Lab 10
Nonvascular and Seedless Vascular Plants

Learning Objectives

- Understand plant classification.
- Understand plant life cycles
- Understand the important characteristics of each phylum.
- Understand the characteristics of each group within each phylum and be able to identify members of each phylum.

Introduction

Plants are multicellular, autotrophic eukaryotes. During photosynthesis, plants use chlorophyll a and b to harness energy from the sun in order to convert carbon dioxide into carbohydrates. Plants exhibit **alternation of generations** between a multicellular haploid stage and a multicellular diploid stage. During this life cycle, plants produce spores in a **sporangium** (plural sporangia) and gametes in a multicellular **gametangium** (plural gametangia). Plants also have multicellular embryos, which are dependent upon the parent plant. Plants have **indeterminant growth**, which means that they grow continuously throughout their lives. This occurs through continuous cell division in areas called **meristems**.

A plant's life cycle is very complex (Figure 1). The **sporophyte** is the multicellular diploid generation which produces **spores** in sporangia. The spores, which are haploid cells, are released and undergo mitosis to produce the **gametophyte**. The gametophyte is the multicellular haploid generation which produces **gametes**, haploid egg and sperm cells by mitosis. The sperm are released and fertilize the eggs to form diploid zygotes. The zygote undergoes mitosis to grow into another sporophyte.

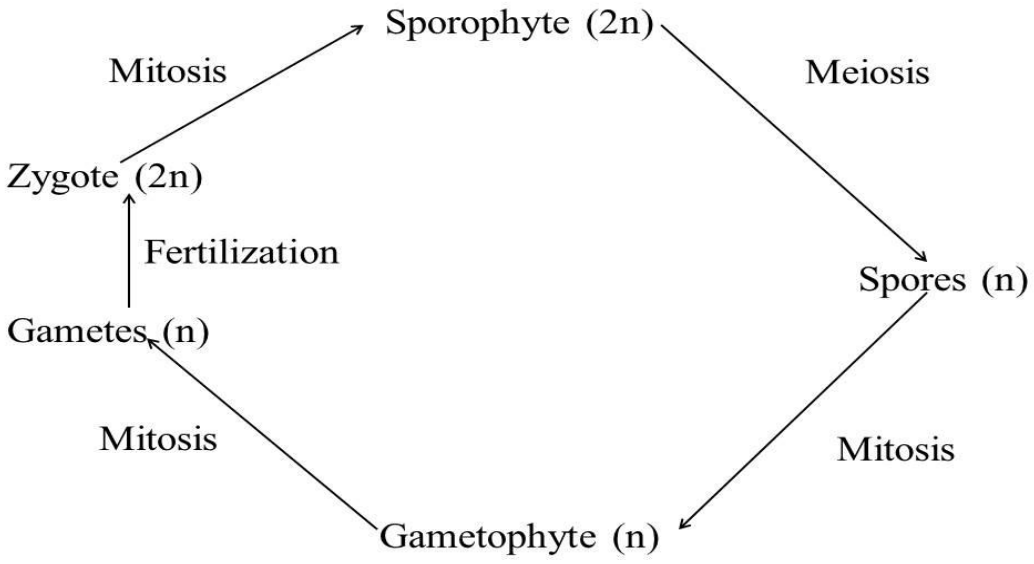

Figure 1: Plant Life Cycle

The nonvascular plants are the most basal groups in the plant kingdom. These plants lack vascular tissue. Therefore, they are usually small plants because they rely on diffusion to transport water and nutrients from one cell to another. The gametophyte is the dominant generation in nonvascular plants because it is the larger generation and is photosynthetic. The gametophyte will produce eggs in **archegonia** (singular archegonium) and sperm in **antheridia** (singular antheridium). Nonvascular plants are not completely adapted to land because the sperm must swim to the egg. Therefore, water is still required for reproduction. After fertilization occurs, the sporophyte grows out of the gametophyte and is dependent upon the gametophyte for nutrients. The sporophyte produces spores which are released to disperse the offspring from the parents. There are three phyla of nonvascular plants. **Phylum Hepatophyta** contains the liverworts. **Phylum Bryophyta** contains the moss and **Phylum Anthocerophyta** contains the hornworts.

