

PLANT ORGANS

I. **Roots** - uptake of water & nutrients; food storage; anchorage; vegetative propagation; hormone & enzyme synthesis.

A. Classification of Roots

1. Growth Patterns (form)

- a. **Fibrous** - many fibrous roots of same size; shallow; anchorage; never reaches water table; covers large area.
- b. **Tap** - 1st root form (primary or central root) is large; reaches water table; found in woody trees, shrubs, carrots, radishes, etc.

2. Origin - where in plant are roots coming from.

- a. **Primary Roots** - first root to emerge from seed.
- b. **Secondary Roots** - originate from Primary Root.
- c. **Adventitious Roots** - form if other roots systems are damaged; comes from stems & leaves; found in monocots.
- d. **Seminal Roots** - originate in grasses; develops behind the primary (central) root.

3. Special Functions

- a. **Storage Roots** - fleshy; abundant parenchyma that stores starch & sugar; e.g. sweet potatoes, red beets.
- b. **Aerial Roots** - originate above ground; support.
- c. **Parasitic Roots** (Haustoria) - penetrates host; e.g. mistletoe.
- d. **Vegetative Propagation** - root systems where asexual reproduction occurs.

B. External Morphology

1. **Root Cap**
2. **Region of Cell Division** (Apical Meristem)
3. **Region of Elongation** (3 Primary Meristems)
4. **Region of Maturation** (Root Hair Zone)

C. Internal Morphology

1. **Apical Meristem**
2. **Protoderm, Ground Meristem, Procambium**
3. **Epidermis, Cortex, Endodermis, Pericycle, Stele, Vascular Cambium, Primary Phloem & Xylem.**
4. **Casparian Strips** - suberin ribbon around endodermal cells; regulates water flow.

II. **Stems** - normally above ground; supports leaves, flowers, & fruit; storage; vegetative propagation; propagation of material.

A. **Types**

1. **Woody** - secondary growth of xylem (wood).
2. **Herbaceous** - secondary xylem absent.
3. **Monocot** - vascular bundles (xylem & phloem) randomly arranged in ground parenchyma; no trunks or secondary growth.
 - a. **Primary Xylem** - some vessel elements are ripped open because of rapid elongation & produce **lacuna**; vascular bundles surrounded by **bundle sheath** (fibers) that supplies support.
4. **Dicot** - vascular bundles arranged in circular pattern.
5. **Annual** - lives for 1 year only.
6. **Biennial** - lives for 2 years only.
7. **Perennial** - lives for more than 2 years.
8. **Deciduous** - all leaves drop at same time.
9. **Evergreen** - leaves drop throughout year but not all at once.
10. **Specialized**
 - a. **Bulb** - stem growing underground; consists mostly of fleshy scale leaves; e.g. onion.
 - b. **Corm** - fleshy underground stem; much like bulbs but consists mostly of stem.
 - c. **Rhizome** - underground stems that grow horizontally & bear adventitious roots; vegetative propagation; leaf & vascular bundle scars present.
 - d. **Tuber** - underground stem grown on tip of a rhizome; apical bud opposite the rhizome scar; axillary buds present; stores food; vegetative propagation; e.g. potatoes.
 - e. **Tendrils** - modified stem which attaches plant to a support; e.g. grape vine.
 - f. **Thorn** - sharp, hard, & pointed stem; probable survival value; leaves are always attached to thorns (stems) as opposed to spines (leaves) which have axillary buds associated with them.
 - g. **Stolon** (runners) - grows above & parallel to ground; not fleshy; vegetative propagation; where buds touch ground roots are put down & leaves grow.
 - h. **Cladophyll** - branches (stems) which develop from axillary buds; look & function like leaves.

B. **Structure** (Dicot) - all stems have buds associated with them; buds in temperate zones have protective layers.

1. **External Morphology**

- a. **Apical Bud** (terminal)
- b. **Axillary Buds** (lateral) - occur at intervals along stem.
- c. **Terminal Bud Scale Scars** - narrow ridges transverse to axis of stem, marking the base of the apical bud scales of previous years.
- d. **Leaf Scars**
- e. **Vascular Bundle Scars**
- f. **nodes & internodes**
- g. **Lenticels** - small slits which develop in corky areas of the stem & allow gas exchange.

2. **Internal Morphology**

- a. **Apical Meristem**
- b. **Protoderm, Ground Meristem, Procambium**
- c. **Pith** - parenchyma.
 - (1) **Pith Ray**
- d. **Primary Phloem & Xylem**
- e. **Vascular Cambium** - meristematic cells.
- f. **Pericycle** - parenchyma & fibers.
- g. **Cortex** - parenchyma & collenchyma.
- h. **Epidermis**
- i. **Cuticle** - deposited on outer surface of epidermis.
- j. **Periderm** - replaces epidermis.
 - (1) **Cork Cells** (Phellem) - impregnated with suberin.
 - (2) **Cork Cambium** (Phellogen)
 - (3) **Cork Parenchyma** (Phelloderm)
- k. **Interfascicular Cambium**
- l. **Wood** (Xylem) **Rays** - radial conduction.

