# Cell division, life cycles, bryophytes & seedless vascular plants

**Introduction to cell division**

In living organisms, division of cells facilitates reproduction, growth, and repair. Single-celled eukaryotes reproduce by dividing into two cells. Cell division is actually two separate, but linked processes. The first is division of heredity material (DNA) in the cell nucleus, called mitosis. The second step is division of cytoplasm and formation of two daughter cells, called cytokinesis.

## Exercise 1- Classifying cells with respect to mitotic stage

1. The growing point of a plant is in its root and shoot tip. Obtain an onion (*Allium*) root tip slide. Under the 4X objective, find the area just behind the loose cap of protective cells (root cap). Look for cells where chromosomes are visible. Switch to the 10X objective and find the sequence of events observed above (compare with Fig. 12.9 in the textbook). Cell division is the first stage of the plant's growth. Draw and label cells in the following stages:

Interphase Prophase Metaphase

Anaphase Telophase Between _____ and _____

2. Now, with your partner, examine a collection of cells in the root tip and call out the stage of every cell that you examine (e.g. interphase, prophase, interphase, interphase, etc). Your partner will make a slash mark for every cell stage you call out on the next page. After you have looked at about 100 cells, stop. Now tabulate results.

| Stage | Number of cells |
|---|---|
| Interphase | |
| Prophase | |
| Metaphase | |
| Anaphase | |
| Telophase | |
| Unknown | |

Which stage was found most often?

_____

What does this tell you about events that occur during the cell cycle?

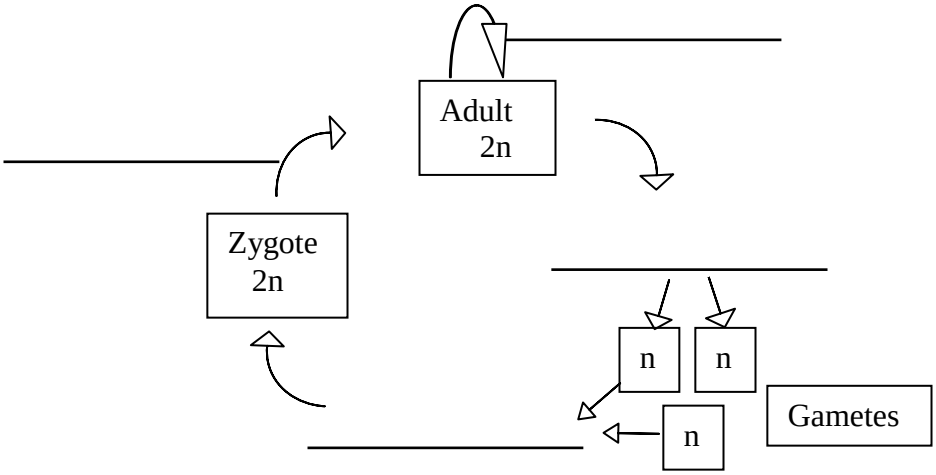
**II. Meiosis**

Meiosis is a special form of cell division. While mitosis starts with duplicated chromosomes and divides them into two genetically identical daughter cells, the first cell division of meiosis reduces the number of chromosomes by half. This is followed by a second division that results in four daughter cells with half the genetic information of the original cell. Meiosis is required for sexual reproduction to produce gametes. When the gametes fuse (syngamy, or fertilization), a zygote results, with chromosome number restored to the starting condition.

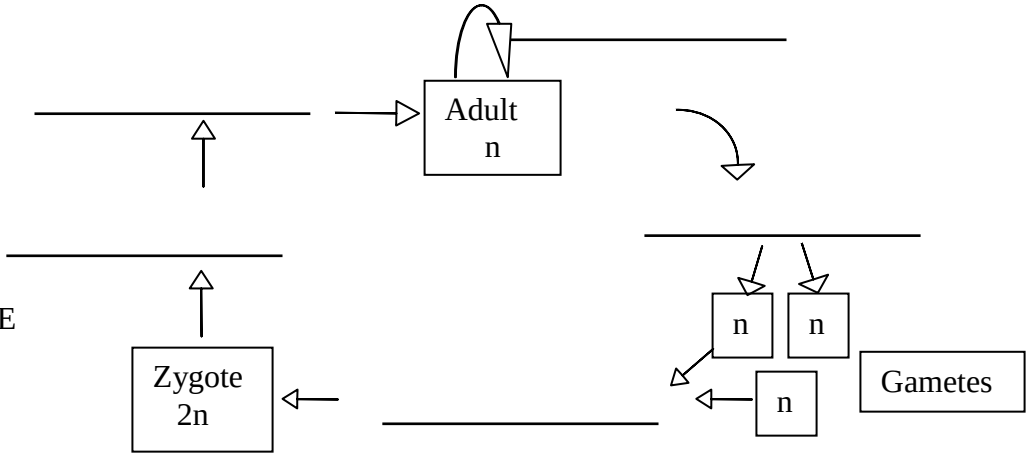
## Exercise 2- Comparing life cycles in different taxa

Based on your understanding of the generalized life cycle, fill in the life cycles on the following page. On the diagrams, where mitosis occurs, indicate whether it is for growth, repair, or reproduction.

