Cheat Sheet

Exploring Gymnosperm Diversity

Phylum Cycadophyta

Cycads are the next largest group of gymnosperms after the conifers. They have large cones and palmlike leaves (true palm species are angiosperms). Only about 130 species survive today, but cycads thrived during the Mesozoic era, known as the age of cycads as well as the age of dinosaurs.

Cycas revoluta

Phylum Ginkgophyta

Ginkgo biloba is the only surviving species of this phylum. Also known as the maidenhair tree, it has deciduous fanlike leaves that turn gold in autumn. It is a popular ornamental tree in cities because it tolerates air pollution well. Landscapers often plant only pollen-producing trees because the fleshy seeds smell rancid as they decay.

Phylum Gnetophyta

Plants in the phylum Gnetophyta, called gnetophytes, consist of three genera: *Gnetum*, *Ephedra*, and *Welwitschia*. Some species are tropical, whereas others live in deserts. Although very different in appearance, the genera are grouped together based on molecular data.

▶ ***Welwitschia.*** This genus consists of one species, *Welwitschia mirabilis*, a plant that lives only in the deserts of southwestern Africa. Its straplike leaves are among the largest leaves known.

Ovulate cones

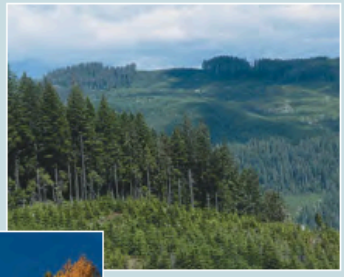
▶ ***Ephedra.*** This genus includes about 40 species that inhabit arid regions worldwide. These desert shrubs, commonly called "Mormon tea," produce the compound ephedrine, which is used medicinally as a decongestant.

◀ ***Gnetum.*** This genus includes about 35 species of tropical trees, shrubs, and vines, mainly native to Africa and Asia. Their leaves look similar to those of flowering plants, and their seeds look somewhat like fruits.

Phylum Coniferophyta

Phylum Coniferophyta is by far the largest of the gymnosperm phyla, consisting of about 600 species of conifers (from the Latin *conus*, cone, and *ferre*, to carry). Many are large trees, such as cypresses and redwoods. A few conifer species dominate vast forested regions of the Northern Hemisphere, where the growing season is relatively short because of latitude or altitude.

Most conifers are evergreens; they retain their leaves throughout the year. Even during winter, a limited amount of photosynthesis occurs on sunny days. When spring comes, conifers already have fully developed leaves that can take advantage of the sunnier, warmer days. Some conifers, such as the dawn redwood, tamarack, and larch, are deciduous trees that lose leaves each autumn.



▶ **Douglas fir.** This evergreen tree (*Pseudotsuga menziesii*) provides more timber than any other North American tree species. Some uses include house framing, plywood, pulpwood for paper, railroad ties, and boxes and crates.

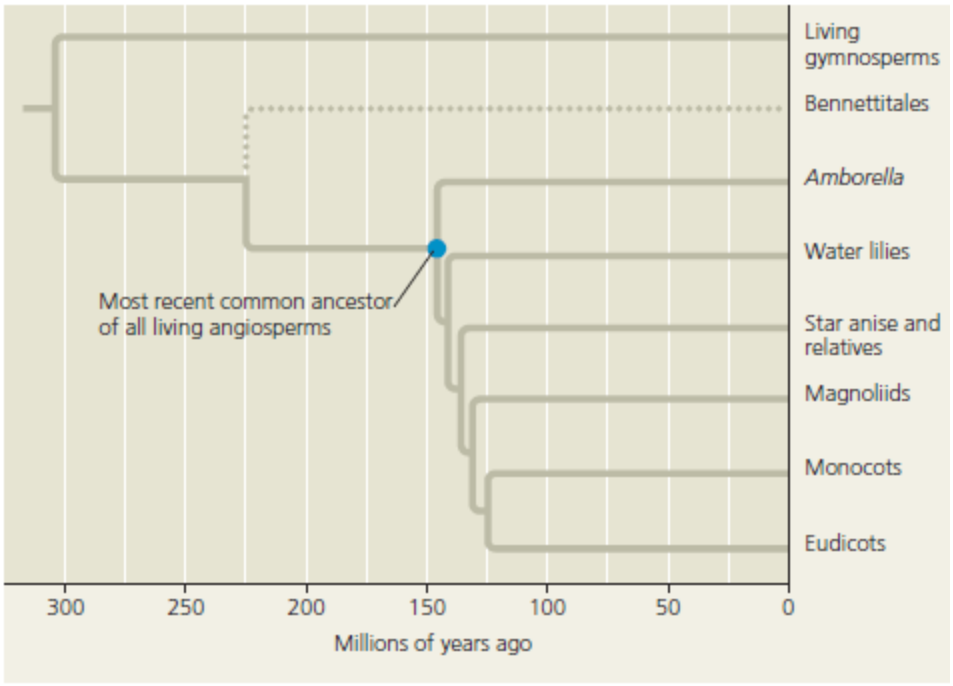
▶ **Common juniper.** The "berries" of the common juniper (*Juniperus communis*) are actually ovule-producing cones consisting of fleshy sporophylls.

