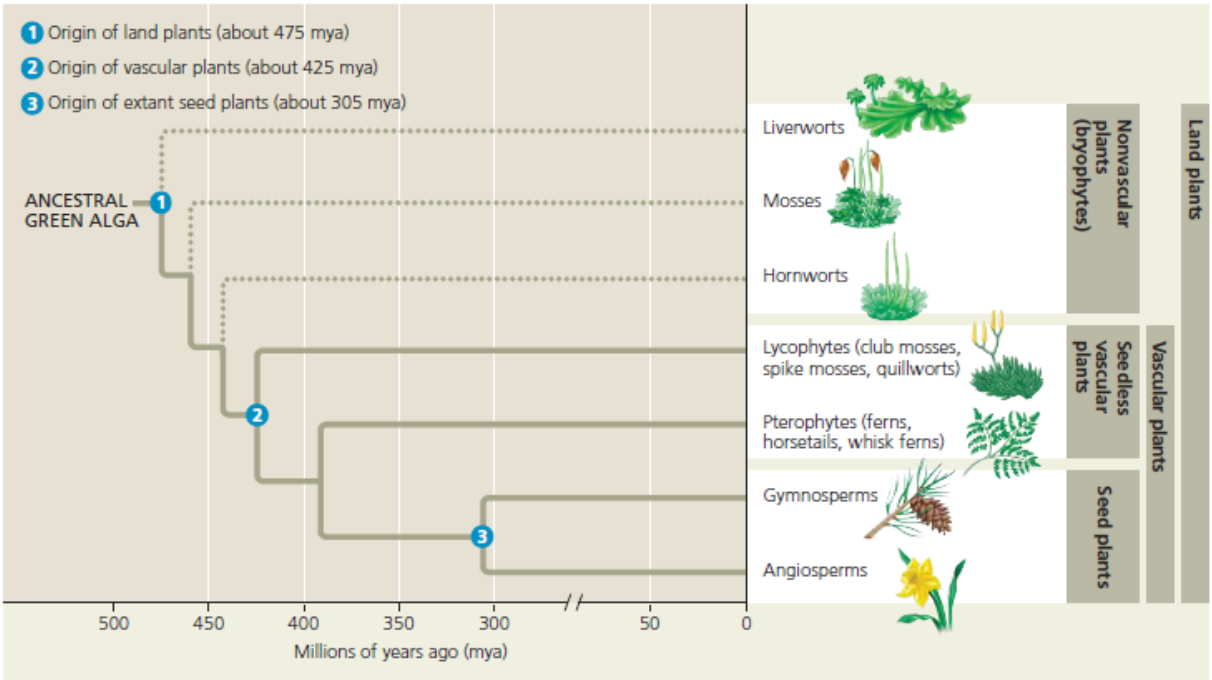
Cheat Sheet


1 Origin of land plants (about 475 mya)
2 Origin of vascular plants (about 425 mya)
3 Origin of extant seed plants (about 305 mya)
ANCESTRAL GREEN ALGA
Liverworts
Mosses
Hornworts
Lycophytes (club mosses, spike mosses, quillworts)
Pterophytes (ferns, horsetails, whisk ferns)
Gymnosperms
Angiosperms
Nonvascular plants (bryophytes)
Seedless vascular plants
Seed plants
Vascular plants
Land plants
500
450
400
350
300
50
0
Millions of years ago (mya)

Lycophytes (Phylum Lycophyta)

Many lycophytes grow on tropical trees as *epiphytes*, plants that use other plants as a substrate but are not parasites. Other species grow on temperate forest floors. In some species, the tiny gametophytes live above ground and are photosynthetic. Others live below ground, nurtured by symbiotic fungi.

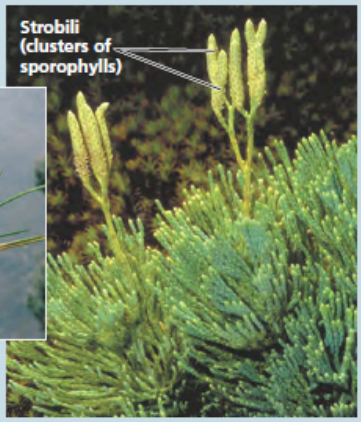
Sporophytes have upright stems with many small leaves, as well as ground-hugging stems that produce dichotomously branching roots. Spike mosses are usually relatively small and often grow horizontally. In many club mosses and spike mosses, sporophylls are clustered into club-shaped cones (strobili). Quillworts, named for their leaf shape, form a single genus whose members live in marshy areas or as submerged aquatic plants. Club mosses are all homosporous, whereas spike mosses and quillworts are all heterosporous. The spores of club mosses are released in clouds and are so rich in oil that magicians and photographers once ignited them to create smoke or flashes of light.

