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Plant Anatomy

I. Unique to Plants
   a. Chloroplasts
   b. Vacuole
   c. Cell Wall
   d. Plasmodesmata
   e. Phragmoplast

II. Plastids
   a. Any class of small organelles, such as chloroplasts, in the cytoplasm of plant cells, containing pigment or food; have their own DNA
   b. Produce: Lipids, amino acids, “secondary” products, some hormones
   c. Store: Starch/lipids
   d. Three Types of Plastids
      i. Chloroplasts- photosynthetic
      ii. Chromoplasts- pigmented: carotenoids
      iii. Amyloplasts- store starch
      iv. *All can interconvert depending on development and environment

III. Chloroplasts
   a. Stroma- colorless fluid inside chloroplast
   b. Thylakoid- site of light-dependent photosynthesis
   c. Granum- stack of thylakoids
      i. Moved around cell to optimize light capture
   d. Inner and outer membranes

IV. Chromplasts and Amyloplasts
   a. Chromoplasts- colored plastid other than chloroplast, has carotenoids, more orange tint (like carrots)
   b. Amyloplasts- non-pigmented organelles responsible for storing starch granules (like in potatoes)

V. Plant Vacuoles
   a. Important For
      i. Turgor and water storage
      ii. Nutrient storage
      iii. Recycling
      iv. Pigmentation
      v. Xenobiotics
         1. Tannins
         2. Polyphenols

3. Proteases
4. Glucosidases
5. Nucleases
6. Neurostimulants

b. Makes up to 95% of cell volume
c. Recycling by autophagy ("self-eating")
d. Contains flavonoids that help attract pollinators with color
    i. Anthocyanins (red, blue purple) are a type of flavonoid that protect plant from intense UV light
    ii. Beets have betalin (anti-oxidants)
    iii. The apple shown on the right is an example of how a leaf covering part of the apple from the sun meant the apple did not have to produce as many anthocyanins over that area

e. Vacuole releases proteases, glucosidases, and polyphenols (to ensure mutually assured destruction)
    i. Proteases- enzyme that breaks down proteins and peptides
    ii. Glucosidases- enzymes that break down starch and glycogen
    iii. Tannins (when polyphenols interact with oxygen and proteins) = make tissue brown
        1. Cutting an apple ruptures the vacuole, exposing it to oxygen, and makes tannins
        2. Found in tea, avocados, brown guacamole, bananas, and apples
        3. Throw lemon juice (anti-oxidant) to prevent exposure to O2 and therefore prevent tannins

VI. Cell Wall
a. Primary wall- thin, flexible layer
b. Secondary wall- thick layer formed inside primary cell wall after cell is fully grown
c. Middle lamella- made of hectin and calcium, it glues plant cells to each other and hectins (acid polysaccharide) "glues" calcium
d. Plamosdesmata- junctions that allow molecules to travel between plant cells; "tunnels" formed through the cell wall allows cells to connect with each other
    i. Desmotubule prevents cytoplasm from one cell to transfer to another cell

        ii. Apoplastic pathway (through cell wall)
        iii. Symplastic pathway (through cytoplastm)
    e. Cell wall prevents cell migration
    f. Starch and cellulose are glucose polymers in plants. Starch is digestible (alpha 1-4 linkage) while cellulose is not by most organisms (beta 1-4 linkage)
    g. Lignin- fills space in cell wall and rigidifies it
    h. Phragmoplast- cell plate for cell division

VII. Plant Cells
    a. Multi-purpose
        i. Unlike animal cells with devoted functions
        ii. Many plant cells can perform many functions at once
        iii. Functions of cell type can vary with tissue and time
    b. Parenchyma Cells
        i. Common among tissues
        ii. Multiple functions
            1. Photosynthesis
            2. Storage (amyloplasts in potato tuber)
            3. Synthesis
    c. Collenchyma
        i. Thickened cell walls for support
    d. Sclerenchyma
        i. Thickened cell wall for support
        ii. Dead at maturity
        iii. Fibers (like in celery and cotton)
            1. Long and in bundles (cotton fibers) and protection
            2. Type of sclerenchyma
        iv. Sclereids
            1. Short and irregular shapes (seed coats, nut shells, and gritty texture of pears)
            2. Type of sclerenchyma
    e. Xylem
        i. Thickened cell walls
            1. Water transport
            2. Support
        ii. Dead at maturity
        iii. Most abundant cell in trees
        iv. Vessel Elements-Angiosperms
            1. Cells arranged as pipes

            2. Perforations at ends
            3. Rings of 2d thickenings
        v. Tracheids- Gymnosperms and Angiosperms
            1. Not connected
            2. Use pits
    f. Phloem
        i. Sieve tubes
            1. Thickened cell walls with sieve plate
            2. Water and nutrient transport
            3. Alive at maturity but no nucleus
            4. Associated with companion cells
            5. Can form clots when damaged

VIII. Plant Tissues

a. Vascular tissue- derived from procambium
    i. Xylem, phloem, and sclerenchyma
b. Ground tissue- derived from ground meristem
    i. Pith and cortex (sites of biochemistry and storage)
c. Epidermal tissue
    i. Epidermis- derived from protoderm
    ii. Epidermis of Root
        1. Root hairs (water and mineral acquisition)
    iii. Epidermis of Leaves
        1. Cuticle
        2. Stomata
        3. Fibers and Trichome
        4. Pigments and defense compounds