

# Plants II – Reproduction:

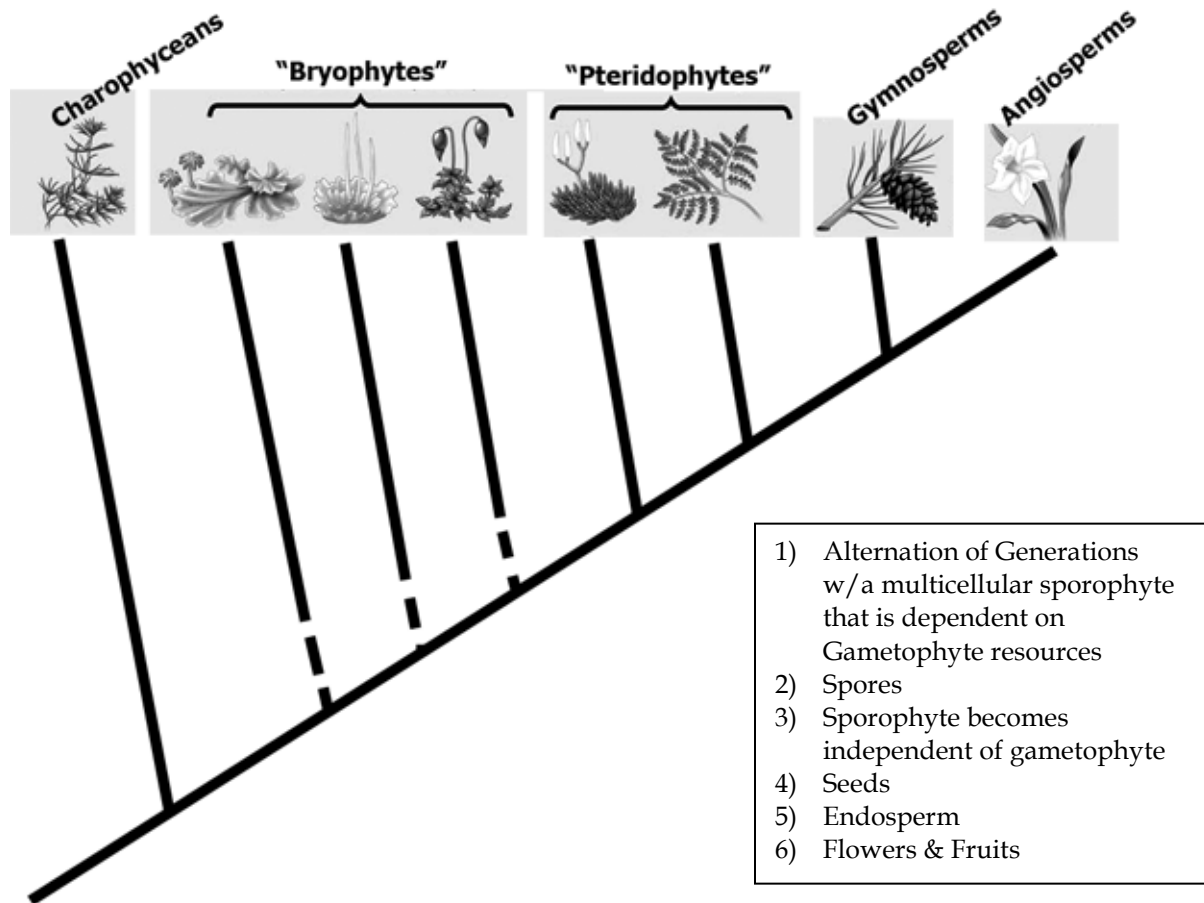
## Adaptations to Life on Land

### Objectives:

- Understand the evolutionary relationships between plants and algae.
- Know the features that distinguish plants from algae.
- Understand the evolutionary relationships of embryophytes.
- Know the phylogeny of plants and when major events in the evolution of plant reproduction occurred.
- Understand alternation of generations and know the life-cycles of all the major groups of plants. Be sure to understand when mitosis and meiosis are occurring, and what their products are.
- Be able to identify antheridia and archegonia and know what they produce.
- Understand the difference between homosporous and heterosporous.
- Understand the selective advantages of seeds, fruits and flowers.
- Know the anatomy of flowers and the different types of flowers.
- Know how fruit is formed and what the major types of fruit are.
- Understand what endosperm is and how it is formed.
- Know the differences between monocots and “dicots” in terms of floral and seed structure.