***Selaginella moellendorffii*, a spike moss**

1 cm

***Isoetes gunnii*, a quillwort**

2.5 cm



***Diphasiastrum tristachyum*, a club moss**

Pterophytes (Phylum Pterophyta)

***Athyrium filix-femina*, lady fern**

25 cm

***Equisetum arvense*, field horsetail**

1.5 cm

***Psilotum nudum*, a whisk fern**

4 cm

Ferns

Unlike the lycophytes, ferns have megaphylls (see Figure 29.14b). The sporophytes typically have horizontal stems that give rise to large leaves called fronds, often divided into leaflets. A frond grows as its coiled tip, the fiddlehead, unfurls.

Almost all species are homosporous. The gametophyte in some species shrivels and dies after the young sporophyte detaches itself. In most species, sporophytes have stalked sporangia with springlike devices that catapult spores several meters. Airborne spores can be carried far from their origin. Some species produce more than a trillion spores in a plant's lifetime.

Horsetails

The group's name refers to the brushy appearance of the stems, which have a gritty texture that made them historically useful as "scouring rushes" for pots and pans. Some species have separate fertile (cone-bearing) and vegetative stems. Horsetails are homosporous, with cones releasing spores that typically give rise to bisexual gametophytes.

Horsetails are also called arthrophytes ("jointed plants") because their stems have joints. Rings of small leaves or branches emerge from each joint, but the stem is the main photosynthetic organ. Large air canals carry oxygen to the roots, which often grow in waterlogged soil.

Whisk Ferns and Relatives

Like primitive vascular plant fossils, the sporophytes of whisk ferns (genus *Psilotum*) have dichotomously branching stems but no roots. Stems have scalelike outgrowths that lack vascular tissue and may have resulted from the evolutionary reduction of leaves. Each yellow knob on a stem consists of three fused sporangia. Species of the genus *Tmesipteris*, closely related to whisk ferns and found only in the South Pacific, also lack roots but have small, leaflike outgrowths in their stems, giving them a vine-like appearance. Both genera are homosporous, with spores giving rise to bisexual gametophytes that grow underground and are only about a centimeter long.

Chapter 29 Questions

1. **What are the closest relatives of plants and what traits do they share with plants?**
2. **What is sporopollenin?**
3. **What are the five traits that are found in plants but not their closest relatives?**
4. **What is a cuticle?**
5. **What are stomata?**
6. **How did early plants survive without roots?**
7. **The walls of ancient spores have structural features that are exclusively found in what living plant?**
8. **What is vascular tissue?**
9. **What are the three phyla of nonvascular plants?**
10. **What are two seedless vascular plant phyla?**
11. **Draw the phylogenetic tree of plant evolution.**
12. **What is a grade?**
13. **What is a seed?**
14. **What are the two types of seed plants?**
15. **What is the dominant stage of the life cycle of bryophytes?**
16. **What is a protonema?**
17. **What are rhizoids?**
18. **What does bryophyte sperm require to reach the eggs?**
19. **What are thalloid liverworts?**
20. **What is a seta?**
21. **What are the differences between liverworts, hornworts, and mosses?**
22. **What are brood bodies?**
23. **Where do sporophytes of bryophytes live?**
24. **What are a foot, a seta, and a capsule?**
25. **What is a peristome?**
26. **What is *Sphagnum*?**
27. **What is special about peatlands?**
28. **Compare/contrast seedless vascular plants and bryophytes.**
29. **How are the ancient relatives of vascular plants different from those of nonvascular plants?**
30. **What are the three main traits that characterize today's vascular plants?**
31. **What are roots?**
32. **What are leaves?**
33. **What are sporophylls?**
34. **What does homosporous mean?**
35. **What does heterosporous mean?**
36. **What are lycophytes?**
37. **When did lycophyte diversity decline?**
38. **What are monilophytes (pterophytes)?**

