16.1 What Are Plants?

You have many reasons to be thankful for plants. Your breakfast came from plants. In fact, most of your food comes from plants or from animals that eat plants. The paper in this book contains wood pulp from plants. Some of the oxygen you breathe comes from plants. So the next time you see a plant, be sure to say thanks! In this section you will learn about the characteristics and types of plants.

Plant characteristics

Plants vary in size and shape

Plants come in all sizes, from the tiny duckweed which grows to only about 10 mm in length, to the giant redwood which grows to about 100 m in height. Plants also come in many different shapes like a feathery fern or a prickly cactus. Some examples of plants are shown in Figure 16.1.

Characteristics common to all plants

Despite their great diversity, all plants share the following characteristics:

- **Plants are producers and use photosynthesis to make food.** Most plants are green. This is because they contain the pigment chlorophyll. As you read in Chapter 8, chlorophyll absorbs certain wavelengths of light and uses that energy to make carbohydrate molecules.
- **Plants have eukaryotic cells with cell walls.** Plant cells have a true nucleus and are surrounded by a cell wall. The cell wall surrounds the cell membrane, protecting the plant and providing a rigid structure.
- **Plants have a cuticle.** A **cuticle** is a waxy layer that covers the parts of a plant that are exposed to air like leaves and stems. The cuticle is an adaptation for living on land that keeps plants from drying out.

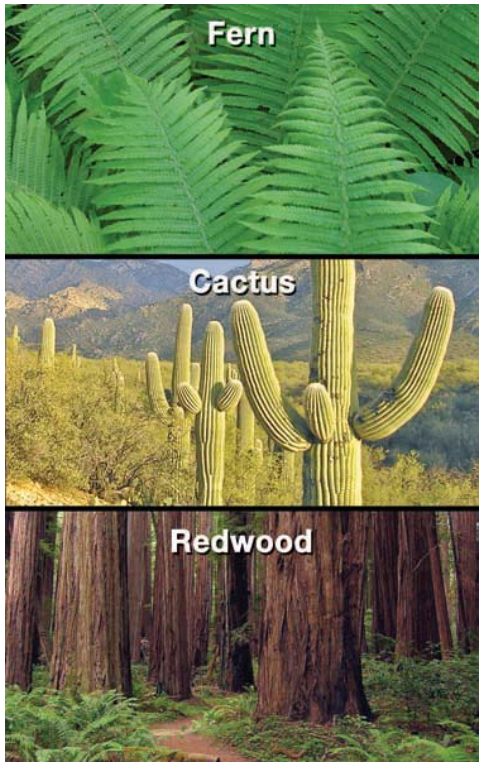

Figure 16.1: *Some representative plants.*

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cuticle - a waxy layer that covers the parts of a plant that are exposed to air like leaves and stems.

Plant classification

Vascular and non-vascular plants

Classification in the Kingdom Plantae is based on the presence or absence of vascular tissues. **Vascular tissues** are made of cells organized into tube-like structures that transport water, minerals, and food throughout a plant.

Non-vascular plants

Non-vascular plants do not have any tissues to transport water and nutrients. Instead, they depend on the processes of diffusion and osmosis to supply their cells with nutrients. Because these processes are slow, non-vascular plants cannot grow very tall. Mosses and liverworts are examples of non-vascular plants.

Vascular plants

Vascular plants have tissues made of cells that transport water and nutrients throughout the plant. Like your veins and arteries, vascular tissues can transport materials over a distance. The evolution of vascular tissues is one of the adaptations that allowed plants to move onto land. **Vascular plants are divided into two groups—those that produce seeds and those that do not.** Plants that do not produce seeds include ferns, club mosses, and horsetails. Plants that produce seeds are divided into *gymnosperms* and *angiosperms,* which you'll learn more about later.