### Plant Reproduction

As you work through this lab you should place the characters/events listed to the right of the phylogeny given below in the correct positions on the tree.



### Multicellular Sporophyte:

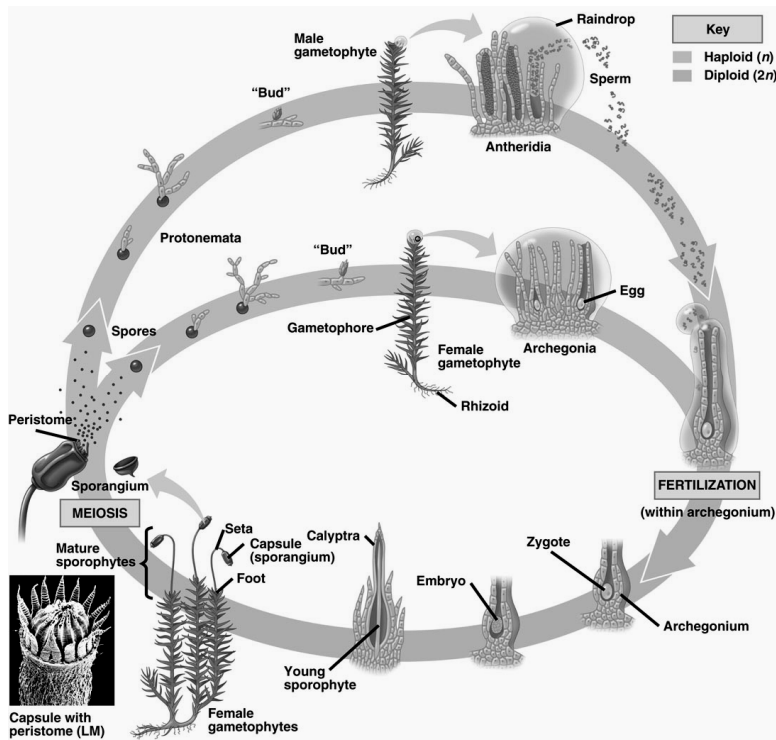
Many algae have what is termed **alternation of generations**. That is they alternate between a haploid (N) stage called the **gametophyte** (this is the stage that produces gametes) and a diploid (2N) stage called the **sporophyte**. Plants are often referred to as **embryophytes** because the multicellular sporophyte is dependent on resources from the gametophyte. In contrast, the sporophyte in charophyceans (the sister group to plants) is unicellular. As you will see there is a trend in plants towards reduction of the gametophyte stage. In "Bryophytes" it is the dominant life-stage, in "Pteridophytes" it has become reduced and the sporophyte is the dominant stage, and in seed plants the gametophyte has become microscopic and is housed within the sporophyte.

### "Bryophytes":

Bryophytes are restricted to moist habitats due in part to the lack of vascularization (you will learn more about this next week). They also require water for fertilization as the sperm, which are produced in the **antheridia**, must swim to

the egg, which is produced and housed in the **archegonia**. Thus, the lack of vascularization and the need for water in fertilization generally restricts the bryophytes to moist areas.

As was stated above, the gametophyte stage is the larger of the two life-stages. The sporophyte arises from the gametophyte after fertilization. The sporophyte generates spores via meiosis, and new gametophytes grow from those spores. The gametophytes produce gametes via mitosis (see diagram below).