39. What is *Tmesipteris*?

40. When were horsetails at their peak?

Chapter 29 Answers

1. Green algae called charophytes
   Cells have circular ring protein in plasma membrane that synthesize cellulose microfibrils of cell wall (noncharophyte algae have linear sets of proteins that synthesize microfibrils)
   Structure of flagellated sperm in plants resembles that of charophytes
   In plants and certain charophytes, group of microtubules called phragmoplast forms between daughter nuclei of dividing cell, cell plate develops in middle of phragmoplast.
2. Durable polymer that forms layer around charophyte zygotes to prevent them from drying out, also found to encase plant spores
3. Alternation of generations - Sporophyte to spores to gametophyte to gametes (repeat)
   Multicellular, dependent embryos - multicellular embryos develop from zygotes retained by tissues of female parent, embryo has placental transfer cells that enhance transfer of nutrients (so significant that plants are called embryophytes)
   Walled spores produced in sporangia - Sporangia (multicellular organ) produces spores encased with sporopellenin from sporocytes (spore mother cells). Charophytes produce flagellated, water-dispersed spores without sporonellin and lack multicellular sporangia
   Multicellular gametangia (produces gametes) - female gametangia called archegonia (pear-shaped organ that produces single, non-motile egg), male gametangia called antheridia (produce sperm often having flagella and release them into environment).
   Archegonia and antheridia lost in many lineages of seed plants
   Apical meristems, regions at growing tips of plant body where cell(s) divide repeatedly
4. Covering of wax and polymers (covers epidermis), acts as waterproofing
5. Specialized pores that support photosynthesis (allow exchange of CO_2 and O_2 with outside ai), main avenue for water loss
6. Formed symbiotic relationships with fungi (mycorrhizae)
7. liverworts
8. Cells joined into tubes that transport water and nutrients throughout the plant body. Most plants have complex vascular tissue, so are called vascular plants
9. Hornworts (Anthocerophyta), liverworts (Hepatophyta), and mosses (Bryophyta) (have simple vascular tissue, informally called bryophytes, not a monophyletic group)
10. Lycophytes (Lycophyta) and monilophytes (monilophyta)
11. See picture
12. Collection of organisms that share key biological features (do not necessarily have common ancestry)
13. Embryo packaged with supply of nutrients inside of protective coat
14. Gymnosperms - seeds not enclosed in chambers (10%)
    Angiosperms - Clade consisting of all flowering plants, seeds develop in fruits (90%)
15. The haploid gametophyte, larger and longer-living than sporophytes
16. Mass of green, branched, one-cell thick filaments, has large surface area, produces “buds” with apical meristem that generates gamete-producing structure called gametophore in favorable conditions

17. Delicate, long, tubular single cells (in liverworts/hornworts) or filaments of cells (in mosses), not composed of tissues, lack specialized conducting cells, do not play primary role in water/mineral absorption, anchors plant
18. film of water, so many bryophyte species are found in moist habitats
19. Liverworts with gametophytes with flattened shape
20. Stalk of a sporophyte of a bryophyte
21. Microscopic sporophyte, does not have stomata (all other plants do)
    Long, tapered sporophyte (about 5 cm long), lacks a seta and consists only of a sporangium. Gametophytes grow mostly horizontally, often have multiple sporophytes attached, form symbiotic relationship with nitrogen-fixing cyanobacteria
    Gametophytes are usually less than 15 cm tall, leaves usually one cell thick. sporophyte are elongated, visible to naked eye, up to 20 cm high, green/photosynthetic when young, tan/brownish red when ready to release spores
22. Small plantlets that detach from the parent plant and grow into new genetically identical copies of their parent
23. Remain attached to parental gametophyte throughout lifetime
24. Embedded in archegonium, absorbs nutrients from gametophyte
    Stalk, conducts materials from foot to sporangium
    Sporangium, produces spores by meiosis
25. Ring of interlocking, tooth-like structures that open under dry conditions and close when it is moist (around mouth of capsule)
26. Peat moss, wetland moss genus that is major component of deposits of partially decayed organic material (peat)
27. Boggy regions with thick layers of peat, peat moss does not decay readily due to phenolic compounds embedded in its cell walls. Low temp, pH, and oxygen level inhibit decay of moss and other organisms, resulting in preserved thousand-year-old corpses (peat used as fuel source, soil conditioner, and packing material for shipping plants). Use of peat releases CO_2
28. Have well-developed vascular systems but lacked seeds, taller than bryophytes.
    Both have flagellated sperm that swim through film of water to reach eggs
29. Had branched sporophytes that were not dependent on gametophytes for nutrition
30. Sporophyte generation is the larger and more complex form
    Have Xylem (conducts water and minerals), includes tracheids (tube-shaped cells that carry water and minerals up from the roots), water-conducting cells in vascular plants are lignified (cell walls strengthened by lignin (polymer))
    Have phloem (cells arranged into tubes that distribute sugars, amino acids, and other organic products
31. Organs that absorb water and nutrients from the soil, anchor vascular plants to the ground, resemble stem tissues of early vascular plants
32. Structures that serve as the primary photosynthetic organ of vascular plants, classified as microphylls and megaphylls
    microphylls - small, often spine-shaped leaves supported by single strand of vascular

tissue (only in lycophytes)
megaphylls - leaves with highly branched vascular system, larger that microphylls

33. Modified leaves that bear sporangia (fern sporophylls produce clusters of sporangia known as sori, usually on underside of sporophylls. in many lycophytes/most gymnosperms, groups of sporophylls form cone-like structures (strobili). Sporophylls of angiosperms called carpels and stamens
34. Have one type of sporophyll bearing one type of sporangium that produces one type of spore that typically develops into a bisexual gametophyte
35. Have two types of sporophylls: megasporophylls and microsporophylls (have megasporangia (producing megaspores that dev into female gametophytes) and microsporangia (producing microspores that dev into male gametophytes)). Describes all seed plants and a few seedless vascular plants.
36. See picture
37. Permian period, before had giant trees, now have smaller species
38. See picture
39. Genus of plants closely related to whisk ferns and found only in SOuth pacific, have small, leaflike outgrowths in stems (homosporous)
40. During Carboniferous period, now only 15 species survive as part of single genus *Equisetum*,