Topic 12: Gymnosperms + Seed and Pollen Basics

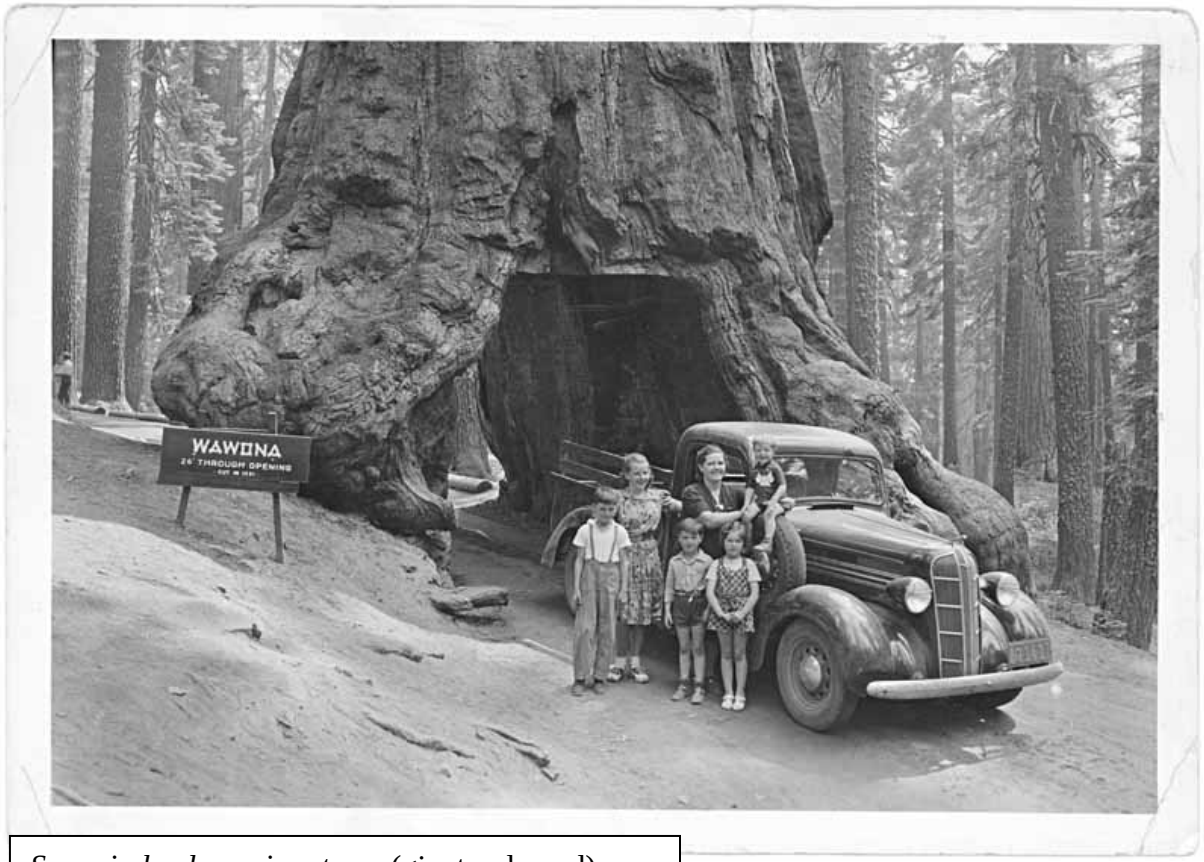
A. General Objectives for today's lab .

1. Compare and contrast the gymnosperms with the other plant groups we've studied thus far.

2. Become familiar with the major groups of gymnosperms (one of which is the Conifers).

3. Learn to use a dichotomous key to conifer genera (singular form is genus).

4. Learn the basic structure of the seed and pollen as a synapomorphy of the seed plants.



Sequoiadendron giganteum (giant redwood)

B. Seeds and Pollen .

The unit of dispersal in seed plants is the seed.

1. The seed consists of three important parts:

1. An embryo (a genetically unique embryonic plant, produced through sexual reproduction).
2. The seed coat (the outer, protective layer of the seed).
3. Some form of nutritive tissue (to nourish the developing seedling, upon germination).

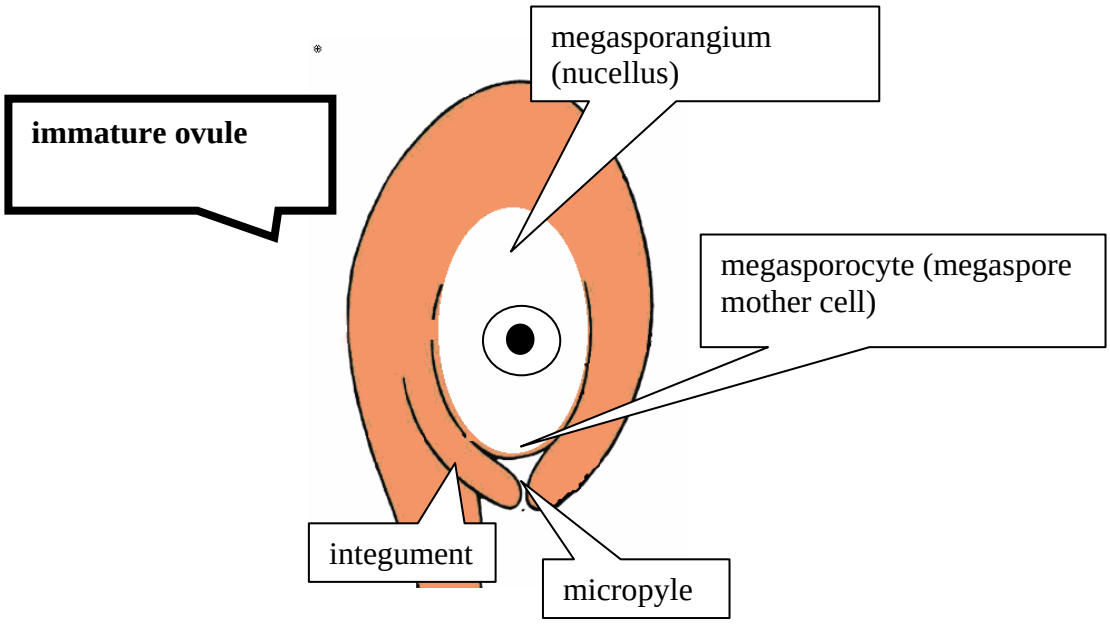
In gymnosperms, this nutritive tissue is megagametophyte tissue. In angiosperms, it is triploid endosperm which is made possible by "double fertilization" (you will learn about double fertilization later in lecture).

A seed develops from an *ovule*. An *immature ovule* consists of the following:

1. The diploid *megasporangium* (also called the *nucellus*). This produces haploid *megaspores* via meiosis.
2. An *integument* (or two). This is an outer protective structure.

A mature ovule consists of the following.

1. The *megagametophyte* (i.e., the female gametophyte; a multicellular, haploid organism that produces the egg cell(s)). The megagametophyte develops via mitosis from one of the megaspores produced previously via meiosis.
2. An *integument* (or two). This is an outer protective structure.

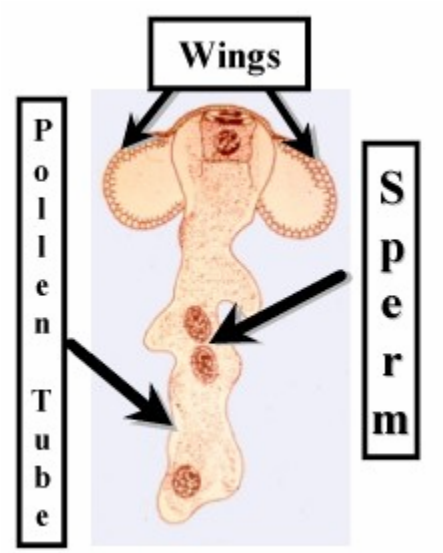


Investigate seed structure in pine. Any nutritive tissue surround the embryo will be megagametophyte tissue.

Draw and label the following:

Seed coat, the embryo with cotyledons (how many cotyledons do you see?), megagametophyte as nutritive tissue.

2. Like the seed, pollen is unique to the seed plants. It represents the protective vehicle for transporting sperm directly to the *egg* of the megagametophyte. Thus, sperm no longer have to swim through water to reach the egg as it did in more primitive plants: in the majority of gymnosperms, pollen is delivered to the ovule ("pollination") via the wind (i.e., most gymnosperms are wind-pollinated). In Angiosperms, pollination may be via wind, bee, bat or bird, etc. Once the pollen is at the ovule, a pollen tube will deliver the sperm to the megagametophyte, and then ultimately the egg. Technically speaking, the pollen is the *microgametophyte* (male gametophyte).



Above, the mature microgametophyte of a pines: a germinating pollen grain (pollen-tube contains two sperm cells). The wings are peculiar to pine pollen and are not characteristic of pollen in general.

Like all gametophytes, the pollen develops from a spore. In this case, these are called *microspores*.

I*nvestigate pollen using the compound microscope. Make drawings.*

Slides available for this are:
1. Mixed Pollen Types

2. Pollen tubes.

C. Gymnosperms .

C1. The four major phyla of gymnosperms .

Cycadophyta (cycads) – *Cycas, Zamia*.

Ginkgophyta (maiden-hair tree) – *Ginkgo biloba*

Coniferophyta (conifers) – *Pinus* (pine), *Sequoia* (redwood), *Abies* (fir) and many other genera.

Gnetophyta (*Gnetum* & friends) – *Gnetum, Ephedra*, & *Welwitschia*.

Learn to distinguish between conifers, ginkgos, and cycads. We will not study Gnetophyta in lab.

C2. Gymnosperm seeds are "naked".

In the conifers, the seeds are *naked* in *cones*. This contrasts with *fruits* of angiosperms, with surround and envelope the seeds.

Inspect the various cones for seeds at your table for seeds.

C3. A male strobilus from a gymnosperm (e.g., *Zamia*, a cycad).

With the microscope, study the male ("staminate") strobilus x-section prepared slide. Note the microsporangia on the sporophylls of the strobilus, with pollen in them. This whole strobilus is analogous to the androecium of the flower in angiosperms.

Compare this to the real strobilus.

C4. <u>Gymnosperm, particularly conifer wood is distinctive from angiosperm wood.</u>

1. *Inspect the <u>prepared slides</u> of angiosperm and gymnosperm (conifer) wood in cross section (these are slides with all three types of wood sections: cross-, tangential, and radial. Choose the cross-section.).*

1a. Make observations of either of the Angiosperm representatives: *Juglans* (walnut), *Celtis* (hackberry), or *Quercus* (oak).

Locate vessel elements, trachieds, and fibers in cross-section.

1b. Now make observations and drawings of the gymnosperm representatives.
Gymnosperm representative: *Pinus* (pine).

Which of the three cell types can you find: vessel elements, trachieds, fibers? You should be able to find only one of these.

Second, locate the resin canals (lined with thin-walled, nonlignified parenchyma cells). When the tree is intact and living, these canals house the resin (made up of turpentine and rosin) that we all know so well from the conifers. Resin canals are peculiar to conifer wood and is responsible for their fragrant, piney smell.

2. Observe the prepared Macerated Oak (*Quercus*) secondary xylem slide. This slide depicts wood that has been digested so that the individual cells separate from one another. Then the suspension of cells is mounted and the result is known as a maceration in which we can determine the types of cells present. Keep in mind that this sample is secondary xylem only so only those cells described above for xylem will apply to your observations.

Initially the cells will not be readily distinguishable and you will need to make careful observations in order to distinguish their characteristics. Use your microscopy skills to bring the cells in and out of focus in order to see detail at the upper and lower surfaces. In addition, systematically move around on the slide in order to maximize your ability to find new cells.

All four cell types will be present!

Label and Draw each type of xylem cell.

Xylem vessel elements will be distinguishable by their large size and the presence of perforation plates at the ends. Label the perforation plates.

Do the vessel elements have pores on the sides?

How can you distinguish the fibers from the tracheids?

Do the tracheids have perforation plates at their ends?

3. Observe the prepared Pine secondary xylem maceration slide. This slide has been prepared in the same manner as the Oak slide observed previously. It too only has xylem cells present.

Label and draw the types of cells found:

How many did you find?

Were any of the angiosperm cell types missing?

What are the structures on the sides of some of the cells in this maceration?

Remember, a fiber does not have these structures on it.

How would a cross-section of pine xylem be distinguishable from an angiosperm cross-section

C5. Conifers do not have ovulate (female) strobili, but "CONES". Cones are actually compound, branching structures. The cone scales with ovules on them are subtended by bracts. In most other gymnosperms, ovules are borne on sporophylls of female strobili.

Prepared Slide: *Compare and contrast a male strobilus with a developing female ("ovulate") cone in Pinus (a conifer).*

D. Key to conifer genera .

A key is a tool for identification. Attached to the back of this lab write-up are a key to conifer genera on MU campus, along with an illustrated glossary with terms you will need for the key.

Key out the conifer genera present in the room or that you come across outside on an outing (INSTRUCTOR's choice). Record your answers below.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

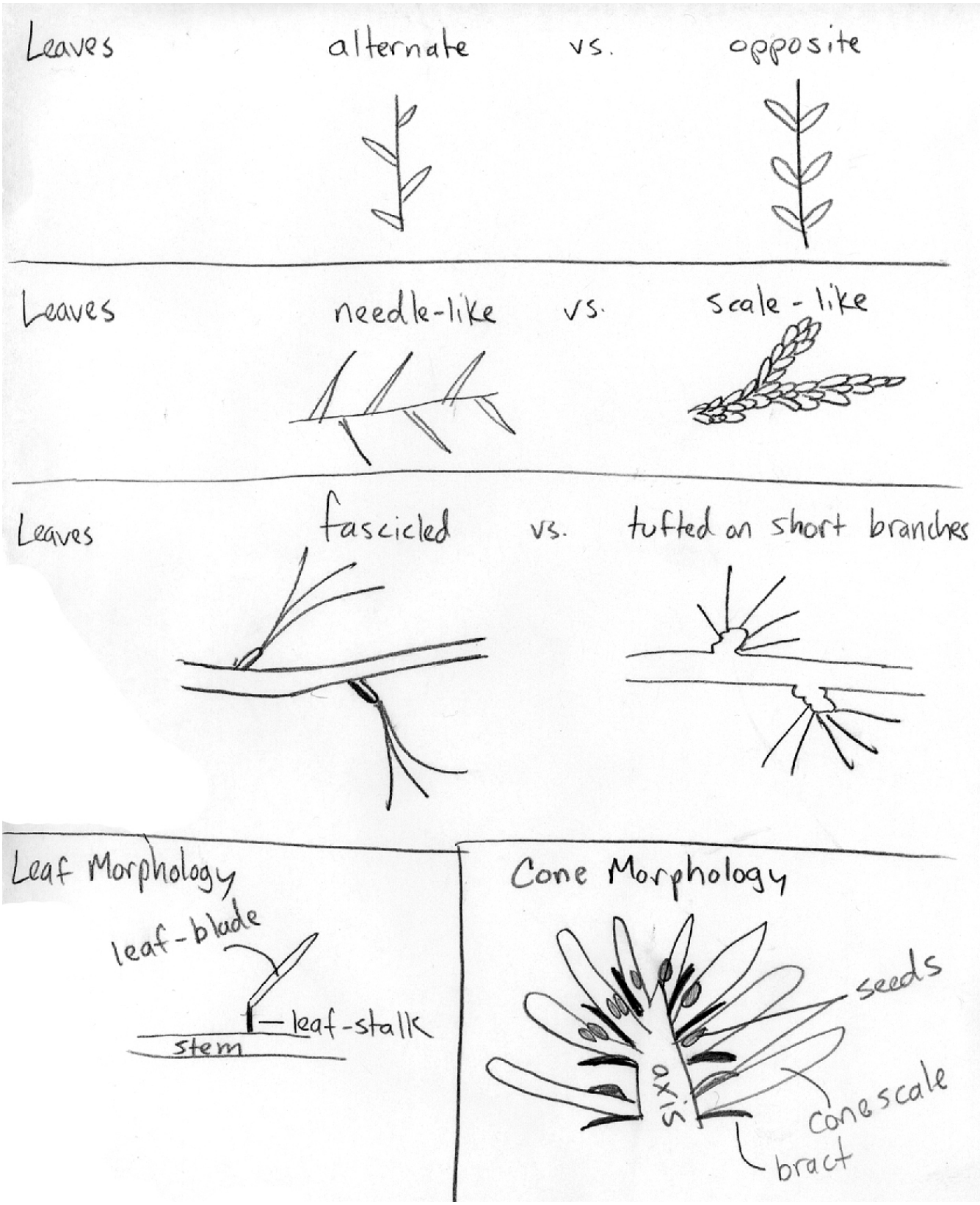
11.