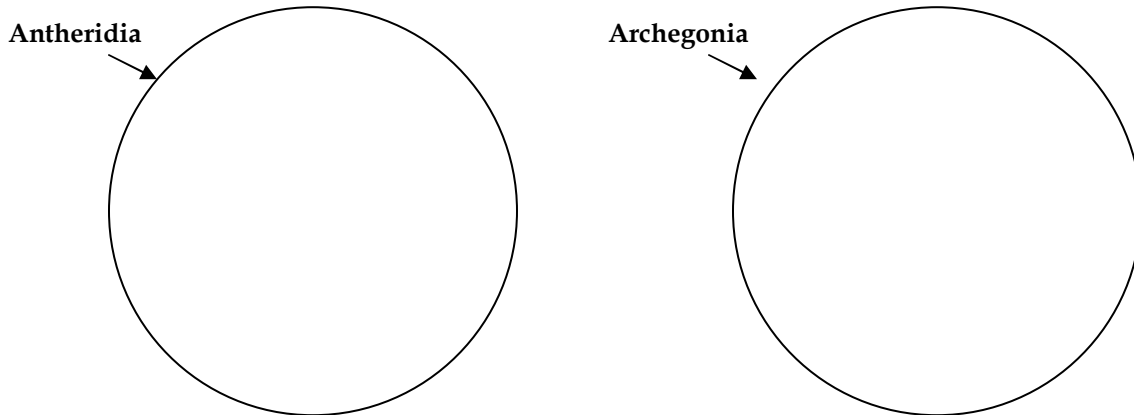


Modified from Fig. 29.8 of your text

► Examine the moss on display and draw a sketch of it. Label the gametophyte and sporophyte. ↓

► Why are the gametes produced by mitosis instead of meiosis?

► Examine the slides of the moss archegonia and antheridia. Sketch what you see and label the egg and the immature sperm.



### **“Pteridophytes” (including Lycophyta, Sphenopsida & Pterophyta)**

Ferns and their allies can achieve larger sizes than bryophytes thanks to their lignified vascular tissue. They also differ from bryophytes in that the sporophyte stage is larger and more complex than the gametophyte stage. However, they are similar to bryophytes in that they require water for fertilization. The sperm swim from the antheridia to the archegonia to fertilize the egg housed there (see life cycle on next page).

#### **Lycophyta:**

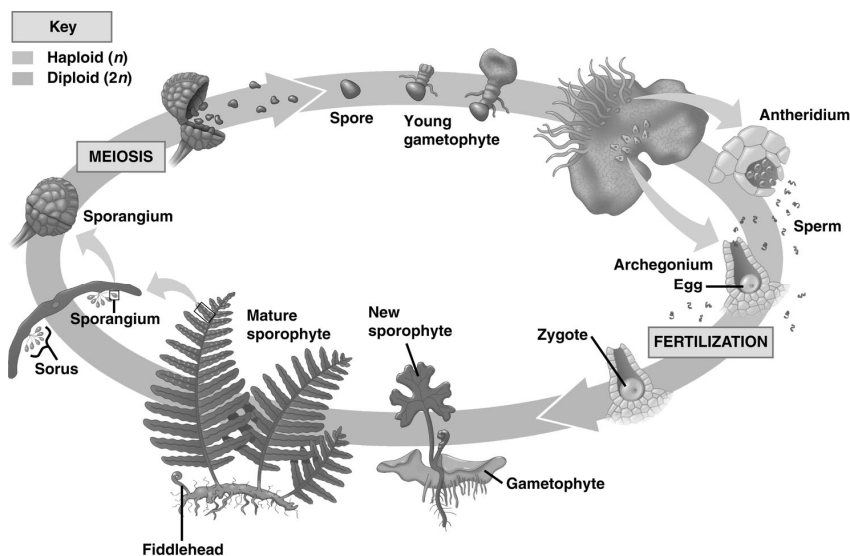
Examine a slide of a club moss (*Selaginella* or *Lycopodium*). Make a sketch and label the microsporangium, microspores, megasporangium and megaspores.

### Sphenopsida or ArthropHYTA:

If a suitable specimen is available, examine a "scouring rush" or horsetail (*Equisetum*). In the space to the right, make a sketch of its growth habit, identifying the sporangium and leaves.

