

Gymnosperms

Gymnosperms are a group of seed plants united and distinguished from the angiosperms by their naked seeds (*gymnos* is Greek for naked; *sperma* is Greek for seed). Otherwise, the three or four major lineages of gymnosperms do not have much else in common. Today you will (1) become familiar with gymnosperms in general, (2) learn how to distinguish them from other non-gymnospermous plant taxa, (3) learn how to distinguish the major gymnosperm lineages from one another, and (4) learn to use a dichotomous key to identify conifer genera.

Before Coming to Lab:

1. What are the three major lineages of gymnosperms that we cover in today's lab?
2. What does the word "conifer" mean and on what lab page did you find the definition?
3. What distinguishes a monoecious species from a dioecious species? On what three pages do these terms appear?
4. What is a strobilus? Draw a basic structure of a strobilus from your lecture text book.



Sequoiadendron giganteum (giant redwood)

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A. Conifers

These are the largest extant (not extinct) group as well as the most economically important group of gymnosperms, defined by their cones (conifer means “cone-bearing”) and resin canals that run through all parts. More characteristics are as follows:

- Trees or shrubs with a branched stem.
- Resin canals throughout.
- Leaves typically evergreen (some deciduous) and needle-shaped.
- Sexual system monoecious (bisexual plants, BUT male and female structures in separate structures) or dioecious (separate male and female plants). Contrast this with synoecious.
- Male sporangia borne in pendulous or erect strobili; strobili in clusters.
- Ovules borne on scales in cones (each scale subtended by a bract).
- Seed coat dry, papery, often winged for wind dispersal.
- **Other notes:** source of “pine tar” and resin (turpentine + rosin); major lumber products (e.g., pine from *Pinus*); major source of pulpwood for paper (e.g., *Tsuga* – the hemlock genus, and *Abies* – the fir genus); popular as ornamentals; other notable genera include *Sequoia* (coastal redwood), *Sequoiadendron* (giant redwood), *Abies* (fir), *Pseudotsuga* (Douglas-fir), and *Taxus* (yew) among many others.

A1. Conifer economic botany.

Most of the value of conifers come from their wood that is used for lumber or paper making. However, there are other important products. At some point today and when the crowd is not too large there, visit the Conifer Economic Botany station to see, smell, and in one case taste various products of conifers including turpentine, pine “nuts”, and gin.

A2. Compare & contrast a strobilus with a cone.

All gymnosperms produce pollen in a male strobilus (plural strobili) and many non-conifer species also produce seeds in a female strobilus. Conifers, however, produce special structures called “cones”. In conifers, the strobilus is a simple (unbranched) modified stem axis with modified leaves called sporophylls on which sporangia produce male spores which then mature into few-celled pollen grains (male gametophytes). The cone of conifers is different in that it is a compound (branching) shoot system where ovules (then seeds) are borne on woody lateral appendages called “scales” that form as branches from axils of small bracts attached directly to the main cone axis.



Strobili, Cones & Dissecting Scope

At your bench, use your naked-eye and dissecting scope to contrast the male strobilus and female cone of a conifer in terms of size and texture.

On the male strobilus, locate and draw a sporophyll with sporangia.

On the cone, locate and draw a cone scale with seeds: then locate the small bract subtending the scale (note that in Douglas-fir the subtending bract is 3-pronged and easily visible, whereas in other genera such as pines the subtending bract is much smaller than the scale and so not easily visible).



Prepared Slide & Compound Scope

Prepared slide of “Young Male & Female Cone” in Pine from back/side of room. Compare and contrast a male strobilus with a developing female cone in pine.

A3. Conifers have resin canals.



Prepared Slides & Compound Scope

Locate the resin canals in a transverse section of pine wood and needle (leaf) obtained from side/back of room. Resin canals are lined with parenchyma cells that produce and secrete the aromatic resin we are all familiar with.

A4. Conifer leaves are needle-like or scale-like.



Live Specimens & a Key to Conifers

Conifer genera and species can be distinguished based on the form and arrangement of their leaves. Use the Key to Conifer Genera (Appendix A, which includes an illustrated glossary of important terms) to identify the genus of up to 15 conifer specimens in the room or outside, and record your answers below. In the process, you will familiarize yourself with the various forms that conifer leaves can take.

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.
- 11.
- 12.
- 13.
- 14.
- 15.

B. Cycads

Cycads comprise an ancient lineage of tropical trees and shrubs: they existed even before and with the dinosaurs and there are even fossils of these tropical plants on Antarctica. Familiarize yourself with cycad morphology and be sure you can properly distinguish cycads from the other gymnosperms in the room.

- Shrubs or trees with a single, typically unbranched stem.
- Leaves typically evergreen; in a terminal rosette; pinnate and leathery; leaflets typically with dichotomous leaf venation; circinate venation common.
- Sexual system dioecious (separate male and female plants).
- Male sporangia borne on sporophylls and grouped into a strobilus.
- Ovules borne on loosely clustered sporophylls (*Cycas*) or into a strobilus (*Zamia*).
- Seed coat may become fleshy and colored to attract animal dispersers.
- **Other notes:** produce neurotoxins – harmful only if ingested (eaten) in large quantities over period of years; thus, otherwise a harmless, ancient, and wonderfully beautiful lineage that is extremely popular in ornamental horticulture.

B1. Carefully examine a male cycad strobilus.



Male Strobilus & Naked Eye.

In the back/side of the room is male strobilus from a cycad. All male strobili in cycads are very similar to one another.

a. Unlike some other taxa, cycad male sporophylls have more than one sporangium on a sporophyll. About how many sporangia do you count on these large sporophylls?

b. Are the sporangia borne on top or beneath of the sporophylls?

