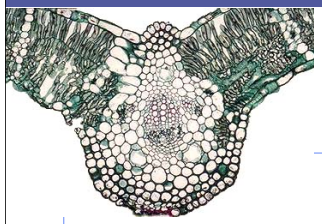
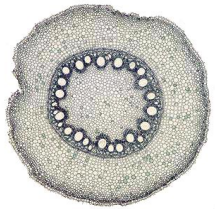
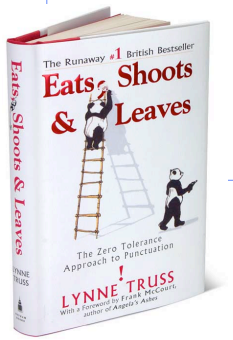


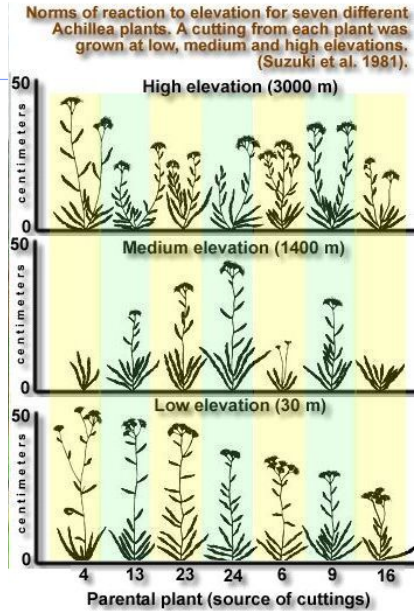




Chapter 35:
Plant Anatomy

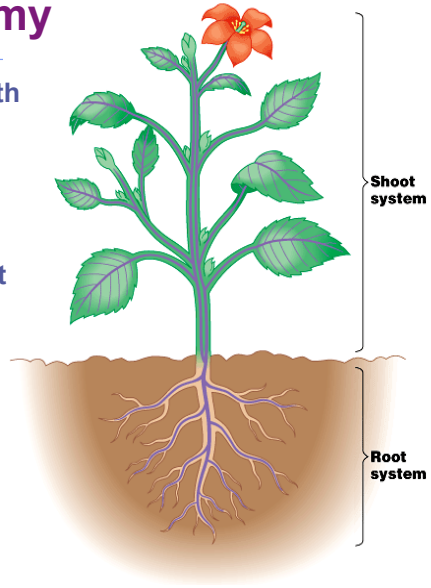
Basic plant anatomy

- Plants typically vary much more within a species than do animals



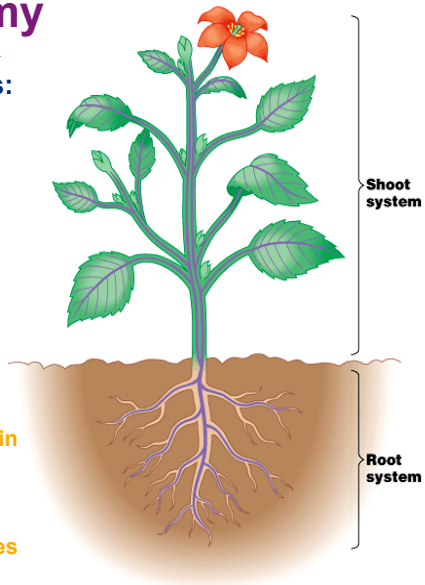
Basic plant anatomy

- Tissue = group of cells with a common function and/or structure
- Organ = several types of tissues that together carry out particular functions for an organisms
- Plants draw resources from two environments:
  1. Water and minerals from below ground
  2. CO_2 and light from above ground



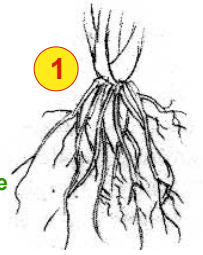
Basic plant anatomy

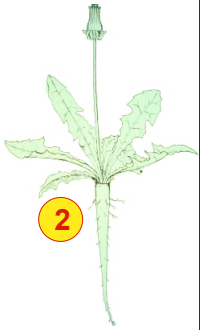
- Plants have 3 basic organs:
  1. Roots
  2. Stems
  3. Leaves
- These organs form a ROOT SYSTEM & a SHOOT SYSTEM
- ROOTS
  - Multicellular organ with various functions:
    1. Anchors a vascular plant in the soil
    2. Absorbs minerals and water
    3. Often stores carbohydrates



