

Biology 204 Laboratory 3. Plant evolution and diversity

Last week, we discussed a variety of photosynthetic protists, even some very large multicellular ones, but said that they weren't true plants. So what is a plant? While that may seem to be an easy question to answer in every day life ("I know one when I see one."), it gets trickier when looking at the whole spectrum of biological diversity, including the protists. In fact, some phylogenies even include the Chlorophyta and macroalgae in the Kingdom Plantae. What do you think about that?

As a whole, the true plants share several characteristics. Plants are multicellular, eukaryotic, photoautotrophs. Plant cells have cell walls of cellulose and other polymers. The cells of the photosynthetic parts contain chloroplasts, and all plants use both chlorophyll a and b, in addition to certain types of accessory pigments. All plants store their food reserves as starch. Plant cells are arranged in tissues and organs that form a plant body, either a thallus (without roots, stems and leaves) or a true plant body (with those organs). And, all the plant sporophytes begin their lives as embryos nurtured by gametophytes (more on this below).

Though some plants have evolved back to aquatic life styles, most plants live on land. Our survey of the land plants will begin with the plants that are most similar to what we think the earliest land plants were like (mosses and liverworts), and continue with the more recently evolved plant phyla, each of which has its own strategies for better dealing with life on the land. Actually, they need to be adapted for life in the air, since that is the medium that surrounds much of the plant body. As you study these plants, be aware of: **(a)** how each group of plants deals with living on land, **(b)** what strategies the plants in the group have that make them better able to live on land than the previous group, and **(c)** in what ways the plants in the group have not been able to better deal with land life.

To obtain this kind of understanding, you need to first use the textbook to become familiar with the life cycle of the plants you are studying. You will study the details of the life history of the moss (most primitive) and the flowering plant (most advanced), and you will be introduced to some of the features of the life cycle of the fern and conifer (two steps along the long evolutionary advancement of plants). Representatives of other phyla intermediate between those four mentioned above are on display.

The first thing to do, as you prepare to look at these representatives is make sure you understand the relationship between the **sporophyte** (spore-producing plant) and the **gametophyte** (egg and sperm producing plant). You should be able to recognize the general form of the plants in each the different phyla on display, but you do not need to know the details of their life cycles except for the mosses and flowering plants.

Objectives

1. Understand the distinctive characteristics shared by organisms in the kingdom Plantae
2. Become familiar with the phyla of plants and how each group deals with living on land.
3. Focus your study of plants on the mosses, ferns, conifers and flowering plants.
4. For these phyla, what strategies does each phylum exhibit that make them better able to live on land than the previous phylum (or in the case of the mosses, better than algae)?
5. For these phyla, in what ways have the plants **not** been able to deal with life on land?
6. Be able to identify an organism on display into its proper kingdom and phylum.
7. In preparation for the later ecological study of lichens and mosses, be sure you can recognize the different identifying structures of mosses (we'll cover lichens next week with fungi).

Key Themes

A major transition in both support structure and fluid transport in plants occurred with the development of vascular tissue in the seedless vascular plants. Further refinement of this structure through secondary growth occurred with the gymnosperms.

True roots and leaves (i.e., those that have vascular tissue present) developed in seedless vascular plants.

All plants have alternation of generations (i.e., a sporic life cycle) in which there are both multicellular gametophytes and multicellular sporophytes. There is a strong evolutionary trend for reduction in the size of the gametophyte relative to the sporophyte.

The development of seeds helped overcome some limitations in dispersal. While dispersal by spores allows for long distance travel, the conditions must be optimum for those spores to germinate and for the resulting gametophytes to develop and survive. The development of seeds allowed for dispersal of a partially developed sporophyte with a source of “reserve food.”

Finding alternatives to needing water for fertilization was a major evolutionary advancement for plants living on land. The angiosperms have the most advanced fertilization techniques, often using co-evolved relationships with animals to accomplish the task.

