

Objectives

- Describe three plant adaptations that evolved in gymnosperms.
- List the four main groups of gymnosperms.

Key Terms

- gymnosperm
- pollen
- seed
- ovule

Although you may never have thought about it, you benefit every day from the products of conifers, such as timber for buildings and furniture, and paper. Conifers, the most common gymnosperms, are among the tallest, largest, and longest-living organisms on Earth.

Gymnosperm Adaptations

Compared to ferns, gymnosperms have three additional adaptations that make survival in diverse land habitats possible. These adaptations include an even smaller gametophyte, pollen, and the seed.

Gymnosperms are plants that bear seeds that are "naked," meaning not enclosed in an ovary.

In gymnosperms, the diploid sporophyte generation is much more highly developed and obvious than the haploid gametophyte generation. A pine tree, for example, is actually a sporophyte on which the tiny gametophytes live in cones. This contrasts with ferns, where the small gametophytes live on their own, without the protection of the larger sporophyte.

A second adaptation of seed plants to dry land was the evolution of pollen. Pollen grains are the much-reduced male gametophytes that contain cells that develop into sperm. In the case of conifers, wind carries pollen from male to female cones, where eggs develop within the female gametophyte. The evolution of pollen allowed sperm to reach eggs by traveling through a dry environment rather than swimming through water.

The third important adaptation of seed plants to life on land is the seed itself. As you have read, a seed consists of a plant embryo packaged along with a food supply within a protective coat.

Figure 19-13 highlights key stages in the life cycle of a pine tree. Within a pollen cone's many spore sacs, thousands of haploid spores develop into pollen grains (male gametophytes). Meanwhile, the female gametophytes develop within structures called ovules. Within each of two ovules on each scale of the female cones, a large spore cell undergoes meiosis and produces four haploid cells. One of these cells survives and grows into the female gametophyte.

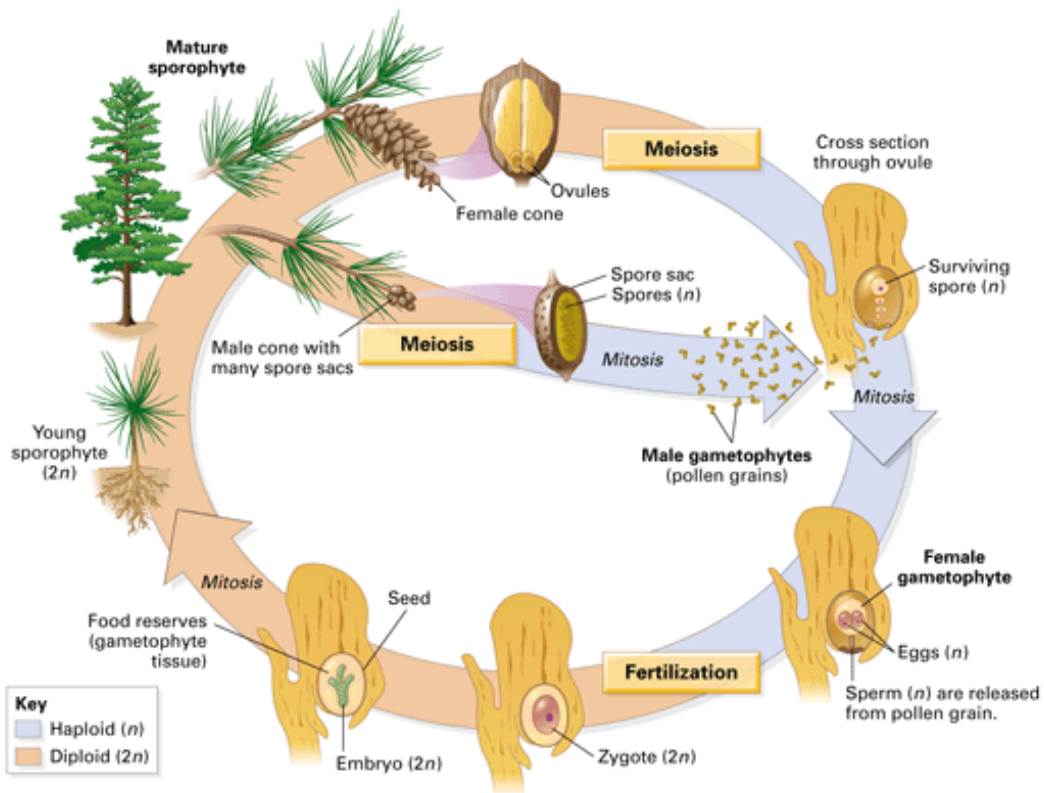


Figure 19-13

In pines and other gymnosperms, the gametophytes develop inside cones. Airborne pollen grains (the male gametophytes) carry sperm to the female gametophytes.

Wind blows pollen from one tree to another. If a pollen grain reaches a female cone, sperm cells mature and fertilize egg cells within the female gametophyte. Often two eggs in an ovule are fertilized, but just one of the zygotes develops into an embryo. This embryo is the new sporophyte plant.

The Diversity of Gymnosperms

At the end of the Carboniferous period, the global climate turned drier and colder. The vast forests of pteridophytes began to disappear. Along with this climate change came the success of seed plants, which can complete their entire life cycles on dry land. Of the earliest seed plants, the most successful were the gymnosperms. Several kinds of gymnosperms grew along with the seedless plants in the Carboniferous swamps. Four phyla of gymnosperms exist today.

Ginkgos *Ginkgo biloba* (the maidenhair tree) is the sole living species of the phylum known as the ginkgophytes. Many species of this phylum were common when dinosaurs were alive. The ginkgo has fanlike leaves that turn yellow and are shed in autumn. What looks like fruits are actually fleshy seeds. The ginkgo is a popular tree in cities, partly because it tolerates air pollution well.

Gnetophytes The phylum known as the gnetophytes includes the plant called Mormon tea, a common desert shrub of the southwestern United States.

Cycads Species belonging to this phylum have large, palm-like leaves. (Don't confuse cycads with true palms, which are flowering plants, not gymnosperms.) Cycad seeds develop on the surface of specialized leaves that are packed closely together, forming a cone.

Conifers Spruces and pines are conifers, as are firs, junipers, cedars, and redwoods. Nearly all conifers are evergreens, meaning they retain leaves throughout the year. But this does not mean their leaves last forever. Leaves such as pine needles are replaced as old ones die, but they are not replaced all at once.