Types of Root Structures

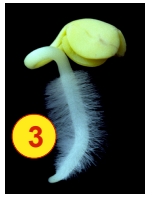
1. **Fibrous Root System**
   - Fibrous roots (1)
     - A mat of thin roots spreading out below the soil surface with no root functioning as the main one
       - Embryonic root dies
       - Many small roots from from stem
       - Each small root forms its own lateral roots
     - Monocots & seedless vascular plants
2. **Taproot system**
   - Tap roots (2)
     - Consists of 1 large vertical root with many small lateral or branch roots
       - Vertical root develops from embryonic root
       - Roots penetrate soil deeply
       - In agiosperms, taproot stores sugars and starches for use during flower and fruit production
     - Eudicots (dicots) and gymnosperms

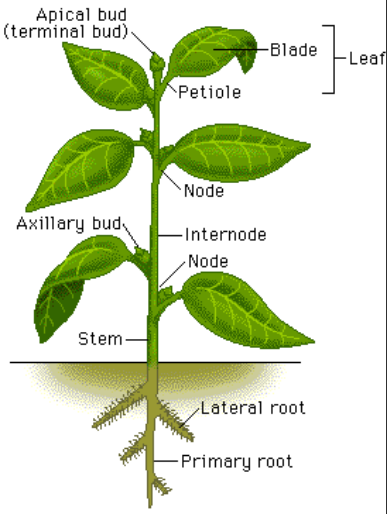




Roots

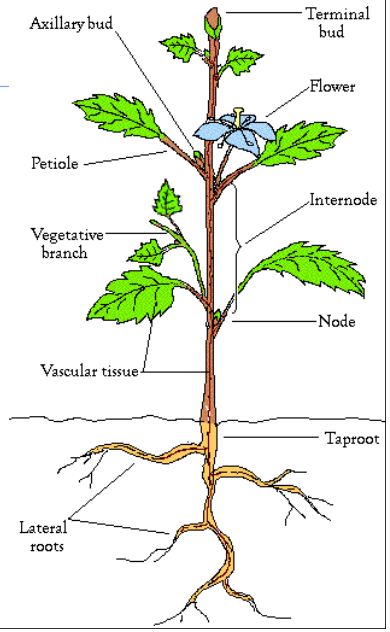
- Most absorption of water and minerals occur near the tip of roots
- Root tips have root hairs (3)
  - Thin tubular extensions of root epidermal cells
    (not a multicellular organ like lateral roots are)
  - increase absorptive surface area
    - Some plant have modified roots that provide more support or anchorage, store water and nutrients, or absorb oxygen





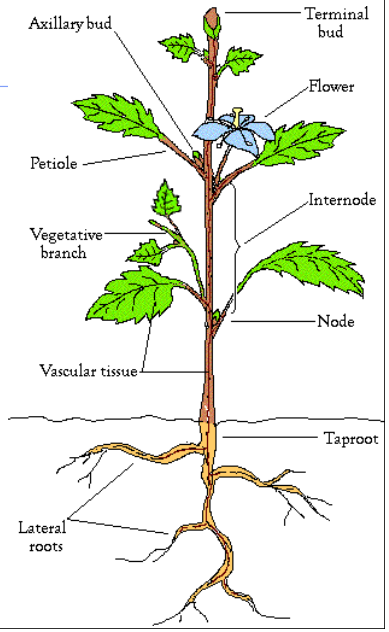
Shoots

- **SHOOTS (stem & leaves)**
  - A stem is an organ consisting of an alternating system of nodes and internodes
    - Nodes = the points at which leaves are attached
    - Internodes = the stem segments between nodes



Shoots

- **BUDS**
  - In the upper angle between the leaf and stem is an axillary bud
    - A structure that can form a lateral shoot, a.k.a. a branch
      - Usually dormant in young shoots
  - Elongation of shoots occur near shoot tip which contains an apical or terminal bud
    - Contains developing leaves and a compact series of nodes and internodes
  - Flower buds form flowers



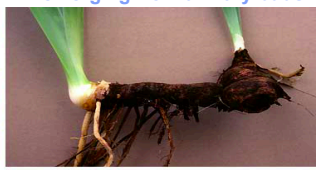
Apical dominance

- Apical dominance = the inhibition of axillary buds by apical buds
  - Increases the plant's exposure to light
    - If light becomes more intense on the side of a plant or if an animal eats the end of the shoot (and the apical bud), axillary buds break dormancy and start growing into a new lateral shoot or branch

