Lab 10: The First Seed Plants: Gymnosperms

Come prepared to walk outside, rain or shine!

One of the most marvelous inventions in the plant world, the **seed**, evolved approximately 370 million years ago. The seed is a defining characteristic of the oldest living seed plants - the **gymnosperms** (which literally means "naked seed"). The gymnosperms are a diverse group that includes everything from *Ginkgo biloba* to white pine.

So far in lab, you have examined the diversity of plants that are spore-dispersed: the **nonvascular plants**, like mosses, and the **spore-dispersed vascular plants**, that is, the lycophytes, ferns, and fern allies. What are some differences between the seedless and seed plants other than a seed? Why are the seed plants the most evolutionarily successful on Earth today?

Unlike in the spore-dispersed plants, the gametophyte of a gymnosperm is contained in, *and completely dependent on*, the sporophyte. Recall that mosses, ferns, etc. have a free-living gametophyte stage. However, the gymnosperms have an amazing adaptation to protecting their gametes and precious embryos in a dry environment … the gymnosperms encase the young embryo within a protective outer layer from the parent plant - the **seed**, which allows for periods of prolonged dormancy.

Seed plants – unlike the spore-dispersed plants – are not dependent on water for reproduction. Unlike the spore-dispersed plants, seed plants produce pollen, the familiar powdery grains that contain the male reproductive cells of seed plants. In gymnosperms, *pollen* is produced by male cones or cone-like structures. Seed plants do not require water for fertilization because of pollen, which is an amazingly brilliant adaptation to dispersing gametes over long, dry distances on the wind!

Review the life cycles from labs 8 & 9. Now is the time to make sure you feel solid about the difference between a sporophyte and a gametophyte, because seed plants do crazy things to reproduce!

KEY TERMS

Gametophyte (haploid; n): the generation in plants that produces gametes via mitosis.

Sporophyte (diploid; 2n): the generation in plants that produces spores via meiosis.

Spore (haploid; n): a haploid reproductive cell produced by the sporophyte that gives rise to a haploid gametophyte.

Seed (diploid; 2n): a mature fertilized plant ovule, consisting of an embryo and its food store surrounded by a protective seed coat.

Pollen: the male reproductive cells of seed plants. The *pollen* grain is the male gametophyte generation of seed-bearing plants.

There are five groups of gymnosperms (four of which are extant):

1. Seed ferns
    * Now extinct
    * Were common in the Permian period (ca. 250-300 million years ago!)
2. Conifers
    * The most familiar group
    * Include pine, spruce, fir, etc.
    * Include the largest trees (sequoia)
    * Include the oldest trees (bristlecone pine)
3. Cycads
    * Superficially palm-like in appearance
    * Primarily tropical plants
4. Ginkgo
    * Now represented by only a single living species, but there used to be more
5. Gnetophytes
    * As in "neat-o-phytes!" (Yes, we are plant geeks.)
    * Three strange genera that may be the closest relatives of the flowering plants

Features of the gymnosperms include:

- **Seeds**, which protect the developing embryo.
- **Heterospory**. The seed plants produce two kinds of spores. The **microspores** become the pollen grains while the **megaspore** becomes the ovule.
- **Sporophyte generation** is even more **dominant** (larger and longer-living).
- Seed plants don't depend on water for fertilization because they have **pollen**. Some still extant ancient groups of gymnosperms, such as the cycads and Ginkgo, however, have motile sperm that swim to the ovule.

The pollen cone and leaves of the cycad *Cycas thouarsii*. (Photo by Nathalie Nagalingum)

Before the campus tour of gymnosperms, your TA will lead you to the greenhouse to view living specimens of cycads. Often mistaken for palms, cycads are actually cone-bearing plants that flourished during the dinosaur era, and have survived in tropical and subtropical climates to the present day. Check out the cycad's super-rough bark, which may have arisen as an adaptation to avoiding being eaten by an herbivorous dinosaur! Also make sure to visit *Welwitschia mirabilis*, endemic to the Namibian desert of southern Africa, and surely one of the weirdest plants ever!

Some conifers in the greenhouse are endemic or native to tropical and subtropical environments, such as the Norfolk Island Pine (*Araucaria heterophylla*) and the Parana pine (*Arauciaia angustifolia)*. Both of these trees are referred to as "pines," however they are only distantly related to true pines, in the genus *Pinus,* such as *Pinus strobus*, the familiar Eastern white pine.

Campus tour of gymnosperms

With your TA, take a walk around campus and look at some of the gymnosperms. As you examine them, notice the variation in the size and shape of leaves. Not all gymnosperms are conifers! For

example, be sure to view visit *Ginkgo biloba*, flourishing beside Morrill Hall. Ginkgo trees are dioecious, meaning that some plants are male and some are female. See if you can figure out which is which!

Planted around campus are several common genera of **conifers**. Depending on your particular path, you may see pines (*Pinus*), spruces (*Picea*), firs (*Abies*), Douglas fir (*Pseudotsuga*), junipers (*Juniperus*), and dawn redwood (*Metasequoia*).

