Unit 8: Biodiversity
Content Outline: Plant Kingdom (8.6) – Part 1

I. About 500 Million years ago (MYA) plants begin to leave the watery environment for land.
   A. This is in an attempt to *avoid competition in the oceans* with protists, animals, and fungi for resources.
   B. Plants are believed to have started around the moist coastal areas.
   C. Plant-like protists (algae) are believed to have been the original source.
   D. Four major groups of plants will evolve over millions of years in response to the changing environment.
      1. Bryophytes (mosses) These are non-vascular.
      2. Pteriodophytes (Vascular, non seed plants)
      3. Gynmosperms (Vascular, naked seed plants)
      4. Angiosperms (Vascular, flowering plants)

II. The following *adaptations will evolve over time* in plants to survive on land in a dryer environment.
   A. *Waxy cuticle* on the surface of the leaves. (This helps to avoid dehydrating.)
   B. *Vascular tissue* (This will transport water and nutrients.)
   C. A *Protective seed* (This helps the survival of the embryonic plant during harsh dry times.)
      1. An added benefit is *dispersal increases*. (Seeds can be "moved" into new territory – away from competition.)
   D. *Flowers and fruit develop*. (These structures help moving to new areas or reproducing by *using animals*.)
      Please provide samples of leaves, seeds, flowers, and fruits, for students to see while discussing.

III. Unifying traits that supports all/most plant common ancestry.
   A. The "basic" structure – Root (below ground) and shoot (above ground).
   B. Apical meristematic tissue at the *tips* of roots and shoots. (Where plants grow in height and length.)
   C. Produce a waxy **Cuticle** on herbaceous parts. ("herb" means "soft, fleshy")
   D. There are **Stomata** (openings) on the leaves for *gas exchange* to occur during photosynthesis.
   E. Most plants possess vascular tissue. (Not found in Bryophytes.)
      1. **Xylem** (Carries *water up* the plant towards the leaves.)(These are *dead, hollow* cells.)
         a. There are two types of xylem cells: **Tracheids** (They are small.) and **vessel elements**. (These are large.)
      2. **Phloem** (Carries *sugar water down* to feed the plant or store in the roots.) (These are *living* cells.)
         a. There are two types of phloem cells: **Sieve-tube members** and **Companion cells**.

Part 2

I. Bryophytes Phylum (Name ends with an "e")
   A. There are three major groups that exist presently.
      1. Hepatophyta (Liverworts) ("hepta" means "liver") ("wort" is old English for "plant".)
      2. Anthocerophyta (Hornworts) ("cero" means "horn")
      3. Bryophyta (True mosses) (Name ends with an "a".) Please try to find this one as a visual.
   B. These are *very small* in size. (Only cellulose in the cell wall…so it is very weak.)
   C. Gametophyte generation is the Dominant generation
      1. Due to the presence of water often in the environment. (This is good for swimming, flagellated sperm.)
      2. Possess leaf-like structures called **microphylls**. They have no veins in them.
      3. They possess structures *similar to roots* called **Rhizoids.** They *support* the gametophores upwards.
      4. The *dependent* sporophyte generation will be produced *on top* of the dominant gametophyte.
         a. **Foot** - This is the support base for the sporophyte generation.
         b. **Seta** (Stalk) - This is for rising up *away from the water* for *greater dispersal of spores*.
         c. **Capsule** - This is the s**porangium** - contains the spore cells that undergo *meiosis* to become haploid.
         d. **Calyptera** - This is the removable protective cap on the capsule.
         e. **Peristome** - This structure is for *discharging or shooting the spores outward* away from the parent plant.
   D. They move water and other materials by *diffusion and osmosis* because there is no vascular tissue present.
      1. Therefore the plant can only be a couple of cells thick/wide.

II. Ecological and Economical Importance of Bryophytes
   A. They are a major food source (producers) in the Tundra. (Such as upper Alaska.)
   B. Peat Moss (A.K.A. *Sphagnum*) is a fuel source and also a CO_2 bank. (Remember, it is a greenhouse gas.)
   C. They can be used as a soil conditioner – as they can hold up 20x its weight in water. (Used by gardeners/farmers.)