Modified shoots

stolons (strawberries)
- horizontal shoots that grow along the surface (allow plants to reproduce asexually from nodes)

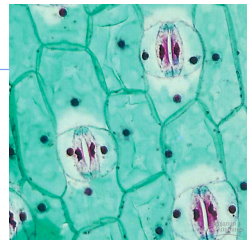
rhizome (ginger)
- horizontal shoots that grow below the surface with vertical shoots emerging from axillary buds



tuber (potato)
- eyes are clusters of axillary buds

bulb (onion)
- underground shoots of mainly bases of leaves that sore food

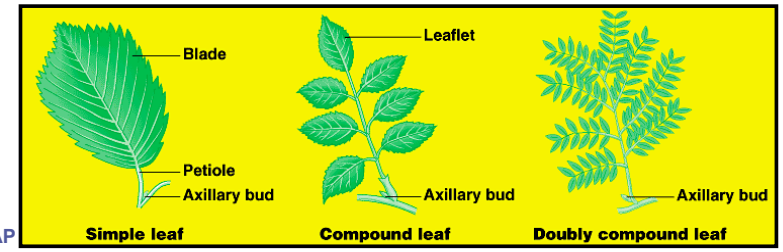
Leaves



- Function
  - Main organs for photosynthesis
    - energy production
  - Allow for gas exchange
  - Allow for Transpiration
    - Though too much water loss is bad, some water loss is necessary in order for the plant to be able to carry minerals up from the soil
- Structure
  - Flattened blade
  - Petiole = stalk that joins the leaf to the stem at a node
    - Many monocots lack petioles and the base of the leaf forms a sheath that envelops the stem

Leave Morphology

- Leaves can be simple or compound
  - Simple leaves
    - Single undivided blade
  - Compound leaves
    - Blade consists of multiple leaflets
    - Each leaflet is missing any axillary bud at its base
      - Allows leaves to withstand strong wind with less tearing
      - Confines pathogens to a leaflet
  - Double Compound leaves
    - Each leaflet is itself divided into smaller leaflets



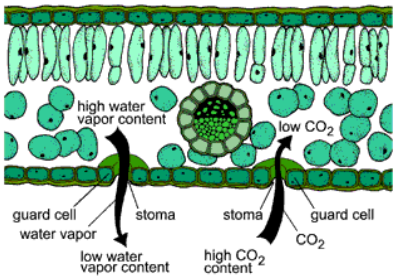
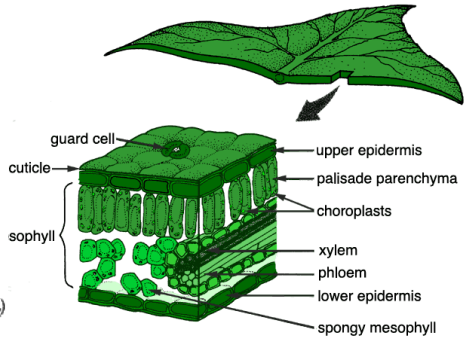
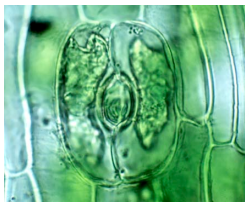
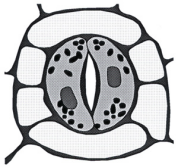
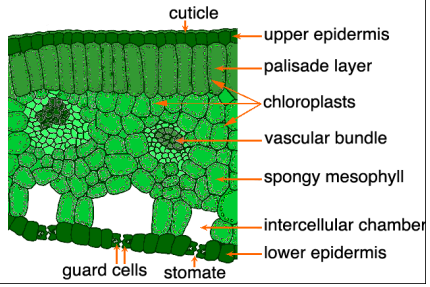


Figure 25. Stomata open to allow carbon dioxide (CO_2) to enter a leaf and water vapor to leave.









