PLANTS AND FUNGI

Lecture Outline

I. Pioneers In a New World
   A. Millions of years ago the only photosynthesizers were cells living in the seas.
   B. The invasion of land began with the cyanobacteria, followed by green algae and fungi.
   C. Today, there is a rich diversity of green plants, making carbon compounds out of water and carbon dioxide using sunlight as the energy source.

II. Evolutionary Trends Among Plants
   A. Overview of the Plant Kingdom
      1. In general, plants are multicelled photosynthetic autotrophs—green in color and self-sustaining.
      2. Most, the gymnosperms and angiosperms, have vascular tissues for transport of water and nutrients; plus they possess root and shoot systems.
      3. Nonvascular plants, such as the bryophytes, have simple internal transport systems (no true roots, stems, or leaves).
      4. The ancestors of plants had evolved by 700 million years ago, but another 265 million years passed before simple stalked species appeared. Within another 60 million years, plants had radiated through much of the land.
   B. Evolution of Roots, Stems, and Leaves
      1. Underground parts developed into root systems, specialized for absorption of water and minerals through extensive cylindrical tubes.
      2. Parts above ground developed into shoot systems, adapted for exploiting sunlight and absorbing carbon dioxide from the air.
      3. Vascular tissue became increasingly extensive: xylem for conducting water and minerals, phloem for products of photosynthesis.
      4. Extensive growth of stems and branches became possible due to the strengthening of cell walls afforded by deposits of lignin.
      5. Stems and leaves were covered by cuticle to minimize water loss; evaporation was controlled by opening and closing of stomata (openings).
   C. From Haploid to Diploid Dominance
      1. The life cycle of simple aquatic plants is dominated by the haploid phase which produces gametes that are dependent on a watery environment to meet and fuse.
      2. The life cycle of complex land plants is dominated by the large, diploid *sporophyte*.
         a. Cells within the sporophyte undergo meiosis to give rise to the haploid spores.
         b. The spore develops into the *gametophyte,* which produces the gametes.
   D. Evolution of Pollen and Seeds
      1. The spores of some algae and simple vascular plants are all alike—homosporous.
      2. In the gymnosperm and angiosperm lineages, the spores are differentiated into two types—heterosporous.
         a. The male gametophytes—pollen grains—are released from the parent plant to be carried by whatever means to the female gametophyte.
         b. The female gametophytes remain in the plant and are surrounded by protective tissues, eventually producing a seed .
      3. Over time the sporophytes, while developing extensive root and shoot systems, began holding onto their spores and gametophytes—protecting and nourishing them.

III. Bryophytes
   A. Bryophytes include the mosses, liverworts, and hornworts.
      1. Although they resemble more complex land plants, they do not contain xylem or phloem.

2. Most species do have *rhizoids* that attach the gametophytes to the soil and absorb water and minerals.

B. These nonvascular plants show three features that were adaptive during the transition to land:
1. Above-ground parts display a cuticle with numerous stomata.
2. A cellular protective jacket surrounds the sperm-producing and egg-producing parts of the plant to prevent drying out.
3. The (dependent) embryo sporophyte begins life inside the (independent) female gametophyte.

C. Mosses are the most common bryophytes.
1. Eggs and sperm develop in jacketed vessels (*gametangia*) at the shoot tips of the familiar moss plants.
2. After fertilization, the zygote develops into a mature sporophyte, which consists of a special structure (*sporangium*) in which the spores develop.

IV. Existing Seedless Vascular Plants

A. The descendants of certain lineages of seedless vascular plants, with names such as whisk ferns, lycophytes, horsetails, and ferns, differ from bryophytes in these aspects:
1. The sporophyte does not remain attached to the gametophyte.
2. It has well-developed vascular tissues.
3. It is the larger, longer lived phase of the life cycle.

B. Although the sporophytes of seedless vascular plants can live on land, their gametophytes cannot because they lack vascular tissues and the male gametes must have water to reach the eggs.

