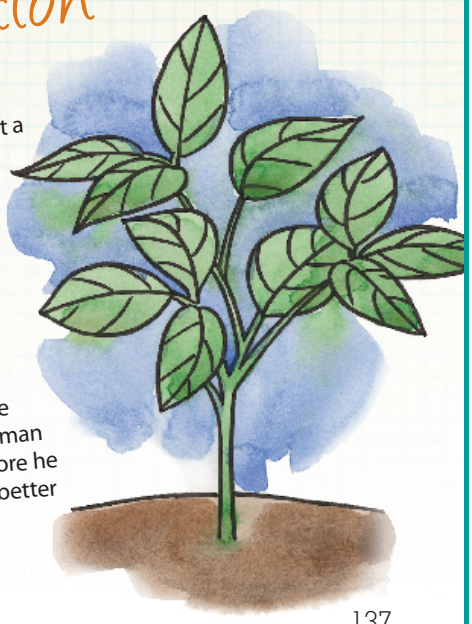
6

Plant Classification

In the frozen tundra grows an unusual "plant." Reindeer moss is an important source of food for caribou, moose, and reindeer. But actually, it is not a moss at all. In fact, it is not even a plant. Reindeer moss is a lichen. Lichens are combinations of two organisms, algae and fungi. The algae provide food through photosynthesis, and the fungi provide water and protection. The organisms live together in a symbiotic relationship—each benefits from the other. Lichens are important not only for animals, but also for breaking down rocks to help produce soil. Today reindeer moss is often more correctly called reindeer lichen. The more that man studies the organisms that God created the more he learns about how the world works. Then he is better able to obey God in all areas of life.



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Chapter preview
Other preview and prereading activities may include using a K-W-L chart, a probe, or an anticipation guide.

Chapter photo
The photo at the top of the page shows different plants growing at the base of a tree.

Student Text diagrams
Diagrams from the Student Text are included on the Teacher's Toolkit CD.

Objectives
- Recognize that man's knowledge must continually be re-evaluated
- Preview the chapter content

Introduction

Man tries to organize and name living things to the best of his knowledge and abilities. But sometimes his knowledge is incomplete. As God allows him to learn more, man may need to change or reorganize living things that have already been classified. [Bible Promise: I. God as Master]

The lichen is one example of an organism that was reclassified because man developed better methods to study it.

Teach for Understanding

Provide time for the student to complete Looking Ahead, Activity Manual page 89. For part B, encourage the student to think of things he would like to learn about gymnosperms and products made from plants. He should write his answers in question form, such as, "What kind of plants are gymnosperms?"

Provide the answers for part A and allow the student to check his work. After the chapter is finished, you may choose to have him look back at this page and check his understanding of the items he missed.

As time allows, discuss student questions from part B about gymnosperms and plant products. You may choose to provide trade books or other resources to help answer questions that are beyond the scope of this chapter.

Allow the student to leaf through the chapter, looking at the headings, pictures, captions, charts, etc., and discuss the things he thinks he will be learning about.

Activity Manual

Preview, page 89

The Looking Ahead page is intended to assess the student's prior knowledge before beginning the chapter.

Lesson 73

Student Text pages 138–41
Activity Manual pages 90–91

Objectives

- Describe differences between vascular plants and nonvascular plants
- Classify vascular plants as seed-bearing plants or seedless plants
- Identify kinds of seedless vascular plants
- Identify the parts of a fern
- Differentiate between facts and opinions

Materials

- pictures of common plants that students would easily recognize: trees, mosses, ferns, flowering plants, grass, and shrubs or bushes

Vocabulary

vascular plant
nonvascular plant
rhizoid
rhizome
frond
fiddlehead

Introduction

Display the pictures of common plants.

What do these pictures have in common? Each picture shows plants.

How would you identify each picture? Answers will vary.

Today we will learn how scientists classify plants.

Teach for Understanding

Purpose for reading

How do scientists classify plants?

How does a vascular system benefit a plant?

Discussion

Refer to the classification diagram in the text as each new plant group is discussed.

