Plant diversity

Preliminary note: We are just doing some highlights here, and we won't be covering fungi since you did that in 103 (they're not plants in any case).

I. Origin of Plants:

- evolved from green algae. Some of these can get quite large and look remarkably like modern plants (e.g., giant kelp off the west coast).

- closest living relative to plants is probably something called a Coleocheate. It likes shorelines surrounding lakes.

- Plants needed to adapt to dry land. Following the outline in the text, we'll consider four major adaptations for this:

1) Need to obtain resources from water and air. The basic structure of a plant includes shoots and roots (more later). **[OVERHEAD, fig. 31.3, p. 624]**

Roots are designed to absorb minerals and nutrients from the soil. They also anchor the plant.

Shoots are designed to photosynthesize and pick up carbon dioxide from the air (and get rid of oxygen).

Both have specialized areas that help the plant grow (more later).

Connecting everything in a plant is vascular tissue. This is composed of two parts:

xylem: moves water through the plant (generally upwards).

phloem: moves nutrients around the plant.

2) Support.

To get more than a few inches tall, plants need specialized supporting cells with lignin deposits (lignin = the “woody” part of a plant). These cells may be separate or be part of the xylem.

3) Water retention.

Plants need special structures to prevent water loss.

A water resistant cuticle (often waxy) serves many plants as a barrier.

Water loss can be controlled by opening or closing special openings in leaves (and sometimes other structures) that regulate water loss.

4) Reproduction.

Like most organisms with sex, plants produce gametes, though depending on the plant and life cycle, the exact way of making gametes can vary widely.

Water is often no longer available to help move sperm to egg.

Plants have adapted by using pollen to move "sperm" to "egg".

Many plants also have "spores"

spores are haploid cells that can go on to make a new organism

note that this organism would be "haploid".

II) Plant diversity:

Section 17.3 in your text gives you a brief overview **[OVERHEAD, fig. 17.2A, p. 344]**

- Bryophytes: a term used for non-vascular plants (think "small plants"). Oldest are about 475 million years old.

- Vascular plants: generally, though not always, larger. Originated about 420 m.y.a.

    - first seed plants are about 360 million years old.

Mosses [Fig., not in book]

In mosses, the dominant form is haploid (i.e., only half the chromosomes)

- The only "diploid" part is a stalk that grows out of the top of the moss plant.

Two other types of "bryophytes" or non-vascular plants:

1) Liverworts (parts of this plant "resemble" a liver, and during the middle ages were thought to treat liver ailments).

2) Hornworts

Club mosses [Fig., not in book]

These days club mosses are fairly small, with height usually measured in inches

Used to get large (tree sized - some were up to 2 m in diamter and over 40 m high).

Can be found on campus

Reproduction is very similar to Ferns (next group)

Ferns [Fig., not in text, but see 17.2C, p. 345]

Also includes horsetails **[fig., not in text]**

The dominant form is diploid, but there is still a small but substantial haploid form.

Stems & leaves, etc. are all diploid sporophytes.

Ferns make haploid spores through meiosis.

Spores will eventually meet up with other spores and make a diploid fern plant.

(The underside of fern leaves have spores).

Remember - both ferns and lycophytes are seedless plants. They used to be the dominant plant on earth

Gymnosperms (also known as naked seed plants since they have no fruit surrounding the seed.)

Several groups, some of which are very familiar **[Figs., not in text]**:

- Conifers (pines, firs, giant redwoods, etc.)

- Ginkgos

- Cycads (look a lot like palms)

- A weird group (Gnetophyta - see picture)

Reproduction:

- Have two types of cones, male and female **[Fig., not in text]**. Female cones are the big recognizable ones.

- male cones release vast quantities of pollen (through meiosis), which hopefully will fertilize the female egg (your text goes into rather more detail - we'll get some of this when we look more closely at plant reproduction).

- When fertilized, the zygote then develops into an embryo. Various supporting cells (some haploid) develop into the seed (provides protection and food to the embryo).

- Seed is dispersed, often through wind.

Angiosperms

flowering plants (seed usually surrounded by fruit).

- have flowers (obviously). Flowers may have male & female structures, or just one or the other.

Two main groups **[Fig. 31.2, p. 623]**, and several smaller groups **[several Figs., not in text]**:

1) Monocots: examples include palms, many crops (corn, rice, wheat), bananas.

2) Dicots: examples include most trees, cacti, euphorbs, etc. (most Angiosperms are dicots).

3) Others : some fairly primitive groups such as water lilies, magnolias, peppers.

- until recently these were mostly classified as monocots.

- "others" is not a taxonomic "group" - it just means these are not monocots or dicots..

Reproduction - sexual:

- In essence, the male part of the flower makes pollen. This is then distributed through wind or using insects (e.g., bees, etc.).

- Flowers are reproductive structures in plants [Fig. 31.9A, p. 634]:

Sepals - cover/protect the flower before it opens.

Petals - the brightly colored parts of the flower (if it is colored).

Stamens - male reproductive parts. Composed of:

anthers - where pollen develop and are stored

filaments - structures holding up anthers

Carpels - female reproductive parts. Composed of:

stigma - at tip of carpel, where pollen are placed.

ovary - contain ovules, which hold eggs and supporting cells.