◀ **European larch.** The needle-like leaves of this deciduous conifer (*Larix decidua*) turn yellow before they are shed in autumn. Native to the mountains of central Europe, including Switzerland's Matterhorn, depicted here, this species is extremely cold-tolerant, able to survive winter temperatures that plunge to –50°C.

◀ **Wollemi pine.** Survivors of a conifer group once known only from fossils, living Wollemi pines (*Wollemia nobilis*) were discovered in 1994 in a national park only 150 km from Sydney, Australia. The species consists of just 40 known individuals in two small groves. The inset photo compares the leaves of this "living fossil" with actual fossils.

▶ **Sequoia.** This giant sequoia (*Sequoiadendron giganteum*) in California's Sequoia National Park weighs about 2,500 metric tons, equivalent to about 24 blue whales (the largest animals) or 40,000 people. The giant sequoia is one of the largest living organisms and also among the most ancient, with some individuals estimated to be between 1,800 and 2,700 years old. Their cousins, the coast redwoods (*Sequoia sempervirens*), grow to heights of more than 110 m (taller than the Statue of Liberty) and are found only in a narrow coastal strip of northern California and southern Oregon.

▶ **Bristlecone pine.** This species (*Pinus longaeva*), which is found in the White Mountains of California, includes some of the oldest living organisms, reaching ages of more than 4,600 years. One tree (not shown here) is called Methuselah because it may be the world's oldest living tree. To protect the tree, scientists keep its location a secret.


Living gymnosperms
Bennettitales
Amborella
Water lilies
Most recent common ancestor of all living angiosperms
Star anise and relatives
Magnoliids
Monocots
Eudicots
300
250
200
150
100
50
0
Millions of years ago

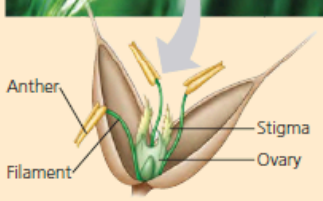
Monocots

About one-quarter of angiosperm species are monocots—about 70,000 species. These examples represent some of the largest families.

Orchid (*Lemboglossum rossii*)

Pygmy date palm (*Phoenix roebelenii*)

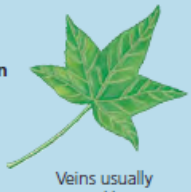
Lily (*Lilium "Enchantment"*)



Barley (*Hordeum vulgare*), a grass

Eudicots

More than two-thirds of angiosperm species are eudicots—roughly 170,000 species. Below is a sampling of eudicot floral diversity.