B2. Compare & contrast arrangement of female sporophylls in *Cycas* vs. *Zamia*.



Live Plants/Cuttings of *Cycas* & *Zamia*.

In the back/side of room are some specimens and photographs showing the female sporophylls in the genus *Cycas* and *Zamia* (which are quite different from one another).

a. Which genus has the sporophylls arranged in a tight strobilus? *Zamia* or *Cycas*?

b. Which genus has pubescent sporophylls?

c. Draw a sporophyll of *Zamia*: be mindful of its shape and the number of seeds on each sporophyll.

d. Draw a sporophyll of *Cycas*: be mindful of its shape and the number of seeds on each sporophyll.

C. Ginkgo

Although there were dozens of species living millions of years ago throughout North America and Northern Asia, today there is just one extant (surviving) member of this interesting lineage, *Ginkgo biloba* (the maidenhair tree).

- Trees with a branched stem.
- Leaves deciduous; typically clustered on lateral short shoots; simple, fan-shaped, with dichotomous venation.
- Sexual system dioecious (separate male and female plants).
- Male sporangia borne in pendulous catkin-like strobili clustered on short shoots.
- Ovules in clusters of 2 or 3 on pendulous peduncle from short shoots.

- Seed coat becomes fleshy at maturity and stinks.
- **Other notes:** produce various terpenoids thought to promote circulation and thereby brain function; popular as ornamentals, ancient lineage; a “living fossil.”

C1. Ginkgo leaves are very distinctive.



Live or Herbarium Specimens of *Ginkgo* Leaves.

Specimens are in back or side of room. Draw a leaf of a ginkgo below, showing petiole, blade, and venation.

a. How is the shape of the blade distinctive?

*b. Is the venation type pinnate, palmate, parallel or something quite different?
Explain.*

C2. Ginkgo reproductive structures are very distinctive.



Fertile Live or Herbarium Specimens of *Ginkgo*.

Specimens are in back or side of room.

a. How are the male and female structures of ginkgo different from one another and different from other gymnosperms in room?

Appendix A. Key to Conifer Genera ©MU Botany 2010

- A. Plants not evergreen
 - B. Branchlets (secondary branches) 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 rounded or round-pointed, and flattened, woody peg-like leaf-stalk absent or if present not very prominent
 - H. Leaves <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 (but not sharp) 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 in cross-section; cones with just a single seed which is partially enclosed in fleshy red covering (aril); often bushes or shrubs **Taxus, Yew**
 - JJ. Leaves angular (not flattened) in cross-section and very sharp-pointed; cones with multiple woody scales present, no fleshy red covering (aril) around seed(s); trees or shrubs.
 - K. Typically bushes to small trees; cone small (< 1 cm diam), soft and berry-like, blue-gray; needle-like leaves (juvenile) and scale leaves (adult) often on same plant..... **Juniperus, Juniper**
 - KK. Larger trees; cone large and round (> 1 cm diameter)..... **Cryptomeria, Japanese Cedar**
 - CC. Leaves scale-like (or at least not especially elongate)
 - L. Branchlets (secondary branches) forming flattened fan-like sprays
 - M. Twiglets (smallest twigs) much flattened; cones elongate; cone-scales flattened, 8-12 **Thuja, Arbor Vitae**
 - MM. Twiglets rounder; cones round; cone-scales shield-shaped, 4-8 **Chamaecyparis, Cypress**
 - LL. Branchlets forming 3-D clusters not at all fan-like
 - N. Cones soft and berry-like, needle leaves (juvenile) and scale leaves (adult) often mixed..... **Juniperus, Juniper**
 - NN. Cones woody
 - O. Cones < 0.5 cm; leaves uniformly scale-like (<2 mm long).... **Chamaecyparis, Cypress**
 - OO. Cones >0.5 cm; leaves longer (>2 mm long). .. **Cryptomeria, Japanese Cedar**

Leaves

alternate

vs.

opposite

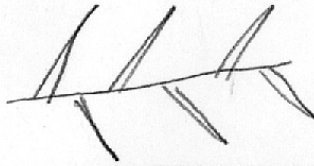


Leaves

needle-like

vs.

scale-like

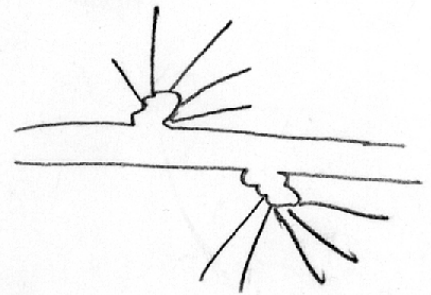
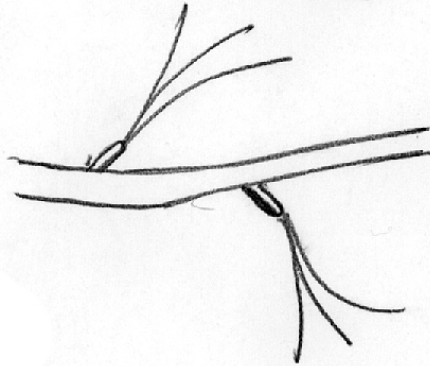


Leaves

fascicled

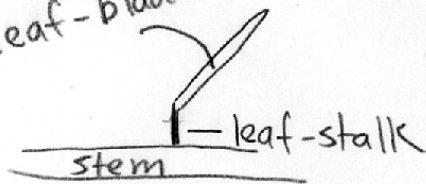
vs.

tufted on short branches



Leaf Morphology

leaf-blade



Cone Morphology

