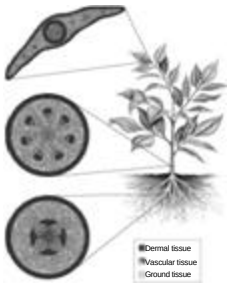
# Roots, Stems, & Leaves




"Plant Anatomy"

## Root Functions:

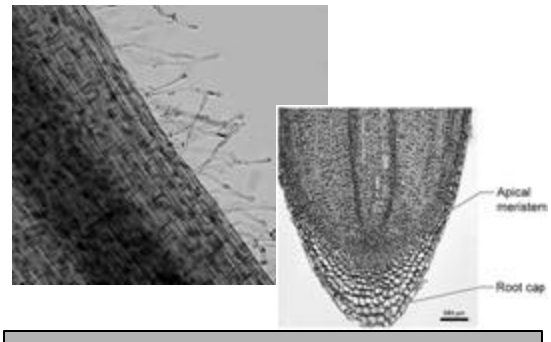
- Anchor plants into the ground
- Absorption of nutrients
- Water and mineral transport

## Roots:

- There are two main root types:
  - Taproots:
    - Appear in most dicots
    - The primary root grows long and thick in comparison to others.
  - Fibrous Roots:
    - Appears in all monocots
    - Roots branch in such a way that no root grows any larger than the rest.

## Root structures:

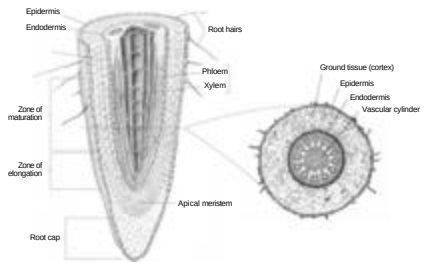
- Epidermis
  - Outer layer of cells (Dermal tissue)
  - Protection and absorption
- Root hairs
  - Tiny cellular projections on the epidermis
  - Increase the surface area of roots for greater water absorption
- Root Cap
  - Covers the tip of roots
  - Tough, but constantly sloughed off and replaced
  - Allows for protection of the root as it pushes through the soil
  - Secretes a polysaccharide slime lubricant so it can easily push through soil
- Apical Meristem
  - Region of rapid cell division of undifferentiated cells
  - Near root tip
  - Meristem tissue
  - Primary growth that lengthens the plant




## Root structures:

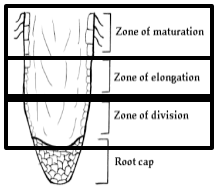
- Cortex:
  - Region between epidermis & vascular cylinder. Supports plant structures & stores food.
  - Made of ground tissue.
- Endodermis:
  - Encloses the vascular system
- Vascular Cylinder
  - Core of vascular tissue
  - Contains the xylem and phloem

## Root Structures:




## Root Zones:

- **The Zone of Cell Division**
  - Three areas just above the apical meristem that continue to divide for some time
- **The Zone of Elongation**
  - Cells elongate up to ten times their original length
  - This growth pushes the root further downward into the soil
- **The Zone of Maturation**
  - Region of the root where completely functional cells are found

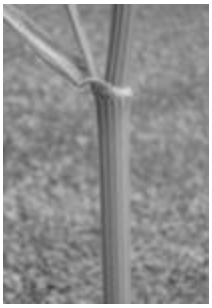



## Specialized Roots:

- **Prop Roots**
- **Aerial Roots**

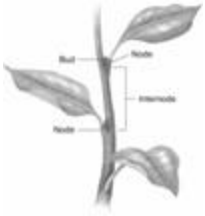
## Stem Functions:

- Produce leaves, branches, flowers
- Hold leaves to the sun for photosynthesis
- Transport materials through the plant