C. Whisk Ferns (Psilophyta)
1. Whisk ferns look like whisk brooms and are not true ferns.
2. They are popular ornamental plants common to tropical and subtropical areas.
3. The sporophytes have no roots or leaves, but rather consist of a system of scalelike branches.
4. The stem houses the xylem and phloem as well as surface cells capable of photosynthesis.
5. Underneath the ground surface short, branching rhizomes serve an absorptive function.

D. Lycophytes (Lycophyta)
1. Lycophytes were once tree-sized but now are represented by small club mosses on the forest floor.
2. The sporophyte has true roots, stems, and small leaves containing the vascular tissue.
3. Strobili bear spores that germinate to form small, free-living gametophytes.

E. Horsetails (Sphenophyta)
1. The ancient relatives of horsetails were treelike; only the moderately sized *Equisetum* has survived.
2. The sporophytes possess underground stems called rhizomes.
3. The scalelike leaves are arranged in whorls around the hollow, photosynthetic stem.
4. Spores are produced inside cone-shaped clusters of leaves at the shoot tip.

F. Ferns (Pterophyta)
1. Ferns bear underground stems (rhizomes) and aerial leaves (fronds).
2. Sori are clusters of sporangia that release spores that develop into small heart-shaped gametophytes.

V. Gymnosperms—Plants with "Naked" Seeds

A. Gymnosperms bear ovules and seed on exposed parts of spore-producing structures.
1. Air currents carry the pollen grains (sperm inside) to the eggs, freeing this group from dependency on water for fertilization.
2. The sporophytes make ovules—reproductive structures that contain the egg-producing gametophyte surrounded by nutritive material and a coat destined to become the seed.

B. Conifers (Coniferophyta)
1. The conifers (cone-bearers) are woody trees with needlelike or scalelike leaves; most are evergreens.
2. The pine tree produces two kinds of spores in two kinds of cones:

        a. Male cones produce sporangia which yield microspores that develop into pollen grains (male gametophyte).
        b. Female cones produce ovules that yield megaspores (female gametophyte).
    3. Pollination is the arrival of a pollen grain on the female reproductive parts, after which a pollen tube grows toward the egg.
    4. Fertilization, which is delayed for up to a year, results in a zygote that develops into an embryo within the conifer seed.
  C. Lesser Known Gymnosperms
    1. Cycads (Cycadophyta)
        a. These palmlike trees flourished during the Mesozoic era, but only about 100 species still exist—confined to the tropics and subtropics.
        b. They bear massive cone-shaped strobili that produce either pollen (transferred by air currents or insects) or ovules.
    2. Ginkgos (Ginkgophyta)
        a. From the diversity of this group during the Mesozoic, only one species has survived.
        b. They are remarkably hardy, showing resistance to insects, disease, and air pollutants.
    3. Gnetophytes (Gnetophyta) are the most unusual gymnosperms; they live in tropical and desert areas.

VI. Angiosperms—Flowering, Seed-Bearing Plants
  A. Angiosperms produce flowers and have special tissues that enclose and protect their ovules and seeds.
    1. Most species have coevolved with pollinators attracted to the pollen and nectar.
    2. This group has dominated the land for 100 million years, living a very diverse habitats.
  B. Dicots and Monocots
    1. Dicotyledonae (dicots) include familiar shrubs, trees (except conifers), and herbaceous plants.
    2. Monocotylendonae (monocots) include grasses, lilies, and the major food-crop grains.
  C. Key Aspects of the Life Cycles
    1. The diploid sporophyte has extensive root and shoot systems; it also retains and nourishes the gametophyte.
    2. Embryos are nourished by the endosperm within the seeds, which are packaged inside fruits.
    3. Unique reproductive structures called flowers have attracted animal pollinators.

