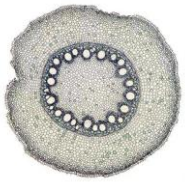
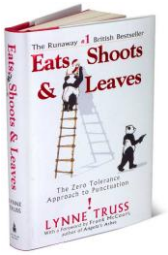
# Chapter 34

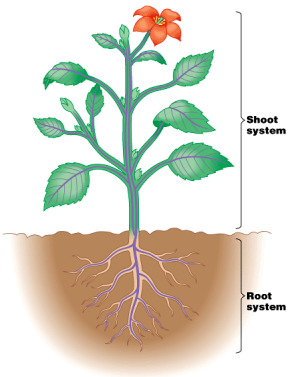
## Plant Anatomy and Growth





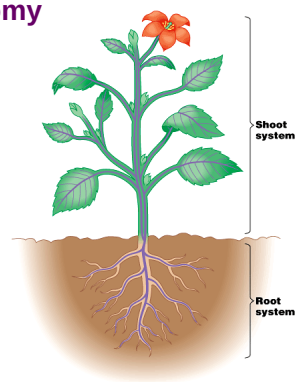

## Basic Anatomy

- root
- shoot (stem)
- leaves



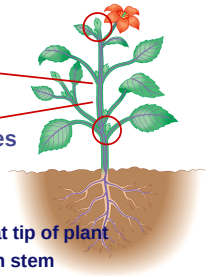

## Expanded Anatomy

- root
  - root tip
  - root hairs
- shoot (stem)
  - nodes
  - internodes
  - apical buds
  - axillary buds
  - flowers
- leaves
  - veins



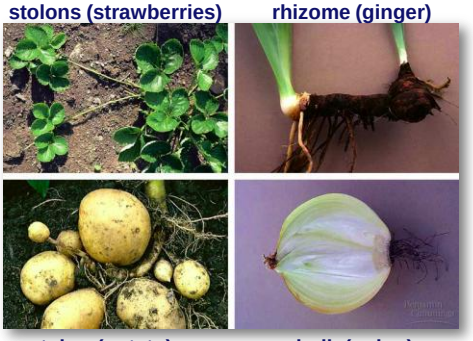

## Shoots

- Shoots consist of stems, leaves & buds
- Stems
  - nodes = points at which leaves are attached
  - internodes = stem segments between nodes
- Buds
  - growth of shoot
    - terminal or apical bud = at tip of plant
    - axillary bud = in nodes on stem



## Modified Shoots

stolons (strawberries) rhizome (ginger)



tuber (potato) bulb (onion)

## Roots

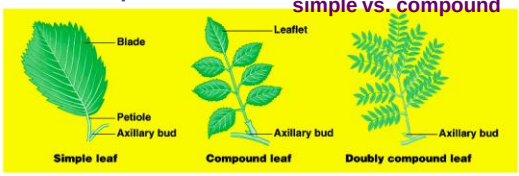
- Roots anchor plant in soil, absorb minerals & water, & store food
  - fibrous roots (1)
    - mat of thin roots that spread out
    - monocots
  - tap roots (2)
    - 1 large vertical root
    - also produces many small lateral, or branch roots
    - dicots
  - root hairs (3)
    - increase absorptive surface area



## Leaves

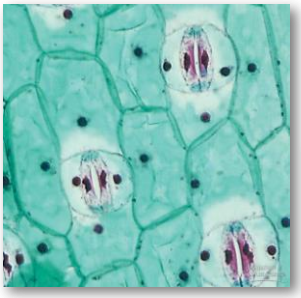
- Function of leaves?
  - photosynthesis
    - energy production
    - CHO production
  - gas exchange
  - transpiration

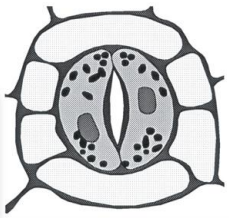
simple vs. compound

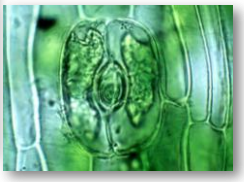



## Stomates

Function of stomates?







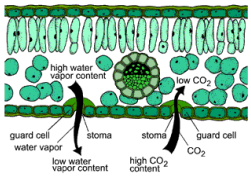
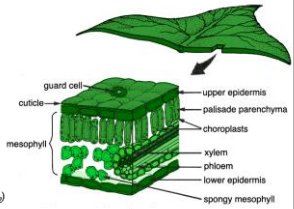
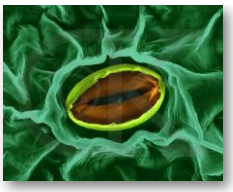
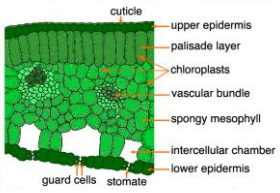



Figure 25. Stomata open to allow carbon dioxide ($CO_2$) to enter a leaf and water vapor to leave.