Key Terms

Sporic life cycle	Plant embryo	Petal
Spores	Root	Sepal
Sporophyte	Stem	Stamen
Gametophyte	Leaf	Carpel
Antheridium	Ovule	Ovary
Archegonium	Pollen	Calyx
Zygote	Seed	Corolla
Heterospory	Flower	Ovule
Homospory	Fruit	
gemmae cups	Microphyll	
Sporangium	Macrophyll	

Samples (refer to the chalkboard for updates)

Prepared slides #'s 1, 19, 21, 23, 28	Representative plants from 9 phyla
Slides and coverslips for fresh preparations	Representative flowers
Forceps	Representative fruits

Introduction

Although the kingdom Plantae includes some members that have “returned” to the aquatic environment, this group of organisms are largely terrestrial. In their general characteristics, and in their **phylogeny** (evolutionary interrelationships of taxa), this kingdom shows a variety of adaptations for coping with the stresses of living on land. Our survey will be taxonomic and the phyla displayed for both groups are arranged in order of more recent evolutionary development. As you survey the specimens and the slides, think about how evolutionary changes in the following characteristics help solve some of the problems of living on land – that is, in air instead of in water.

1. The vascular system, which carries water and nutrients from the roots to the rest of the plant (xylem) and photosynthate (i.e., sugars made during photosynthesis) from the leaves down to the roots and up to the growing stems (phloem). How have the cells become more specialized and why is this useful as the plants grow bigger?

2. Structural support. How are plants able to grow so tall and why is this an important strategy?

3. Roots and leaves. How have these become more specialized?

4. The life cycle. While all plants have a sporic life cycle (alternation of generations), how does this differ for different types of plants?

5. Strategies for fertilization. What major steps happened between each of the major groups we are investigating? What great leaps were made in the Angiosperms and how has this influenced the number of species in this group?

6. Dispersal of offspring. What major steps happened between each of the major groups we are investigating? What great leaps were made in the Angiosperms and how has this influenced the number of species in this group?

What to do

Fresh specimens and slides will be available for all the major groups. Study the specimens and answer the questions accompanying each section of the lab, making brief illustrations and descriptions of what you see in your lab notebook (see Laboratory Introduction and the archived file on the course web site, “Background Review of Basic Research Methods”).

Kingdom Plantae

BRYOPHYTES

Mosses (phylum Bryophyta) and liverworts (phylum Hepatophyta) make up most of the bryophytes, which are tiny plants averaging less than 10 cm in height, and usually much less. Hornworts (phylum Anthocerotophyta) are relatively uncommon and will not be on display in the lab. The small size of bryophytes is largely due to their lack of complex tissues for support and

for internal conduction. However, the absence of these tissues does not limit the bryophytes to a narrow range of habitats because they have their own special strategies for living on land, such as the ability to survive desiccation. Support of taller bryophytes (mosses) is accomplished by the combined efforts of the cell walls and the turgor pressure of the cytoplasm within the cell walls (see your text for an explanation of this). They also tend to occur in clusters that hold each other up and help conserve water.

In bryophytes, the **gametophyte** is dominant and responsible for most of the photosynthesis, and for production of gametes. Its small, ground-hugging form favors fertilization because a surface film of water is necessary for sperm transport to the egg. The **sporophyte** plant is physically supported and at least partially nourished by the gametophyte. Thus, the sporophyte can never grow any larger than the gametophyte. However, bryophyte sporophytes have one feature that allows them to relate successfully to life on land: they produce wind dispersed spores.

Phylum Bryophyta ("Mosses")

The gametophyte

Examine the leafy gametophytes of the living examples provided. You will see that most mosses occur in dense mats composed of numerous tiny plants. Pull up one of the gametophytes that does not have a sporophyte on it. Remove a "**leaf**", mount it on a slide, and observe it on the microscope. Try to determine its thickness. Leaves are the photosynthetic organs of plants — because moss leaves are on gametophytes, they are really not equivalent to the other leaves you will see on all the other plants in lab - which are sporophytes. On the base of the gametophytes, find the fine rhizoids that anchor the plant to the substrate (there are no true **roots**, which have vascular tissue for conducting water and photosynthate).