### Homospory vs. Heterospory:

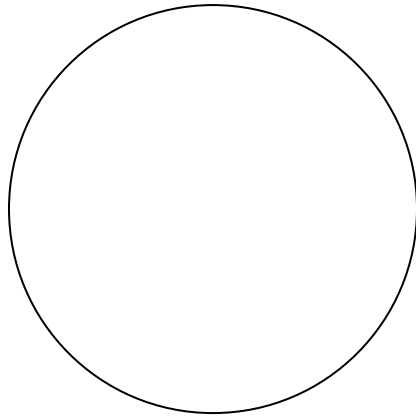
Most pteridophytes are **homosporous**. That is they produce spores of equal size that germinate into gametophytes that produce both male and female gametes. In ferns the spores are produced in sporangia that are found in clusters called **sori**. The sori are found on the ventral surface of fern fronds. When the spores are released they will germinate and become a **prothallus** (the gametophyte). Once the egg (housed in the archegonium) is fertilized the new sporophyte begins to grow. The sporophyte emerges directly from the gametophyte, and eventually the gametophyte disappears all-together.



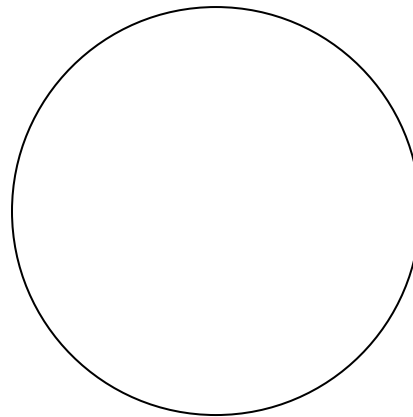
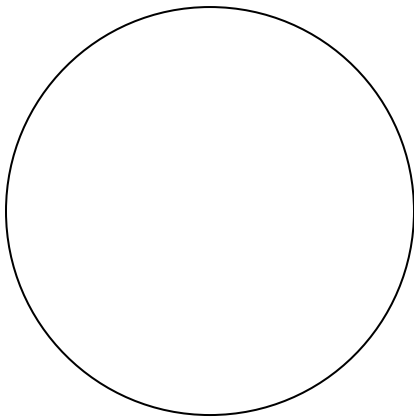
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**Pterophyta (ferns):**

► Examine the fern frond and the demonstration slide of a fern leaflet with sori. Make a sketch of the leaflet and sori as seen under the microscope and label the sori.



► Examine the set of three fern prothallia under the dissecting microscope. Make a sketch of the two larger ones and label the gametophyte and sporophyte (if present).



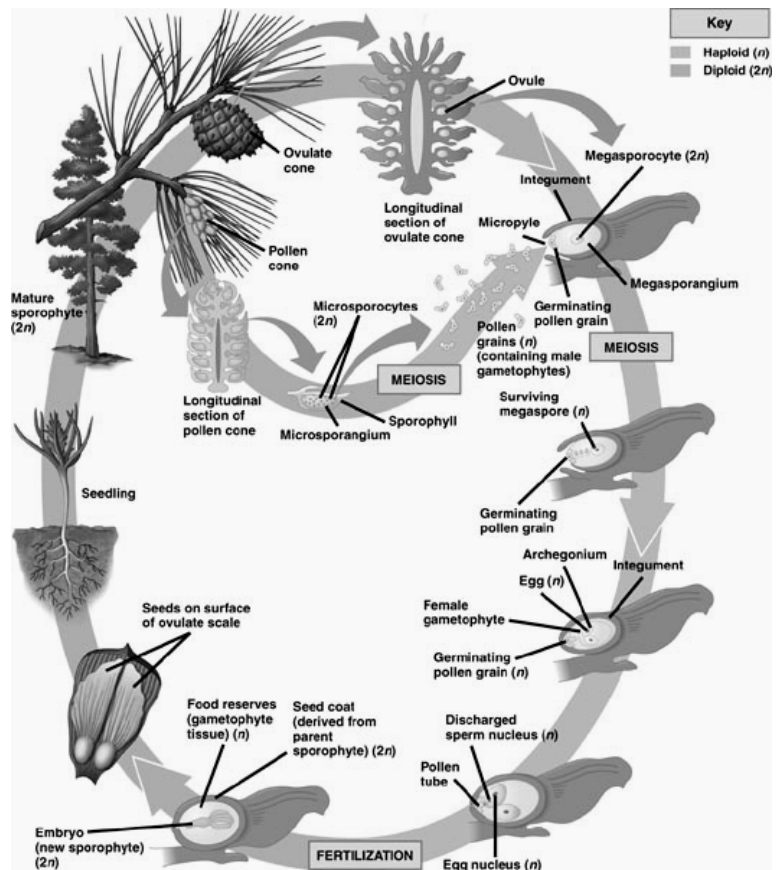
► Examine a slide of a fern prothallus under the microscope. Make a sketch and label the archegonia and antheridia.

