

Lecture Outline: Plant Structure and Growth

I. *Classification of Plants and Angiosperms*

A. Plants are a **true clade**/monophyletic taxon

B. Major Plant Groups

1. Nonvascular plants (also called **bryophytes**)

2. Vascular plants (contain vessels)

a. Seedless vascular plants (e.g., the **ferns**)

b. Seeded plants

(1) **Gymnosperms** (naked seed, e.g., conifers)

(2) **Angiosperms** (chambered seed, **flowering plants**)

i. Hallmarks (The three Fs): **Flowers**, double fertilization, **fruit**

ii. Most successful plants; most living plant species are angiosperms

C. Angiosperm Subdivisions: Monocots vs. Eudicots

1. Cot part means **cotyledon** (seed leaf)

2. Cotyledon function: transfers nutrients to the **embryo**

3. Monocots: **One cotyledon**

4. Eudicots (Dicots): Truly **two cotyledons**

D. Key Differences (Comparison)

1. Embryo: One cotyledon (Monocot) vs. Two cotyledons (Eudicot)

2. Leaf Venation (veins pattern)

a. Monocots: Typically **parallel veins** (e.g., corn/grasses)

b. Eudicots: **Highly branched** or netlike pattern

3. Vascular Bundles in Stems (cross-section)

a. Monocots: **Scattered** (dispersed) throughout the stem

b. Eudicots: Arranged in a **circle**

4. Root System

a. Monocots: **Fibrous root system** (no single taproot); branches are uniform

b. Eudicots: Possess a large **taproot**, mainly for anchoring

5. Pollen Grain (microscopic): Monocots typically **single opening**; Eudicots **three openings**

6. Flower Petals: Monocots **multiples of three**; Eudicots **multiples of four or five**

II. *Basic Anatomy and Modified Structures*

A. Body Composition

1. **Shoot system** (above ground): Consists of stems, buds, flowers, leaves
2. **Root system** (below ground): Anchoring and water/nutrient absorption

B. Shoot System Components

1. Leaves: Specialized organs for **photosynthesis**
 - a. Stem-like part of leaf is the **petiole**
 - b. Shoots can be: **Vegetative** (leaves, for growth) or **Reproductive** (flowers)
2. Buds: Sites of new growth
 - a. **Apical buds**: On the very ends (apex/tip) of shoots
 - b. **Axillary buds**: At branch points (*nodes*/axle)
3. Internode: Part of shoot **between two nodes**

C. Root Structure and Function

1. Main function: Allowing **water and dissolved minerals to enter** the plant
2. Absorption achieved via **root hairs** (microscopic projections/microvilli) on individual cells

D. Exceptional/Unusual Structures (Modified Organs)

1. Unusual Roots
 - a. **Storage roots** (e.g., radish): Bulbous, store nutrients
 - b. **Pneumatophores** (air roots): Modified roots for acquiring oxygen in waterlogged soil
 - c. **Strangling aerial roots: Adventitious** roots (growing above ground and downward)
2. Unusual Stems
 - a. **Rhizomes**: Underground, horizontal stems (name means root, but it is a stem)
 - b. **Tubers** (e.g., potato): Underground **storage stems**
 - c. **Stolons**: Horizontal, above-ground stems (can form new plants/clones)
3. Modified Leaves
 - a. **Spines** (e.g., cactus): Non-photosynthetic, modified for **protection**/water retention
 - b. **Tendrils**: Modified for attachment and support (coil and drag the plant)
 - c. **Reproductive leaves**: Modified for **asexual reproduction** (producing clones)
 - d. **Storage leaves** (e.g., onion): Store nutrients underground

III. **Plant Tissues and Cell Types**

A. Three Major Tissue Types

1. **Dermal tissue**: Outer covering (dermis means skin)
2. **Vascular tissue**: Contains tube-like vessels (purple part in cartoon)
3. **Ground tissue**: Catchall category, fills space between dermal and vascular tissue

B. Cell Types Based on Toughness (Enkma Tissues)

1. **Parenchyma cells** (Least tough): Thin-walled, primary function is **photosynthesis** (e.g., mesophyll)