1) **List the common name and Latin name of at least five trees you visit. Note at least one distinguishing feature of each.**

Common name	Latin name (binomial)	Feature

2) **Choose one of the gymnosperms you visited on the tour and sketch it here. <u>Include labels</u> for all major organs, including leaves, reproductive organs like cones (if visible), stem (branches or main stem). Speculate on the root structure and include it in your sketch.**

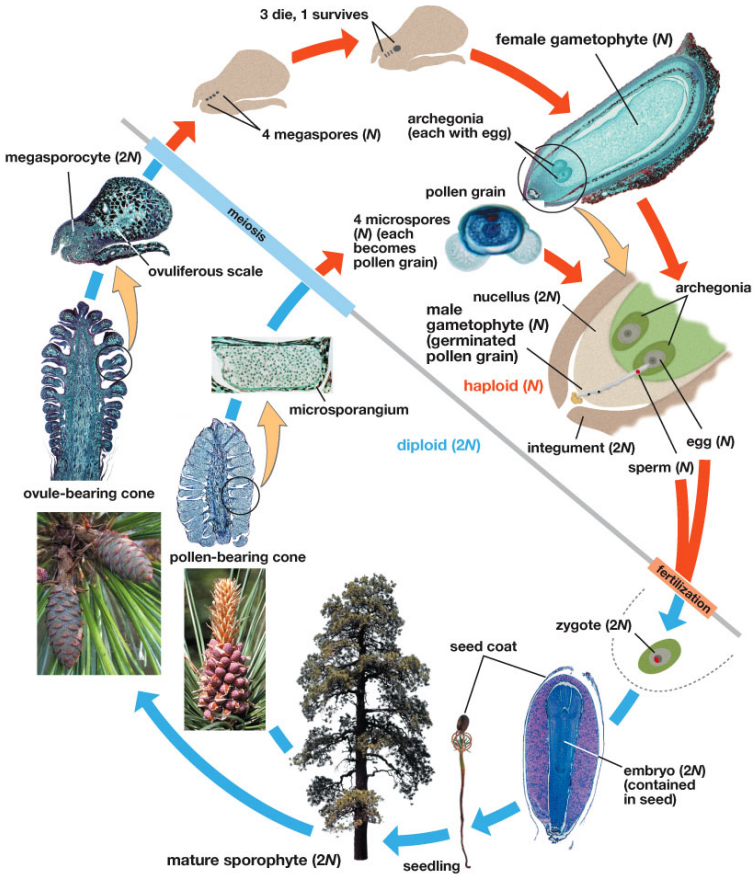
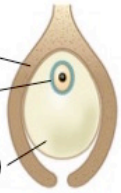
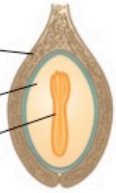


Figure 22.14 Plant Biology, 2/e © 2006 Pearson Education

Gymnosperm life cycle. Continually refer back to this figure throughout today's lab to help you answer questions about gymnosperm structures and functions.

Ovules	**Ovule (gymnosperm)**: Integument (2*n*); Megaspore (*n*); Megasporangium (2*n*) 
Pollen	**Pollen grains make water unnecessary for fertilization** 
Seeds	**Seeds: survive better than unprotected spores, can be transported long distances**: Seed coat; Food supply; Embryo 

Major characteristics of gymnosperms. Ovules, pollen and seeds are adaptations to terrestrial life on Earth, thus leading to the success of the earliest seed plants

3) Where in the plant is the sporophyte? Where is the gametophyte?

4) Examine the microscope slides of the female cones of a conifer under a compound microscope. (You may also want to view the slides under a dissecting scope to see everything in context; however, a compound scope will give you higher resolution.) Draw them and label the parts using your book and this lab manual as a reference.

5) Look at the conifer cones we have in lab. Draw two here, highlighting three major differences. Label whether each is a female or a male cone.

Now, make a wet mount slide of pine pollen grain. In a wet mount, a drop of water is used to suspend the specimen between the slide and cover slip. Place the sample of pine pollen on the slide. Using a pipette, place a drop of water on the specimen. Then place on edge of the cover slip over the sample and carefully lower the cover slip into place. This method will help prevent air bubbles from being trapped under the cover slip. Your objective is to have sufficient water to fill the space between cover slip and slide. If there is too much water, the cover slip will slide around. Take a piece of paper towel and hold it close to one edge of the cover slip. This will draw out some water. If too dry, add a drop of water beside the cover slip. Practice this until you get used to it.

6) When your slide is ready, look at the pollen grain under the compound microscope. Note or draw the shape of the pollen. Based on the pollen structure, do you hypothesize that pines are mainly wind- or animal pollinated? Why?

7) Now, using your knowledge of non-vascular plants (mosses, hornworts, and liverworts), spore-dispersed vascular plants (lycophytes, ferns, and fern allies), and the seed plants, complete the table below. Put a check mark in the appropriate cells to indicate the traits each plant group has.

	Non-vascular plant	Club moss	Horsetail	Fern	Seed plants
Gametophyte conspicuous					
Sporophyte conspicuous					
Xylem and phloem					
Sperm that swim					
Roots					
Seeds					
Ovules					
Flowers/Fruits					

Before leaving lab...

Turn in your complete lab assignment (all questions answered) to your TA. Points will be docked if you do not turn in your assignment before leaving lab. Your graded assignment will be returned to you next week.

TOTAL: ____/10