Part 3

I. About 420 MYA, the first *vascular* plants evolve as plants move farther away from water.
   A. The first group of vascular plants to evolve are *seedless in terms of reproduction*. Sperm still need to swim in water.
   B. They have moved farther inland to *avoid competition* with Bryophytes.
      1. The sporophyte will become the dominant generation. (Due to the environment being less "swampy".)
      2. The gametophyte will remain very small, but now it is *dependent* on the larger sporophyte.

II. Evolutionary adaptations needed for a *drier environment* farther away from water.
   A. *Lignified* cells to increase *cell wall strength*. (Needed to allow roots to burrow through the soil to find water.)
      1. Lignin is a stronger, stickier sugar used to reinforce the cellulose cell wall.
         Please remind students that sugars are referred to as carbohydrates.
   B. *Pectin* to help reinforce the *weight bearing* of cells. (Need to grow taller.)
      1. Pectin also is a stronger, stickier sugar.
   C. *Vascular tissues evolve to move fluids*. (No longer dependent on osmosis/diffusion from the environment.)
   D. *Real roots* evolve from rhizoids. This allows for absorbing and transporting water and nutrients.
   E. *Real leaves* (megaphylls) begin to evolve from an increasing microphyll. ("phyll" means "leaf")
   F. Reduced gametophyte generation; increased sporophyte generation. (Environment is becoming drier.)
      Please stress to students that the gametophyte generation is heavily dependent upon the presence of water; whereas the sporophyte is less dependent… it still needs water though (rain).

III. Modern Pteridophytes
   A. Two different phyla exist
      1. Lycophytes
         a. Most went extinct about 250 MYA. (Pangaea formed- causing swampy areas to dry up.)
            i. These formed the first real forests. (They decomposed to make crude oil or coal "fossil fuels".)
               Please explain to students that fossil fuels are oil and coal used for energy.
         b. Existing species are mostly tropical.
         c. Some are **Epiphytes** –air plants. They grow in the branches of trees.
         d. Sporophylls (leaves) are rich in oil. (They were the source of first flash photography.)
      2. Pterophyta
         a. Psilophyteas
            i. Characteristic "y" branching.
         b. Sphenophytes (A.K.A. horsetails or ***Equisetum***)
            i. Characteristic Jointed stems with Whorls (rings) of megaphylls (leaves).
            ii. Hollow stem moves oxygen to the roots for cellular respiration. (Similar to Bamboo.)
            iii. Silica embedded megaphylls have a sandpaper texture.
         c. Ferns
            i. Characteristic megaphylls called **Fronds.**
            ii. Develop from **Fiddleheads.** (As seen on front of the book.)
            iii. Spores develop on the underside of the megaphylls in groups called **Sori.**
            iv. Produce a tiny heart –shaped gametophyte generation.

Part 4

I. About 300 MYA, Gymnosperm Phylum of plants begins to evolve.

II. Adaptations needed for much drier and cooler environments:
   A. A greatly reduced gametophyte generation. (It becomes a single, microscopic cell.)
   B. Reduced size of leaves. (The leaves of pines are called needles.) Please provide an example as a visual.
   C. Thick, waxy cuticle on the leaves.
   D. The leaves remain all year, hence the term "evergreens". They shed a little at a time, like a dog sheds hair.
   E. Large plants with thick bark.
   F. Cones for reproduction. The female cones (large and hard) contain the seeds. Males (small and yellow) contain the pollen grains that contain the sperm.
      1. The wind and rain carry the pollen grains to the female cones for fertilization.
      2. Seeds have a food source for the developing embryo inside. (Please see if students know why we eat seeds… to get that high-energy source.)

III. Gymnosperms "Naked Seed Plants"
   A. Most produce cones (A.K.A. conifers)
   B. Four phyla exist today
      1. Ginkophyta
         a. Only one species still exists – *Ginko biloba*.
         b. Characteristic *oriental fan shaped leaves*. (They turn bright yellow in fall.)
      2. Cycadophyta
         a. Possesses a large cone in the center of palm like leaves. (These are similar to fronds.)
         b. Mainly used as yard ornamentation.
      3. Gnetophyta
         a. These are extreme desert plants.
         b. *Welwitschia* – Among largest leaves of all plants. (Grows in Africa)
         c. *Ephedra* – Produces ephedrine (Used in diet pills); Become Tumble weeds when they die. (scatter seeds)
      4. Coniferophyta
         a. Two types of cones produced are produced:
            i. Male cones – these appear long, narrow, and yellow. (Pollen grains are yellow.)
            ii. Female cones – These are large and wide. (If green –unfertilized; if brown – fertilized.)
         b. Evergreen needle leaves
            i. Very thin leaves reduce water loss through the stomata and make food all year long.
            ii. Very thick, sticky cuticle on the leaves.
         c. Thick and sticky sap to keep animals from eating the plant. (Sap is used to make turpentine.)