## Stem Structures:

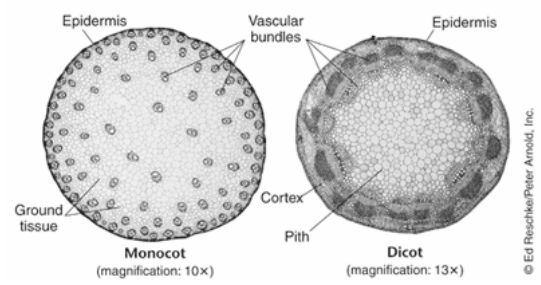
- Surrounded by epidermis:
  - Epidermal cells have thick cell walls and cuticle. (Cuticle is a waxy protective coating.)
- Nodes:
  - Location of leaf attachment
- Internodes:
  - Regions between nodes
- Leaf scar:
  - the scar left on a stem or branch when a leaf falls off
- Bud:
  - Tissue that is undeveloped
  - Tissue that can make new stems (branches) and leaves



## Stems:

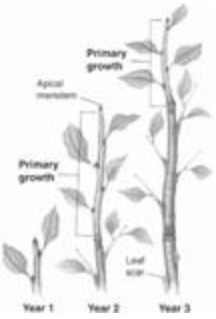
- Monocot stems
  - Distinct Epidermis
  - Ground tissue: mainly parenchyma cells
  - Vascular bundles: Scattered
    - Phloem: faces the outside of the stem
    - Xylem: faces the center
- Dicot and Gymnosperm stems
  - Distinct Epidermis
  - Ground tissue: mainly parenchyma cells
    - Inside the ring of vascular bundles: Pith
    - Outside the ring of vascular bundles: Cortex
  - Vascular bundles: In organized rings
    - Phloem: faces the outside of the stem
    - Xylem: faces the center

## Monocot/Dicot Stems:




## Primary Stem Growth:

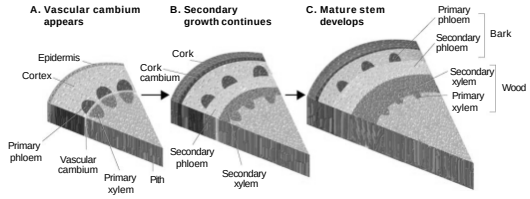
- Apical Meristem:
  - Plant lengthening meristem located at the tips of roots and stems.
  - Divide every year.
  - Responsible for Primary growth:
    - Increase of plant length
    - Primary stem growth for one year includes: stem and several leaves.
    - Each year the primary growth is at the tips.
      - Amount of primary growth is used to determine the health of the tree and available nutrients.




## Secondary Stem Growth:

- Lateral Meristem:
  - Meristem that increases the girth of stems and roots.
  - Responsible for Secondary growth:
    - Increasing width of plant.
  - In Dicots and Conifers, lateral meristematic tissues are called vascular cambium and cork cambium.
    - Vascular Cambium:
      - produces vascular tissue
      - increases thickness of stem
      - is a thin layer between the xylem and phloem
      - divides to become new xylem and phloem
      - Pushes Xylem to the center and Phloem to the outside
    - Cork Cambium
      - Produces the outer covering of stems (bark)

## Secondary Stem Growth:




## Woody Stems:

- Wood: Made of Xylem
- Bark: Made of Phloem

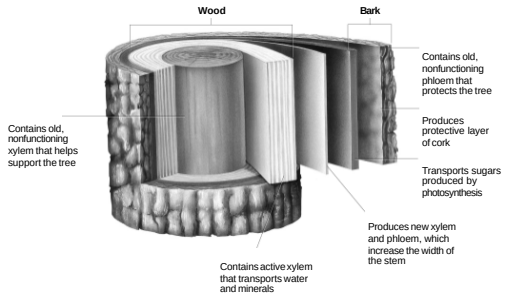
## Wood:

- Heartwood:
  - Nonfunctioning xylem
  - In the center of the stem
  - Used as support for the tree
  - Darkens with age due to impurities that collect and can not be removed
- Sapwood:
  - Active and functioning xylem; youngest cells
  - Conducts/transports fluids
  - Light in color
- Spring wood:
  - AKA: Early wood
  - Large, light colored, thin cell walled xylem cells that undergo rapid growth in the spring
- Summer wood:
  - AKA: Early wood
  - Grow later in the season
  - Cells are smaller and have thicker cell walls (makes them darker in color)
- Annual Rings:
  - Each is made of one layer of spring wood and one layer of summer wood.
  - Quantity: used to estimate age.
  - Size: provides information on weather (wet/dry year)
    - Thick: favorable conditions for tree growth
    - Thin: unfavorable conditions for tree growth

## Bark:

- All tissues outside the vascular cambium
  - » Remember: The vascular cambium increases the width of the stem and forces the phloem outward. This causes the older tissues to split and fragment.
  - – Phloem
    - Transports sugars produced in photosynthesis
  - – Cork cambium
    - Surrounds the cortex
    - Produces the thick protective cork layer
  - – Cork
    - Cells with a thick cell wall and oils, fats, or waxes for waterproofing and water loss prevention
    - Outermost cells are dead

## Woody Stems:

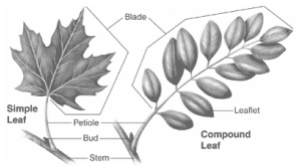



## Modified Stems:

- Some stems are modified for storage and dormancy.
- Modified stems remain underground.
  - – Tuber:
    - store food
    - ie: potato
  - – Bulb:
    - stem with short thick leaves that store food and protect the stem; remain dormant for long periods
    - ie: Amaryllis
  - – Corm:
    - similar to a bulb; thickened stem that stores food with an outer covering made of thin leaves
    - ie: crocus, gladiolus
  - – Rhizome:
    - Horizontal stems that grow underground; dormancy periods
    - ie: ginger

## Leaves:

- Specialized structures for photosynthesis, transpiration, and gas exchange.
- Remember:
  - – We have simple and compound leaves.
  - – We have blades, petioles, leaflets, veins, midribs…



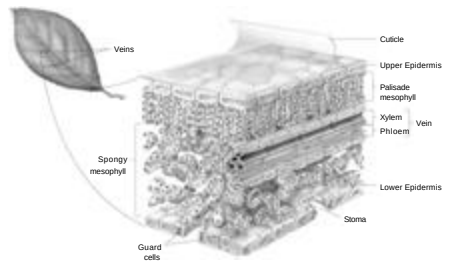

## Leaf Structures:

- Epidermis:
  - – Upper and lower
- Cuticle:
  - – waxy covering over the upper epidermis to form a waterproof barrier
- Vascular tissue:
  - – connected directly to vascular tissue of stems;
  - – called veins (consisting of both xylem and phloem)

## Leaf Structures:

- Mesophyll:
  - – specialized ground tissue that carries out photosynthesis
- Spongy Mesophyll:
  - – irregularly shaped
  - – have large intracellular spaces (loosely packed)
- Palisade mesophyll:
  - – directly under the upper epidermis
  - – absorb light as it enters the leaf
  - – closely packed elongated cells (Columnar cells)
  - – parenchyma cells, photosynthesis occurs here.

## Leaf Cell Types:




## Leaf Structures:

- Stomata (singular is Stoma):
  - pore like openings on the lower epidermis
  - allow for gas exchange ($CO_2$ and $O_2$) between the leaf and the environment and also lower water loss
  - open during the day (during photosynthesis) and closed at night or when in hot/bright sunlight or dry conditions
- Guard Cells:
  - specialized cells on the lower epidermis that control the opening and closing of stomata
  - respond to conditions in the environment (wind, temp…)
  - open and close stomata based on water pressure within the leaf
    - high pressure: thin outer cell walls are forced into a curved shape and the inner cell walls pull apart due to swelling
    - low pressure: inner walls pull together and close the stomata

## Stomata: