Name: _____ Date/Lab time: _____

**Lab 8:VASCULAR PLANTS: Non-Flowering Seed-Bearing Vascular Plants (Gymnosperms)**

Supplies:

| | |
|---|---|
| Gymnosperm branches<br>Pollen cones<br>Seed cones<br>Gymnosperm Seeds | Ginkgo branch with "fruit"<br>Gnetophyta<br>(*Ephedra*, *Gnetum* and *Welwitschia*) |
| Cycads | Pine nuts |
| Microscope slides of cones (younger and older)<br>Do we have older cone slide? No☹ | Pine needle cross section showing stomata |

Vocabulary to know: Deciduous, Dioecious, Fascicles, Gamete , Heterosporous , Megagametophyte, Megasporangia , Microgametophyte , Microsporangia , Microspores, Microstrobulus , Ovule , Pollen, Pollen cone, Seed, Seed cone

**LAB SYNOPSIS:**

We will compare and contrast the available gymnosperms in lab

We will examine the morphology and anatomy of the vegetative and reproductive organs of the gymnosperms.

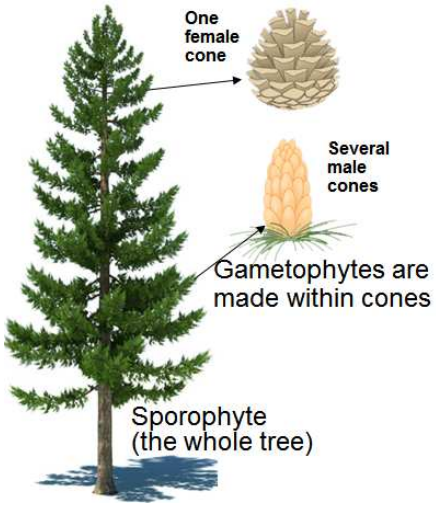
Anatomy of the male, pollen cone vs. the female, seed cone.

Introduction:

**Gymnosperms**- Vascular, seed-bearing plants that do not produce flowers and do not enclose their seeds within a fruit. In other words, plants with ovules not enclosed within ovaries.

There are 4 phyla of plants that fit the above definition of gymnosperm:

Kingdom Plantae
- Phylum Cycadophyta (cycads)
- Phylum Ginkgophyta (Ginkgo)
- Phylum Gnetophyta (lacks a common name)
- Phylum Pinophyta (conifers)




**Gymnosperms**

The term gymnosperm ("naked-seed") is not a taxonomic term. It merely describes the groups of non-flowering seed-bearing plants. Gymnosperms include four phyla: Phylum Pinophyta (conifers), Phylum Cycadophyta (cycads), Phylum Ginkgophyta (Ginkgo) and Phylum Gnetophyta (lacks a common name). We will be focusing on the Pinophyta, the group most common in our area. We will have examples of the other 3 phyla as well (hopefully).

Like the angiosperms, conifers and other gymnosperms produce seeds. Most, <u>but not all,</u> gymnosperm seeds are contained within complex seed-bearing structures called strobili (separate male and female cones). Gymnosperm seed are <u>never</u> enclosed in true fruits.

Also as in angiosperms, gymnosperms have a distinct alternation of generations with a large sporophyte and 2 small microscopic gametophytes. In many gymnosperms these gametophytes are made within separate cones. Male cones (pollen cones) and female cones (ovulate or seed cones).