Part 5

I. About 200 MYA Angiosperms begin to evolve due to increased water availability.

A. Angiosperms are the flowering plants (Anthophyta)
B. They are seed producing, vascular plants.
C. Sporophyte is the dominant generation. Gametophyte generation remains a single cell.

II. Adaptations for a "new and wetter" environment:

A. Vessel element xylem tissue evolves to transport more water to the leaves. (Tracheids were too small.)
B. More water leads to larger leaves to perform more photosynthesis. (More sugars leads to fruit production.)
C. Flower (It is a specialized shoot (stem) for pollinator attraction.) (Floral identity genes are responsible.)
Please help students understand that when a flower is to form at the end of a stem, the stem genes have to "shut off" and the flower producing genes get "turned on". Once the flower is no longer needed. They reverse.
    1. Flowers have four circles of specialized, modified leaves.
        a. **Sepals** – These are the green protective leaves. (Form the bud.)(They are *non-reproductive*.)
        b. **Petals** – These are the colored attractant leaves. (They are fragrant and also *non- reproductive*.)
        c. **Stamen**- This is the male sporophyll. Site of pollen grains. (It is *reproductive*.)
            i. **Anther** -Part with the yellow pollen grains; and **filament** - It is a support stalk.
            ii. Pollinator to transport pollen grain. (Example of coevolution)(Reduce competition.)
        d. **Carpel/Pistil** – Site of female sporophyll (It is *reproductive*.)
            i. **Stigma** (sticky top), **Style** (the neck), **ovary** (Contains the ovules and eggs.)
Please provide various flowers for students to examine.
D. **Fruit** (It is a ripened ovary.) Developed to promote seed dispersal by animals eating the fruit.
    1. Green fruit (unripened, hard, unscented, and sour – no sugar.)
    2. Colored fruit (ripened, soft, scented, and sweet – lots of sugar.)(**pericarp** – skin of the carpel/fruit.)
    Please ask students why the color change… to attract animals to eat… seed dispersal.
    3. After fertilization the ovary wall thickens to become pulp of the fruit. (Inside are the seeds.)
    4. Fruit structures for seed dispersal:
        a. **Kites** (These fruits are carried by the wind.)
        b. **Burrs** (These fruits are carried by the fur of animals.)
        c. **Edible** (Animal digestive tract weakens the seed coat and seed deposited with fertilizer in new area.)
    5. Fruit types
        a. **Simple**- Possesses one ovary. It will have a single seed. (A.K.A. pits.) (Peach)
        b. **Aggregate** – one flower with several carpels. It will have several seeds. (Blackberry)
        c. **Multiple** – Several flowers fused together to produce "one" fruit. (Pineapple)
        d. **Dry** – These are grains and nuts.
    6. Seedless Fruits? (This is hormonal trickery.)
E. **Double fertilization** (Zygote AND endosperm "food" will be produced.)
    1. Pollen tube is created by the 1 "digger" sperm.
    2. The other 2 enter through the micropyle (small pore). (One fertilizes the egg; other the polar nuclei.)
    3. **Cotyledons** (These are embryonic leaves.) (1leaf – **monocot**; 2 leaves– **dicot/eudicot**)

III. Types of Angiosperms (There are over 200,000 species.) (They make up 90% of all plants.)

A. Basal Angiosperms (These are the oldest species.)(They lack vessel elements xylem.)
B. Magnoliids (These are transitional species mainly. They are evergreens like Gymnosperms, but make flowers.)
C. Monocots
D. Eudicots "true dicots"

IV. Angiosperm Plant uses

A. Sources of *food and medicines*.
B. Perfumes and decorations