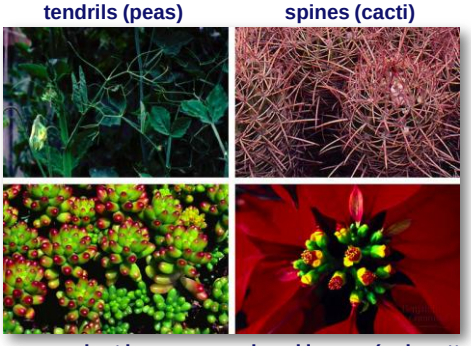





## Modified Leaves

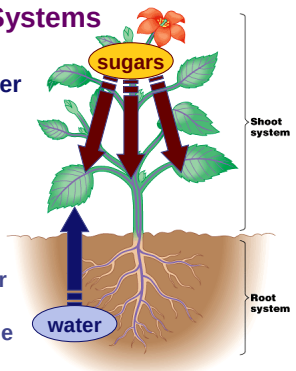
tendrils (peas) spines (cacti)



succulent leaves colored leaves (poinsetta)

## Interdependent Systems

- Both systems depend on the other
  - roots receive sugars & other nutrients from photosynthetic parts
  - shoot system depends on water & minerals absorbed from the soil by roots




## Putting it all together…

- Obtaining raw materials
  - sunlight
    - leaves = solar collectors
  - $CO_2$
    - stomates = gas exchange
  - $H_2O$
    - uptake from roots
  - nutrients
    - uptake from roots

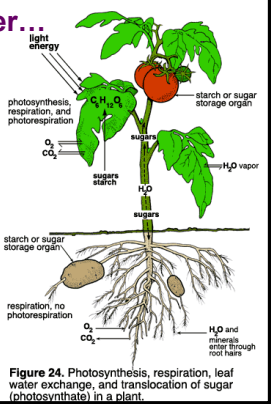
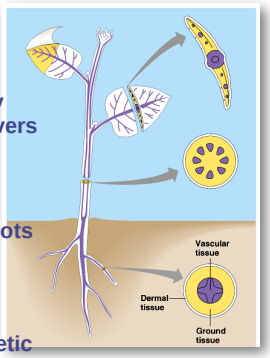


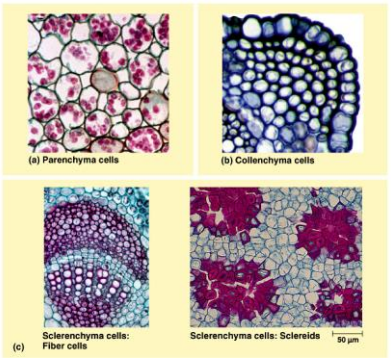

Figure 24. Photosynthesis, respiration, leaf water exchange, and translocation of sugar (photosynthate) in a plant.

## Plant Tissues

- Dermal
  - "skin" of plant
  - single layer of tightly packed cells that covers & protects plant
- Vascular
  - transport materials between roots & shoots
  - xylem & phloem
- Ground
  - everything else: storage, photosynthetic
  - bulk of plant tissue




## Plant Cell Types in Tissues

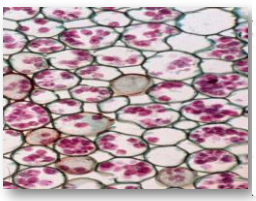


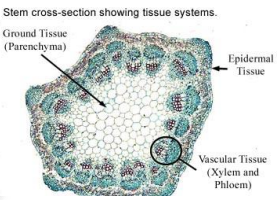

## Plant Cell Types in Tissues

- Parenchyma
  - "typical" plant cells = least specialized
  - photosynthetic cells, storage cells
  - tissue of leaves, stem, fruit, storage roots
- Collenchyma
  - unevenly thickened primary walls = support
- Sclerenchyma
  - very thick, "woody" secondary walls = support
  - rigid cells that can't elongate
  - dead at functional maturity

## Parenchyma

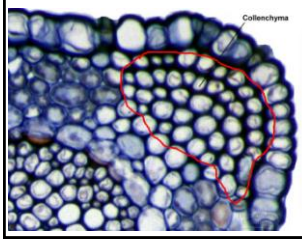
- Parenchyma cells are relatively unspecialized, thin, flexible & carry out many metabolic functions
  - all types of cells develop from parenchyma