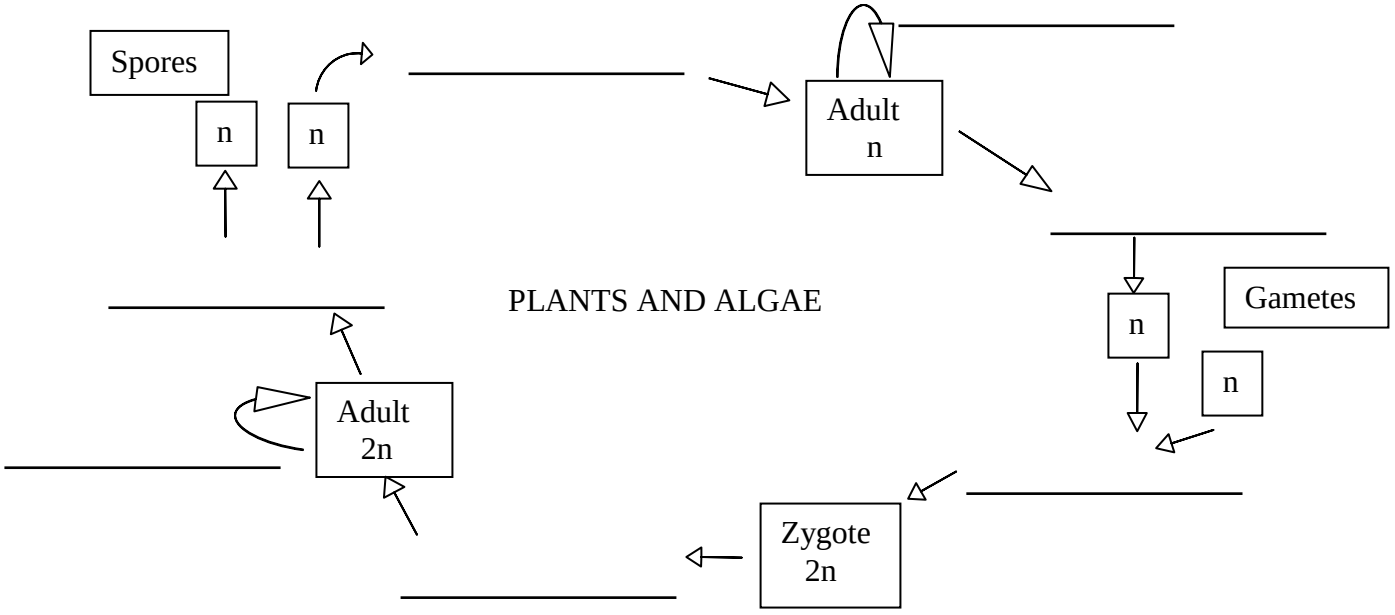
ANIMALS




FUNGI and ALGAE




PLANTS AND ALGAE



**Bryophytes and seedless vascular plants**

Plants were the first complex organisms to colonize land about 460 million years ago. Today, the Plantae is represented by over 280,000 species. Plants dominate most terrestrial environments. Terrestrial plants have a heteromorphic alternation of generations, where haploid and diploid stages look very different. This laboratory will look at bryophytes (no vascular tissue) and seedless vascular plants (ferns and their allies).

Review of organisms in Kingdom Plantae covered in this lab (see Table 29.1 of your text)

- Phylum Bryophyta - mosses: *Mnium, Sphagnum, Polytrichum*
- Phylum Hepatophyta - liverworts: *Marchantia*
- Phylum Anthocerophyta - hornworts
- Phylum Pterophyta - ferns: *Osmunda*, horsetails: *Equisetum*
- Phylum Lycophyta - lycophytes, club mosses: *Selaginella*

## Exercise 4- Examining moss (Phylum Bryophyta)

These plants possess multicellular gametangia, a multicellular embryo, and cells that transport water over a short distance. They produce no seeds and have no vascular tissue (tissue that conducts water and nutrients to different parts of the plant). In Bryophytes, the gametophyte constitutes the free living plant and is the most prominent part of the life cycle. Review the moss life cycle (Fig. 29.16) while examining the following:

1. Observe living specimens of the adult gametophyte phase of the life cycle. Moss plants have numerous leaf-like phyllids attached to a stem-like structure. Root-like rhizoids anchor the plant but do not conduct water. Mosses absorb water like a sponge, but they can also dry out and become dormant. Briefly describe the difference between a moistened and dry moss specimen.

