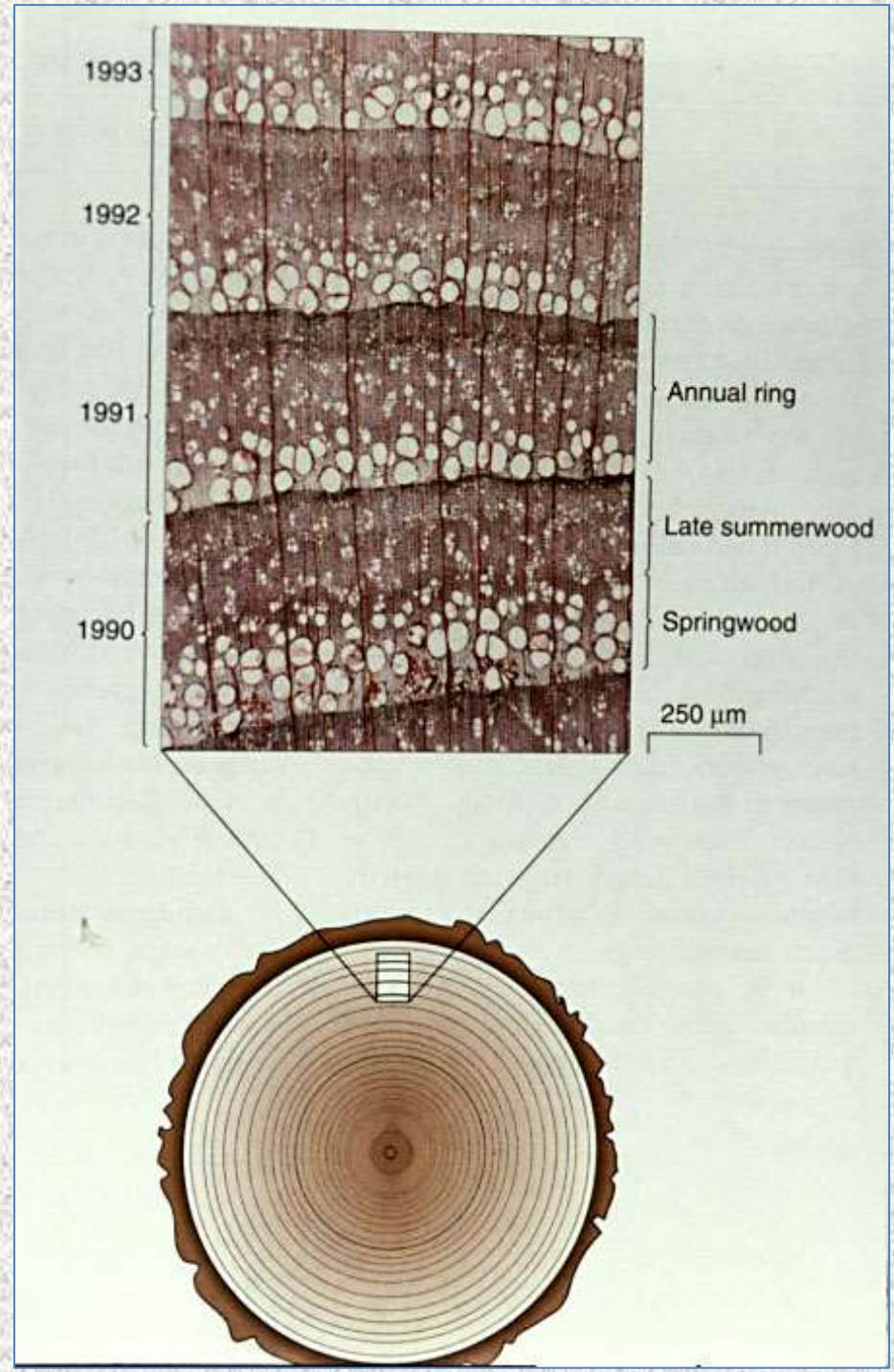
Wood


earlywood
latewood
growth ring
ray
pith
heartwood
sapwood
vascular cambium
inner bark
secondary phloem
cork cambium
outer bark
© 2006 Merriam-Webster, Inc.