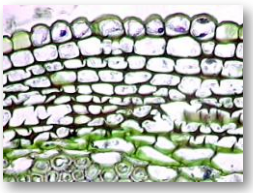


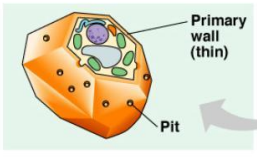


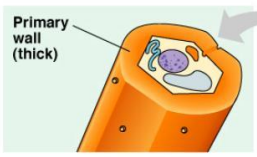

## Collenchyma

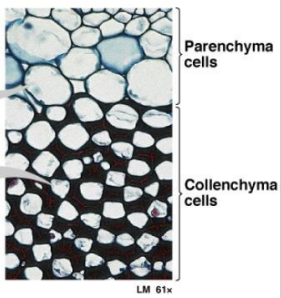
- Collenchyma cells have thicker primary walls & provide support
  - help support without restraining growth
  - remain alive in maturity



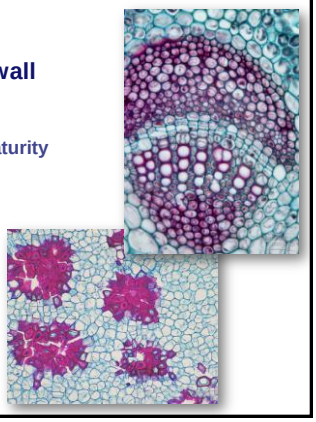


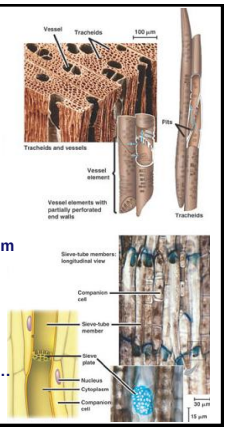
## Sclerenchyma

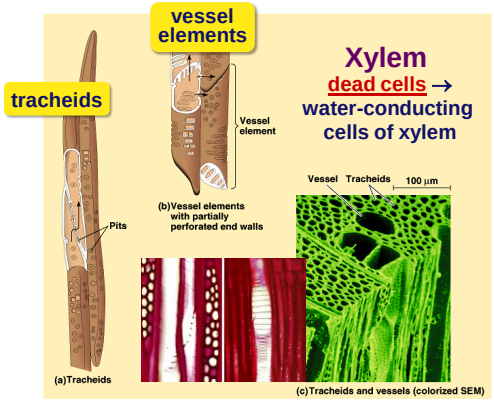
- Thick, rigid cell wall
  - lignin (wood)
  - cannot elongate
  - mostly dead at maturity
- Support cells
  - xylem vessels
  - tracheids
  - fibers
    - rope fibers
  - sclereids
    - nutshells
    - seed coats
    - grittiness in pears



## Vascular Tissue

- Transports materials in roots, stems & leaves
- Xylem
  - carry water & minerals up from roots
  - tube-shaped dead cells
    - only their walls provide a system of microscopic water pipes
- Phloem
  - carry nutrients throughout plant
    - sugars (sucrose), amino acids…
  - tube-shaped living cells



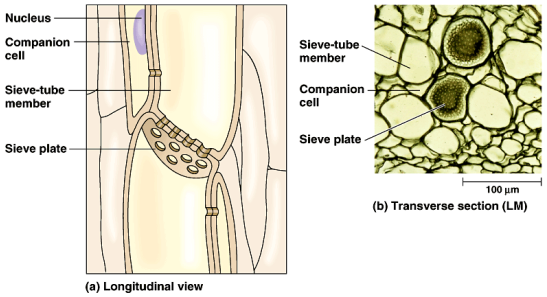




## Xylem

- Dead at functional maturity
- Cell elongated into tubes
  - tracheids
    - long, thin cells with tapered ends
    - walls reinforced with lignin = support
    - thinner pits in end walls allows water flow
  - vessel elements
    - wider, shorter, thinner walled & less tapered
    - perforated ends walls allows free water flow