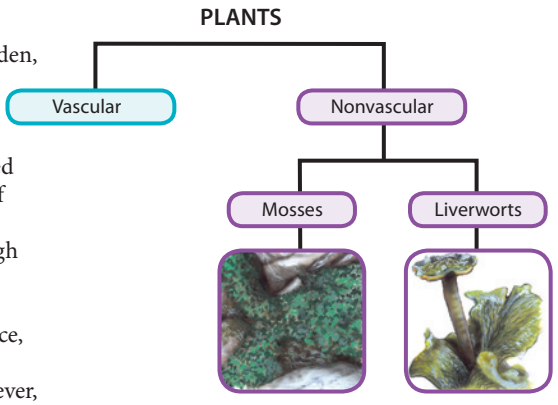
What are some common characteristics of most plants? Possible answers: roots, stems, leaves, ability to make their own food

Plants show God's love of beauty. God could have made all plants exactly the same, but He chose to make them fulfill their purpose through variety and beauty.

What are some ways that scientists classify plants? Possible answers: how they reproduce, growing habits, seed structure, height

What do you think of when you think of plants? You might think of flowers in a yard, vegetables in a garden, or a forest of tall trees. The Bible tells us in Genesis 1:11–13 that God created plants on day three of Creation. The plants that God created come in all shapes and sizes. Most of them have roots, stems, and leaves and can make their own food through photosynthesis.

Plants can be classified in many different ways—by how they reproduce, their growing habits, their seed structures, or even their height. However, when scientists separate plants into two big categories, they usually classify them by how each plant transports water. Most plants have tubelike structures that transport water from the roots to the stems and leaves. These plants are called **vascular** (VAS kyuh lur) **plants**. Plants that do not have these structures are called **nonvascular plants**.



Nonvascular Plants

All plants need water to survive. Most conduct this water up from their roots and throughout the plant using their vascular tissue. Giant trees push water many meters upwards against the force of gravity. Because nonvascular plants lack roots and tissues for conducting water, they must absorb water and nutrients through their leaves. As a result, most do not grow very big or tall.

Mosses

Scientists have identified more than ten thousand species of moss. Moss is a nonvascular plant found in most places around the world. Most species of moss are only a few millimeters tall, but some tropical mosses can be as tall as 70 cm (27½ in.). Moss plants usually grow in groups and spread out over large areas. They can grow on rocks, in soil, and sometimes even on other plants, such as tree trunks.

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SCIENCE BACKGROUND

Mosses
Three major categories of mosses include peat mosses, granite mosses, and true mosses. Peat mosses, especially sphagnum, often grow in bogs. The acidity in bog water prevents plants from decaying, so dead moss compresses into layers, forming peat. Some people use peat as a fuel for heating and cooking, as well as for medicine. Peat is also used in gardening.

Hornworts
Hornworts, another nonvascular plant, are similar to liverworts, but they are seldom found on rocks and tree trunks. They usually live in damp soil among grasses. Hornworts produce spores inside horn-shaped stalks.

Reproduction
All of the plants mentioned in this lesson reproduce by spores. Unlike seeds, spores have no stored food available for the new plant. Spores are discussed in Chapter 12, *Reproduction*. Many of these seedless plants can also reproduce asexually by sending out rhizomes or stolons to spread and form new plants.

SCIENCE MISCONCEPTIONS

Common moss misnomers
Not everything named "moss" is a moss. Spanish moss, a member of the pineapple family, is a flowering plant. Reindeer moss is actually a lichen, and club mosses are vascular plants.

Mosses do not have true roots. Instead, they have thin, rootlike structures called **rhizoids** (RY zoydz). Mosses also have tiny leaves that grow from stemlike structures. These leaves are usually only one cell thick.

Even though they are small, mosses are very beneficial. They are often one of the first plants to grow in areas destroyed by volcanoes or fires. They also help prevent erosion by holding dirt in place. Some mosses, such as peat mosses, have been used for heating, cooking, and medicines.

leafy liverwort

Moss Plant

Liverworts

Liverworts can look similar to mosses, but their leaves are arranged differently. More than eight thousand species of liverworts have been identified. Liverworts got their name because people thought that their leaves resembled the shape of a liver.