Examine the tips of several gametophytes for reproductive structures. If the tip has a flat, spread out cluster of "leaves," the plant is a male gametophyte and the **antheridia** (sperm-producing organs) are located within this flat circle of leaves. If the leaves at the tip are not flat and spread out, the plant is a female gametophyte, and the **archegonia** (egg-producing organs) are hidden among the topmost leaves. Find examples of both gametophyte sexes. Further study of these sex organs will be done on a prepared slide below. Be able to identify male and female moss gametophytes.

The sporophyte

Examine sporophytes on the living moss plants and identify the stem (seta), and the sporangium at its end (this may be covered by a calyptra, which is derived from the neck of the archegonium and is gametophyte tissue). Select a sporophyte. Remove the calyptra if necessary. Identify cap at the end and remove it with forceps if it is present. Examine the sporophyte under the dissecting scope and observe the (peristome) teeth around the opening. Breathe on the capsule and observe the teeth. If nothing happens, wet the capsule, then watch as it dries. For a moss individual with a sporophyte, was the gametophyte a male or a female? What is the function of the spores?

Moss life cycle

Prepared slide (# 1) includes several stages in the life of a moss. Refer to the diagram in your lecture notes or text. The first material on this slide (under the round coverslip to the left) is a whole mount of the protonema, the alga-like (filamentous) stage of the gametophyte that first develops from a newly germinated spore. Once this stage has developed sufficiently, it produces

buds that grow into the leafy gametophytes that you have already examined macroscopically. Ultimately, the leafy gametophyte will produce eggs and sperm. The next part of the prepared slide (under the square coverslip, moving the slide to the left - and the image moves right) is a longitudinal section of the top of a male gametophyte showing the **antheridia**, which are essentially bags of sperm. Among the antheridia are hairlike filaments known as paraphyses and cross sections of leaves. Then there is a section of a female plant showing the **archegonia**, one of which should show a contained egg. When sperm from one plant fertilize the egg of another, a **zygote** results. This grows into an **embryonic** sporophyte and later matures into the full-sized sporophyte you have examined macroscopically. The final sections on the slide shows a cross section through the sporophyte stem and a longitudinal section through a sporangium with hard-walled spores within (although the spores may have fallen out of the section). For these different structures, which parts are 1N and which parts are 2N?

Phylum Hepatophyta ("Liverworts")

Examine the gametophytes of the available material of liverworts. Note that each plant has either a ribbonlike thallus (the thalloid liverworts) or a collection of leafy stems (the leafy liverworts). Sporophytes may be available for you to observe. The sporophytes of liverworts are distinctly different from those of mosses, being much simpler and shorter lived. The liverworts can also reproduce asexually by means of gemmae (small pieces of thallus), which are splashed by raindrops out of small cups (**gemmae cups**) on the surface of the thallose liverworts.

SEEDLESS VASCULAR PLANTS

If people valued ancient plants in the same way they appreciate old works of art or antique furniture, the seedless vascular plants (and the bryophytes) would be by far the most desirable of all land plants. Seedless vascular plants are much older than flowering plants, dating back 300-400 million years to the Devonian and Carboniferous periods. Most of these early plants are extinct, and in the groups that have survived, there are very few representatives. Only about 210 genera of seedless vascular plants still survive.

Seedless vascular plants have many features that give them a competitive advantage over the bryophytes for surviving well on land. The most important of these is the presence, in the sporophytes, of a vascular system for transport of water and food throughout the plant body. Part of this system, the xylem, also helps provide structural support for growing taller. However, the plants still retain some features in their life histories that are holdovers from their aquatic algal ancestry, such as the necessity of water for the sperm to swim to the egg and the production of wind-blown spores.

All the seedless, vascular plants you will see in lab are sporophytes, with one exception: you will also study the gametophytes of ferns. Gametophytes exist for all the other phyla; they are just much smaller and harder to find than fern gametophytes.