Monocot Characteristics		Eudicot Characteristics
 One cotyledon	**Embryos**	 Two cotyledons
 Veins usually parallel	**Leaf venation**	 Veins usually netlike
 Vascular tissue scattered	**Stems**	 Vascular tissue usually arranged in ring
 Root system usually fibrous (no main root)	**Roots**	 Taproot (main root) usually present
 Pollen grain with one opening	**Pollen**	 Pollen grain with three openings
 Floral organs usually in multiples of three	**Flowers**	 Floral organs usually in multiples of four or five

California poppy (*Eschscholzia californica*)

Pyrenean oak (*Quercus pyrenaica*)

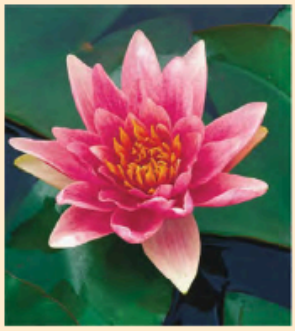
Dog rose (*Rosa canina*), a wild rose

Snow pea (*Pisum sativum*), a legume

Zucchini (*Cucurbita pepo*) flowers

Basal Angiosperms

Surviving basal angiosperms are currently thought to consist of three lineages comprising only about 100 species. The oldest lineage seems to be represented by a single species, *Amborella trichopoda* (right). The other surviving lineages diverged later: a clade that includes water lilies and a clade consisting of the star anise and its relatives.



Water lily (*Nymphaea "Rene Gerard"*). Water lilies are living members of a clade that may be predated only by the *Amborella* lineage.

Star anise (*Illicium*). This genus belongs to a third surviving lineage of basal angiosperms.

Amborella trichopoda. This small shrub, found only on the South Pacific island of New Caledonia, may be the sole survivor of a branch at the base of the angiosperm tree. *Amborella* lacks vessels, which are present in angiosperms in later-developing lineages. Consisting of xylem cells arranged in continuous tubes, vessels transport water more efficiently than tracheids. Their absence in *Amborella* indicates they may have evolved after the lineage that gave rise to *Amborella* diverged.

Magnoliids

Magnoliids consist of about 8,000 species, most notably magnolias, laurels, and black pepper plants. They include both woody and herbaceous species. Although they share some traits with basal angiosperms, such as a typically spiral rather than whorled arrangement of floral organs, magnoliids are more closely related to eudicots and monocots.

Southern magnolia (*Magnolia grandiflora*). This member of the magnolia family is a woody magnoliid. The variety of southern magnolia shown here, called "Goliath," has flowers that measure up to about a foot across.

Table 30.1 Examples of Plant-Derived Medicines

Compound	Source	Use
Atropine	Belladonna plant	Eye pupil dilator
Digitalin	Foxglove	Heart medication
Menthol	Eucalyptus tree	Throat soother
Quinine	Cinchona tree	Malaria preventive
Taxol	Pacific yew	Ovarian cancer drug
Tubocurarine	Curare tree	Muscle relaxant
Vinblastine	Periwinkle	Leukemia drug

Chapter 30 Questions

1. **What is a seed?**
2. **What is special about the gametophytes of seed plants?**
3. **What is the difference between most seedless vascular plants and seed plants in terms of spore production?**
4. **What is integument?**
5. **What is an ovule?**
6. **What is a pollen grain?**
7. **What is pollination?**
8. **What is the micropyle?**
9. **How does a pollen grain discharge sperm into the female gametophyte within the ovule?**
10. **Where does the seed coating come from?**
11. **What advantages do seeds have over spores?**
12. **What are conifers?**
13. **What is the difference between pollen cones and ovulate cones in conifers?**
14. **When did characteristics found in pines and other living seed plants originate?**
15. **How old are the oldest gymnosperm fossils?**
16. **When did gymnosperms start to become more prominent?**
17. **During what time did gymnosperms dominate terrestrial ecosystems?**
18. **What are the four gymnosperm phyla? Describe them.**
19. **How many plant phyla are there?**
20. **What plant phyla encompasses all angiosperms?**
21. **What is a flower?**
22. **What is a sepal?**
23. **What are petals?**
24. **What are stamens?**
25. **What are carpels?**
26. **What is a pistil?**
27. **What is a fruit?**
28. **What is the pericarp?**
29. **What makes up a male gametophyte in angiosperms?**
30. **What makes up a female gametophyte?**
31. **What occurs in double fertilization?**
32. **What is a cotyledon?**
33. **What is endosperm?**
34. **In what other phyla does double fertilization occur?**
35. **When are angiosperms thought to have evolved?**
36. **Draw the phylogenetic tree of angiosperms**
37. **What are the Bennettitales?**
38. **What are vessel elements?**

39. Why do scientists believe that the common ancestor of angiosperms was woody?
40. What is the difference between monocots and eudicots?
41. What are eudicots?
42. How are dicots that are not eudicots classified?
43. Describe the four main angiosperm families.
44. Which six crops yield 80% of all calories consumed by humans?
45. Give 7 examples of plant-derived medicines.
46. What gives willows their medicinal properties?