Like mosses, liverworts have rhizoids. They usually grow in moist places, especially on rocks near streams and waterfalls. Leafy liverworts are often mistaken for mosses. Their leaves are on stemlike structures similar to those of mosses. Other liverworts, though, do not have a stem structure. Their leaves are usually flat, like plates.

LANGUAGE

Liverwort

The name *liverwort* comes from an old English name meaning "liver plant" (*lifer* = "liver" and *wyrt* = "plant"). People used to think that the shape of a plant indicated its medicinal value, so they believed that liverworts could help liver problems. The modern scientific name for a liverwort is *Hepaticae*, which is Latin for *liver*.

Discussion

How do scientists separate plants into two main categories? by how each plant transports water

What is the difference between vascular plants and nonvascular plants? Vascular plants have tubelike structures that can carry water to all parts of the plant. Nonvascular plants do not have these structures.

What do all plants need to survive? water

Why are nonvascular plants usually small? Since they do not have roots and tissues for conducting water, the leaves absorb water and nutrients.

Where have you seen mosses grow? Answers will vary but may include along the rocks of a stream or on live and dead trees.

Why might tropical mosses be able to grow so much larger than mosses in other parts of the world? Tropical areas, such as rain forests, often receive more moisture. The high humidity allows mosses to get water even when the leaves are off the ground.

What are rhizoids? thin, rootlike structures of nonvascular plants

How thick are most tiny moss leaves? one cell thick

What are some benefits of mosses? Possible answers: They are the first plants to grow in areas burnt by volcano eruptions or fires. They help prevent erosion. They are used in cooking, heating, and medicines.

How are mosses related to weathering and erosion? They help prevent erosion, but they also secrete acids that help break down rocks into soil.

How did liverworts get their name? People thought their leaves resembled the shape of a liver.

Where do liverworts grow? in moist places, especially near streams and waterfalls

Which type of liverworts are often mistaken for mosses? leafy liverworts

How are leafy liverworts similar to mosses? Their leaves are on stemlike structures, similar to the leaves of mosses. Liverworts and mosses both have rhizoids.

Although leafy liverworts have a stem and leaf structure similar to that of mosses, what other leaf shape can liverworts have? flat, like plates

Discussion

Why can vascular plants grow larger than nonvascular plants? The vascular system transports water and food and helps to strengthen and support the plant.

How are ferns, horsetails, and club mosses different from other vascular plants? They do not have seeds.

Horsetails, club mosses, and ferns all grow from rhizomes. How are rhizomes different from rhizoids? A rhizome is an underground stem. Rhizoids are the rootlike structures of nonvascular plants.

What kind of stems do horsetails have? tall, hollow, jointed stems

What is unusual about the leaves of a horsetail? Possible answers: They are often colorless. They look like scales. They clasp the stem close to each joint.

Why do you think horsetails produce food in their stems and branches instead of in their leaves? Answers will vary, but elicit that their brown or colorless leaves do not contain chlorophyll, so they cannot make food in their leaves.

Where are horsetails usually found? Possible answers: riverbanks, marshes, ditches, and meadows

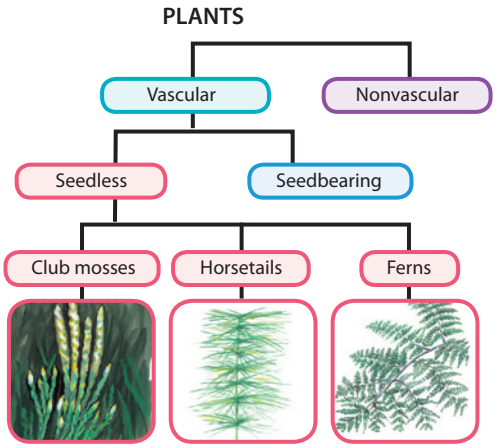
Discuss *Science & History*.

Why did people in colonial times call horsetails "scouring rushes"? They used horsetails to scour and scrub their pots.