2. Mosses reproduce asexually by adding new individuals to a clump and spreading. In most species, an individual may be female or male. Sexual reproductive structures (gametangia) are borne at the top of the gametophyte. Males produce antheridia, which contain sperm cells, and females produce archegonia, which surround the egg cell. The sporophyte, grows out of the gametophyte and depends on it for water and nutrients (Fig 29.15c).

Remove a single moss individual from the clump with gametophytes and sporophytes, following instructions provided by your instructor. Examine your moss individual under the dissecting microscope and compare it to Fig 29.16. Draw your moss plant and label the following structures: rhizoids, phyllids, seta, and sporangium (= capsule). Then indicate which sex the plant is and indicate which parts are gametophyte and which are sporophyte tissue.

3. Now place your moss plant on the center of the dissecting scope and pierce the sporangium with a dissecting needle. With a second dissecting needle, tear the capsule open to reveal the spores inside. Add a drop of water to the open sporangium using a plastic Pasteur pipette, and make a microscope slide of the spores. Examine the spores carefully under high power and draw one.

4. Obtain the slide labeled "Moss protonema" and observe with the 4X and 10X objectives. The protonema grows from the spore and consists of a group of filaments made up of green cells. It looks superficially like an alga. Eventually, cells will differentiate. To which life cycle stage do the spores and protonema belong?

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5. Observe the prepared slide "Moss antheridia and archegonia" under low (4x) and medium (10x) power on the compound microscope. The antheridium has a single layer of sterile cells surrounding many sperm. The archegonium has several sterile cell layers around a single egg. (If the egg fell out during slide preparation, you will see a clear area instead of the egg.) These multicellular gametangia of mosses are produced at tips of the gametophyte. Water must be present for sperm to swim from antheridium to egg in the archegonium.

   Which process (meiosis or mitosis) produces the gametes in *Mnium*? (Hint: examine ploidy level of the gamete producing structures in the life cycle on Fig. 29.16 very carefully).

   _____

   From which structure does the sporophyte embryo develop?

   _____

   Draw and label an antheridium (left side) and archegonium (right side) and compare your observations with Fig. 29.16 in the text. Label the sperm and egg cells on your drawing. Why do we call these structures multicellular gametangia?

6. The wetland moss *Sphagnum* is an ecologically very important plant. It grows in bogs, referred to as peat bogs and makes the bog a very acidic place where organisms decay especially slowly. *Sphagnum* phyllids possess a mixture of photosynthetic and water storage cells (Fig 29.19). Even when dead, these cells retain their water storage capacity. The following exercise will demonstrate the water storage capacity of *Sphagnum*.

Obtain a palm-sized piece of dry *Sphagnum* from your instructor and examine some phyllids under the dissecting scope. Then bring your moss to the balance at the side of the room, weigh it, and record the weight below. Now bring your piece of moss to the sink, briefly run cold water over it until it is soaked, and squeeze it until it is no longer dripping. Reweigh it, record the weight and determine the weight of the water absorbed. Then record the percent of the wet mass occupied by water. After 1 hour, reweigh.

| *Dry weight* (g) | *Wet weight* (g) | *amount of water (g)* wet wt – dry wt | *percent water* 1 – (dry wt/wet wt) | *Wet weight* after 1 hr | *percent water* after 1 hr |
|---|---|---|---|---|---|
| | | | | | |

After your first reweighing, examine the moss phyllids under the dissecting scope again. How did they change visually after being wetted?

What do your data and observations tell you about the mechanism by which *Sphagnum* retains water?

**Exercise 4- Examining liverworts (Phylum Hepatophyta)**

The bryophytes consist of three phyla. Mosses are members of the largest phylum, Bryophyta. The two other phyla are small. The liverworts make up the phylum Hepatophyta and hornworts the phylum Anthocerophyta.

7. Examine the liverwort *Marchantia* on display. *Marchantia* grows by producing a horizontal thallus (flattened body). Male gametangia are produced on antheridial stalks capped by a small 'umbrella' and female gametangia are produced on archegonial stalks that look like small palm trees. Draw one of these structures and identify its sex.

8. Under the demonstration dissecting scope, you will see a liverwort with small cups containing even smaller, green disks. Liverworts make these gemmae in asexual reproduction. The small disks are groups of cells that splash out of gemmae when hit by a drop of water. After dispersal, the disk will grow into another *Marchantia* plant. Since gemmae are a form of asexual reproduction, which cell division process produced these small green disks?