Chapter 30 Answers

1. Embryo and its food supply surrounded by a protective coat
2. They are microscopic and retained within sporangia of the parental sporophyte, protects gametophyte (seedless vascular plant gametophytes must fend for themselves)
3. Most seedless are homosporous, seed plants are heterosporous
4. Layer of sporophyte tissue that envelops and protects megasporangium (one integument around gymnosperm's, two around angiosperm's)
5. The megasporangium, megaspore, and their integument (s)
6. Male gametophyte enclosed within a pollen wall (walls outer layer made of molecules secreted by sporophyte cells)
7. Transfer of pollen to the part of the seed plant that contains the ovule
8. The only opening through the integument
9. Germinates and gives rise to a pollen tube (sperm do not need flagella because they are transported by pollen tube)
10. It is derived from the integument
11. Seeds are multicellular and can remain dormant for long periods of time (spores have short lifetimes), seeds have stored supply of food
12. Cone-bearing plants, include pines, firs, and redwoods
13. Scales are microsporophylls, in microsporangium, cells called microsporocytes undergo meiosis, producing microspores, each of which develops into a pollen grain

    Scales are compound structures (megasporophyll and modified stem tissue), megasporocytes undergo meiosis and surviving megaspores become female gametophytes

    most trees have both types
14. late Devonian period (380 mya)
15. 305 my old, lived in moist Carboniferous ecosystems
16. Between transition from Carboniferous to Permian (299-252 mya), climate became drier, gymnosperms better suited to dry climate than other plants
17. mesozoic era (252-66 mya)
18. Cycadophyta, Ginkgophyta, Gnetophyta, and Coniferophyta, see picture
19. 10
20. anthophyta
21. Unique angiosperm structure specialized for sexual reproduction
22. Usually green and enclose flower before it opens
23. Usually bright colored and can help attract pollinators
24. Microsporophylls, stalk called filament, and terminal sac called anther (produces pollen)
25. megasporophylls, container where seeds are enclosed. At tip is sticky stigma that receives pollen, style leads from stigma to ovary (contains one or more ovules)
26. Can refer to single carpel (simple pistil) or two or more fused carpels (compound pistil)

27. Formed when ovary walls thicken after fertilization
28. The wall of the ovary
29. haploid generative cell that divides to form two sperm and a tube cell that produces pollen tube
30. Also called embryo sac, consists of a few cells, one of which is egg
31. Two sperm cells discharged by pollen tube into embryo sac. One fertilizes egg, other fuses with two nuclei in large central cell of female gametophyte (produces triploid cell)
32. Seed leaves
33. tissue rich in starch and other food reserves, develops from triploid central cell
34. Gnetophyta, but fert gives rise to two embryos
35. early Cretaceous period (140 mya), began to dominate in mid cretaceous (100 mya)
36. see picture
37. group with flower-like structure that may have been pollinated by insects, but did not have carpels or flowers
38. Efficient water-conducting cells that are found in most present-day angiosperms, not found in Bennettitales, *Amborella*, water lilies, and star anise
39. *Amborella*, one of first angiosperms to diverge from others, is woody
40. see picture
41. clade including most dicots (dicots, characterized solely by having two cotyledons, form a paraphyletic clade)
42. Four lineages, including *Amborella*, water lilies, and star anise/relatives (basal angiosperms because they diverged from others early in history). Fourth (magnoliids) evolved later.
43. see picture
44. Maize, rice, wheat, potatoes, cassava, sweet potatoes
45. See picture
46. Chemical called salicin (aspirin is a derivative called acetylsalicylic acid)