Modified leaves

tendrils (peas)
-allow plant to cling to a support

spines (cacti)
-protection and an adaptation to prevent water loss

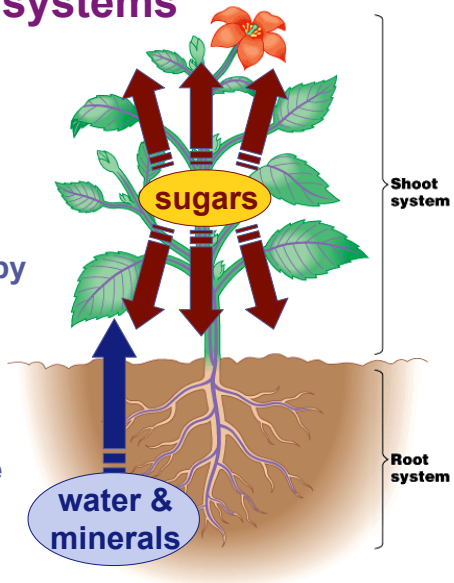
succulent leaves
- adapted to store water

colored leaves (poinsetta)
-brightly colored leaves surround flowers to attract pollinators

AP Biology

Interdependent systems

- **Both systems depend on each other**
  - **roots** depend on sugars produced by **photosynthetic leaves**
  - **shoots** depend on water & minerals absorbed from the soil by roots

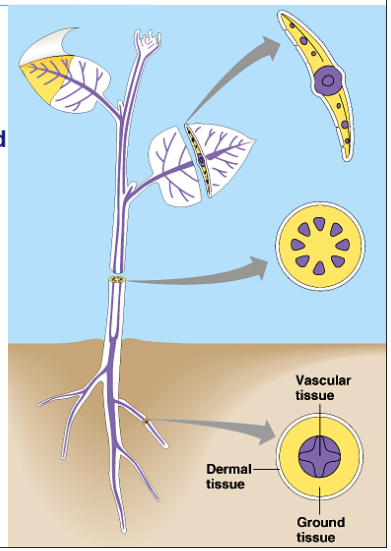


AP Biology

Plant TISSUES of plant organs

1. **Dermal tissue system**
   - Outer protective covering
   - epidermis (“skin” of plant)
     - single layer of tightly packed cells that protects plant and prevents water loss

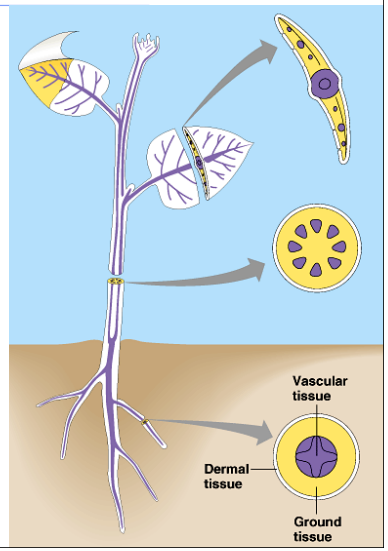
     - Trichomes = hairlike outgrowth of shoot epidermis that reduce water loss, reflect excess light, function in defense by forming barrier, secreting toxins etc…
     - Periderm replaces epiderm in older regions of stems and roots in woody plants
   - Cuticle = waxy coating on plants prevents water loss



AP Biology

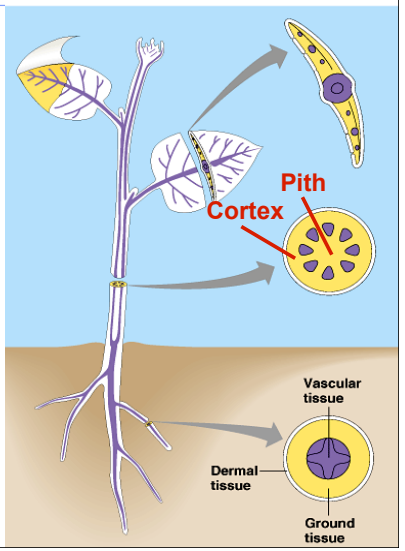
Plant TISSUES of plant organs

2. Vascular tissue system
   - Long distance transport system in shoots & roots
     - xylem
       - Conducts water and minerals upward from roots into shoots
     - Phloem
       - Transports sugars from photosynthesis
   - Stele = (Greek for "pillar') vascular tissue of root or stems
     - Vascular cylinder of xylem and phloem in roots
     - Vascular bundles = separate strands containing xylem and phloem *(aka: VEINS)*