- Pollen is then deposited near the female structures, and then by a complicated process will "grow" towards the haploid female "egg".

- The details are quite a bit more complicated than this.

- Once fertilized, we have a zygote.

Animal - plant interactions are a major factor behind the evolution of plants:

- Flowers often have a design that allows pollination by only one type of animal

    - Some even open up at night to be pollinated by bats

    - Some are pollinated by flies and reek like a decaying corpse

- The resulting zygote then forms an embryo surrounded by nutrients (similar to gymnosperms), but this "seed" is usually surrounded by a fruit.

- Fruit often has structures that help disperse (spread) the seed.

    - Often fruit tastes good so that animals eat the fruit (w/ seed). The seed passes unharmed through the digestive tract of the animal, and is then deposited (together with a nice pile of fertilizer!).

    - Other fruits have wings, burrs (to attach to animals), or other parts that help them disperse.

Seeds remain viable for very variable time periods.

- Some, like tomato seeds only last a year or two.
- Some desert plants can have seeds that last hundreds of years.
- Water often helps seeds germinate

Reproduction - asexual:

most plants readily grow by asexual reproduction:

- fragmentation
- runners
- root sprouts
- cuttings
- much of our agriculture depends on asexual (vegetative) reproduction
    - fruit trees in particular, but also raspberries, potatoes, etc.

III. Plant structure and function:

Basic plant anatomy **[OVERHEAD, fig. 31.3, p. 624]**:

Roots: - anchor plant
- absorb minerals & water
- store food

- have root hairs that increase the surface area and allow water & mineral absorption.

Shoots: - stems, leaves & reproductive parts
- stems: above ground, support leaves & flowers
- leaves: main site of photosynthesis

- associated structures include:

- nodes - point where leaves are attached to stem
- internodes - areas between nodes
- terminal bud - at tip of stem, has developing leaves, etc.
- axillary buds - between the leaf & stem. Usually dormant, but can start to grow if influence of terminal bud wears off (terminal bud prevents axillary buds from growing).

Roots & shoots can be highly modified by different plants **[Fig. 31.4 p. 625]**:

- Carrots & sugar beets have an enormous root that stores energy.

- strawberries have horizontal stems that run along the ground

- potatoes have tubers, enlarged areas at the ends of roots where food is stored.

Leaves can be highly modified as well.

- have many different shapes

- some are even modified as tendrils (see fig. 31.4C)

Plant tissue systems **[Fig. 31.5A, p. 627]**:

- Epidermis - outside covering of the plant
  - protects the plant, acts as a barrier

- vascular tissue - made up of xylem and phloem

- xylem - transports water upwards

- phloem - transports nutrients to all parts of the plant

- more complex than xylem since it needs to transport in different directions.

- ground tissue - everything else. Photosynthesis, storage, support, etc.

Plant growth:

- in general, plants grow throughout their lives (don't stop growing).

- plants are either annuals, biennials, or perennials:

    - annuals - live one year (wheat, corn, some wildflowers)
    - biennial - live two years (beets & carrots)
    - perennials - live more than two years (e.g. trees, etc.)

- plants can get old. Some giant sequoias are over 3000 years old. Some Bristlecone pines over 4000 years **[Fig., not in text]**. Most don't live that long.

- meristem are unspecialized cells that cause growth. When this makes new branches, roots, or makes existing branches or roots longer, this is "primary growth" **[Fig. 31.7A, p. 630]**.

    - "apical" meristem is usually found at the tips of branches & roots, or at the axillary buds.

- Secondary growth - this is the widening of woody plants (e.g., how you get a trunk from a twig) **[Fig. 31.8A, p. 632]**.

    Two layers of meristem (called "cambium" here):

        - vascular cambium - makes secondary xylem (more xylem) on the inside, and secondary phloem on the outside.

            - xylem is not just vascular tissue, it also provides a lot of support.

            - the secondary xylem is composed of fibers, tracheids & vessels, and so is very strong (woody).

            - over the years, it's the secondary xylem that makes the "wood" in a tree.

            - the secondary phloem never gets much thicker - it stays on the outside, and excess cells are sloughed off.

        - cork cambium - makes cork. A thick outside layer that protects the tree (basically bark). As the tree grows, older cork is also sloughed off like the secondary phloem.

- Tree trunks **[Fig. 31.8B, p. 633]**

    - dark center is heartwood. Non functioning xylem, filled with stuff to prevent rotting.

- lighter circle - sapwood. Functioning xylem

- Rays running through wood - parenchyma cells that move nutrients around.

- then the outside layers discussed above:

    - vascular cambium
    - bark (secondary phloem, cork cambium, cork)

- Secondary xylem cells are much larger in the spring; this gives trees in temperate climates rings (the cells put down during the rest of the year are much smaller).

IV. Some concluding comments:

Plants are incredibly important for many different reasons:

- they feed the world (not just humans)

- they provide oxygen

- they provide other important things like:

    - clothes/shelter/medicines

Note that our agriculture (for food) is based almost entirely on Angiosperms.

- All grasses, fruit trees, “vegetables”. etc. are angiosperms.

We'll get back to some of these ideas when we do Conservation Biology.