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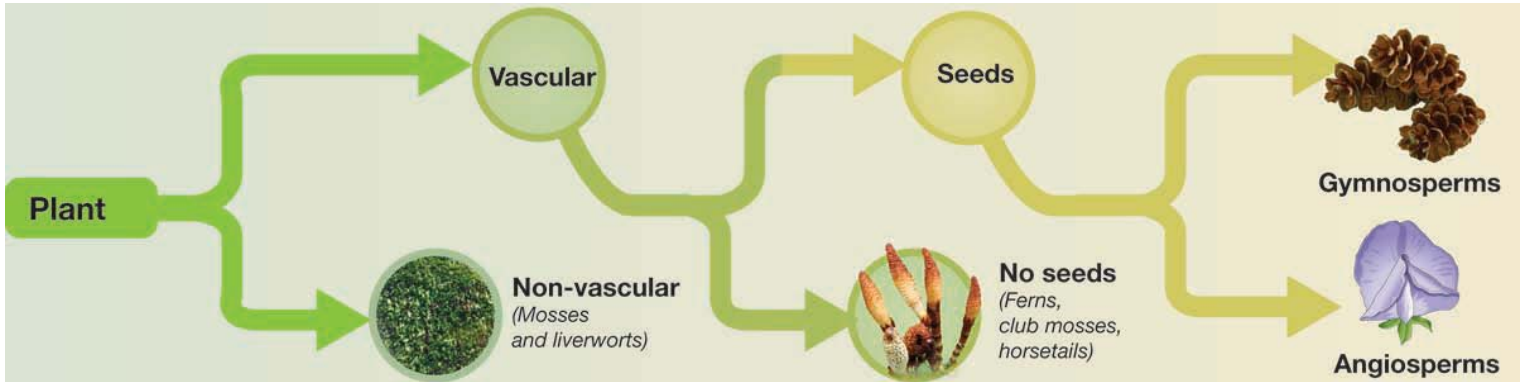
vascular tissues - cells organized into tube-like structures that transport water, minerals, and food throughout a plant.

non-vascular plants - do not have any tissues to transport water and nutrients.

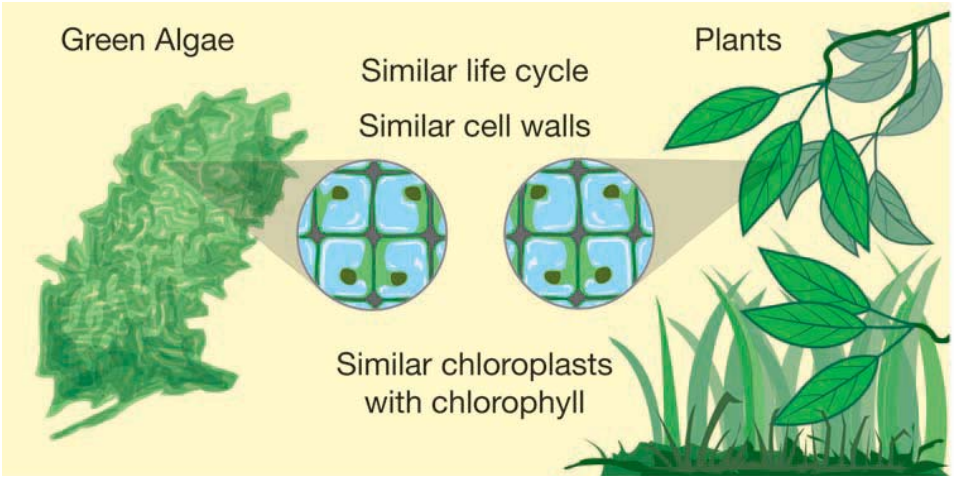
vascular plants - have tissues made of cells that transport water and nutrients throughout the plant.



Plant evolution

Plants and green algae

Because plants are similar in many ways to green algae, scientists think that both may have originated from an ancient species of green algae. Algae and green plants both have a life cycle that involves alternation of generations. Both contain the same type of chlorophyll and make the same type of starch. Also, both have similar cell walls.



A brief evolutionary history

The first ancestors of plants show up in the fossil record during the late Ordovician Period—about 450 million years ago. Plants started out living in water, an ideal environment that supported cells and transported nutrients to the cells. As Earth's environments changed, plants had to adapt to life on land. They evolved adaptations for support, protection, and to prevent them from drying out. They also evolved vascular tissues for transporting water and nutrients throughout their bodies. Figure 16.2 shows the evolutionary relationships among plant groups.

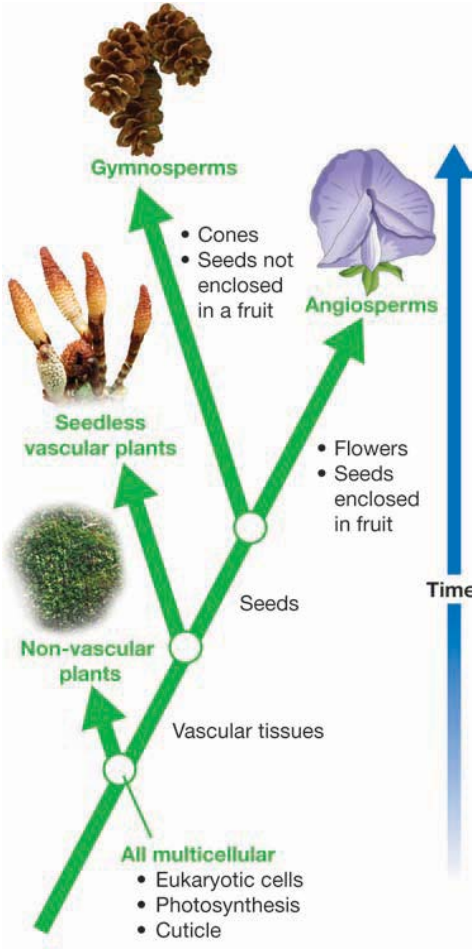


Figure 16.2: *A cladogram that shows evolutionary relationships among major plant groups.*