Phyla Psilotophyta, Lycophyta and Sphenophyta

Among extant seedless vascular plants, the Psilotophyta ("Whisk Ferns") appear to have the most ancient ancestors; fossils that are very similar to living forms have been found in sediments of the Silurian period over 400 million years old. *Psilotum* is the more common of the two extant genera; it grows in tropical and subtropical regions of the world and is available to

study in the lab as a potted plant. It exhibits several primitive characteristics: dichotomous branching, lack of true leaves (instead they have “enations” which don’t have any associated vascular tissue) and relatively simple **sporangia** (structures where spores are produced; see Fig. 29.21, p. 590). Identify each of these structures on the specimen in class.

Lycophyta (“Club Mosses”) have moss-like appearance of the leafy stems (but these are sporophytes, not comparable to moss gametophytes) and the strobili (singular: strobilus, which is a cluster of sporangia each with a leaf underneath it) on the ends of the stems, which give them a club-like appearance. They also have a primitive version of true leaves called **microphylls** (see Fig. 29.22, p. 591). The most common representatives of Lycophyta are *Lycopodium* and *Selaginella*. *Lycopodium* species are common ground-dwelling plants in the forests of the Pacific Northwest, though many other species are found in the tropics as well. The genus *Selaginella* exhibits a feature that is an advancement over the other genera of seedless vascular plants displayed in lab, and one that played a crucial role in the evolution to the seed plants (next groups): **heterospory**. Heterospory is the production of two different types of spores, each in a different structure. Little spores (microspores) develop into male gametophytes. Big spores (megaspores) develop into female gametophytes. Find the strobili. Why might this structure be advantageous compared to the arrangement of the sporangia in *Psilotum*? The other seedless vascular plants we will observe are **homosporous**; that is, they produce one type of spore. The Bryophytes are also homosporous. Although there are separate male and female gametophytes, the spores look identical and they are all produced in the same structure on the sporophyte.

Equisetum, the only genus in Sphenophyta (“Horse Tails”), includes 29 species. Horsetails form extensive subterranean networks of rhizomes (underground stems), which send up numerous aerial stems. The stems are usually jointed and are branched, with a whorl of branches and reduced leaves (microphylls) arising from each joint. Some species have separate photosynthetic and reproductive (with strobili) stems, while other species have strobili and leaves on the same stem. How does the arrangement of the sporangia and associated structures change? How does this change hint at the evolutionary steps leading to the development of cones in the Coniferophyta and flowers in the Anthophyta (Angiosperms or flowering plants)?

Phylum Pterophyta (“Ferns”)

Ferns are the most highly evolved of the seedless vascular plants. Many more kinds of ferns are extant (about 200 genera) than plants in the other seedless vascular plant phyla. Like other seedless vascular plants, ferns have a reproductive cycle with independent sporophyte and gametophyte phases, and they require water for the sperm to swim to the egg. Unlike other seedless plants, ferns have leaves that are megaphylls (complexly veined leaves), which have the potential to add significantly to the photosynthetic ability of the plant.

Fern sporophytes

Most of the body of the fern is made up of **leaves**, which arise directly from the rhizome (a horizontal underground **stem**). Above-ground stems are rare. Each leaf is called a frond. It consists of (1) a photosynthetic blade, that is usually divided into smaller units called pinnae, and (2) a petiole, the stalk that attaches the frond to the rhizome. The rhizome is usually just under the surface of the ground, and produces adventitious (develop secondarily) **roots** and new leaves from its growing tips. When young, the new leaves are tightly rolled into fiddleheads, which unroll and expand as the leaves mature. These leaves are **megaphylls** (see Fig. 29.22) that are thought to have evolved from filling in between many small branches. All the Gymnosperm and Angiosperm leaves will be megaphylls as well.

Examine the living fern specimens, and locate the above structures on them. How does leaf structure change when comparing the different groups of seedless vascular plants?