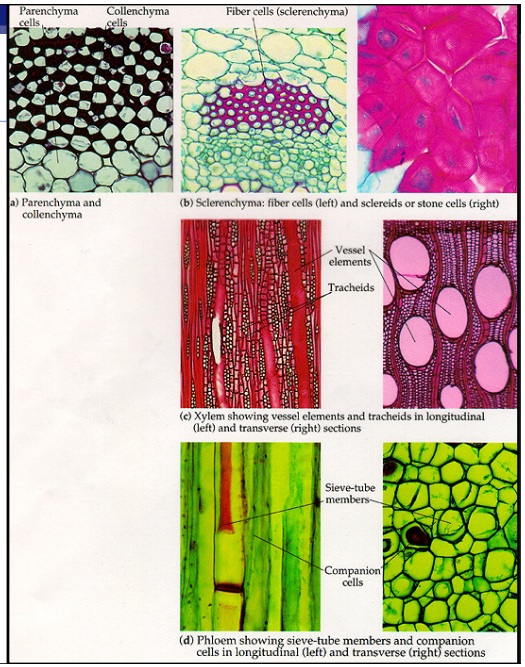
Plant TISSUES of plant organs

3. Ground tissue system
   - Pith = ground tissue internal to vascular tissue
   - Cortex = ground tissue external to vascular tissue
   - bulk of plant tissue
     - Includes....
       - The photosynthetic mesophyll cells
       - Cells for storage



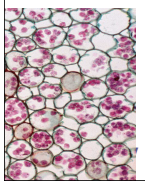
Plant CELL types

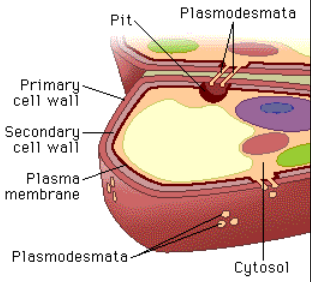
1. Parenchyma
2. Collenchyma
3. Sclerenchyma
4. Water-conducting cells of the Xylem
5. Sugar-conducting cells of the Phloem

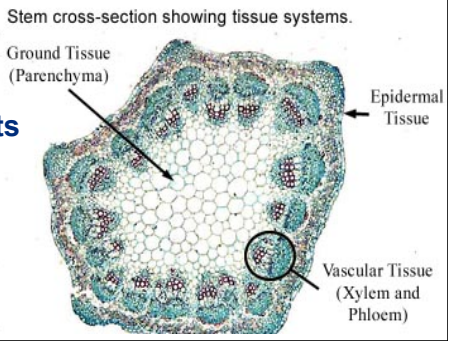


Parenchyma

- Parenchyma cells are unspecialized
  - Primary cell walls are thin, flexible
  - Lack secondary walls
- carry out many metabolic functions
  - "typical" plant cells = least specialized
  - photosynthetic cells
  - storage cells
  - tissue of leaves, stem, fruit, storage roots
- all other cell types in plants develop from parenchyma

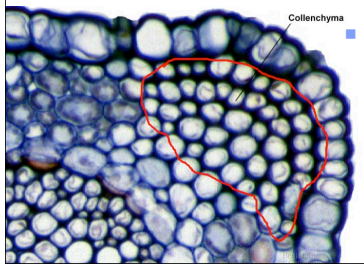


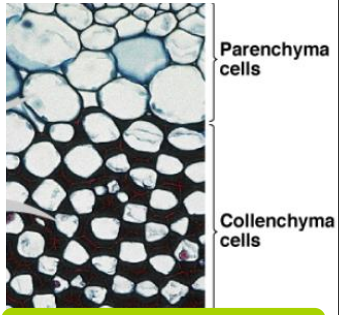




Collenchyma

- Collenchyma cells have thicker primary walls & provide support to young parts of plant shoots
  - Lack secondary cell walls
  - Unevenly thickened primary walls
  - Cell walls lack hardening agent lignin
    - Can elongate to help support without restraining growth
    - remain alive in maturity

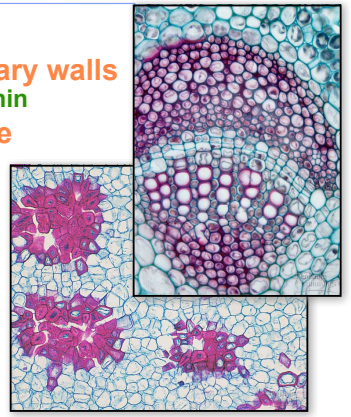




the strings in celery stalks are collenchyma

Sclerenchyma

- Cells for support
  - very thick, "woody" secondary walls
    - Cell wall strengthened with lignin
  - rigid cells that can't elongate
    - Occurs in tissues that have stopped growing
    - Dead at functional maturity (missing protoplast)
- Two types of Sclerenchyma
  - fibers
    - Rope-like threads
      - Ex: hemp
  - sclereids
    - Shorter with very thick lignified secondary walls
      - Ex: Give nutshells & seed coats hardness
      - Ex: grittiness in pears

