Chapter 30: Green Plants

Note: The group Green Plants includes both land plants AND green algae.

Reasons:
closely related to land plants and form a monophyletic group with them
both contain chloroplasts with chlorophyll a and b and B-carotene; thylakoid membranes similar
sperm and peroxisomes are the same
cell walls are similar in composition
both store energy as starch

I. Why do biologists study green plants?
  a. Ecosystem services
    i. Produce oxygen gas by photosynthesizing
    ii. Fix carbon dioxide gas and use it to make sugar
    iii. Build soil by contributing organic matter
    iv. Prevent erosion by holding soil particles together with roots
    v. Prevent runoff by softening rain drop impact and holding water
    vi. Moderate local climate by reducing temperature and increasing humidity
    vii. Provide food for herbivores
  b. provide humans with goods and services
    i. provide food
    ii. provide fuel (wood, coal, peat, petroleum)
    iii. provide fibers for textiles and rope
    iv. provide lumber for building material
    v. provide drugs (Table 30.1)

II. How do biologists study green plants?
  a. Morphological traits (Land Plants)
    i. Nonvascular
    ii. Seedless vascular
    iii. Seed plant
      1. gymnosperms
      2. angiosperms
  b. using the fossil record (fig 30.8)
    i. 700-725 mya – green algae in rocks (700 mya – diversificationof green algae; high oxygen in oceans
    ii. 475 mya – first land plants – spores with sporopollenin, cuticle, spore-producing structures sporangia
    iii. 445 mya- water-conducting tissue, roots
    iv. 359 mya – spores, branches, leaves, tree trunks (lycophytes, hoursetails, ferns) forested swamps
    v. 251 mya – emergence of gymnosperms (both wet and dry environments on land) seeds
    vi. 150 mya – first flowering plants
  c. evaluating molecular phylogenies (fig 30.9) demonstrate major high points of evolution
    i. based on DNA and morphology
      1. note: green plant group is monophyletic, but green algae group is not. Another reason to include green algae with land plants.
      2. land plants are monophyletic: the transition from water to land occurred once. Diversification occurred later.
      3. non-vascular plants- still unclear if they are mono or paraphyletic

III. What themes occur in the diversification of green plants?
  a. Adapting to dry conditions
    i. Benefits of living on land
      1. better light
      2. carbon dioxide more available
    ii. Beneficial adaptations

1. Prevent water loss
    a. Cuticle (waxy, watertight sealant)
    b. Stomata (openings in leaf surface that allow for gas exchange while minimizing water loss)
        i. Openings in cuticle
        ii. Controlled by guard cells
2. Transporting water
    a. Upright growth
        i. Allows for maintaining contact with wet soil with better access to sunlight.
    b. transporting water
        i. aided in support AND transporting water
        ii. figure 30.11
        iii. tracheids (tapered ends with gaps in secondary cell wall)
        iv. vessel elements (ends have gaps with gaps in primary and secondary cell walls)
3. Mapping evolutionary change
    a. Figure 30.12 puts together evolutionary milestones and their place on the Phylogenetic tree.

b. How do plants reproduce on dry land?
  i. Sporopollenin – tough coat surrounding spores
  ii. Gametes produced in complex, multi-cellular structures
    1. gametangia
        a. distinctively male (antheridium) and female (archegonium)
        b. present in all land plants except angiosperms
  iii. Embryo retained on parent plant and nourished by it
    1. eggs form inside archegonium
    2. after fertilization, zygote remains attached to parent
  iv. Alteration of generations (figure 30.16)
    1. multicelled haploid = gametophyte
    2. multicelled diploid = sporophyte
    3. start with gametophyte (n) and trace cycle. Be sure you can answer:
        a. What is the difference between the zygote and the spores?
        b. How is haploid condition achieved? (where, by what process?)
        c. How is diploid condition restored (where, by what process)?
        d. By what process are gametes made?
        e. By what process are spores made?
  v. variations on alteration of generations (figs 30.17, 30.21, 30.22)
    1. In plants, sometimes the gametophyte is the dominant generation, sometimes the sporophyte is.
        a. Mosses – gametophyte is dominant stage; sporophyte is short-lived and feeds off of gametophyte.
        b. Ferns (and other vascular plants) – sporophyte is dominant stage; gametophyte is very small, even microscopic in some species.
        c. Switch to sporophyte dominance is significant. Diploid is better than haploid.
    2. Other innovations --- seed plants only
        a. Heterospory (two different spore-producing structures, making two distinctly different spores.)
            i. Microsporangia produce microspores.
                1. Microspores – develop into male gametophytes, which produce a smaller gamete: the sperm

    ii. Megasporangia produce megaspores.
        1. Megaspores – develop into female gametophytes, which producer a larger gamete: the egg.

b. pollen grain
    i. male gametophyte surrounded by a tough coat of sporopollenin
    ii. enables sperm to reach female gametophyte without swimming
    iii. also prevents drying out
c. seeds
    i. embryo + food supply + protective coat
    ii. some surrounded by fruit to aid in dispersal
d. flowers
    i. angiosperms only
    ii. contains
    iii. Contain two key reproductive structures: stamens and carpels
        1. **Stamen** contains the anther, where microsporangia develop
        2. **Carpel** contains the ovary in which the ovules are found; ovules contain megasporangia
    iv. Evolution of flower is a variation of heterospory, with key innovation being the ovary
    v. Evolutionary significance: attract pollinators, increase chances of pollination
e. Fruit
    i. derived from ovary
    ii. encloses one or more seeds
    iii. evolutionary significance: efficient seed dispersal
f. summary (fig. 30.26)