VII. Characteristics of Fungi
  A. Major Groups of Fungi
    1. Over 56,000 species of fungi have been identified and there are many more.
    2. About 430 million years ago fungi started invading the land.
    3. There are three major groups (zygomycetes, sac fungi, and club fungi)and one "catch-all" category ("imperfect" fungi).
  B. Nutritional Modes
    1. Fungi are heterotrophs that utilize organic matter.
        a. Some (saprobes) get their nutrients from nonliving matter.
        b. Others (parasites) thrive on tissues in living hosts.
    2. All fungi rely on extracellular enzymatic digestion and absorption.
    3. Fungi are valuable decomposers in the environment.
  C. Key Features of Fungal Life Cycles
    1. Fungi reproduce both asexually and sexually, producing large numbers of nonmotile spores.
    2. The food-absorbing part of the fungus is a mesh of branching filaments called the *mycelium.*
        a. Each tubular filament is a *hypha* with chitinous walls.
        b. Interconnections and perforations allow cytoplasmic flow necessary for transport to nonabsorptive parts of the body.

VIII. Consider the Club Fungi
  A. A Sampling of Spectacular Diversity

1. This group includes commonly seen puffballs and shelf fungi, rusts and smuts, as well as edible mushrooms.
2. Many are symbionts with roots of forest trees; some saprobic types decompose plant debris, others destroy field crops.

B. Examples of a Fungal Life Cycle
1. Club fungi (for example, the common mushroom) produce spores on the gills of the cap at the top of a stalk extending above the ground.
2. When spores land on a suitable site, they germinate to produce extensive underground mycelia that then reproduce sexually, resulting in a dikaryotic stage.

IX. Spores and More Spores
A. Fungi produce lots of spores—asexual or sexual, or both.
1. Dispersed by air currents, the small, dry spores land and germinate to form mycelia.
2. Stalked structures on the mycelia release spores to propagate the line.

B. Producers of Zygosporangia
1. Members of the zygomycetes are saprobes of decaying plant matter in the soil; others such as black bread mold live on stored food
2. Sexual reproduction begins when two hyphae (different mating strains) grow toward each other and fuse.
   a. The zygote becomes enclosed in a zygosporangium, which later releases haploid spores that will germinate to produce stalked structures.
   b. From these structures haploid spores will escape to produce new mycelia, releasing spores

C. Producers of Ascospores
1. The hyphae of multicelled species produce ascocarps (sacs) bearing ascospores.
2. Multicelled forms include edible morels and truffles, plus *Penicillium,* famous as a source of antibiotics and *Aspergillus*, the fermenter of soy sauce.
3. Single-celled yeasts are useful in baking (carbon dioxide production makes the bread "rise") and for alcoholic-beverage production.

D. Elusive Spores of the Imperfect Fungi
1. This group includes all fungi lacking a known sexual phase.
2. Members of this group are often moved out when sexual spores are discovered.

X. Beneficial Associations Between Fungi and Plants
A. Symbiosis refers to species that live in close association.
1. If one species is a victim, the association is parasitism.
2. If both partners benefit, the relationship is called mutualism.

B. Lichens
1. Lichens are mutualistic associations between fungi and cyanobacteria, green algae, or both.
   a. The fungus parasitizes the photosynthetic alga upon which it depends entirely for its food.
   b. The algae derive very little benefit other than a protected place to survive.
2. Lichens live in inhospitable places such as bare rock and tree trunks.
   a. By their metabolic activities, lichens can change the composition of their substrate.
   b. They are unusually sensitive to air pollution

C. Mycorrhizae
1. A mycorrhiza is a symbiotic relationship in which fungi hyphae surround roots of shrubs and trees.
   a. The hyphae of exomycorrhizae do not penetrate the cells of the root.
   b. The hyphae of endomycorrhizae do penetrate the cells of the root.
2. Because of its extensive surface area, the fungus can absorb mineral ions and facilitate their entry into the plant.

D. As Fungi Go, So Go the Forests
1. Collectors have seem a decline in populations of wild mushrooms since the early 1900s.

2. Since both edible and toxic species are both declining, the most probable cause is the increased levels of pollutants in the air.