Non-vascular plants

Characteristics of non-vascular plants

The non-vascular plants include the mosses and liverworts. These are small, simple plants usually found in moist locations. Because they lack vascular tissues, each cell in the plant must absorb water and nutrients through osmosis and diffusion. Thus, mosses and liverworts do not grow very tall. Mosses and liverworts need water to carry the sperm to the eggs for fertilization. The life cycle of non-vascular plants shows an alternation of generations. It includes a *sporophyte* stage that produces spores and a *gametophyte* stage that produces sex cells.

Liverworts

You may have seen liverworts growing on wet rocks and soil in shady places (Figure 16.3). The sporophyte stage of a liverwort looks like a tiny palm tree. The body of the gametophyte stage is leafy and flattened. **Rhizoids** are root-like growths that extend from beneath the body and anchor the plant. They are not considered roots because they do not have vascular tissues.

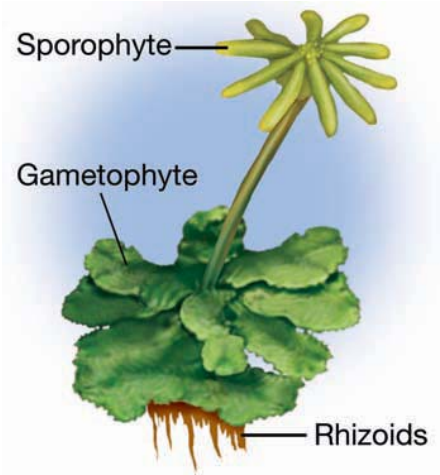


Figure 16.3: *Liverworts.*

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rhizoids - root-like growths on mosses and liverworts that anchor the plant to a surface and do not have vascular tissues.

Mosses

Mosses usually grow together in large colonies and cover an area like a carpet (Figure 16.4). Each moss plant consists of a leafy stalk with rhizoids at the base to anchor the plant. The sporophyte stage of a moss has a *capsule* on top that contains the spores.

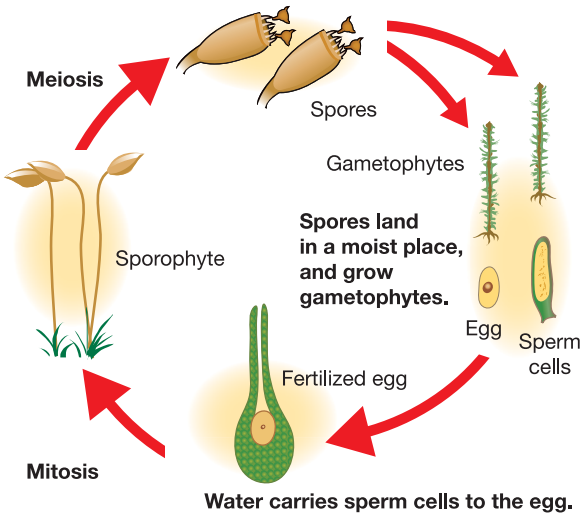


Figure 16.4: *A carpet of moss.*

Seedless vascular plants

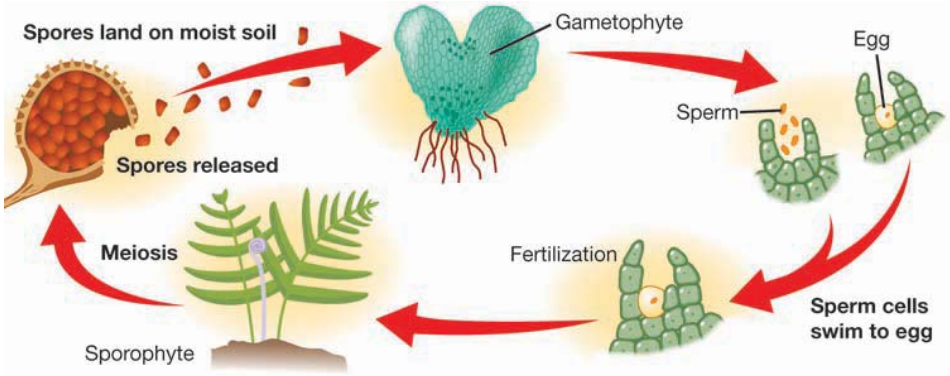
What are seedless vascular plants?