## Phloem: Food-Conducting Cells

- Sieve tube elements & companion cells



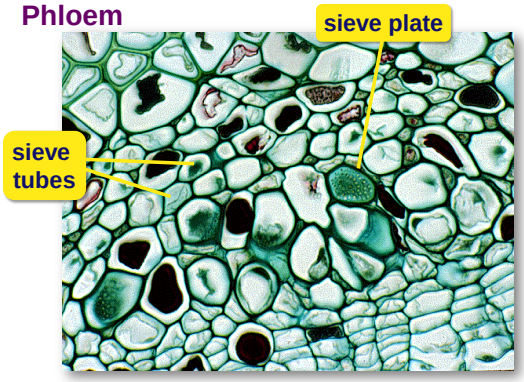

## Phloem: Food-Conducting Cells

- Sieve tube elements & companion cells

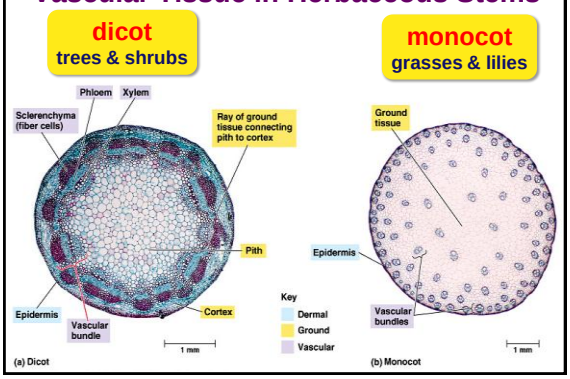
## Phloem

- Living cells at functional maturity
  - lack nucleus, ribosomes & vacuole
    - more room: specialized for liquid food (sucrose) transport
- Cells
  - sieve tubes
    - end walls, sieve plates, have pores to facilitate flow of fluid between cells
  - companion cells
    - nucleated cells connected to the sieve-tube
    - help sieve tubes

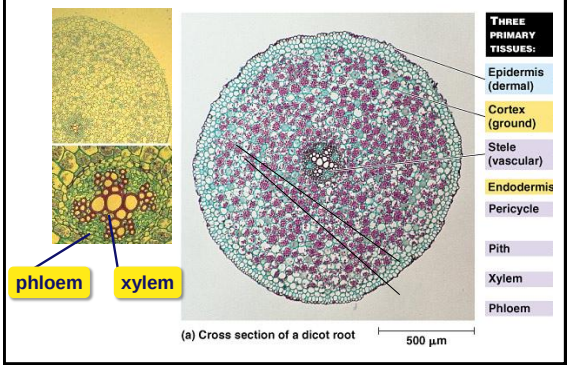
## Phloem



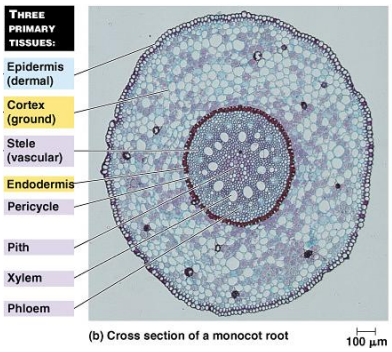

## Vascular Tissue in Herbaceous Stems




## Root Structure: Dicot




## Root Structure: Monocot

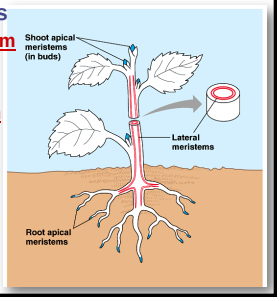



## Indeterminate Growth

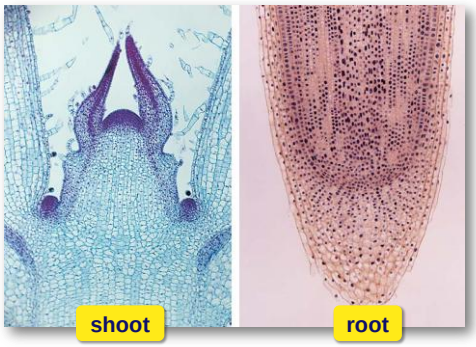
- Unlike animals most plants grow throughout their life
  - annuals
    - life cycle within 1 year
    - germination → flowering → seed production
  - perennials
    - live many years
    - does not die of old age, only disease or trauma

## Meristem

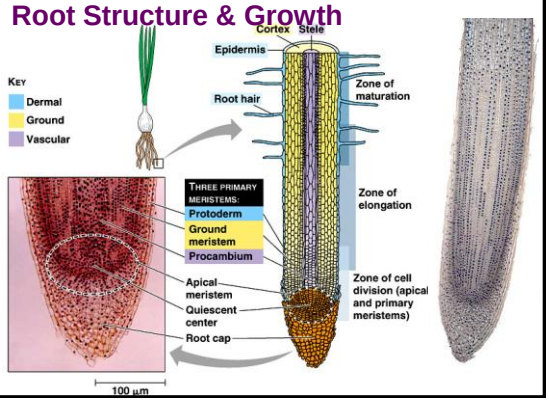
- Regions of growth
  - perpetually embryonic tissue
  - regenerate new cells
    - apical shoot meristem
      - growth in length
      - primary growth
    - apical root meristem
      - growth in length
      - primary growth
    - lateral meristem
      - growth in girth
      - secondary growth