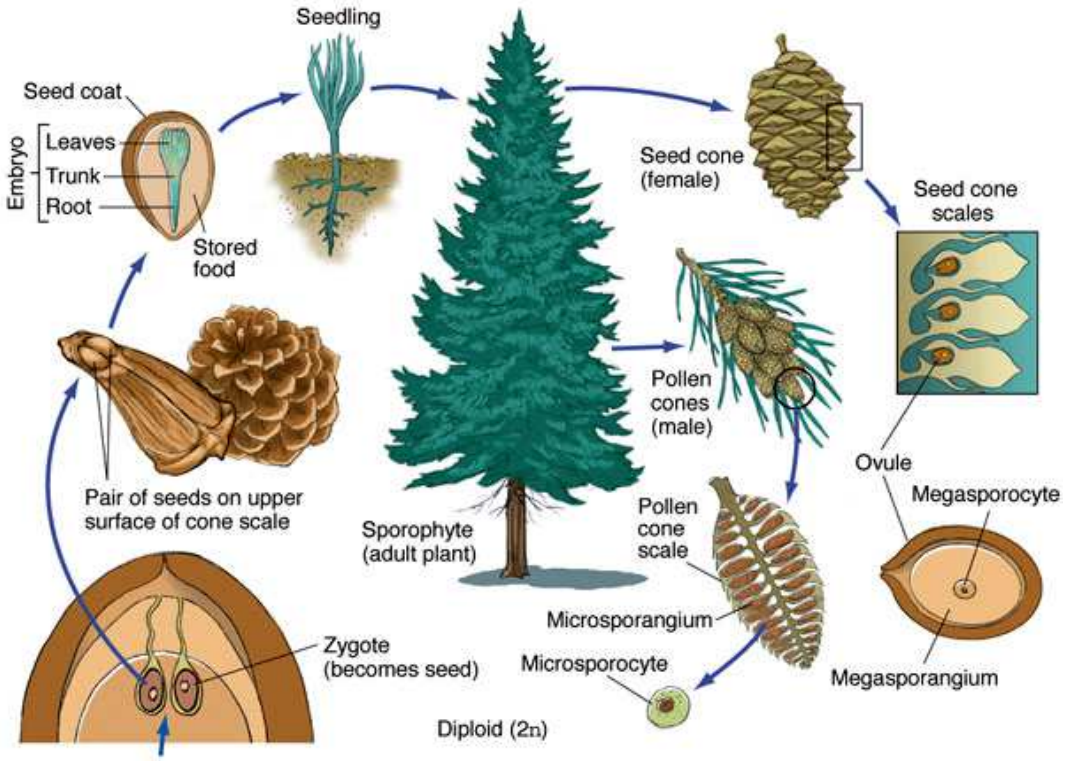
<u>Male gametophyte (pollen)</u> multicellular organism that will make the sperm.

<u>Female gametophyte</u> multicellular organism that will make the egg (remains in seed cone).

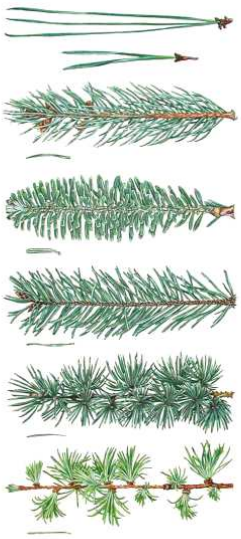
**PHYLUM PINOPHYTA - CONIFERS**

Most conifers are large trees and dominate vast forested regions of the Pacific Northwest and other parts of the Northern Hemisphere. They mature into some of the tallest and oldest of the living organisms on earth. They have extensive root systems. Large woody stems and usually small needle-like leaves. Most conifers are **evergreen** but some are **deciduous**, loosing their leaves every year (such as the Pacific NW Larch, *Larix occidentalis*).

The reproductive structures of the conifers are on 2 separate strobili (cones) (**seed cones** and **pollen cones**). Two types of spores are produced (male and female, discussed below). Each type of spore germinates and develops into multicellular gametophytes while retained on their respective cone. The male gametophyte develops into pollen and is released into the wind and pollinates the female gametophyte. The female gametophyte remains on the seed cone throughout fertilization and embryogenesis, released only as a matured seed.




The above figure illustrates alternation of generation in the conifer, pine.
Circle parts identified as you proceed through the lab.



**A. The Sporophyte Generation of Conifers**
**True Roots Stems and Leaves**

1. Examine the various examples of conifer branches. Identify the leaves on each branch. Notice that on some species of conifer leaves are borne singly while some are borne in bundles called **fascicles**. This is an important feature for distinguishing genera of conifers.

2. Examine the slide pine stem meristem. How does it compare to that of angiosperm shoot tips? Put your observations in the Plant Forms Table.

⇨ 3. Sketch branches from 2 different conifer species, one with leaves in bundles and one with leaves borne singly. Clearly show needles.

| | |
|---|---|
| | |

4. Make a cross section of a leaf/leaflet from the above 2 species. Examine the cross section under the dissection scope. What is the cross sectional shape of each leaflet?
It the leaflet round? Half round? Quarter round????

⇨ What relationship is the cross section shape to the number of leaflets in the bundles?

What you should note from the above is that leaflets from bundles are subdivisions of the whole. For example, a leaflet from a 4-needle pine looks like ¼ of a whole round needle. ⊗

5. Other conifer leaves are scale-like as seen in Cupressaceae (the cypress family) like juniper and "cedar". Note: the things we call cedar in Oregon are not true cedar. True cedars are native to Eurasia.

If available examine microscope slides of (pine leaf cross sections)
Compare and contrast the tissues with those seen in angiosperms. Put your observations in the Plant Forms Table.