The fern examples you just looked at were all an example of **homospory**. However a few Pteridophytes have independently evolved **heterospory** (as have seed plants as you will see shortly). In heterosporous plants there are two types of spores, **megaspores** and **microspores**. Megaspores produce female gametophytes, and microspores produce male gametophytes. In addition, the gametophytes never leave the confines of the spore, and are now microscopic in size.

## Seed Plants:

Seed plants comprise **gymnosperms** and **angiosperms**. The names are Greek in origin with gymnosperm meaning “naked seed” and angiosperm meaning “receptacle seed” (referring to the fact that the seeds of angiosperms are housed in fruits). As was stated above, all seed plants are heterosporous, but in addition to that, the megaspore is not released from the sporophyte. Instead, the megaspore is housed within an **ovule**. After fertilization the ovule becomes the seed and the ovule’s integument becomes the seed coat. The microspores become **pollen grains** that house the male gametophyte, which produces sperm. When the pollen grain comes in contact with the

female reproductive structure, a **pollen tube** grows and the sperm (or sperm nuclei) travel down the pollen tube and fertilizes the egg. Pollen grains are covered by an extremely durable outer-coat made of sporopollenin. This tough coat makes the pollen very resistant to degradation (as a result, pollen is abundant in the fossil record). Thus, extra protection is given to the gametophytes by either housing them within ovules, or encasing them in sporopollenin. Furthermore, the seed itself is very durable (especially compared to spores) and contains a source of nutrients (derived from the female gametophyte) for the growing embryo.



## Gymnosperms:

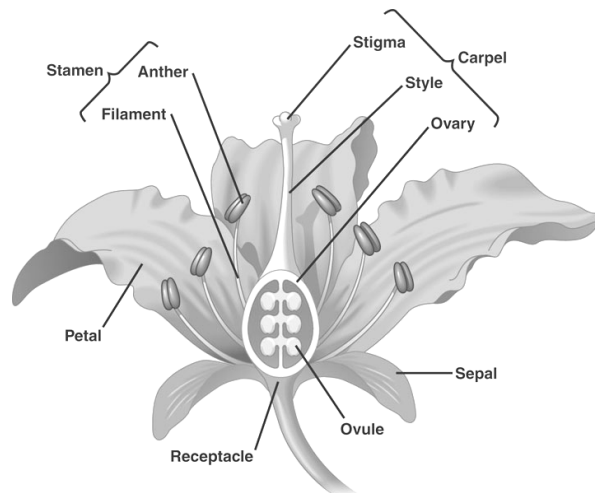
In gymnosperms, the megaspores and microspores can be found in the female and male cones respectively. Pollen is carried by the wind to the female cones where fertilization takes place (the life cycle of a gymnosperm – a pine tree, is shown on the right).

► **Observe the examples of male and female cones and the seeds that are produced via fertilization.**

► **Consider the fact that the pollen of gymnosperms is carried by the wind (i.e. it is not delivered via a vector directly to an ovule). On a scale from a minute amount to copious amounts, how much pollen do you think gymnosperms produce? Hint: have you ever had the misfortune to park your car underneath a conifer?**

## Angiosperms:

Three interrelated-features are found only in angiosperms: **flowers, fruit & endosperm**. This suite of characters represents a key innovation. Flowering plants have undergone an explosive radiation resulting in ~ 235,000 species! Refer to the figure on the right to identify flower parts. Pollen is produced in the **anthers**. When a pollen grain lands on the **stigma** a pollen tube grows down the length of the **style** and two sperm nuclei are released in the ovary. Next, a process known as double fertilization occurs. Not only is the egg fertilized, but the second sperm nucleus fertilizes the gametophyte to produce a 3N tissue known as **endosperm**. Endosperm acts as the energy reserve for the growing embryo. The ovary (and sometimes other floral parts) develops into the fruit, which houses the seed. The developing embryo has