Sporangia. A sorus (plural sori) is a cluster of **sporangia** on a fern leaf; usually on the underside of the leaves. Many ferns also have an indusium, a small, sterile flap of tissue that protects the sorus. Locate the sori on the underside of the living fern leaves provided, and compare their locations on different ferns. Examine a sorus on the underside of a leaf with the dissecting microscope, locating the sporangia and the indusium if one is present. Place a portion of a leaf with damp sori on the dissecting scope and shine a bright light on it. Observe the sporangia as they dry out. What happens? How do the sporangia release spores?

Fern gametophytes

After spores are shed by the sporangia, they germinate into gametophytes. Fern gametophytes are minute, disc-shaped structures only a few millimeters in diameter. A fern gametophyte (prothallus) is bisexual. However, in many, the antheridia and archegonia mature at different times, which makes it less likely that the plant will fertilize itself.

Examine living specimens of fern gametophytes with the dissecting microscope. Reproductive structures will probably not be visible, but you may see a young sporophyte growing from the thallus. Examine the prepared slide (# 19) of a fern gametophyte under low to intermediate power (40x at most) of your compound scope. **DO NOT USE HIGH POWER OR YOU WILL CRACK THE SLIDE.** Find the antheridia and archegonia scattered among the rhizoids. How does the fern gametophyte differ in size and complexity from the fern sporophyte? Is this similar too or different from what is seen in the Bryophytes?

CONE-BEARING SEED PLANTS: THE GYMNOSPERMS

The evolution of the seed was a significant achievement for land plants. The seed contains a sporophyte which is already partly developed and which also is supplied with nutrients for quick, vigorous growth (see Fig. 30.2, p. 599 in your text). In the reproduction of seed plants, the seed replaces the spore as the dispersal unit. It can survive adverse conditions better than many spores, and it grows and develops under conditions suitable for the mature sporophyte.

The seed plants include the cone-bearing plants (gymnosperms) and the flowering plants (angiosperms). Gymnosperm seeds are described as naked because they are not enclosed in fruits as are those of angiosperms. Some gymnosperms, such as yew (*Taxus*) and *Ginkgo*, have highly reduced cones that consist of only one seed with an associated fleshy appendage.

Phylum Coniferophyta (“Conifers”)

Conifers are the most numerous gymnosperms today. Their sporophytes are **woody** trees or shrubs. The development of secondary growth (wood), which allows plants to increase their diameter as they grow taller, was one factor that accounts for the current success of seed plants. Why might this development be important when living “in air”. The developments of the seed and of waterless fertilization were also huge factors in the success of the gymnosperms. The seed's origin was made possible by the extreme reduction in size of the female gametophyte, and was accompanied by reduction in size of the male gametophyte, which became so small that the entire plant could be carried to the female gametophyte by the wind. The female gametophyte in seed plants is nourished by the sporophyte that produced it until the seed is fully formed and ready to be released.

The conifer sporophyte

Examine the conifer branches that are available and note the variation in the size, shape, and arrangement of the leaves. The two largest families of conifers are Pinaceae, which include the pines (*Pinus*), true firs (*Abies*), spruces (*Picea*), Douglas firs (*Pseudotsuga*), and hemlocks (*Tsuga*), and Cupressaceae, which includes cedars, arborvitae, cypresses, and junipers. In general, Pinaceae have long slender leaves (needlelike in *Pinus*), and Cupressaceae have scalelike leaves. Other conifer families that may be available are Taxodiaceae (sequoia, redwood, baldcypress) and Taxaceae (yew).

Reproductive structures: pollen cones

Look for and examine the **pollen** cones from at least one representative on display. Pollen shed from these cones are _____ (in terms of the life cycle), greatly reduced in size that have grown from the spores produced in the pollen sacks (sporangia) and the pollen, not the spores, is dispersed by wind. Examine the prepared slide (# 21) of the pollen cone of *Pinus*. Locate the pollen sacks (sporangia) and the pollen. See fig. 30.9, p. 605.