Wood

- Wood is secondary xylem that builds up year after year.
  - Vascular cambium is dormant during winter.
  - **Annual ring** is made up of spring wood and summer wood.
    - Summer wood has a lower proportion of vessels than spring wood.
- In older trees, inner annual rings, called heartwood, no longer function in water transport.

Growth Rings



1914
When the tree was 6 years old, something pushed against it, making it lean. The rings are now wider on the lower side, as the tree builds "reaction wood" to help support it.

1924
The tree is growing straight again. But its neighbors are growing, too, and their crowns and root systems take much of the water and sunshine the tree needs.

1927
The surrounding trees are harvested. The larger trees are removed and there are once again ample nourishment and sunlight. The tree can grow rapidly again.

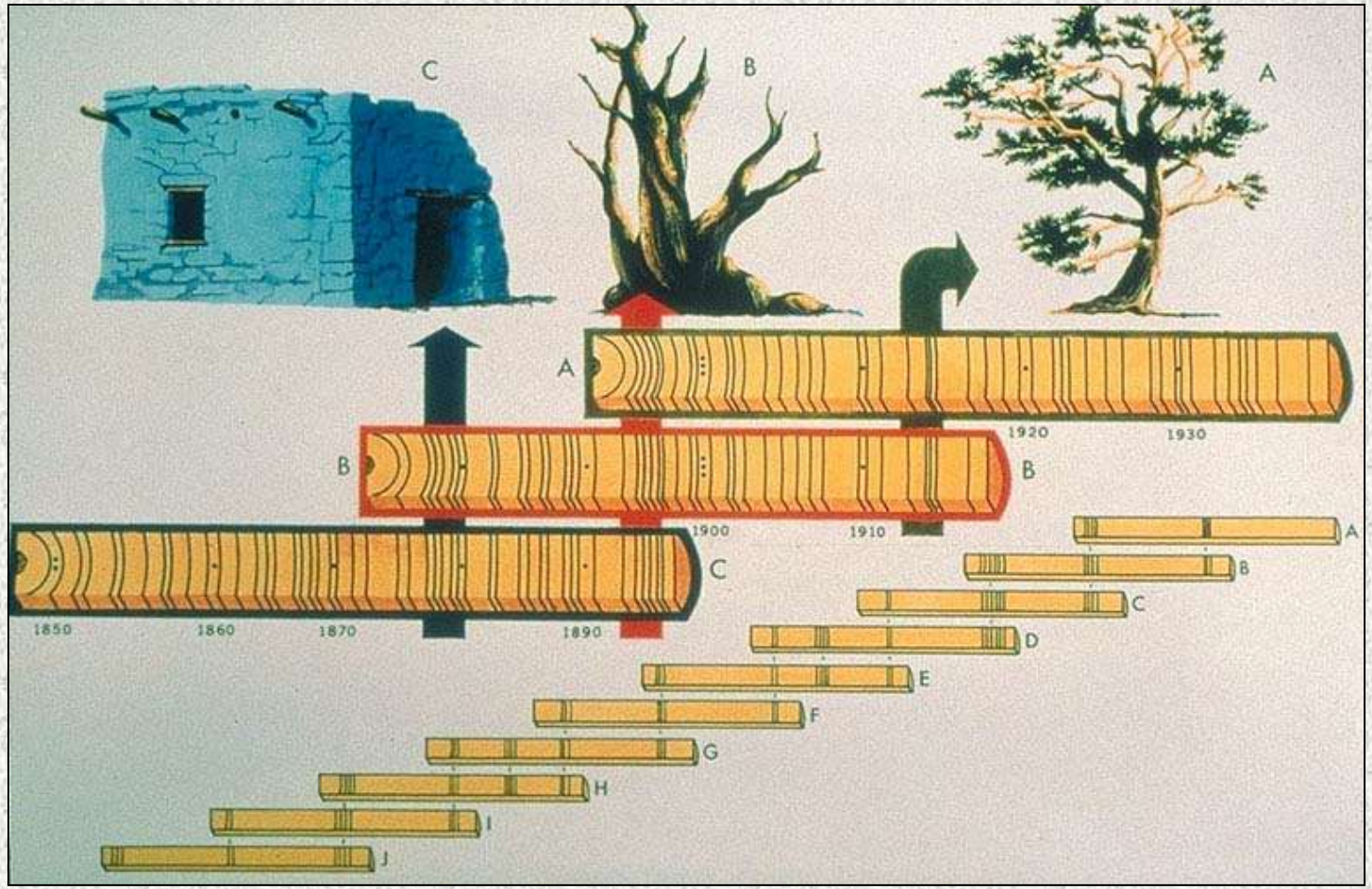
1930
A fire sweeps through the forest. Fortunately, the tree is only scarred, and year by year more and more of the scar is covered over by newly formed wood.