**B. The Gametophyte Generation of Conifers**

All seed baring plants are **heterosporous** (2 types of spores are produced, male spores and female spores). These spores will separately develop into the male and female gametophyte.

**Seed cone** (ovulate cone)**-** contain ovules.

**Ovule**- contains those structures which will mature forming the seed.

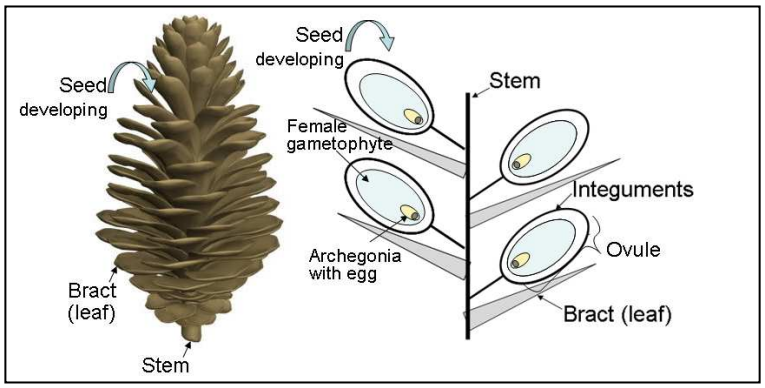
**Female sporangia** (megasporangia)- Sac within the ovule were meiosis will occur producing the 4 female spores. Only one survives forming the female spore.

**Female gametophyte**- formed from cell divisions of the female spore.

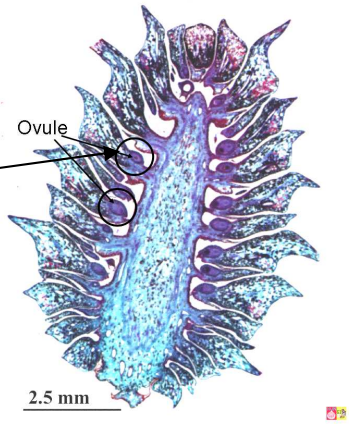
**Archegonium**- part of the female gametophyte within which the egg develops. Note: angiosperms lack archegonia

**Female gametophyte** (will form the egg)

The female gametophyte of conifers forms within **the female sporangia** (female spore sac) as reduced axillary shoots. The female sporangia are enclosed within a layer of maternal cells called the integuments. The structure below the sporangia is a bract (a modified leaf associated with a reproductive structure). The bracts of conifer female strobilus (seed cones) are woody and make up the bulk of the seed cone.




A single cell within the sporangia called the female spore mother cell undergoes meiosis producing 4 haploid cells (3 of these cells abort). The remaining haploid cell undergoes cell division producing from 256 to several thousand cells. This whole haploid structure is the female gametophyte. Some of these cells differentiate into the archegonia containing the female **gamete** (egg). This whole structure is referred to as an **ovule** (egg, archegonia, integuments and the free nuclear female gametophytic tissue). Following fertilization, this ovule develops into the **seed**.
Note: angiosperms egg cells do not form within archegonia.




PROCEDURE- Drawing

1. Examine the prepared slide of a developing ovulate cone "Pine Cone, Female" slide.

2. Draw and label one ovule from a seed cone. Label the following: ovule, female gametophyte, archegonia and egg (if visible). Label too the integuments and bracts.

Check the "mature embryo" slide as to what becomes following fertilization and embryo development. Also check out the samples of pine "nuts" used in making yummy pesto. This is

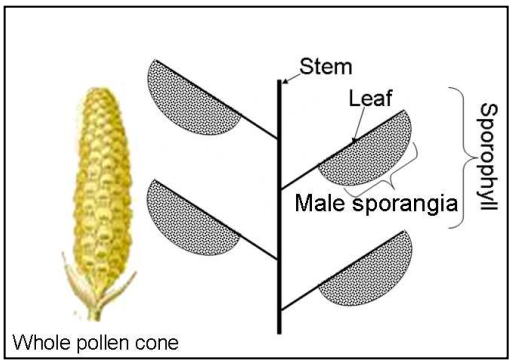
**Pollen cone-** produces pollen.