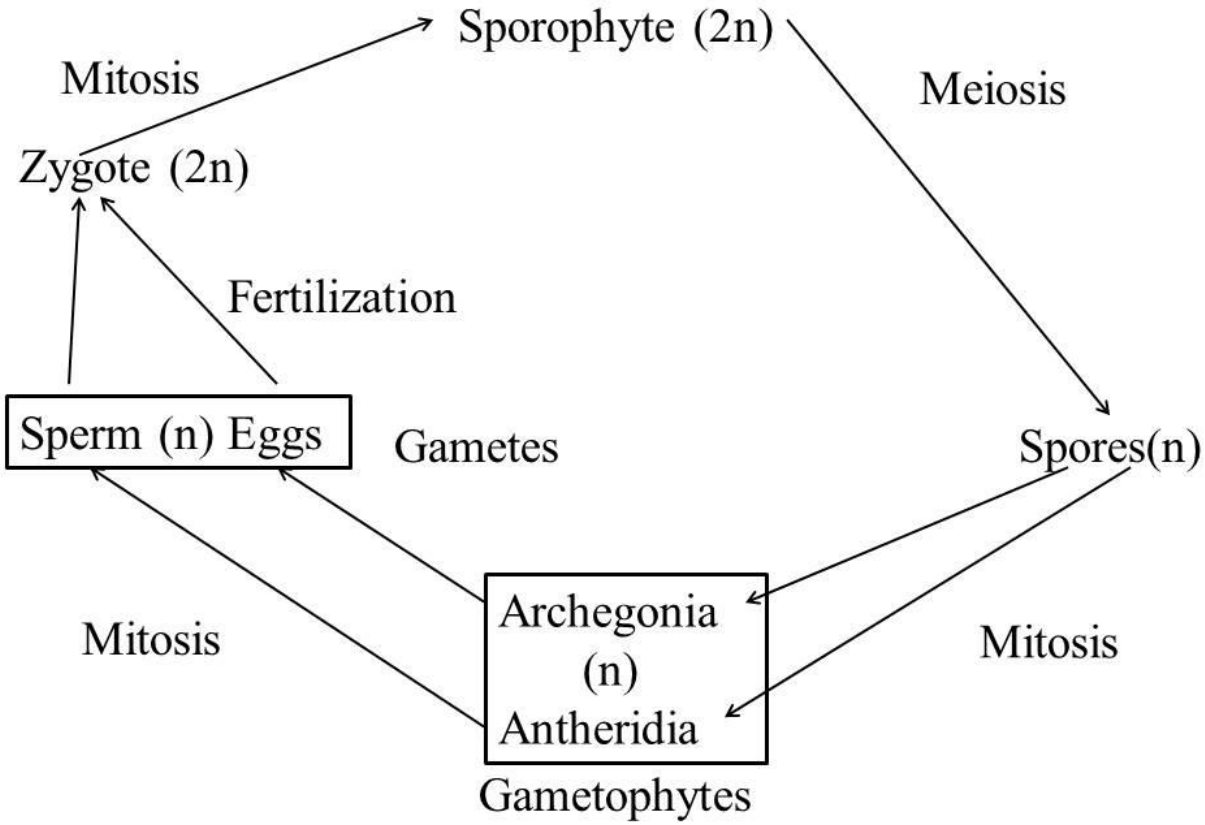

Figure 2: Nonvascular Plant Life Cycle

The majority of the phyla in Kingdom Plantae are vascular plants. These plants have developed two specialized types of vascular tissue. **Xylem** is a type of vascular tissue which transports water, and **phloem** is a type of vascular tissue that transports nutrients. Vascular tissue allows plants to transport water and nutrients longer distances, which permits vascular plants to grow larger than nonvascular plants. The sporophyte is the dominant generation in vascular plants. It is hypothesized that the diploid sporophyte is better adapted to land

because having two copies of each chromosome makes these plants less susceptible to deleterious mutations. Also, the vascular plants have true roots and leaves.

The vascular plants can be divided into seedless vascular plants and seed plants, which will be discussed in the next lab. The seedless vascular plants have **sporophylls**, which are leaves that have sporangia. These sporophylls may be in the form of a **strobilus** (plural strobili), a spike at the tip of the stem, or a **sorus** (plural sori), a cluster on the leaf. In seedless vascular plants, the gametophyte lives independently of the sporophyte. Water is still required for reproduction in the seedless vascular plants because the sperm must still swim to the egg.

There are two phyla of seedless, vascular plants. **Phylum Lycophyta** contains the club moss, spikemoss, and quillworts. These plants have **microphylls**, which are leaves with a single unbranched strand of vascular tissue. **Phylum Monilophyta** contains the whisk ferns, horsetails, and ferns. These plants have **megaphylls**, which are leaves with branched vascular tissue.

I. Phylum Hepatophyta

This phylum contains liverworts. These plants are called liverworts because their **thallus** (body) resembles the lobes of a liver. The thallus of a liverwort may have several **gemma cups**, which are structures from which the antheridia and archegonia develop. The antheridia, the male gametophytes, are flower-shaped structures that grow from the thallus on stalks. The archegonia, the female gametophytes, are umbrella-like structures that also grow from the thallus on stalks.

Activity I: Liverworts

Materials:
Marchantia preserved specimens

Procedure:
1. Examine the specimen and identify the anteridium, archegonium, and gemma cup.
2. Sketch and label the specimen in the space below.