Reproductive structures: ovulate cones

The genera *Pinus* (pines) and *Chamaecyparis* (yellow cedars) differ from other conifers in that their reproductive cycles require two seasons to complete, rather than one (see Fig. 30.9, p. 605 in your text). Pollination occurs in the spring, but pollen tube growth, fertilization, and embryo and seed development are not completed until the fall of the following year. Therefore, at most times of the year there will be two overlapping reproductive cycles going on simultaneously on a single tree. In addition, ovulate cones of *Pinus* may remain on the tree for many years after they shed seed.

Examine the available mature **ovulate cones**. Look for any **seeds** that may not have been shed (two per cone scale). Examine the prepared slide (# 23) of the ovule of *Pinus*. Notice that it is much smaller than the mature ovulate cones. Central to each scale you will find the ovules. The seed develops from the fertilized ovule. Conversely, an ovule is an undeveloped seed. An ovule contains the sporangium wall, a single gametophyte that has grown from one of the spores produced in the sporangium and the unfertilized eggs within the female gametophyte. Which parts are 1N and which parts are 2N? When the ovulate cone is still very small, it opens to allow pollen to enter, then it closes back up. The pollen (male gametophyte) produces a short pollen tube which grows to the egg of the ovule and releases a nucleus (no sperm) that fertilizes the egg. After fertilization, the zygote develops into an embryonic sporophyte, while the remaining gametophyte tissue matures as a food source for the young seedling. When the seeds are ready to be shed, the ovulate cone (which has become much larger and has also become woody) reopens to release the seeds. How does the conifer gametophyte differ in size and complexity from the conifer sporophyte? Is this similar to or different from what is seen in the Bryophytes and the Pteridophytes? What might be a difficulty for plants as the gametophyte is progressively reduced? How do the conifers solve this problem?

Other Gymnosperms: Phyla Cycadophyta, Ginkgophyta and Gnetophyta

Although the conifers are the most familiar and most common gymnosperms, they are not the only living gymnosperms. The cycads (Cycadophyta), ginkgos (Ginkgophyta), and gnetophytes (Gnetophyta) each have at least one living representative. In some ways, these gymnosperms are even more interesting than the conifers. For example, cycads and ginkgos have pollen that

produces pollen tubes, but they also have swimming sperm! Cycads and ginkgos are of further interest because they are what many call "living fossils." That is, our living representatives look very much like the oldest fossils known, which in the case of cycads and ginkgos date back to the Permian period (250 million years ago)!

Examine available representatives of cycads, ginkgos, and gnetophytes. If pollen or ovulate cones are available, compare them to those of the conifers seen earlier. Superficially, Cycads and Ginkgos resemble other types of plants. Which other types of plants and in what characteristics? Given the phylogeny of these taxa (see fig. 30.4, p. 601), what does this tell you about the evolution of these characteristics? Why does it make sense that cycads are considered to have reproductive characteristics transitional between the seedless vascular plants and the conifers (see fig. 30.6, p. 602)?

FLOWERING SEED PLANTS: THE ANGIOSPERMS

Phylum Anthophyta

Of all land plants, the angiosperms, or flowering plants, have developed the most efficient mode of sexual reproduction, and they have done it with the invention of the flower. For most humans, the **flower** is simply a thing of beauty, but in plants it is a highly refined mechanism to optimize precise pollen transfer and reception. The angiosperms have found a way to have their pollen transferred by animals, which results in a precision in pollen transfer that is unheard of in non-flowering plants.

By enclosing their seeds in a **fruit**, angiosperms are able to exploit animals yet again to carry their seeds longer distances so that they can colonize new habitats. The gametophytes in angiosperms are the smallest of all land plants, consisting of only a few cells each (pollen and ovules). While many ecosystems are dominated by gymnosperms in terms of overall biomass, the angiosperms have the most species of any of the plant groups. About 250,000 of the approximately 270,000 species of plants are angiosperms. The huge radiation of angiosperms is due in part to the co-evolution of angiosperms with specific pollinators (affecting flower morphology) and seed dispersers (affecting fruit morphology). While many angiosperms are woody, allowing for tall growth, many others have a herbaceous growth form, which makes it possible for a seed to grow into a mature plant and reproduce sexually in one season. What evolutionary advantages might this have, especially if environmental conditions are changing rapidly?