What other names did horsetails have? pewterworts, shavegrass

Vascular Plants

Plants with vascular systems are able to grow larger than mosses and liverworts. This is because the vascular system strengthens and supports the plant and also transports water and food to all parts of the plant.



Seedless Vascular Plants

Horsetails

Most vascular plants have seeds. However, horsetails, club mosses, and ferns are three types of vascular plants that do not have any seeds. Horsetails grow from underground stems called **rhizomes** (RYE zohmz). These plants are mostly tall, hollow, jointed stems. Some horsetails have needlelike branches that grow in a circle around each joint, but other horsetails do not have any branches. The leaves are very small and are often brown or colorless.

They look like tiny scales that clasp the stem close to each joint. Horsetails usually produce their food in the stems and branches instead of in the leaves. Even though only about thirty species of horsetails exist, they can be found in many different locations. Horsetails thrive in moist places such as riverbanks, marshes, ditches, and meadows.

SCIENCE & HISTORY

Horsetails have many different names and many different uses. In Colonial times, horsetails were often called scouring rushes. Early Americans used the horsetails to scour and scrub their pots. They were also called pewterworts, since they could be used to polish metal and pewter. Another name was shavegrass because they could even be used to sand wood.

SCIENCE BACKGROUND

Spike mosses and quillworts

Two other types of plants closely related to club mosses are spike mosses and quillworts. A well-known spike moss is the resurrection plant. This plant curls up when dry and unfurls when moistened. It can survive several years in dry conditions. Spike mosses are usually found in the tropics. Quillworts grow in water or in areas where they can be partially underwater for part of the year. Quillworts are sometimes called Merlin's grass.

SCIENCE MISCONCEPTIONS

Fern misnomer

The asparagus fern is not really a fern. It is actually an asparagus, a member of the lily family. This fern is a flowering plant and does not produce spores.


club moss

Club mosses

Although club mosses may look similar to mosses, they really have little in common with them. Club mosses do not usually grow taller than 30 cm (almost 12 in.). They can resemble small evergreen trees and are often called ground pines. Club mosses are frequently found in forests near streams or other moist places. In tropical climates, however, some species of club mosses live on trees.

Ferns

Scientists have identified at least twelve thousand species of ferns. Some ferns, such as rock ferns, can tolerate heat and drought. But most ferns need moisture. Ferns are often found by streams and waterfalls or in wooded areas and pastures.

Like horsetails, ferns grow from rhizomes. Rhizomes can grow to be quite long, and many **fronds**, the leafy branches of a fern, can grow from just one rhizome. Tree ferns found in the tropics sometimes have fronds that are almost 4 m (13 ft) long. However, other ferns are small, having fronds that are only about 1.5 cm (0.6 in.) long.

When a fern is just beginning to grow, its fronds are coiled up tightly. The coiled-up frond is called a **fiddlehead** because it resembles the top of a violin. Some fiddleheads, such as those from an ostrich fern, are edible and are sometimes used in salads or vegetable dishes. Others, though, are quite poisonous.

One of the most common ferns is the bracken fern. The fronds of this fern may grow to be as long as 2 m (6½ ft). They are shaped like triangles, and each frond has three leaflets. Bracken ferns are often found in wooded areas, especially near oak, pine, and maple trees.

QUICK CHECK

1. What are the two main classifications of plants?
2. Name three ways that vascular systems benefit plants.
3. How are rhizomes different from rhizoids?


bracken fern

DIRECT A DEMONSTRATION

Look at the parts of a fern

Materials: a fern

Point out the fronds and any fiddleheads that may be growing. If possible, show the underground rhizomes.

HISTORY

Uses for club mosses

Spores from club mosses have been used in fireworks, dusting powder, and flash powder used in early photography.

Discussion

Why are club mosses often called ground pines? because they resemble small evergreen trees

Where are club mosses typically found? near streams or other moist places

What is the highest height that club mosses may reach? 30 cm

Where can ferns usually be found? Possible answers: in moist places, wooded areas, or pastures

Which part of a fern is the frond? the leafy branch

Where are tree ferns usually found? in tropical areas

Why do you think the fronds of tree ferns are so much longer than the fronds of other ferns? because tropical areas usually receive more water

What is a fiddlehead? a tightly-coiled, developing frond

Why is it called a fiddlehead? because it resembles the top of a violin

Why are fiddleheads sometimes dangerous? Although some fiddleheads can be eaten, others are poisonous.