12.

13.

14.

A. Plants not evergreen
B. Branchlets short and stubby, persistent, alternate.....***Larix*, Larch**
BB. Branchlets elongate, deciduous, opposite.....***Metasequoia*, Dawn Redwood**
AA. Plants evergreen
C. Leaves needle-shaped or otherwise elongate and well-diverging from the stem
D. Leaves in fascicles of 2, 3, or 5.....***Pinus*, Pine**
DD. Leaves borne singly or tufted on stubby side-branches (but not fascicled)
E. Leaves tufted on stubby side-branches..... ..... ***Cedrus*, Cedar**
EE. Leaves borne singly
F. Leaf ending at stem, so stem is woody in texture and color.
G. Leaves sharp-pointed and square in cross-section, with small woody peg-like leaf-stalk..... .....***Picea*, Spruce**
GG. Leaves round-pointed and flattened, woody peg-like leaf-stalk absent or if present not very prominent
H. Leaves usually <1.25 cm long, with distinct leaf-stalk; cones 1-2 cm long .....***Tsuga*, Hemlock**
HH. Leaves >1.5 cm long, with no distinct leaf-stalk (although perhaps with a gradually narrowed leaf-base); cones >2.5 cm long
I. Needles flat, rounded and blunt at tip, with swollen round base, base not persistent and leaving a round leaf scar on twig; cones erect with scales deciduous at maturity .....***Abies*, Fir**
II. Needles flat, pointy at tip; cones pendulous, scales persistent, with very long 3-lobed bracts that look like the rear-end of a mouse; needle-base not swollen, leaf-scar either not round or not very big.....***Pseudotsuga*, Douglas Fir**
FF. Leaf-base decurrent along (i.e., the base runs along) the stem for some distance, such that twig stem to which leaves are attached appears green.
J. Leaves flattened and round-pointed; cones with just a single seed which is partially enclosed in fleshy red aril; often bushes or shrubs .....***Taxus*, Yew**
JJ. Leaves angular (not flattened) in cross-section and sharp-pointy; cones round and larger (> 1 cm diameter) and with more than one seed and no fleshy aril; trees.....***Cryptomeria*, Japanese Cedar**
CC. Leaves scale-like (or at least not especially elongate)
K. Branchlets forming flattened fan-like sprays
L. Twiglets much flattened; cones elongate; cone-scales flattened, 8-12 .....***Thuja*, Arbor Vitae**
LL. Twiglets rounder; cones round; cone-scales shield-shaped, 4-8 .....***Chamaecyparis*, Cypress**
KK. Branchlets forming 3-D clusters not at all fan-like
M. Cones soft and berry-like, needle leaves (juvenile) and scale leaves (adult) often mixed.....***Juniperus*, Juniper**
MM. Cones woody
N. Cones < 0.5 cm; leaves uniformly scale-like and <2 mm long .. ..***Cupressus*, Cypress**
NN. Cones >0.5 cm; leaves longer (>2 mm long) .....***Cryptomeria*, Japanese Cedar**



Illustrated glossary for help with conifer key.