1942
These narrow rings may have been caused by a prolonged dry spell. One or two dry summers would not have dried the ground enough to slow the tree's growth this much.

1957
Another series of narrow rings may have been caused by an insect, such as the larva of the sawfly. It eats the leaves and leafbuds of many kinds of coniferous trees.

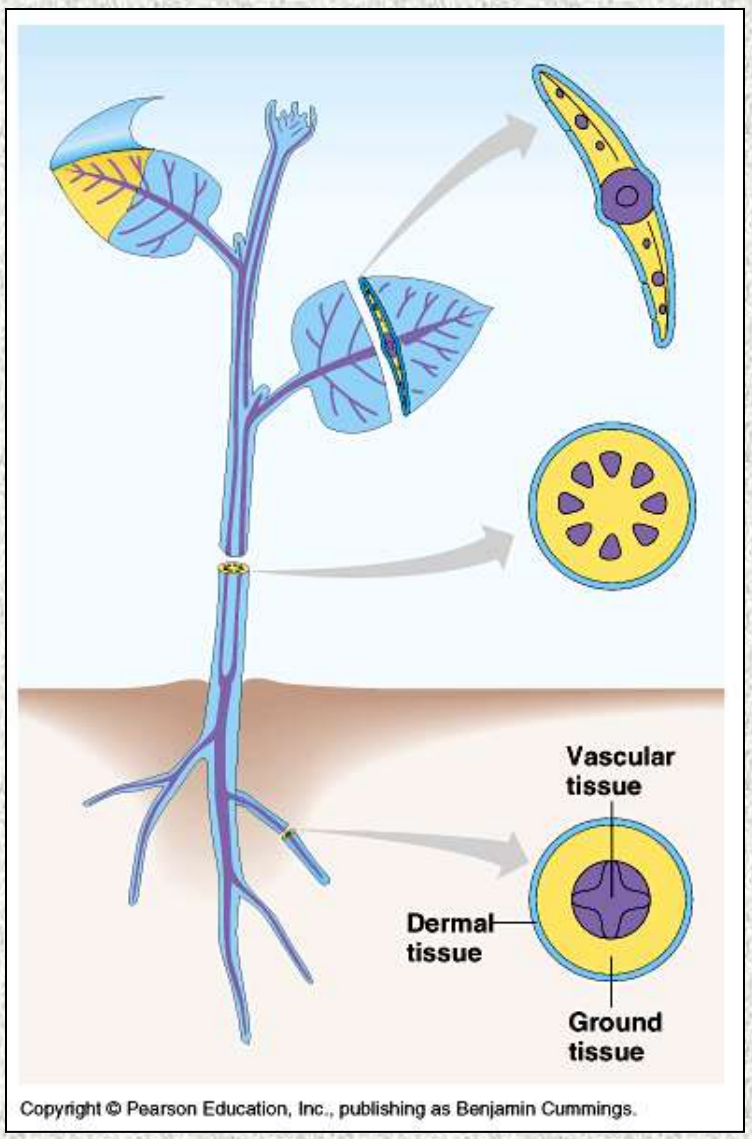
Box Figure 3.1 The pattern of annual rings is correlated with events in the life of this tree.
Source: St. Regis Paper Company, New York, NY, 1966.