Which fern is sometimes used in salads or vegetable dishes? ostrich fern

What is one of the most common ferns? bracken fern

How large are bracken ferns? sometimes as long as 2 m (6½ ft)

Where are bracken ferns often found? in wooded areas

Answers

1. vascular and nonvascular
2. They strengthen and support the plant, transport water and food to all parts of the plant, and enable the plant to grow larger.
3. Rhizomes are underground stems from which seedless vascular plants grow. Rhizoids are the thin, rootlike structures of nonvascular plants.

Activity Manual

Reinforcement, page 90

Expansion, page 91

This page provides practice in discerning facts and opinions.

Lesson 74

Student Text pages 142–45
Activity Manual pages 92–93

Objectives
- Classify seed-producing plants as gymnosperms or angiosperms
- Identify four kinds of gymnosperms
- Identify two kinds of conifers
- Describe ways that man uses conifers

Materials
- box of tea containing gingko
- picture of the Statue of Liberty that includes the base

Vocabulary
angiosperm gymnosperm

Introduction
How many of you have at least one pet at your house?

We can divide the class into two groups: pet owners and non-pet-owners.

How can we divide the pet owner group into categories? Possible answer: Separate by types of pets.

Name the two main categories of plants we studied in the previous lesson. vascular and nonvascular

Just as we can separate the group of pet owners into smaller categories, scientists can separate vascular plants with seeds into smaller categories.

Teach for Understanding
Purpose for reading
What are some differences between gymnosperms and angiosperms?

Which is the largest group of gymnosperms?

What are some kinds of conifers?

Discussion
What two things do seeds contain? the embryo of a new plant and food reserves

How do scientists further classify seed-producing vascular plants? by how the seeds are produced


cycad

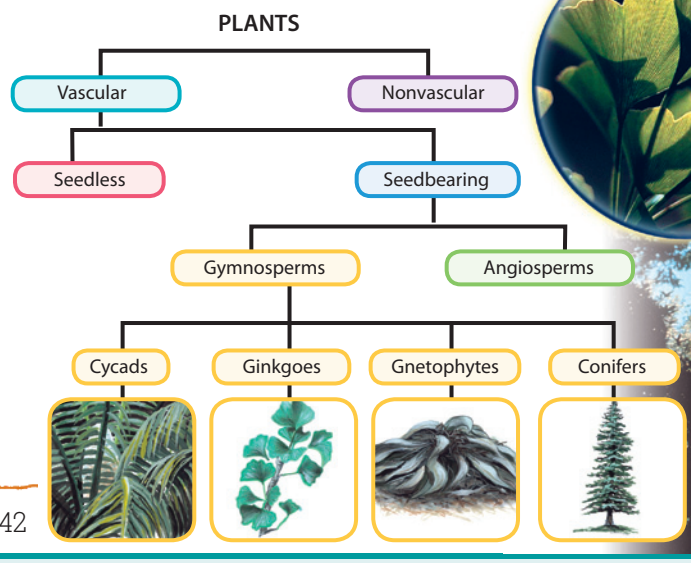
Seed-Bearing Vascular Plants
Seeds can be smaller than a flake of oatmeal or bigger than a hand. However, no matter the size, each seed contains the embryo of a new plant and has food reserves stored for that plant. Vascular plants can be classified by how those seeds are produced.

Angiosperms (AN jee uh SPURMZ) are vascular plants that have flowers, and their seeds are protected inside a fruit. **Gymnosperms** (JIM nuh SPURMZ) do not have flowers, and their seeds are usually produced inside cones. The seed coat provides the only protection for these seeds.

