Plant Structure and Function

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Biology 11
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Plant Kingdom

• Traits of the kingdom
  – Multicellular
  – Cell walls of cellulose
  – Pigments
    • Chloroplasts w/ chl a & b
    • Accessory pigments (ie, carotenoids)
  – Primarily terrestrial
  – Dominant P/S organisms on land
Adaptations required to live on land

• Shoot = portion above ground
  – Leaves for P/S – increase surface area for light & CO₂ absorption
  – Flowers for reproduction
  – Fruit for dispersal
Adaptations required to live on land

• Roots = portion below ground
  – Root hairs increase **surface area** for absorption
  – Anchor plant
  – Absorb water
  – Absorb minerals, nutrients, etc.
Adaptations required to live on land

- Adaptations to avoid dehydration
  - Waxy cuticle covers stems & leaves
    - Decreases evaporation
    - Inhibits gas exchange
Adaptations required to live on land
Adaptations required to live on land

• Adaptations to avoid dehydration
  – Waxy cuticle covers stems & leaves
    • Decreases evaporation
    • Inhibits gas exchange
  – Stomata on leaves
    • Allow gas exchange
    • Guard cells close over stoma to minimize water loss
Adaptations required to live on land
Adaptations required to live on land

Guard cells

Stoma open during daytime

CO₂

Stoma closed at night

H₂O
Adaptations required to live on land

• Vascular system
  – Provides transport
    • Water & P/S products carried throughout plant
  – Provides support
    • Holds leaves up for sunlight
Vascular Tissue

• Xylem
  – Carries water and minerals from roots to leaves
  – Dead cells
  – Hollow with pores or pits to allow water movement
Xylem Function

Transpiration pulls water out

Water molecules adhere to each other due to H-bonds

Roots actively pump minerals in, water follows via osmosis
Vascular Tissue

- **Phloem**
  - Carries P/S products from leaves to roots, etc.
  - Living cells
  - Plasmodesmata (=gap junctions)
Phloem Function -- Translocation

1. High sugar in leaves is actively pumped into phloem, water follows via osmosis from xylem

2. High pressure at source pushes sugar solution towards root

3. Sugar actively pumped into root, water leaves via osmosis into xylem
Plant Growth

• Primary growth
  – Growth in length or height
  – Occurs at tips of branches and roots

• Secondary growth
  – Growth in diameter
Plant Growth

• Meristematic tissue
  – Region of plant cell growth
  – Undifferentiated, unspecialized
  – Rapid rate of mitosis
  – Area of cell division
    • Cells will differentiate later
Plant Growth

• Apical meristem
  – Found at tips of stems and roots
  – Produces primary growth
  – Cells formed here are primary tissues
    • Will differentiate into stems, leaves, flowers later
Plant Growth

- Primary growth
  - Growth occurs at tip
  - One cell pushed forward, will wear off
  - One cell pushed back, will elongate causing growth
  - Will later differentiate
Plant Growth

- Lateral meristem
  - Occurs as a ring of cells inside stems and branches
  - Vascular cambium
    - Produces secondary growth
    - Cells here differentiate as they are formed
      - Xylem is pushed inside the ring and dies
        » Form tree rings
      - Phloem is pushed outside the ring
        » Living cells that eventually die (bark) and wear away
        » not permanent, no rings
Secondary Growth

Year 1
Early Spring

Growth

Primary xylem
Epidermis
Vascular cambium
Cortex
Primary phloem

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Secondary Growth
Secondary Growth

Year 1
Early Spring

Growth

Primary xylem
Epidermis
Vascular cambium
Cortex
Primary phloem

Late Summer

Growth

Secondary xylem (wood)
Cork cambium
Secondary phloem

Year 2
Late Summer

Growth

Shed epidermis
Cork
Bark
Secondary xylem (2 years’ growth)
Secondary Growth

• Secondary growth gives rise to tree rings
  – One ring = one year in temperate regions
    • Count rings to tell age of tree
  – Rings wider when season is wet
    • More water uptake expands cells further
    • Width of rings tells about climate that year
Tree Rings