1. Remain **alive at functional maturity**
2. **Collenchyma cells** (Intermediate toughness): Thicker cell walls, provide structure (e.g., green stem)
 1. Remain **alive at functional maturity**
3. **Sclerenchyma cells** (Most tough): Thickest cell walls, rich in **lignin** (lignified)
 1. Provide **structure and protection**
 2. **Die at functional maturity**

IV. **Vascular Tissue Structure and Transport**

A. Vessels and Sap

1. **Xylem**: Conducts **water** and dissolved minerals (thin sap)
2. **Phloem**: Conducts **sugar** (highly concentrated, thick/viscous sap)

B. Xylem Composition (Dead at Maturity)

1. Made of **tracheids** (smaller diameter) and **vessel elements** (larger diameter)
2. Cells **die at functional maturity** to function as hollow structures for water flow
3. Water passes through **perforation plates** (vessels) or pits (tracheids)

C. Phloem Composition (Alive at Maturity)

1. Made of **sieve-tube elements**
2. Connect via **sieve plates** (full of holes)
3. Sieve-tube elements must remain **alive at functional maturity** for active transport (sugar movement)
4. Kept alive by neighboring **companion cells**

V. **Plant Growth and Development**

A. Growth Types and Meristems

1. Most plants exhibit **indeterminate growth** (grow until death)
2. Growth occurs at **meristems** (sites where new material is added; juvenile tissue)

B. Primary vs. Secondary Growth

1. **Primary Growth**: Increase in **length**. Occurs first, at **primary meristems** (apical/axillary)
2. **Secondary Growth**: Increase in **diameter**/width/girth. Occurs after primary growth

C. Secondary Growth via Lateral Meristems (Cambia)

1. Lateral meristems develop **after** primary growth has occurred in that region
2. **Vascular cambium** (red cylinder): Produces secondary xylem (inward) and secondary phloem (outward)
3. **Cork cambium** (blue cylinder): Produces cork/bark (exterior structures)

D. Secondary Xylem Accumulation

1. Secondary phloem is sloughed off/worn away (does not accumulate thickness)

2. Secondary xylem is produced inward and **accumulates**, forming **tree rings** (wood)
3. **Heartwood** (older xylem) is darker, clogged with **resin**, providing support (no water conduction)
4. **Sapwood** (newer xylem) is functional for water conduction
5. **Girdling** (damaging vascular cambium all the way around) kills the tree

E. Root Tip Growth (Primary Growth Example)

1. **Root cap**: Toughened, dead cells protecting the tip from abrasion
2. **Zone of cell division** (proliferation): Site of apical meristem where new cells are created by mitosis
3. **Zone of elongation**: Cells grow longer in one direction, increasing root length
4. **Zone of differentiation**: Cells mature into specialized tissue types (e.g., vascular tissue, root hairs)

F. Regulation of Shoot Growth

1. **Apical meristem dominance**: Apical bud signals inhibit axillary buds, prioritizing length/height
2. If the apical meristem is destroyed (nipped), **axillary buds take over**, resulting in branching
3. New root branches erupt from the **vascular cylinder** to connect to existing vessels

VI. Tissue Arrangement in Organs

A. Leaf Structure (Cross-section)

1. Epidermis: Outer layer waterproofed by **waxes** (lipids)
2. **Stomata** (openings): Allow CO₂ entry for **carbon fixation**; formed by **guard cells**
3. Mesophyll: Interior tissue for photosynthesis (mostly parenchyma cells)

B. Root Tissue Arrangement (Cross-section)

1. Eudicot Root: Vascular tissue centralized; Xylem forms an **X-like structure** in the center
2. Monocot Root: Vascular bundles **spread out** in the center core

C. Stem Tissue Arrangement (Cross-section)

1. Eudicot Stem: Vascular bundles arranged in a **ring**
2. Monocot Stem: Vascular bundles **dispersed** throughout the stem
3. In all stem bundles: **Phloem faces outward** (superficial); **Xylem faces inward** (deep)