Gymnosperms
Scientists divide gymnosperms into four smaller groups: cycads (SY kadz), ginkgoes (GING kohz), gnetophytes (NEE tuh FYTES), and conifers (KON uh furz). Cycads often are mistaken for palm trees because they look like tree ferns or palms. However, they produce pollen in a cone that can grow to be quite large. The trunk of a cycad can be above the ground or below the ground. Cycads are often used in landscaping as ornamental plants.

The ginkgo tree has flat, fan-shaped


ginkgo tree



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SCIENCE BACKGROUND

Gymnosperms
These seeds usually develop in cones, but they are sometimes protected by fleshy seed coats. Even though yews and junipers have seeds that look like berries, the "berry" is actually the seed coat.

Grouping
The families of conifers include the pines (in both the northern and southern hemispheres), yellowwoods, yews, plum yews, junipers, and cypresses, as well as redwoods and sequoias. Spruces, firs, larches, cedars, and pines are some members of the pine family.

MATH **Measuring**
Allow the student to measure some of the sizes discussed in Fantastic Facts.

SCIENCE MISCONCEPTIONS

Gymnosperms
Make sure that students realize that conifers are not the only gymnosperms. Conifers are the most numerous and well-known gymnosperms.

BIBLE **Productivity**
The Bible uses a tree as an illustration in Psalm 1. There the Psalmist says that someone who meditates all the time in the Scriptures will be like a tree planted by a river. Just like a tree needs water to be strong and produce fruit, Christians need God's Word to be strong and produce fruit. [BATs: 7b Exaltation of Christ]

gnetophyte

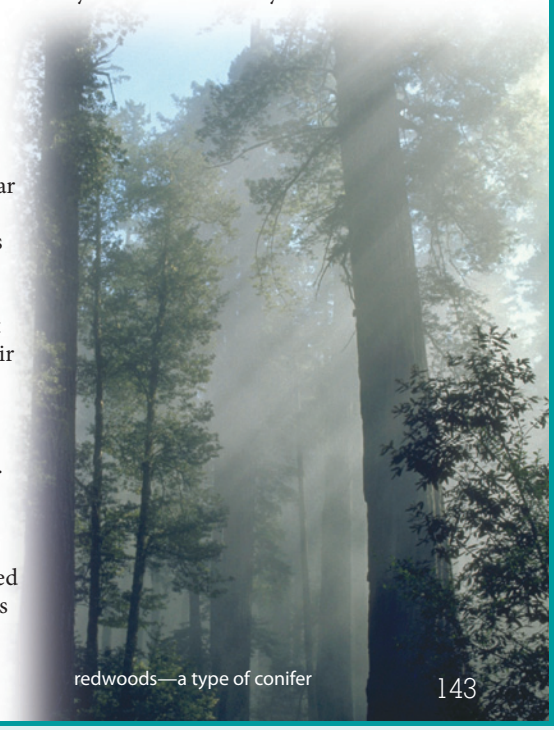
FANTASTIC FACTS

The tallest conifer is a redwood tree in California. It was measured in 2007 and was found to be a little over 116 m (379 ft) tall—about 23 m (75 ft) taller than the Statue of Liberty. The largest conifer is a sequoia named General Sherman. Its largest branch is a little more than 2 m (7 ft) in diameter. It is 11 m (36 ft) wide at its base and has bark that is almost 1 m (3 ft) thick.

leaves that turn yellow in autumn before they fall to the ground. Ginkgoes are often planted in cities because they can tolerate air pollution. They also are very resistant to pests and diseases. Their dried leaves have been used in herbal medicines and teas for many years.

Gnetophytes are usually found in hot, dry deserts or in tropical rain forests. They can be trees, shrubs, or vines. The cones of some gnetophytes can resemble flowers, and their vascular systems are somewhat similar to those of angiosperms. However, gnetophytes are gymnosperms.