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9. Examine the slide '*Marchantia* gemma cup' to see how a cross section of a gemma cup made on a slide compares to the same structure on a live organism. Locate the gemmae. Besides the fact that they are produced through asexual reproduction, what else is very different about gemmae from the moss spores that you examined earlier?

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**Exercise 6- Examining seedless vascular plants**

Unlike bryophytes, seedless vascular plants (ferns and fern allies) have true vascular tissue with water conducting cells (in the xylem) and lignin. We will look at structures associated with the fern life cycle. Compare your observations with Fig. 29.23 in the textbook.

1. Observe living material of ferns. The adult fern plant, unlike moss, is a sporophyte. The leaf is called a frond and is attached to a horizontal stem covered by brown scales. The stem is known as a rhizome and has true roots for anchoring and water absorption. Underneath the leaf you will see brown spots. These are called sori (singular: sorus) and contain numerous, small sporangia (Fig 29.24). Fern species are often distinguished by the location of the sori on the leaf. Compare three different ferns on display with respect to position of the sori.

| *Fern* | *Description of leaf* | *Position of sori* |
|---|---|---|
| Fern 1 | | |
| Fern 2 | | |
| Fern 3 | | |

2. Now take a small piece of leaf from the fern indicated by your instructor and place it under the dissecting microscope so that you can see the sori and individual sporangia. Now place the sorus onto a microscope slide and tease a few sporangia onto the slide with a dissecting needle, while looking through the dissecting scope. Once you have a few sporangia on the slide, add a drop of water and place a cover slip onto the slide. Now place the slide under the compound scope. Locate a sporangium with spores and draw it and the spores below.

3. Obtain the slide labeled "Fern prothallium" and observe under the low power objective. The prothallium or prothallus is the adult gametophyte and is typically heart-shaped. You will see round spheres near the middle and edge of the prothallus and dark structures near its notch. Switch to the 10X objective. The small spheres contain numerous cells that will develop into sperm. These are antheridia. Look at the dark structures near the notch. By through focusing you will be see an inflated base and short neck, the archegonium. Since the gametophyte grows in moist soil, a film of water is often available for sperm to swim to the archegonium and fertilize the egg. The zygote develops into an embryo on the gametophyte. Unlike bryophytes, the fern sporophyte becomes independent and the gametophyte eventually disappears.

Draw the fern prothallus and label the antheridia and archegonia.

4. Vascular plants have photosynthesizing organs to collect light, called _____. Conducting tissue brings nutrients from leaves down the _____, which supports leaves, to the _____, which anchor the plant in the soil and collect water to bring to leaves. The tissue that brings water up from the roots is called _____ and the tissue that brings nutrients down from the leaves is called _____ (see figs 35.7, 35.8, 35.9, and 35.15 for hints).

5. Now take a stem of a fern plant shown by your instructor and cut a very thin slice of the stem and place it under your dissecting scope. Draw the major regions on the stem and identify the conducting tissue.

6. Examine the slide 'Pteridium rhizome' under the compound scope. This shows a cross section of root tissue. Using Fig. 35.15 in your text, identify the conducting tissue that brings food from leaves to roots, and the tissue that brings water from roots to leaves. Name and describe this tissue below

| *Tissue type* | *Tissue name* | *Description of cells (stain color, thickness of cell wall)* |
|---|---|---|
| Food | | |
| Water | | |

7. The phylum Lycophyta are the lycopods. Today this is a small group, but about 380 million years ago were the dominant plant life on earth and produced great forests of plants over 250 feet tall. Observe the picture of reconstructed ancient lycopod trees. Most of the coal we use today is derived from this period of earth's history and from these plants. You will observe a living member of this group in the plant *Selaginella*. Today, lycopods are no more than 1 meter tall. How do these plants differ from ferns in overall structure?

8. The horsetails represent a very different kind of early vascular plant. The plants are composed of green jointed stems that are topped by a cluster of sporangia called the strobilus. Like lycopods, horsetails grew to great heights in the past. Pictures of reconstructed ancient sphenophytes are available. Today, horsetails reach height of about 1-2 meters. Observe the material of *Equisetum*, the only living genus of this entire phylum. Which of the three main organs of vascular plants appear not to be found in this specimen?

9. Fern diversity between Darwin and Stevenson Hall. Ferns tend to grow in shady, moist places, and on our campus they were planted on the north (shady) side of Darwin Hall. Before we finish lab today, we will examine several ferns and determine whether they presently have sori on their leaves. Follow your instructor outside and describe three ferns with respect to overall growth form, leaf form, and presence or absence of sori.

| *Fern* | *growth form* | *leaf form* | *Position of sori* |
|---|---|---|---|
| Fern 1 | | | |
| Fern 2 | | | |
| Fern 3 | | | |