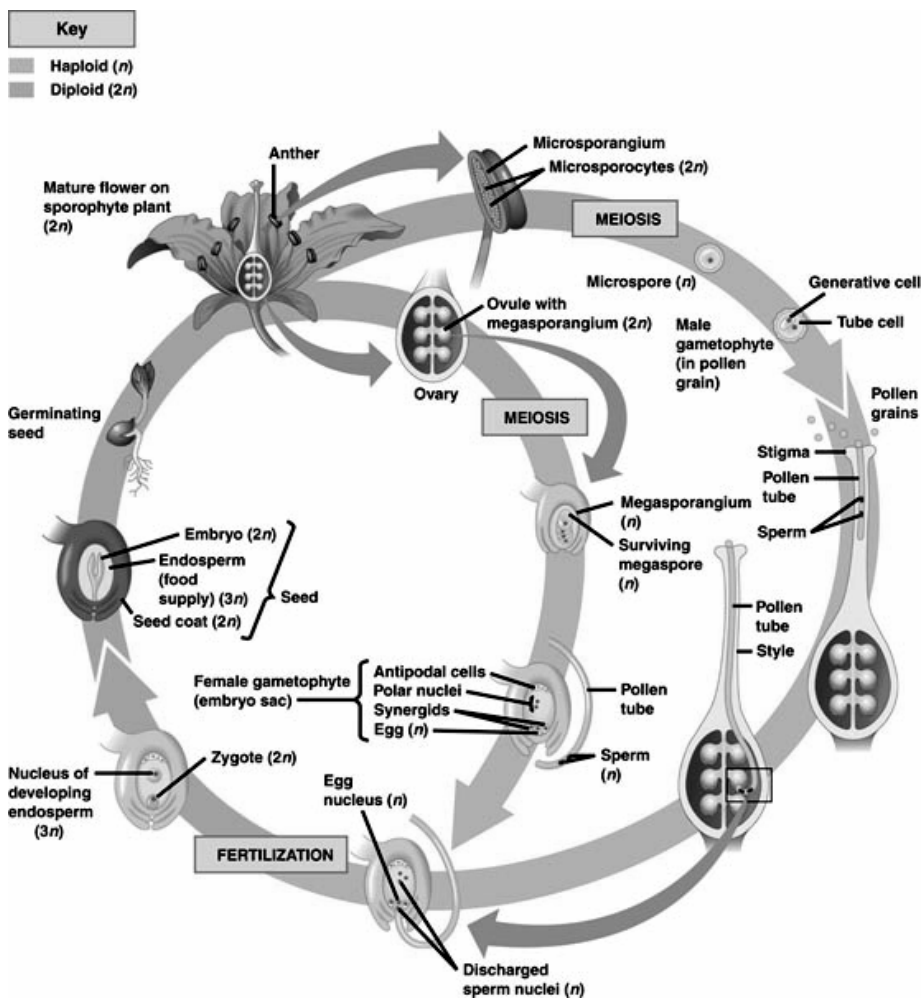


Modified from Fig. 30.7 of your text.



either one (in the case of **monocots**) or two (in the case of **dicots**) seed leaves (**cotyledons**). **Monocots** usually have flower parts in multiples of three or six, leaves and petals with parallel veins, and vascular bundles scattered throughout the stem with no orderly pattern. **Dicots** (also called Eudicots) usually have flower parts in multiples of four or five, leaves and petals with netlike, branching veins, and stems with vascular bundles arranged in a circular ring.

There is tremendous diversity in flowers, fruits and seeds. Flowers have co-evolved with their pollinators. Pollination modes range from wind (or water) dispersed to use of an animal vector such as an insect, bird or bat. Animal pollinators are attracted to the flowers by features such as color or scent, and are often rewarded with nectar. Fruits range from dry to fleshy and may be dispersed by wind, water, sticking to animals, or being eaten and having their seeds conveniently deposited in a pile of fertilizer (feces). The life cycle of an angiosperm is shown below.



Modified from Fig. 30.10 of your text.