The seedless vascular plants include ferns, club mosses, and horsetails (Figure 16.5). Because they have vascular tissues, these plants can grow taller than mosses and liverworts. A typical fern can reach heights of a meter or taller. Tropical tree ferns can reach a height of about 20 m. Ancestors of seedless vascular plants were even taller than their modern descendents. The first forests contained club mosses that grew to around 40 m tall! Modern club mosses are less than a meter tall.

Figure 16.5: *Seedless vascular plants.*

Ferns

You can find ferns in tropical forests, temperate forests, and even in the Arctic. The form of a fern you will notice is the sporophyte. Figure 16.6 shows the structures of a fern. The leafy branch of the fern is called a *frond*. If you look underneath a fern frond, you may see small patches that contain the spores. Not every frond has spores under it. Ferns have an underground stem called a *rhizome* from which the fronds unfurl. Young fronds are tightly coiled and are called *fiddleheads*. The fern gametophyte is heart-shaped and about half the size of a pea. It has female parts that produce eggs and male parts that produce sperm. Like non-vascular plants, ferns need water to transport sperm cells to egg cells.



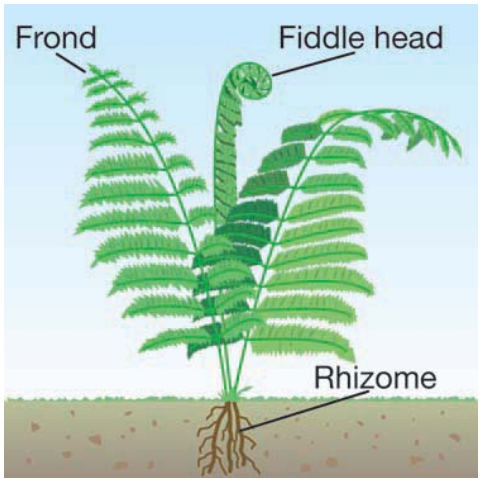


Figure 16.6: *The structures of a typical fern.*

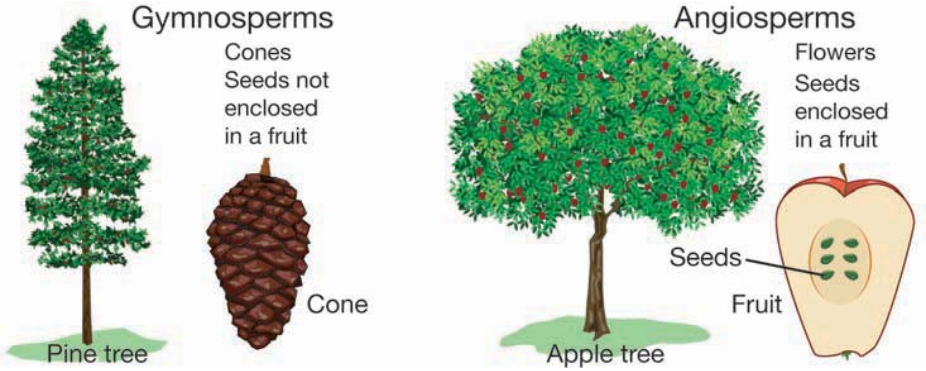
Vascular plants with seeds

What are seeds?

The types of plants you are probably most familiar with are trees, grasses, and flowers. These familiar plants are very different from mosses and ferns. They have the ability to produce *seeds*. A **seed** is a structure that contains a plant embryo and a supply of food inside a protective covering. A seed forms after fertilization and is made up of a plant embryo, stored food, and a tough covering. The three parts of a seed are shown in Figure 16.7.

Gymnosperms and angiosperms

Gymnosperms are a group of vascular plants whose seeds are not surrounded by a fruit. The seeds of many gymnosperms are housed in cones. Most gymnosperms are trees such as pine, fir, and spruce. **Angiosperms**, also known as flowering plants, produce seeds within a fruit. They are the most diverse of all plant groups and include fruit trees, roses, corn, grass, and oak trees.



Adaptations for life on land

Seed plants have many adaptations for living on land. Seeds are more resistant to drying out than spores. Unlike spores, seeds contain stored food to nourish the embryo and help it sprout and grow. Also, seed plants do not require water for reproduction. Recall that mosses and ferns need water for fertilization to occur. In addition, seed plants have well-developed vascular systems for transporting water and nutrients throughout their bodies.