A:

B:

C:

II. Phylum Bryophyta

This phylum contains moss, which are small low-growing plants that are often found along the forest floor. The green portion of the plant is the gametophyte. The antheridia, which produce several sperm each, and the archegonia, which only produce a single egg in each archegonium, develop at the tip of the gametophyte. The sperm will swim from the antheridium to the archegonium and fertilize the egg. When this occurs, a brown sporophyte grows out of the top of the gametophyte. An enlarged **capsule** can be found at the end of the sporophyte. The capsule contains sporangia, which produce spores.

Activity 2: Moss Specimen

Materials:
Moss specimens

Procedure:
1. Examine the specimens and sketch it in the space below.
2. Identify and label the sporophyte and gametophyte.

A:

B:

Activity 3: Moss Antheridia

Materials:
Moss antheridia slides

Procedure:
1. Focus the slide on high power (40X) of a compound light microscope and sketch it in the space below.
2. Label the antheridium and the sperm.

A:

B:

Activity 4: Moss Archegonia

Materials:
Moss archegonia slides

Procedure:
1. Focus the slide on high power (40X) of a compound light microscope and sketch it in the space below.
2. Label the archegonium and the egg.

A:

B:

Activity 5: Moss Capsule

Materials:
Moss capsule slides

Procedure:
1. Focus the slide on high power (40X) of a compound light microscope and sketch it in the space below.
2. Label the capsule, sporangium, and the spores.

A:

B:

C:

III. Phylum Lycophyta

This phylum contains the quillworts, the spikemoss, and the club moss. The sporophyte is the dominant generation in these plants and therefore the largest and most visible. The sporophylls form strobili in this phylum. These plants have microphylls, small leaves with only one strand of vascular tissue

Activity 6: Club Moss

Materials:
Club moss specimens

Procedure:
1. Examine the specimens and sketch it in the space below.
2. Identify and label the leaves and strobili.

A:

B:

IV. Phylum Monilophyta

This phylum contains the horsetails, whisk ferns, and ferns. The sporophyte is the dominant generation. Unlike lycophytes, these plants have megaphylls, leaves with branched vascular tissue.

Horsetails have silica in their cell walls, which makes their stems gritty. Because of this, they were used by pioneers to scrub pots and are sometimes called scouring rushes. Their stems have segments and a strobilus, containing the sporangia, may be found at the tip of the stem.

The whisk ferns are unusual because they have lost many complex structures like true leaves and roots. Whisk ferns do not have strobili or sori. Instead the sporangia are small spherical structures.

The ferns are the most common group in this phylum. They have compound leaves called **fronds**. Sori (round, brown structures containing the sporangia) can sometimes be found on the underneath side of the frond. In some species of fern, the sorus is covered by an **indusium**. The structure of the sori and the presence or absence of an indusium can be used to identify different species of fern. The fern gametophytes live independently of the sporophytes and are often microscopic. The gametophytes are usually shaped like a heart or a mitten. The archegonia usually develop toward the notch in the heart or mitten-shaped gametophyte, while the antheridia develop toward the base of the gametophyte.

Activity 7: Horsetails

Materials:
Horsetail specimen

Procedure:
1. Examine the horsetail specimen and sketch it in the space below.
2. Identify and label the strobilus.

A:

Activity 8: Whisk Ferns

Materials:
Psilotum specimens

Procedure:
1. Examine the specimens and sketch it in the space below.
2. Identify and label the sporangia.

A:

Activity 9: Fern Sporophytes

Materials:
Fern frond specimens

Procedure:
1. Examine the fern frond and sketch it in the space below.
2. Identify and label the sori.

A:

Activity 10: Fern Sorus

Materials:
Fern indusium slides

Procedure:
1. Focus the slide on low power (10X) of a compound light microscope and sketch it in the space below.
2. Label the frond, the sorus, the indusium, the sporangia, and the spores.

A:

B:

C:

D:

Activity 11: Fern Gametophytes

Materials:
Fern antheridia slides Fern archegonia slides

Procedure:
1. Focus the fern antheridia slide on low power (10X) using a compound light microscope and sketch it in the space below.
2. Label the antheridia.

A:

3. Focus the fern archegonia slide on low power (10X) using a compound light microscope and sketch it in the space below.
4. Label the archegonia.

Review Questions

1. Complete the following chart.

Phylum	**Vascular Tissue: yes or no**	**Dominant Generation: sporophyte or gametophyte**	**Water is Required for Reproduction: yes or no**
Hepatophyta			
Bryophyta			
Anthocerophyta			
Lycophyta			
Monilophyta			

2. Why are nonvascular plants not completely adapted to land?

3. Why are vascular plants better adapted to land than non-vascular plants?

4. Why are seedless vascular plants not completely adapted to land?