## Apical Meristems

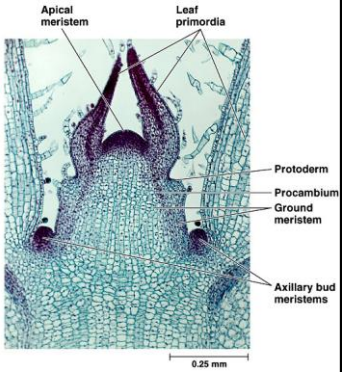



## Root Structure & Growth




## Shoot Growth

- Apical bud & primary growth of shoot
  - region of stem growth
  - axillary buds "waiting in the wings"

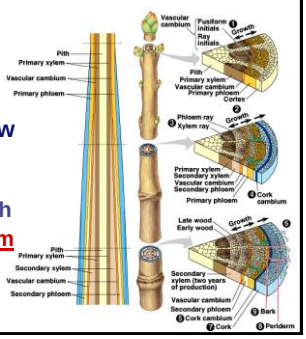



## Shoot Growth

- Since woody plants grow from year to year, they evolved a different growth system than herbaceous plants which die back each year

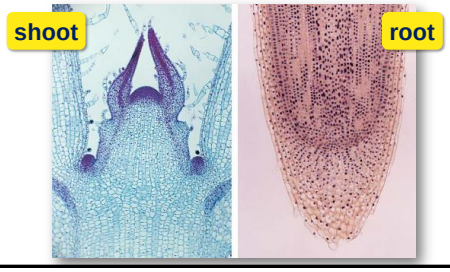

## Growth in Woody Plants

- Woody plants grow in height from tip
  - primary growth
  - apical meristem
- Woody plants grow in diameter from sides
  - secondary growth
  - vascular cambium
    - vascular meristem layer



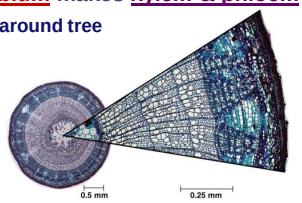
## Growth in Woody Plants

- Primary growth
  - tips of roots & shoots (apical meristem)
  - restricted to youngest parts of plant



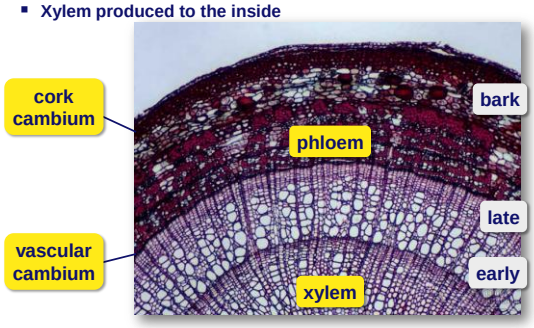

## Growth in Woody Plants

- Secondary growth
  - thickens & strengthens older part of tree
  - cork cambium makes bark
    - growing ring around tree
  - vascular cambium makes xylem & phloem
    - growing ring around tree

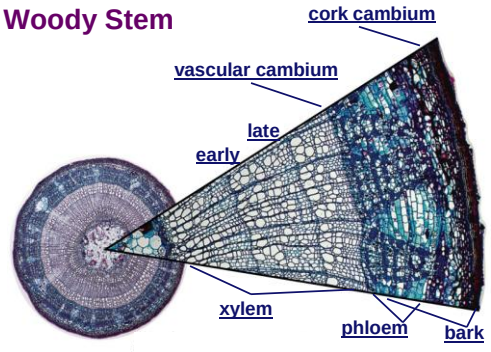



## Woody Stem

- Phloem produced to the outside
- Xylem produced to the inside



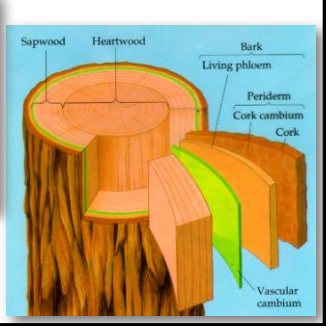

## Woody Stem




## Tree Trunk Anatomy

tree girdling

What does girdling do to a tree?




## Climate Effects of Plant Growth