Dendrochronology – Study of Annual Growth Rings



Vegetative Organs

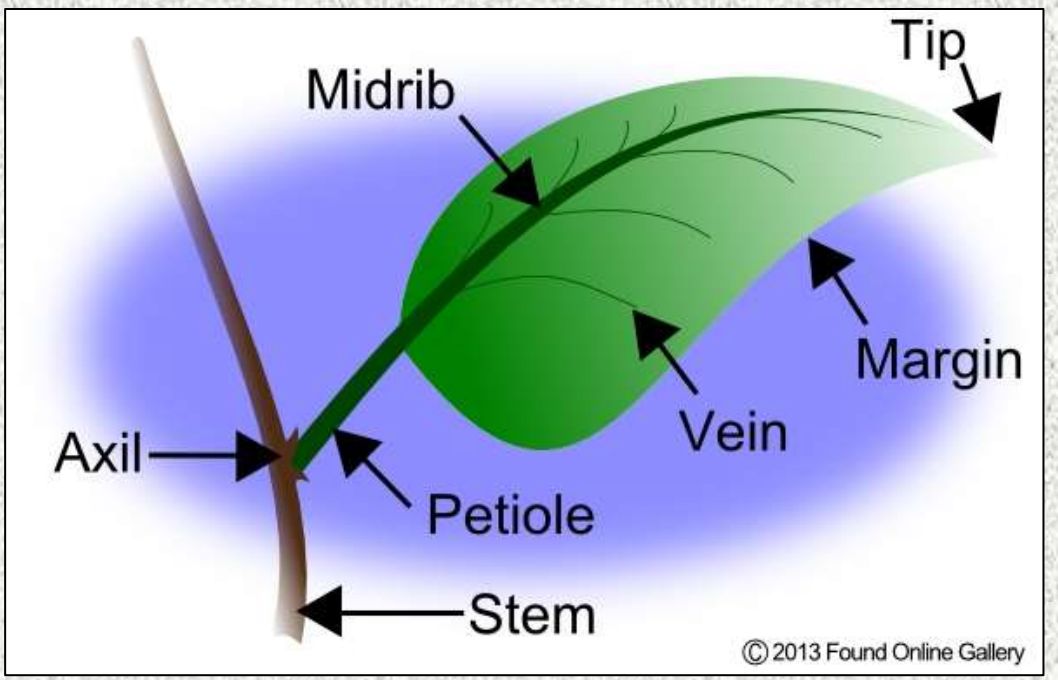
- Roots
- Stems
- Leaves

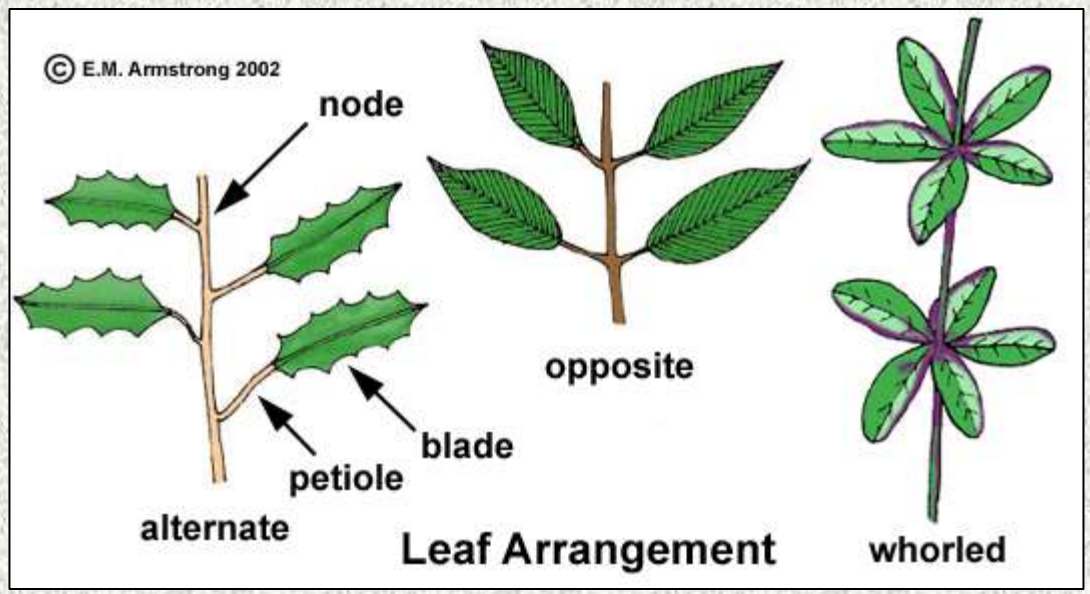


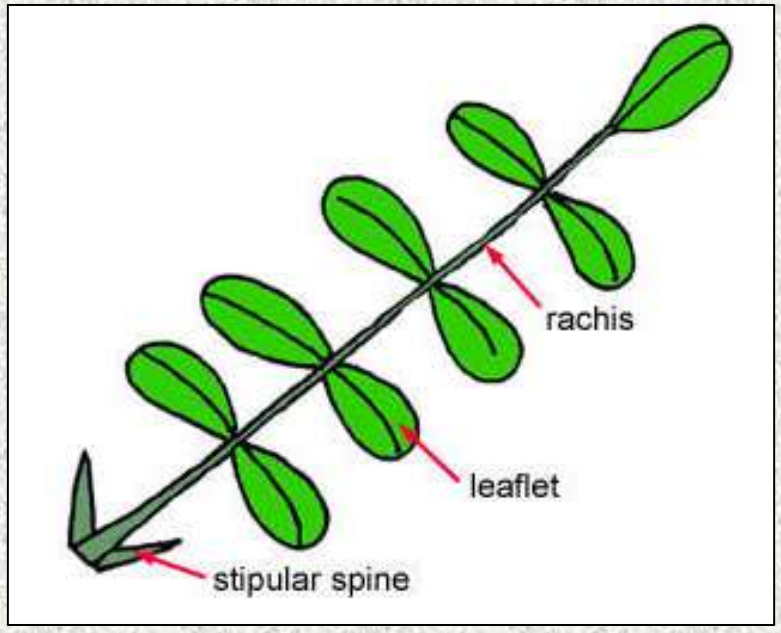
Leaves

- The leaf is the major part of the plant that carries on photosynthesis.
- Photosynthesis requires water, carbon dioxide, and sun.
  - Foliage leaves are usually broad and thin.
    - **Blade** – Wide portion of foliage leaf