C. Wood (Secondary Xylem)

1. **Heartwood** - central darkened core no longer functional in storage or transport of water & minerals.
 - a. **Tyloses** - ingrowths of adjacent living parenchyma cells through pits & into lumens of dead vessel elements.
2. **Sapwood** - functional xylem.
3. **Softwood** - found in conifers; composed mostly of tracheids.
4. **Hardwood** - found in dicots; more complex; made of vessel elements, fibers, & some tracheids.
5. Pericycle cracks; periderm formed; annual rings (spring & summer wood) form; cavitation occurs.

III. Leaves - Food Production; Transpiration; Originate from leaf primordia.

A. Structure

1. **Petiole**
 - a. **Sessile Leaves** - leaves without a petiole.
2. **Blade**
3. **Veins** - vascular system that also supplies support.

B. Venation - vein patterns in leaves.

1. **Parallel Venation** - all main veins are parallel; monocots.
2. **Pinnately Veined** - one very large main vein (mid rib) with minor veins attached to it.
3. **Pinnately Parallel** - mid rib with perpendicular minor veins (minor veins parallel to each other).
4. **Palmately Netted** - all major veins originate from one point.

C. Leaf Types

1. **Shade** - much larger & thinner than Sun leaves; single palisade layer; large (many) intercellular space in spongy mesophyll; stomates may be on both surfaces; veins smaller & less in number.
2. **Sun** - opposite of Shade Leaves; two or more palisade layers; smaller & thicker; stomates on lower surface only; veins larger & greater in number; small intercellular spaces in spongy mesophyll.
3. **Simple** - undivided blade.
4. **Compound** - leaf blade divided into leaflets; Pinnately or Palmately veined; axillary bud at base of petiole; no apical bud (distinguishing point).
 - a. **Rachis** - area where leaflets are attached.
5. **Hydrophytic** - grow in submerged or very humid environment; very small & few veins; no cuticle or stomates; large spaces in spongy mesophyll.
6. **Xerophytic** - grow in very dry environment; thick cuticle; lots of lignified tissue; sunken stomates & deep convolutions; leaf small in size & sometimes reduced to spines.
7. **Mesophytic** - grow in moderate conditions; moderate venation, cuticle, lignification.
8. **Monocot** - no petiole; parallel venation.
9. **Dicot** - any venation except parallel.
10. **Specialized**
 - a. **Bud Scales** - protects buds in temperate environments or during winter.
 - b. **Insectivorous** - traps insects for nutrition; e.g. pitcher plants, sun dews, venus fly traps.
 - c. **Storage**
 - (1) **Cotyledons** - stores food.
 - (2) **Succulent** - stores water.
 - d. **Tendril**
 - e. **Spine** - axillary bud present.
 - f. **Propagative** - gives rise to other plants asexually.
 - g. **Sexual Reproduction** - parts of flowers; sepals, petals, stamens, pistils.
 - h. **Vestigial Leaves** - reduced leaves; tiny, scale like; e.g. cactus.

D. Patterns of Leaf Arrangement

1. **Alternate (Spiral)** - 1 leaf at a node.
2. **Opposite** - 2 leaves at a node.
3. **Whorl (Whorled)** - 3 or more leaves at a node.

E. Internal Structure (Typical Dicot Leaf)

1. **Upper Surface** (ventral)
2. **Lower Surface** (dorsal)
3. **Epidermis** - single layer of complex cells with no intercellular spaces except at stomates; upper & lower.
 - a. **Epidermal Hairs**
 - b. **Guard Cells** - photosynthetic.
 - c. **Glandular Hair Cells**
4. **Mesophyll** - parenchyma with chloroplasts.
 - a. **Palisade**
 - b. **Spongy**
5. **Vascular System** - veins.
6. **Cuticle** - can be on upper & lower surfaces.

F. Ecology of a Leaf - sources of:

1. food - lettuce, cabbage, etc.
2. flavor - spices.
3. fibers - hemp, flax.
4. wax
5. drugs
6. pleasure leaves - tobacco, tea.

G. Abscission (Senescence) - leaves get old & fall off of stem; very little lignified tissue at base of petiole (abscission zone), hormone produced by parenchyma (pectinase) that dissolves middle lamella, leaf weakens & falls off, leaf scar suberized & cork forms.