**Sporophyll**- modified leaf containing sporangia.

**Male sporangia** (microsporangia)- Sac were meiosis will occur producing the 4 male spores.

**Male gametophyte (pollen)**- formed from cell divisions of the male spore.

**Sperm**- male gamete within the male gametophyte.




**Male gametophyte (AKA pollen)**

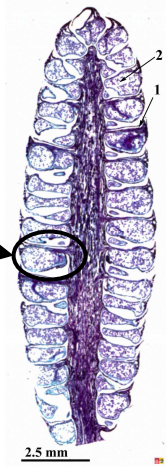
Within the pollen cone, **male sporangia** (male spore sacs) are retained on the lower part of modified leaves, thus these structures are sporophylls (a leaf producing a reproductive structure). All the sporophylls together make up the whole pollen cone (microstrobilus). Meiosis occurs within the sporangia producing 4 haploid **male spores**. Many cells within the sporangia undergo meiosis to produce 1000's of male spores. Each male spore undergoes only a few mitotic divisions resulting in the mature pollen grain (4-6 cells). The pollen grain is the male gametophyte- i.e. multicellular haploid generation that produces the **male gametes** (there are 2 sperm nuclei in each mature pollen grain of pine).

PROCEDURE- Drawing

1. Examine the prepared slide of a developing pine pollen cone. "Pine Cone, Male" slide

2. Draw and label a male cone (pollen cone) labeling one sporophyll, male sporangium and microgametophyte (pollen).

Examine pollen under higher magnification to highlight details. They should look like Mickey Mouse.




**PHYLUM CYCADOPHYTA - CYCADS**

Cycads are plants found native in the tropics and subtropics (a popular house plants). They have unbranched stems and grow as high as 15 meters in some species. They have a crown of large pinnate leaves and overall resemble palm trees (palm trees are flowering plants while cycads are not flowering plants). Cycad's life cycles are similar to those of conifers however, after pollination the sperm of cycads are flagellated and swim after pollination to the ovule.

1. Examine the cycad plant present in lab (if available or in your textbook). Particularly notice the large leathery leaves and, if present, the terminal position of the cone.

**PHYLUM GINKGOPHYTA**

This phylum contains only one living species *Ginkgo biloba*. Local fossils indicate this species was very common in the Pacific Northwest up to about 50 million years ago. The phylum was thought to be completely extinct but native populations exist in parts of China. The plant grows very well here and is often planted in parks and boulevards (usually only males are planted- see duty 3 below for reason why).

PROCEDURE- Observation

1. Note the flattened leaves with fan-like venation present on the *Ginkgo* sporophyte. *Ginkgo* is **deciduous**, loosing its leaves every fall.

2. *Ginkgo* is **dioecious** ("two" "houses") meaning it has separate male and female plants. The female tree does not produce cones, instead 2 sporangia are produced on the ends of short stalks (though one of the two often aborts). The mature seed is surrounded by a fleshy integument and resembles a fruit. The conifer *Yew* has a similar "fruit". The base of modified bract grows, surrounding each seed forming an aril. True fruits develop only in flowering plants (angiosperms) from the wall of ovaries. Gymnosperms seeds are not enclosed in ovaries (recall; their seeds are naked)

3. If you can stomach the foul smell, exam the seed of *Ginkgo* by cutting and digging it out of the integument. Some consider the integument and the seed a delicacy.

**PHYLUM GNETOPHYTA**

The Gnetophyta is composed of only three genera that do not look very much alike (*Ephedra*, *Gnetum* and *Welwitschia*). The later 2 are found in subtropical, tropical and temperate regions. We have one representative, *Ephedra*, which occurs in southeastern Oregon.

PROCEDURE- Observation

1. If available, examine the specimens of *Ephedra* (Mormon tea). The female reproductive structures do not look very cone-like compared to the other gymnosperms we have examined.

2. Examine the specimen of *Welwitschia,* if present in lab, and compare it to the illustrations provided in your textbook.

Questions:

1. Why is wind-dispersed pollen an important phenomenon in the evolution of plants?

2. One of the major trends in plant evolution (mosses → ferns → gymnosperms → angiosperms) is the reduction of the size of gametophytes. Describe the male and female gametophyte of gymnosperms in terms of size and location vs. what you saw in angiosperms. Recall in angiosperms the male and female gametophytes are smaller then those seen in gymnosperms. Record your information in your Plant Forms Table

3. Compare the leaf forms illustrated in the gymnosperms i.e. how do they differ between conifers, *Ginkgo*, cycads etc. Record your information in your Plant Forms Table.

4. What are the major differences between the alteration of generations of flowering plants and gymnosperms?

5. What is the difference between the female gametophyte and the ovule?

6. Why is the fleshy structure around the ginkgo seed **not** considered a fruit? (you may need to review the angiosperm lab for the answer to this.)