

Biology 3B Laboratory

Nonvascular and Seedless Vascular Plants

Objectives

- To understand the general systematic relationships of the Bryophytes and Pteridophytes
- Learn the basic plant life cycle, “alternation of generations”
- Learn the gametophyte dominant life cycle of bryophytes
- Recognize members of the “bryophytes”
- Learn the life cycle of ferns and their allies
- Learn the distinguishing characteristics of the pteridophyte groups

Introduction

Today we will begin our survey of the modern plants. Taxonomists are currently re-evaluating the relationships and origins of these organisms. In Figure One you see a cladogram indicating some of the current ideas regarding modern plants. Some authors use the Kingdom Embryophyta to describe all modern plants. However, we will always use your textbook as the “default” in systematics. Thus, we will use the Kingdom Plantae as shown in Figure One.

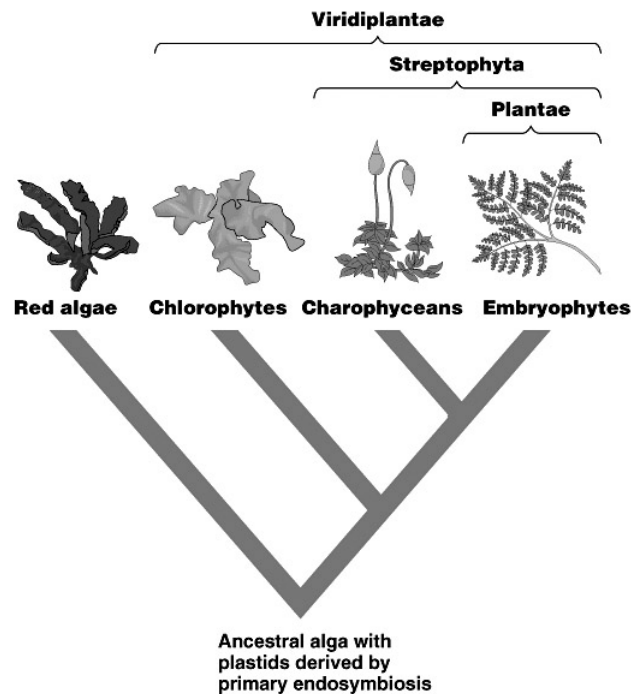


Figure One. Proposed relationships between plants and plant-like groups

The extant **Kingdom Plantae** contains four natural groups. These are the Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. In Figure Two you see a simple cladogram relating these groups to the outgroup, Charophyceans. The Charophyceans are a group green algae that appear most closely related to the organisms in the Kingdom Plantae. In this laboratory you will investigate two of these groups, Bryophytes and Pteridophytes.

The Bryophytes

Three separate phyla are included in the bryophyte group. These include the Phylum Hepatophyta, also known as liverworts; the Phylum Anthoceroophyta, also known as hornworts; and

the Phylum Bryophyta, also known as mosses. Important taxonomic note: The term bryophytes refers to all organisms in these three phyla; the term Bryophyta refers only to those organisms in the Phylum Bryophyta (the mosses). The bryophytes lack the vascular tissues, xylem and phloem, found in other plants. Thus, most of these plants cannot grow very large and require damp habitats.

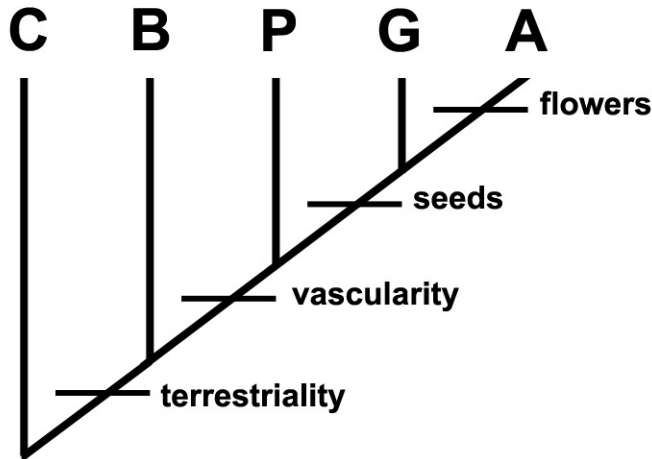


Figure Two. Relationships within the Kingdom Plantae. C= Charophyceans, B = Bryophytes, P = Pteridophytes, G = Gymnosperms, A = Angiosperms