The majority of gymnosperms are *conifers*. Most conifers are tall, straight trees, but some are woody shrubs. Their leaves are often needlelike or scalelike. Almost all conifers are evergreen and are able to make food year-round through the process of photosynthesis. This food making allows conifers to live in colder climates than deciduous (dih SIJ oo us) trees, which lose their leaves during winter. The needle-shaped leaves also shed snow well, which helps keep branches from breaking. The smaller surface area of the leaves also helps the trees lose less water, making them better able to resist droughts and dry conditions in many climates.



redwoods—a type of conifer

DIRECT A DEMONSTRATION

Demonstrate how conifer leaves retain moisture

Materials: two paper towels, water

Direct the student to wet each paper towel with an equal amount of water. The student should lay one paper towel flat to dry and roll the other into a tight tube. Let the paper towels sit for several hours. To get quicker results, set them in front of a fan.

Which paper towel dried first? the flat one

How does this show why conifer leaves retain moisture better than flat leaves? Answers will vary, but elicit that leaves with a greater surface area dry faster. Conifer leaves have less surface area, so they retain water better.

Some girls may have also experienced this principle if they have ever braided wet hair. Wet hair that is braided takes longer to dry than wet hair left loose.

GEOGRAPHY

Ginkgo plantation

The world's largest plantation of ginkgo trees is located in Sumter, South Carolina. The trees are kept shrub-sized, and the leaves are gathered and shipped to Europe. There the dried leaves are used to produce ginkgo extracts.

Find Sumter, South Carolina, and Europe on a map. Encourage the student to research the uses of ginkgo leaves and the places in Europe that process them.

Discussion

What are two main differences between angiosperms and gymnosperms? Angiosperms have flowers, and their seeds are protected by a fruit. Gymnosperms do not have flowers. Their seeds usually develop in cones and do not have any protective covering other than a seed coat.

How many groups are gymnosperms divided into? four

What are these groups? cycads, ginkgoes, gnetophytes, and conifers

Which type of plants are cycads often mistaken for? palm trees

Why are ginkgoes often planted in cities? because they can tolerate air pollution

What other uses do gingkoes have? Their crushed leaves are sometimes used for herbal medicines and teas.

Display the tea that contains ginkgo.

Which of the gymnosperm groups are you least likely to see on a daily basis? gnetophytes **Why?** They are usually found only in deserts or rain forests.

Why do you think conifers are probably the most well-known tree group? because there are more conifers than other gymnosperms

Why can conifers survive in the cold better than deciduous trees can? Possible answers: They can produce food year round. Their needles shed snow more easily.

What are deciduous trees? trees that lose their leaves during winter

Why would being able to shed snow well be more important to evergreen trees than deciduous trees? Possible answers: Evergreen trees live in colder climates where there is more snow. During the winter, deciduous trees do not have leaves to hold snow, but the weight of snow on evergreens might cause branches to break.

How does the shape of a conifer's leaves help the conifer to resist droughts? Needle-shaped leaves lose less water, so they keep more water available for the tree.

Discuss *Fantastic Facts*.

What kind of tree is the tallest conifer? redwood

Display the picture of the Statue of Liberty and compare its size to other features in the picture, such as people.

Which is taller, the tallest redwood or the Statue of Liberty? the tallest redwood

What is the name of the largest conifer? General Sherman

Discussion

What is the easiest way to identify a conifer? looking at its leaves

Why is it difficult to determine a standard color or length for a conifer's needles and cones? Climate and growing conditions affect the growth and development of needles and cones. Growth and development can vary from tree to tree even within the same species.

Which conifers are probably the most familiar? pine trees

What is one way to identify different kinds of pine trees? by the number of needles that are bound together

In what ways do people use pine trees? Possible answers: lumber, cabinets, fence posts, telephone poles, paper

How is resin beneficial to conifers? It seals off wounds on the tree and protects the tree from diseases and insects while it heals.

Compare what happens when a pine tree is injured with the healing process when your skin is cut. Possible answers: The resin seals and protects the tree's wound in a way similar to how a scab forms a seal and protects you from infection.

What are some uses for resin? Possible answers: tar, turpentine, inks, paints, adhesives, rosin

What is amber? hardened resin

Discuss the different kinds of pines pictured at the top of the page.

Which two conifers are often mistaken for one another? firs and spruces

How are the needles of firs and spruces different from the needles of other conifers? Each fir and spruce needle is directly attached to the branch.