## Flowers:

There are many flower types based on several categories. Flowers may be **complete** or **incomplete**. Complete flowers have all floral parts, whereas incomplete flowers lack one or more floral parts. Flowers may also be **perfect** or **imperfect**. Perfect flowers have both male and female parts, whereas imperfect flowers have only male or female parts. Plants that have imperfect flowers may be either **monoecious** or **dioecious**. **Monoecious** ("one house") plants have male and female flowers together on the same plant, whereas **dioecious** plants have male and female flowers on separate plants (in "two houses"). Lastly, flowers may be solitary or clustered together into inflorescences.

► **Working in pairs, take a flower from a plant such as *Alstromeria*. Record the number of each of the floral parts in the table below (Note: in this flower, the sepals are the same color as the petals instead of being green - which is more common). Then, cut the flower in half longitudinally. Take the most intact half and make a sketch of it labeling all of the floral parts.**

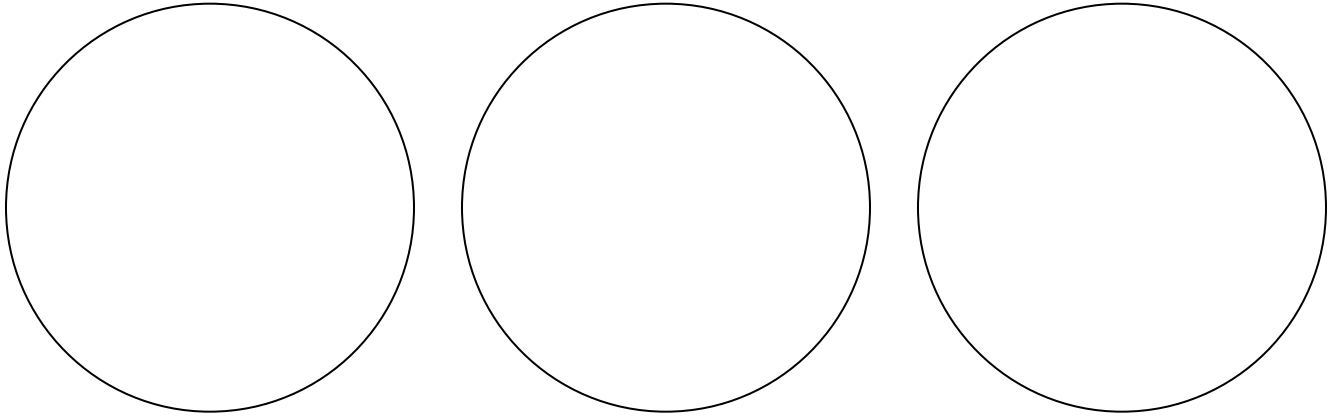
Stamens (Anther + Filament)	
Carpels (Stigma + Style + Ovary)	
Ovules	
Petals	
Sepals	
Receptacle	

### Sketch

► **Monocots tend to have floral parts in multiples of three, while dicots have floral parts in multiples of four or five. Is *Alstromeria* a monocot or dicot?**

► **Is the flower of *Alstromeria* complete or incomplete, and is it perfect or imperfect?**

► Observe the cross sections of a *Lilium* ovary, immature anther and mature anther. Label the ovules and microspores/pollen grains where appropriate.



► What difference(s) do you notice between the immature and mature anthers?

### Fruits:

The ovary of the flower develops into the fruit and sometimes other floral parts are involved as well. For example the ovary of an apple flower forms the core of an apple and the fleshy part of the fruit is formed from other floral parts.

► Observe the examples of fruit provided and give an example of each type of fruit in the outline below.

I. Simple: one ovary → one fruit

A. Fleshy: \_\_\_\_\_

B. Dry

1. Dehiscent: splits open along a seam \_\_\_\_\_

2. Indehiscent: does not split open \_\_\_\_\_

II. Complex

A. Aggregate: many ovaries from a single flower \_\_\_\_\_

B. Complex: many ovaries from many flowers \_\_\_\_\_

III. Accessory: other floral parts included \_\_\_\_\_

**Seeds:**

► Take a bean seed that has not germinated and cut it in half longitudinally. Sketch one of the halves and label the seed coat, endosperm and embryo.

► Take a bean seed that has germinated and make a sketch of it. Label the cotyledons. Is the seed a monocot or a dicot?