Chapter 1

Exploring Botany

In This Chapter

- Building plants one cell at a time
- Finding out about how plants work
- Connecting plants and people

Botany is the study of plants, including plant structure, function, reproduction, diversity, inheritance, and more. Plants may seem like they're part of the background of your life, when really they're at the center. The food you eat, the clothes you wear, the materials that make up your home — all these things depend upon plants. Plants remove carbon dioxide from the atmosphere, helping to keep your planet from getting too warm for life as you know it. They provide homes for insects and other animals, filter impurities out of ground water, and help protect shorelines from erosion.

And beyond all these useful things plants do, they're just cool! Plants have many unique strategies that help them survive in all different kinds of environments. They trap and trick insects, grow in the ground or up in the rainforest canopy, and manage to survive everywhere from the glacial arctic to the hot, dry deserts. They seem so different from people, and yet when you really look at how plants grow and function, you'll be surprised at how similar they are to you. This chapter offers an overview of the science of botany, giving you a peek into the mysteries of plants.

Taking a Close Look at Plant Structure

You might not think so, but plants are a lot like you. Their bodies are made of cells (see Chapter 2) that are organized into tissues (see Chapter 3) that form the familiar plant organs of roots, stems, and leaves (see Chapter 4). Plant cells use the same basic chemistry as your cells, storing information in DNA, using carbohydrates for energy, and putting proteins to work. And your cells and plant cells are both *eukaryotic cells,* meaning they have a similar structure that includes a nucleus and cellular organelles.

Organizing plants into roots, stems, and leaves

Plants reach out to the sun with their leaves, absorbing light energy so that they can make sugar through the process of photosynthesis. Most leaves are flat because that's the best shape for spreading out and catching lots of sun. But plants can also make leaves in different shapes for different purposes, such as tendrils for hanging on and climbing, spines for protecting the plant against grazing animals, or thick, fleshy leaves for storing water.

Plant stems support the leaves, holding them in different arrangements so that they don't shade each other and can absorb the most light. New plant growth occurs at stem tips as cells divide to make stems grow longer and to build new leaves, branches, and sometimes flowers. Some plant stems, such as those in cacti, are green so that they can do photosynthesis. Other types of stems, such as the runners of a strawberry plant, grow along the ground, sending up new plants at intervals along the horizontal stem.

Plant roots are in charge of getting water for the leaves and stems by absorbing water from the soil. Along with the water, plant roots absorb minerals that provide them with the nitrogen, phosphorous, and other elements they need to function. Some plants, such as dandelion, have long tap roots that reach down deep into the soil, while others, such as grass, have many small fibrous roots. Plants like corn may make extra roots, called *prop roots,* that start from the stem above ground and then grow down to sink into the earth.

Finding ways to procreate

Plants have many ways of reproducing themselves. When plants reproduce sexually, they make special reproductive cells called *spores* (see Chapter 5). Many familiar plants make a structure that's even better at starting the next generation — the *seed.* Seeds protect the plant embryos they carry and nourish them with stored food.

Some plants that do sexual reproduction get fancy and produce showy flowers (see Chapter 5) designed to attract animals to help spread their pollen around. Other flowering plants just dangle their flowers in the wind and let the wind do the work.

Flowers contain the male and female parts of the plant that will participate in sexual reproduction.

Pollen comes from the male part of flowers, carrying and protecting the plant sperm. The female parts of flowers house the ovules that contain the eggs. *Pollination* occurs when pollen arrives at the female part of the flower. The pollen releases the sperm so that they can fuse with the egg, causing *fertilization,* and starting the next plant generation. After fertilization in flowering plants, the ovaries within the flowers develop into fruits (see Chapter 5). Some fruits are sweet and fleshy, inviting animals to come eat the fruit and then disperse the seeds. Other fruits are dry and designed to either float on the breeze, hitch a ride on some animal fur, or even explode to release their seeds. Whatever the method, the goal is the same — to find a nice, new home for the embryos inside the seed to grow.

Figuring Out Plant Functions

In addition to being made of cells and having similar chemistry, plants use many of the same strategies that you do to solve life's challenges. Both you and plants need a source of building material, called *matter,* to build the cells of your body, and you both need a source of *energy* so that you can build things and move around (see Chapter 6). And just like you, plants need to transport food and fluids around their bodies. Finally, you and plants both grow and develop, responding to changes in your environment.

Making and using food

The go-to source of matter and energy for all living things is food. Of course, one big difference between you and a plant is that you have to get your food by eating another organism, while plants can make their own.

Plants make their own food through the process of *photosynthesis* (see Chapter 7). Although the process of photosynthesis is pretty complex, you can get the main idea if you think of it like a recipe. The ingredients are carbon dioxide from the atmosphere and water taken up from the soil. You then follow these directions:

1. **Use light energy from the sun to combine carbon dioxide and water, rearranging the atoms to form sugar and oxygen.**
2. **Serve sugar to all parts of the plant that need matter and energy and throw the oxygen gas away.**
3. **If you have leftovers, you can combine the sugars into starch to store some for later.**

When plants want to use some of the sugar they've made to provide themselves with matter and energy, their cells do the same thing that your cells do with food, they break it down in a process called *cellular respiration* (see Chapter 7). Cellular respiration is a series of chemical reactions that basically unpack food molecules, making the matter and energy available to cells. When cells use cellular respiration to extract all the energy they can from food molecules, they release the waste matter as carbon dioxide and water.