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seed - a structure that contains a plant embryo and a supply of food inside a protective covering.

gymnosperms - vascular, seed-producing plants whose seeds are not enclosed in a fruit.

angiosperms - vascular, seed-producing plants whose seeds are enclosed in a fruit.

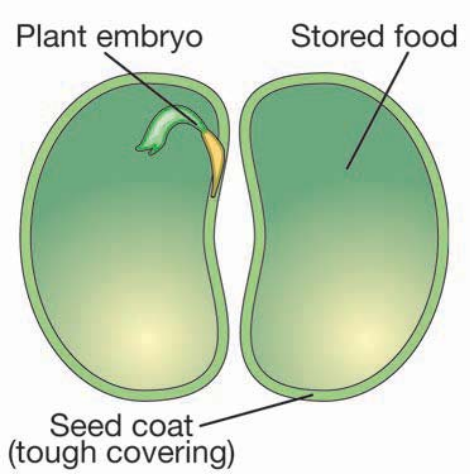


Figure 16.7: *The three parts of a seed.*

More about seed plants

Gymnosperms

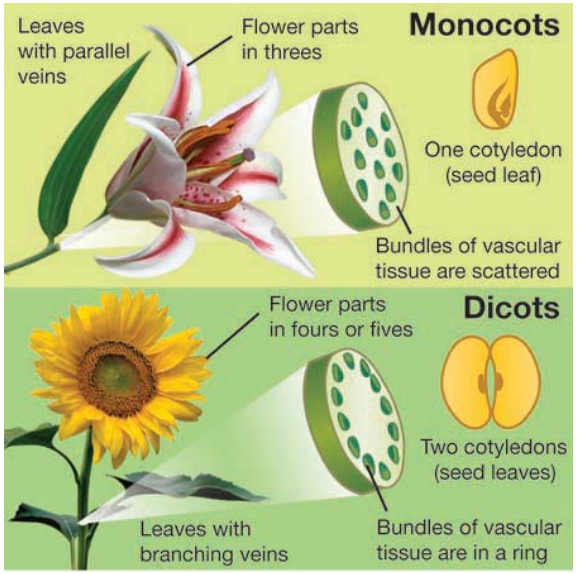
Gymnosperms do not produce flowers and their seeds are not enclosed in a fruit. Gymnosperms include conifers, cycads, and gingkoes. A gymnosperm called the bristlecone pine may be the oldest living organism on Earth (Figure 16.8). One bristlecone pine is believed to be almost 5,000 years old!

Conifers are a group of gymnosperms

The *conifers*, including pines and firs, are a group of gymnosperms that have cones. There are male and female cones on the same plant (Figure 16.9). Male cones produce male gametophytes called *pollen*. Pollen are dust-like particles that produce sperm. The female cone produces the eggs. Wind carries pollen to the female cone on the same or different plants. Sperm are released and fertilize the eggs. The seeds develop inside of the female cone.

Angiosperms

Angiosperms are flowering plants that produce seeds enclosed in a fruit. Angiosperms are divided into two classes—*monocots* and *dicots*. The two classes have different numbers of cotyledons in their seeds. A **cotyledon** is an embryonic leaf found inside of a seed. Monocots (*mono* = 1) have one cotyledon and dicots (*di* = two) have two. In monocots, bundles of vascular tissue are scattered while in dicots, the bundles form a ring.



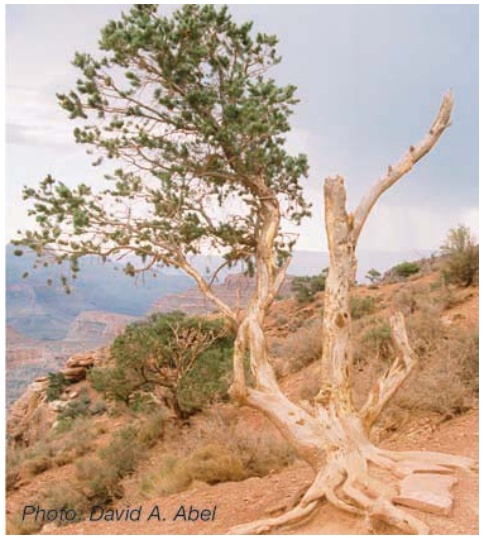


Figure 16.8: *The bristlecone pine is the oldest living thing on Earth.*

Figure 16.9: *Male and female cones on a pine tree.*