The flower

Your goal here is to identify the parts of a flower and describe the function of each part, how its function fits into the angiosperm life cycle, and how the features of the flower contribute to the reproductive success of angiosperms. Examine one example of living flowers provided, usually *Lilium*, which is a monocot. Locate and describe the **sepals**, the **petals**, the **stamens**, and the **carpels**. How many sepals are there? Are they similar to the petals or different? How many petals are there? How many stamens are there? Take one stamen and look at it under the dissecting microscope. Identify the filament and the anther. Determine whether the anther has opened to release the pollen. Locate the **ovary**, **style**, and **stigma** (or stigmas). Cross section the ovary or ovaries. Locate the ovules. If you are looking at fused carpels, can you determine how many carpels have fused? Depending on the species, you may be able to find nectaries; they are often located near the base of the carpels or stamens. What is their purpose?

Other flowers are available for study. Be sure you can identify the above structures on these flowers. Examine at least one other flower in detail (a dicot) and compare it to the first one you looked at in terms of numbers of parts, their shape and arrangement. How do dicot and monocot flowers differ?

Fruits

A **fruit** is defined as the mature ovary wall containing mature seeds. Note that the botanical definition of “fruit” is very different from the grocery store definition of “fruit”. How do the two definitions differ? In most angiosperms, the fruit wall is specially modified to disperse the seed, protect it from damage, or both. Study the variety of fruits provided in the lab. Make sure that you can: (a) identify the fruit wall, and (b) suggest how the wall may function in dispersal of each fruit type.

The Angiosperm life cycle

The angiosperm life cycle (see Fig. 30.17, p. 610) has both similarities to and differences with the Gymnosperm life cycle. Examine the prepared slide (Slide # 28) of the ovary of *Lilium*. How many carpels does it appear to be composed of? Locate the ovules. Try to find an ovule in which you can see a female gametophyte. If your slide does not have a good section of an ovule, look at someone else's slide. Which female gametophyte is larger – the one in Angiosperms or the one in Gymnosperms? Following fertilization of the egg, how is the endosperm in Angiosperms similar to the female gametophyte in gymnosperms in terms of function, yet different in terms of genetic makeup? How does this difference result from double fertilization?

Lab prep for TA's

For collection.

Mosses with antheridia and archegonia

Leafy liverworts with sporophytes

Thallose liverworts with gemmae cups

Lycophyta: Club mosses

Equisetum: Horsetails

Ferns with sporangia:

 Sword fern

 Licorice fern – get whole rhizome

Conifers:

 Auracaria (monkey-puzzle tree)

 Doug fir – with pollen and ovulate cones

 Pine – with pollen and ovulate cones

 True firs

 Red cedar

Other gymnosperms: Ginkgo (lab sample and check for live leaves)

Flowering plants – a variety to show anthers, pistils, petals and sepals:

 Monocots

 Dicots

 Fruits and nuts – animal dispersed (eaten), animal dispersed (hooks and barbs), wind dispersed

Greenhouse specimens

Psilotum

Selaginella

Equisetum

Ferns

Store specimens

 Monocots – something liliaceous (lily or tulip) with big anthers and pistils, clear calyx and corolla

 Dicots – something with big anthers and pistils, clear calyx and corolla

 Fruits and nuts – animal dispersed (eaten), animal dispersed (hooks and barbs), wind dispersed. And a mix of “vegetable-like” and “fruit-like” fruits: Apple, avocado, peas in a pod (not snowpeas), strawberries, tomato, zucchini, coconut.

Get Attenborough video on flower sex. Set up video screen.