    - **Petiole** – Stalk attaching blade to stem
    - Leaf Axil – Upper acute angle between petiole and stem where the axillary bud is found
  - Tendrils – Leaves that attach to objects
  - Bulbs – Leaves that store food

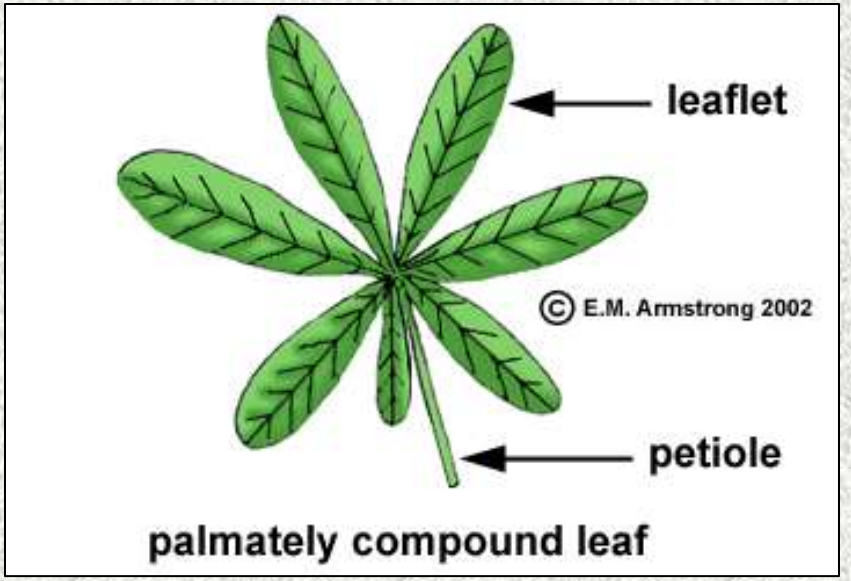
Leaves


Tip
Midrib
Margin
Vein
Axil
Petiole
Stem
© 2013 Found Online Gallery


© E.M. Armstrong 2002
node
opposite
blade
petiole
alternate
Leaf Arrangement
whorled