Transporting materials

All the cells of a plant need food to provide them with matter and energy. Plants usually make sugars in their leaves, so they have to ship those sugars from the leaves to the rest of the plant. Likewise, plants take in water through their roots, but they need to get water to the entire plant, especially to the leaves where it's needed for photosynthesis. So, just like you have veins and arteries to transport blood around your body, plants have vascular tissue that specializes in the transport of sugar and water (see Chapter 9).

Plants transport dissolved sugars using a special type of tissue called *phloem,* and they transport water and dissolved minerals using a tissue called *xylem.*

Phloem transports sugar from the leaves where it's made through photosynthesis, to all parts of the plant that need it for growth or that will store it as starch for later. Xylem transports water from the roots up through the plant to supply all the cells with the water they need.

Responding to hormones

Yet another similarity between you and plants is that they use *hormones* to direct their growth and development (see Chapter 10).

Although plants never go through puberty (lucky plants!), they do undergo major developmental changes such as when a seed switches from being dormant to beginning to grow, or when a flowering plant decides it's the right time of year to start putting on a floral display. Plant hormones also direct responses like helping plants shoots grow toward the light and causing plant roots to grow downward toward the pull of gravity.

Considering Plant Reproduction and Genetics

Plants grow like, well, like weeds. That's because weeds are plants. (Okay, now I'm just being silly.) But seriously, plants grow when groups of cells at their tips, called *apical meristems,* divide in two to produce new cells. The process of cell division that adds new growth is called *mitosis* (see Chapter 11). Plants do mitosis pretty much the same way your cells do. Woody plants also do mitosis to grow wider, adding girth to tree trunks.

Plants also reproduce sexually, combining sperm and egg to make the next generation of plants. The sperm and egg, which are produced by a type of cell division called *meiosis* (see Chapter 11), carry copies of the DNA from the parent plant, passing their traits onto their offspring.

By following the inheritance of traits from one generation to the next through the science of *genetics* (see Chapter 12), scientists can figure out how plant genes interact with each other to determine the traits of a plant.

Exploring the Wide World of Plants

Planet earth is filled with a glorious diversity of plants. Plants can be as tall as the mighty redwood tree, or as small as the tip of a pin. They can grow so rapidly that they go from seed to seed in a month, or they can live for over a thousand years. Since plants moved onto the land over 400 million years ago, they've evolved to live in every type of environment (see Chapter 13): Today, plants grow in the deserts, in the rainforests, in the ocean, and up on the mountain. Some plants make flowers, while others make cones. Plants may trap insects as a source of minerals or lure them in to help with pollination. With all these different strategies and environments, you can probably imagine that some pretty amazing plants are out there, from delicate mosses (see Chapter 15), to sturdy pine trees (see Chapter 16) and colorful flowers (see Chapter 17).

Botanists study all the different kinds of plants to understand how each one gets what it needs to survive and reproduce. They also compare the structures and DNA code of plants to figure out the relationships between plant groups and reconstruct how plants evolved (see Chapter 14).

Making Connections Between Plants and People

The lives of people are completely interwoven with the lives of plants:

- **Plants support the ecosystems of which people are a part.** Without plants to supply food to the web of life, what would you eat? (For more on this topic, see Chapter 18.)
- **People can modify plants to make them more nutritious or so they produce medicines.** Genetically modified foods are very controversial, but they have benefits as well as risks (see Chapter 19).
- **People grow plants for food.** The origins of human agriculture stretch back 10,000 years. And the switch from hunting and gathering to farming changed the entire structure of human societies (see Chapter 20).
- **People use plants to make clothing.** Cotton and flax plants are used to make cotton and linen clothing. Some of the dyes people use to give their clothing color also come from plants. (see Chapter 20).
- **People get medicines from plants.** Digitalin for heart disease, aspirin to reduce fever, and artemisinin for malaria are just a few examples of the powerful drugs people have extracted from plants(see Chapter 20).
- **People use plants for building materials.** People use wood for houses, furniture, and tools, or straw as material for roofs or bricks.
- **People reduce their stress and improve their fitness by taking a walk and admiring the plants.** Seriously, reducing stress is important. Stress has major impacts on people's health. And for many people, nature has a soothing effect.
- **Plants help keep water clean.** You probably hear people talking about wetlands, how they're important, and how they're disappearing at a rapid rate, thanks to development. Wetlands are communities with certain types of plants and soils. As the rain falls across areas where humans live, it picks up lawn fertilizers, motor oil from cars, poop from pets, and more. If this runoff flows through a wetland before it enters our streams and lakes, the plants and bacteria in the wetlands will remove lots of the dangerous substances on the way. Having wetlands to slow the flow of water also helps prevent flooding.

However you look at it, from the similarities of plants to other organisms, their beauty, or their usefulness to humans, you can certainly find lots of good reasons to know a little bit more about plants.