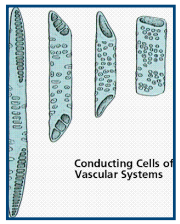


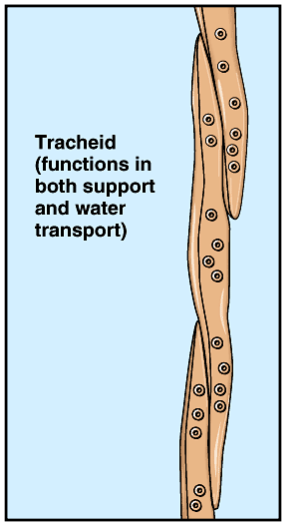
Xylem's water conducting cells

Two types:

- Tracheids
- Vessel Elements

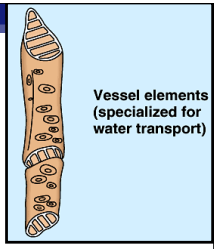
1. Tracheids
   - Elongated and tapered tubular cells
     - Dead at functional maturity
   - Secondary walls fortified with lignin providing support and preventing collapse
   - In Xylem of almost all vascular plants
     - Chief water-conducting element in gymnosperms and lower vascular plants, also found in Angiosperm xylem.
   - Contains pits but no perforations

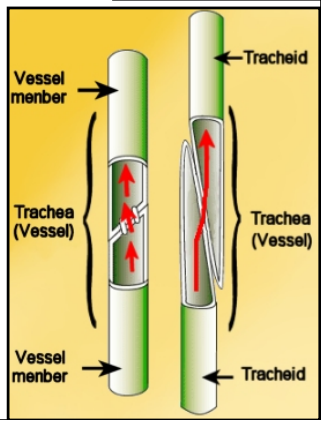




Xylem's water conducting cells

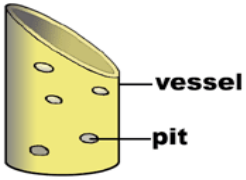
2. Vessel elements
   - Elongated tubular cells
     - Wider, shorter, thinner walled than tracheids
     - Dead at functional maturity
   - Aligned end-to-end forming Vessels
   - End walls of vessel elements have perforated plates
     - Allows water to flow freely through the vessels in the xylem
   - Chief water-conducting element in angiosperm xylem.
     - Found additionally to tracheids in angiosperms (a few gymnosperms and seedless vascular plants)
   - Contains pits and perforations

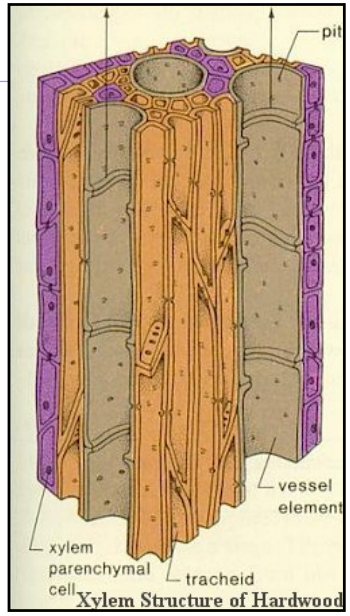




Xylem cell pits

- Secondary walls of both these cells are interrupted by pits
  - PIT = thinner regions where only primary walls are present
    - Pits allow water to migrate out of these cells laterally