[Diagram of tree rings with labels: Annual rings, Heartwood, Sapwood, Vascular cambium, Bark, Secondary phloem, Cork cambium, Cork]
Lost Colony of Roanoke

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Plant Hormones

• What is a hormone?
  – Molecule that binds to receptor protein and triggers reaction inside cell
Plant Hormones

• What is a hormone?
  – Molecule that binds to receptor protein and triggers reaction inside cell

• Hormones have target cells
  – Different target cells may respond differently to same hormone
Plant Hormones

• Plants respond to hormones
  – Start growing
  – Stop growing
  – Bends towards light
  – Differentiation of specialized cell types
Plant Hormones

• Auxins
  – Group of growth hormones
  – Indoleacetic acid (IAA) most common
  – Produced at stem tips, root tips, embryos, young leaves, fruit
Plant Hormones

• Auxins
  – Shoot growth (primary growth)
Plant Hormones

- **Auxins**
  - Shoot growth (primary growth)
    - Auxin produced in apical meristem and migrates to zone of elongation
    - Causes cells behind apical meristem to elongate
    - Cut off stem tip
      - no more auxin, no more primary growth
Plant Hormones

• Auxins
  – Secondary growth
Plant Hormones

• Auxins
  – Secondary growth
    • Auxin produced in apical meristem eventually migrates to zone of differentiation
    • Auxin stimulates differentiation of secondary xylem and phloem
Plant Hormones

• Auxins
  – Abscission
    • Dropping of leaves & fruit
Plant Hormones

• Auxins
  – Abscission
    • Dropping of leaves & fruit
    • Older leaf and fruit stems ↓ auxin production
      – Cells at base of stem disintegrate
      – Leaves or fruit fall off branch
Plant Hormones

• Auxins
  – Phototropism
    • Growing tips bend towards light
Plant Hormones

- Auxins
  - Phototropism
    - Growing tips bend towards light
    - Auxin migrates away from light
      - Causes elongation on “dark” side of stem
      - Stem bends toward light
Plant Hormones

• Auxins
  – Apical dominance
Plant Hormones

• Auxins
  – Apical dominance
    • Auxin from apical meristem inhibits side branches
      – Pinch off apical meristem to get bushy plants
Plant Hormones

• Auxins
  – Gravitropism
Plant Hormones

- Auxins
  - Gravitropism
    - Stems grow up
    - Roots grow down
    - Stems and roots respond differently to auxin
Plant Hormones

• Gibberellins
  – Group of growth hormones
  – produced in stems, young leaves, seeds
  – Cell division and elongation
    • Stem elongation
    • ↑ gibberellins gives long, thin stems w/few leaves
  – Enhances auxins
    • Fruit development
Plant Hormones

• Ethylene
  – Ripens fruit
  – Leaf abscission
  – Fading of chlorophyll
  – Fading of flowers

• What do you do with an avocado to ripen it more quickly?
Plant Hormones

• Ethylene
  – Ripens fruit
  – Leaf abscission
  – Fading of chlorophyll
  – Fading of flowers
Photoperiod

• Light helps regulate plant life cycle
  – Most plants respond to amount of light/dark
  – Flowering often triggered by photoperiod
    • Short-day plants (actually long-night plants)
      – Flower early spring or fall
    • Long-day plants (actually short-night plants)
      – Flower in summer
    • Day–neutral plants respond to something other than photoperiod
Photoperiod

• Mechanism for flowering
  – Actually respond to #dark hours
    • Phytochrome is agent of flowering
      – Two forms – $P_{far-red}$ and $P_{red}$
      – $P_{red} \rightarrow P_{far-red}$ in light
      – $P_{far-red} \rightarrow P_{red}$ slowly in dark
    • Phytochrome far-red is active form
      – Inhibits flowering in short day plants
      – Stimulates flowering in long day plants
Photoperiod

$P_{\text{far-red}}$ stimulates flowers  

$P_{\text{far-red}}$ inhibits flowers