Bryophyte Life History

Bryophytes demonstrate “alternation of generations.” The gametophyte is the dominant generation in all three phyla. The gametophyte produces gametes (via mitosis) in multicellular gametangia. Gametangia may be female (archegonia) or male (antheridia). Following fertilization, the zygote develops (via mitosis) into an embryo, and ultimately into a diploid sporophyte. This sporophyte is typically attached to, or part of the female gametophyte. The sporophyte matures and produces haploid spores that develop into gametophytes (Fig. Three).

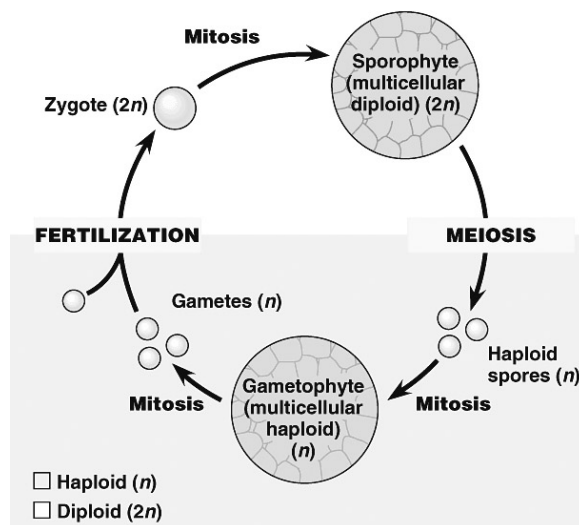


Figure Three. Generalized life cycle for plants.

Phylum Hepaticophyta: Liverworts

Liverworts were probably the earliest land plants. There are over 5000 species of liverworts. There are two forms of the gametophytes, thallose (flattened) and leafy. We will observe *Marchantia*, a thallose form.

- Observe a cross-section of the **thallus** of *Marchantia*. Sketch the cross-section. Notice that the section is not many cells thick. Why might this be so? The photosynthetic cells are on the upper surface. The lower layers of cells are for storage. On the lower surface are **rhizoids** that anchor the thallus to the substrate. In the uppermost layer you will see **pores** that allow gas exchange.
- Liverworts can reproduce asexually. This can occur by fragmentation or through gemma development. Observe a slide of gemmae (singular is gemma). The **gemmae** are seen inside **gemma cups**. Falling raindrops can cause the gemma to splash out of the cups. If they fall on moist soil they can develop into new gametophytes. Sketch gemmae in gemma cups.
- Sexual reproduction through the production of gametes by male and female plants. Archegoniophores are specialized stalks on female plants that bear **archegonia**. Each archegonium consists of a neck and venter in which the **egg** sits. Observe a slide of *Marchantia* archegonia. Sketch the egg within the archegonium. Observe the prepared specimen of archegonia and sketch the overall archegonium.

- Antheridiophores are specialized stalks on the male plants that produce **antheridia**. **Flagellated sperm** are produced in antheridia and released during periods of rainfall. These sperm fertilize the egg in the venter, where the zygote develops. Observe a cross section slide of *Marchantia* antheridia. Sketch an antheridium. Also sketch antheridia from the prepared material.
- The sporophyte develops within the female gametophyte. Examine the mature sporophyte slide. The sporophyte is attached to the gametophyte by a **foot**. **Spores** (with red-stained nuclei) are produced by meiosis in a **capsule** located on a **stalk** that extends downward from the foot. The long green strands located among the spores are called **elaters**. The elaters assist in spore dispersal.

Phylum Anthoceroophyta : Hornworts

Hornworts represent a small group (100 species, 6 genera) of bryophytes. The primary characteristic is the long, tapered horn-shaped sporophyte that emerges from a flattened thallus. Observe and sketch any other materials that are present.

Phylum Bryophyta : Mosses

Mosses are a relatively diverse group of bryophytes. Because they can tolerate a broader range of environmental conditions (sometimes extreme desiccation) they are found in a wide variety of habitats.

- The gametophyte begins as a **protonema**. The gametophyte buds off of the protonema. Observe and sketch buds on the slide of *Mnium*.