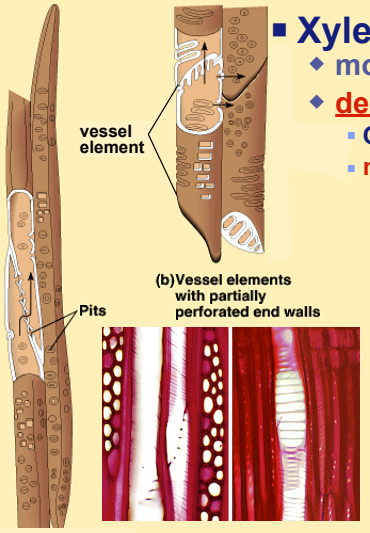




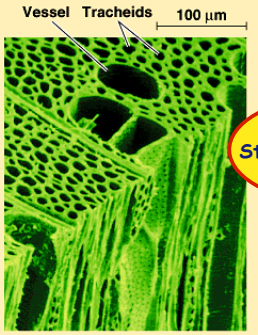
Xylem Structure of Hardwood

Vascular tissue

vessel elements

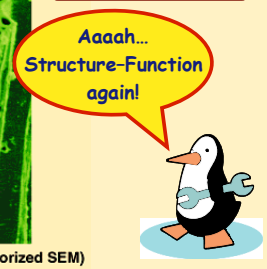


- Xylem
  - move water & minerals up from roots
  - dead cells at functional maturity
    - Only lignified cell walls remain
    - need empty pipes to efficiently move H_2O
      - Water moves by transpirational pull



(c)Tracheids and vessels (colorized SEM)

dead cells



tracheids

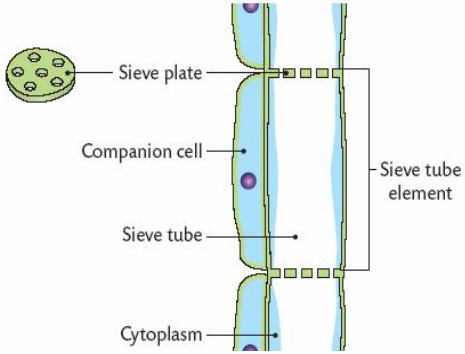
Sugar-conducting cell of the Phloem

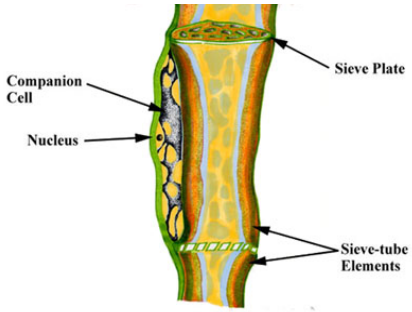
- Unlike Xylem, phloem cells are living cells at functional maturity
  - They have a cell membrane & cytoplasm
    - Soooo…. They can control of diffusion
- Cells

Sugar Conducting cells
- loose their nucleus, ribosomes, vacuole & various cytoskeletal elements
  - more room for easier specialized transport of liquid nutrients (sucrose)
- Sieve cells
  - Long narrow cell
    - In seedless vascular plants and gymnosperms
- Sieve tubes
    - Sugar conducting cells in angiosperms
  - Contain Sieve plates as end walls: have pores to facilitate flow of fluid between cells

Additional cells of the Phloem

- Companion cells
  - Non-conducting cells alongside sieve tube element
  - Nucleated cells connected to the sieve-tube through plasmodesmata
    - Nucleus and ribosomes of companion cells also serve sieve tubes

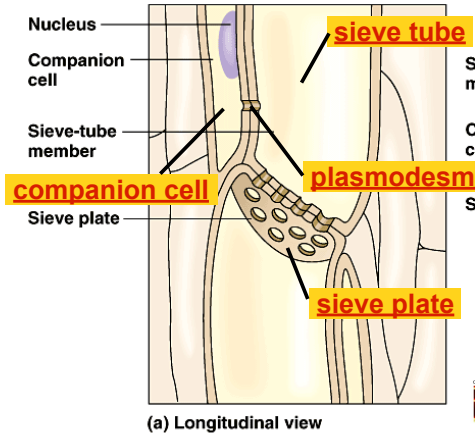




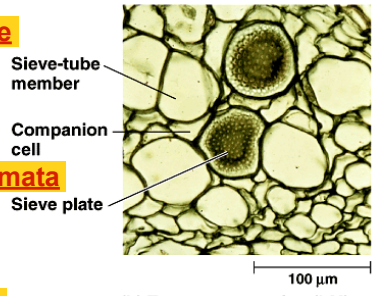
Sieve-Tube

Phloem: food-conducting cells

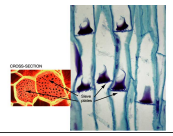
- carry sugars & nutrients throughout plant



(a) Longitudinal view



(b) Transverse section (LM)



living cells