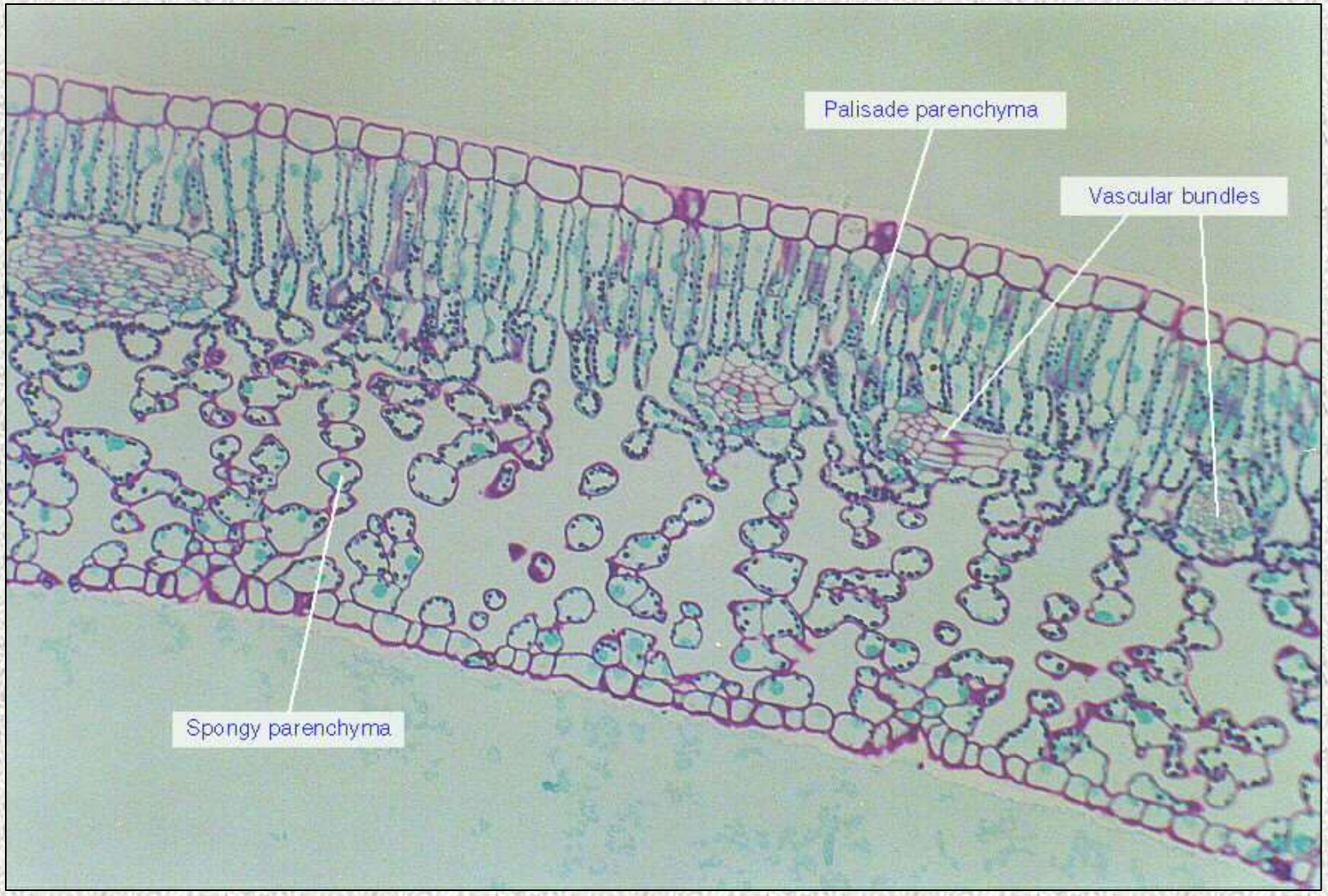
Pinnately compound leaf



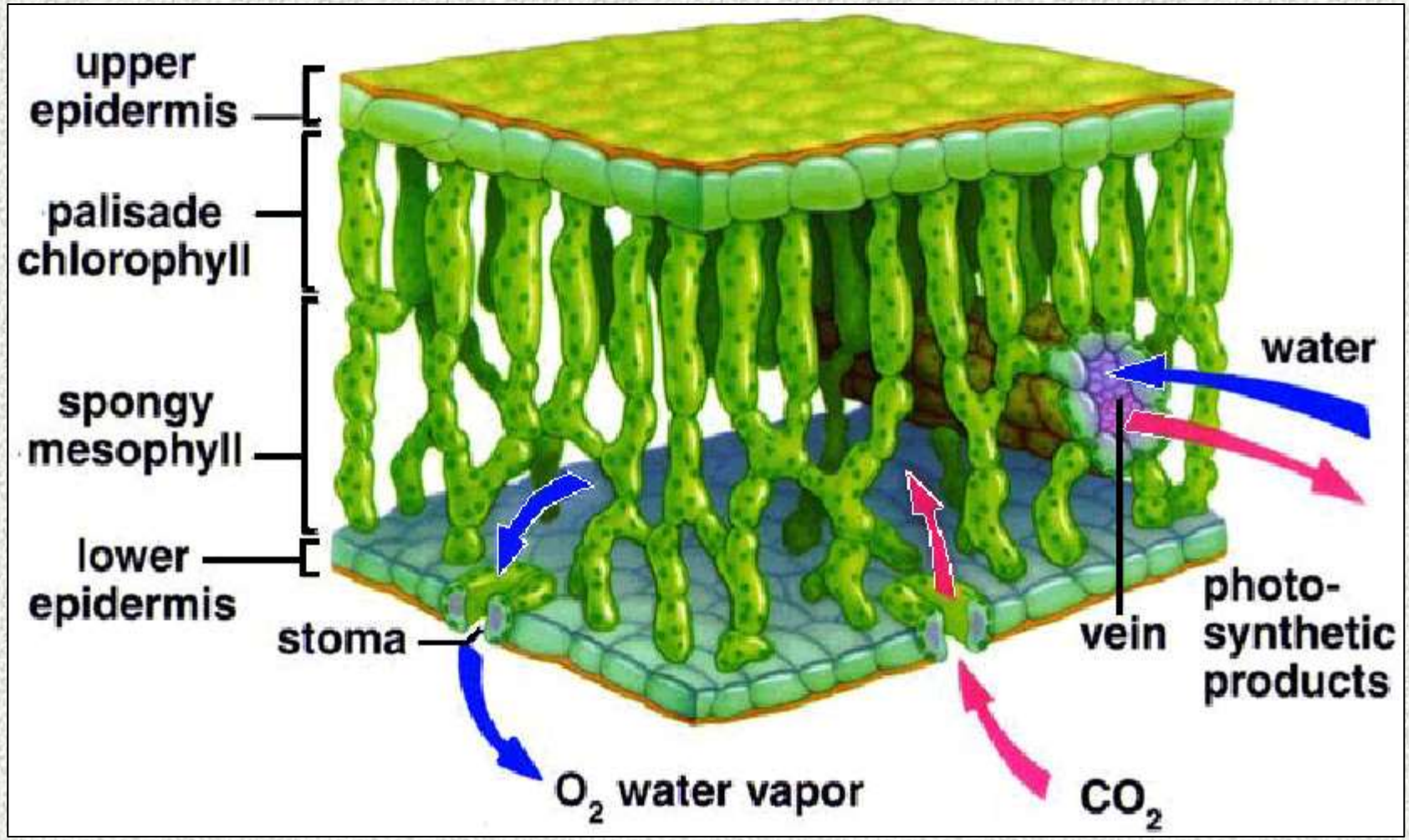
palmately compound leaf

Dicot and Monocot Leaves

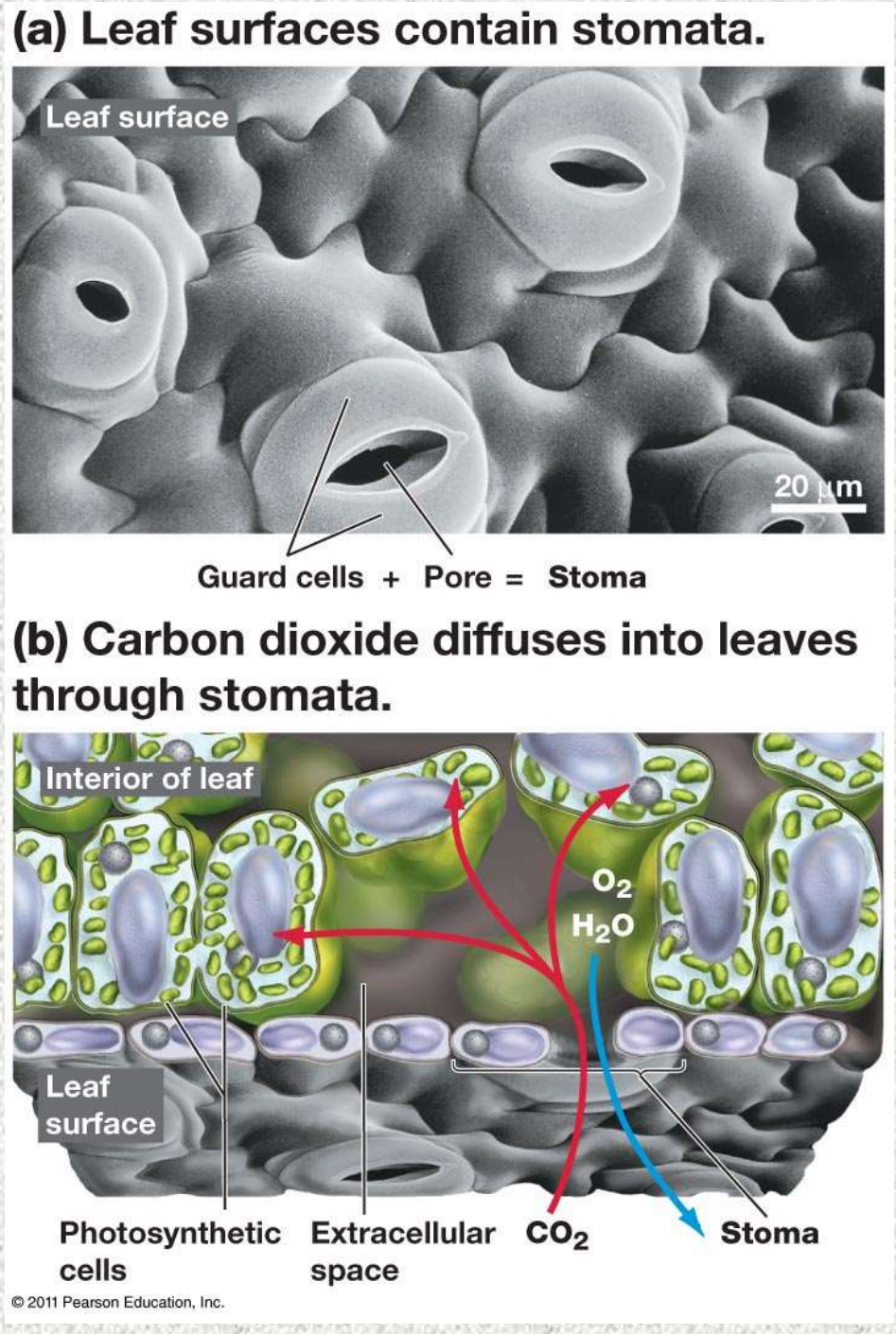
Cross section through a leaf



Leaf Structure



Stomata


(a) Leaf surfaces contain stomata.
Leaf surface
20 µm
Guard cells + Pore = Stoma
(b) Carbon dioxide diffuses into leaves through stomata.
Interior of leaf
O_2
H_2O
Leaf surface
Photosynthetic cells
Extracellular space
CO_2
Stoma
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Leaf Modification

End