- The gametes develop in antheridia and archegonia of male and female plants. Observe a moss antheridium slide. Sketch the mature antheridium.

- Observe a slide of a moss archegonium. Sketch the mature archegonium, with the neck, venter and egg. As the archegonium matures, cell lining the neck disintegrate and form the canal leading to the egg. Sperm swim through this canal to the egg.

- The moss sporophyte consists of capsules located on **setae** (stalks) above the gametophyte. The sporophyte is attached to the gametophyte by a structure called the **foot**. Observe the moss sporophyte slide. Sketch the seta and capsule containing the spores.

- Observe the slide of Sphagnum leaves. Observe the dried Sphagnum. This moss is typically call “peat moss” and is used commercially for many things.

Seedless Vascular Plants: Pteridophytes

There are two phyla of non-flowering vascular plants. These include the Pterophyta, or true ferns; and the Lycophyta, or club mosses. In these plants a vascular system connects the leaves, stems and roots. The sporophyte is dominant in all plants in this group. There are two groups identified within the pteridophytes based upon leaf size. The **megaphylls** (large leaves) includes the fern, which have large leaves with many veins. The **microphylls** (small leaves) represent the balance of the seedless vascular plants and have small leaves with only one vein. All pteridophytes have sporophylls (spore-forming leaves). Sporophylls are the spore bearing “leaves” found in the sporophyte generation. Sporangia, the site for meiotic spore formation, are located on the sporophylls.

Phylum Lycophyta: Club Mosses

Club mosses, horsetails and whisk ferns dominated the landscape 350 million years ago. These plants became the coal and oil deposits upon which the current dominant species depends for energy. Many of these groups evolved huge forms; today the modern forms are usually quite small. Club mosses have roots, stems and leaves. They can reproduce asexually via **rhizomes**. There are less than 1000 species, arranged into 5 genera. Many of these look superficially like small pine trees. Most are ground dwelling, however, in Malaysia (esp. Borneo), a giant *Lycopodium* hangs from trees.

- Observe any Lycophytes present in the lab. Sketch the stem and leaves of *Lycopodium*. Describe the arrangement of the leaves. If possible, find the rhizome.
- Sporangia of *Lycopodium* are found on modified leaves called **sporophylls**. These are clustered into cone like structures called **strobili**. Observe a cross section of a strobilus and sketch cone-like structure with the spores. The spores of *Lycopodium* are very small and highly flammable. In the past they were used as flash powder for early photography; they were also sold as *Lycopodium* powder, which could be thrown into the air and then ignited with a small concussion, which would kill house flies!

- Observe the fern life cycle mount. Find and sketch the gametophytes called **prothalli**. Identify the archegonia, antheridia and rhizoids on a prothallus.
- Observe and sketch some of the fossil ferns present in the lab. Sketch a blade and vein pattern for one of the fossil ferns.

Whisk Ferns

There are only two extant whisk ferns, *Psilotum nudum* and *Tmesipteris*. *Psilotum* is fairly widespread, whereas *Tmesipteris* is restricted to islands of the south pacific. Whisk ferns are **homosporous**, the sporophyte produces only one type of spore. *Psilotum* lacks roots and leaves.

- Observe the living specimen of *Psilotum nudum*. Describe the branching pattern seen in the stems. Are any sporangia present on the stems? Where are they located on the stems? Make sketches of the stems and sporangia.

Horse tails

The only extant genus of these plants is *Equisetum* (which means “horse tail”). These plants are easily distinguished by their ribbed and jointed stems. The stems have silica deposits in the epidermal cells, resulting in a rough feel. During past time, the stems of *Equisetum* were used to scrub dishes, sand wood and clean metal. Thus they are also known as “scouring rushes.”

- Observe the living specimens of *Equisetum*. Are there leaves present? Sketch the node and internode region of one plant.

- Observe fossil horsetails and compare them to the living specimens.

- Reproduction in horsetails may be asexual, by fragmentation, or sexual via cones called **strobili**. Strobili are produced at the terminus of specialized, non-photosynthetic stems. Observe the living specimens and search for strobili.

- Observe the slide of a cross-section of *Equisetum* stem. Identify the epidermis. Find the vascular tissue (**xylem** and **phloem**).