How are spruce needles different from fir needles? Spruce needles are attached to the branches on little woody pegs. They are also stiff, prickly, and four sided. Fir needles are flat and flexible.

The easiest way to identify a conifer is to look at its leaves. Depending on the climate and growing conditions, the color, length, and texture of the needles and cones may vary from tree to tree. However, each family of conifers has certain characteristics that are unique to its group.

Pine trees

Pine trees are probably the most well-known conifers. They have woody cones that are often egg shaped and needles that are bound in bundles. Lodgepole pines have needles bound in groups of two, while ponderosa pines have needles in bundles of three. White pines and sugar pines have needles in bunches of five. People use the wood of pine trees for many different things, including lumber, cabinets, fence posts, telephone poles, and paper.

When a pine tree is cut or its branches are broken, sticky resin (REZ in) seeps out to clog up the wound. This protects the tree from diseases and insects while it heals. Resin from pine trees and other conifers can be used in a large variety of products, such as tar, turpentine, inks, and paints. Resin is also used for adhesives, such as the sticky part of a bandage. Musicians use a form of resin called rosin (RAHZ in) on the bows of stringed instruments such as violins and cellos. Sometimes insects are fossilized within hardened resin called amber.

Firs and spruces

Firs and spruces are often mistaken for each other. Unlike those of other conifers, each of their needles is attached directly to a branch. Fir needles are flat and flexible. Spruce needles, however, are stiff and prickly and are attached to the branches by little woody pegs. Most spruce needles are four sided.

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SCIENCE BACKGROUND

Douglas fir

Sometimes common names are confusing. The Douglas fir is not really a fir. It was named by Scottish botanist David Douglas and is similar to both the fir and the spruce. In 1867 it was separated from the firs and spruces and placed into a different group.

The cones of a Douglas fir hang down and have three-pointed bracts. Its needles are soft and flat with round tips. Douglas firs have been used for railroad ties, shipbuilding, flooring, boxes, and ladders. The Douglas fir is also the state tree of Oregon.

SCIENCE & THE BIBLE

When King Solomon built the temple and his palace, he used cedars and firs from Lebanon. Hiram, king of Tyre, provided as many firs and cedars as Solomon needed (1 Kings 5). The cedar of Lebanon has a deep-red-colored wood that has a pleasant aroma and was considered to be a valuable building material. This tree can grow to be over 30 m (100 ft) tall.


cedar of Lebanon

Another way to distinguish between firs and spruces is to look at their cones. Fir cones stand upright on the branches and are sometimes violet colored when young. In autumn the cone scales fall off as the seeds are dispersed. The small stem of the cone stays attached to the branch. Spruce cones hang down from the branches and can stay on the tree for several years. Therefore, a spruce tree can have both old and new cones on the tree at the same time.

Wood from firs is used for pencils and plywood, as well as in construction and landscaping. Spruce wood is used in canoe paddles, furniture, paper, and musical instruments.


silver fir

QUICK CHECK

1. What are the four groups of gymnosperms?
2. Which group is the largest?
3. What is the easiest way to identify a conifer?

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SCIENCE BACKGROUND

Cedar as a building material

Cedar is a good material to work with because it weighs much less than oak or cypress. It is very straight and does not easily rot like other woods.

Discussion

How can the cones on a tree identify whether the tree is a fir or a spruce? Fir cones stand upright on the tree. Spruce cones hang down and can stay on the tree for several years.

How can spruce trees have old and new cones on the tree at the same time? because their cones can stay on the tree for several years while the seeds develop

Discuss the photos of the spruce and silver fir. Compare the needles.

What are some ways that fir trees are used? Possible answers: pencils, plywood, construction, and landscaping

What are some ways that spruce trees are used? Possible answers: canoe paddles, furniture, paper, and musical instruments

What are some other common uses for firs, spruces, pine trees, and other conifers? Possible answers: Christmas trees and decorations

Discuss *Science & the Bible*.

Which conifers did Solomon use extensively in the building of the temple? the firs and cedars of Lebanon

Who provided the firs and cedars? Hiram, King of Tyre

Why do you think cedar would have been an appropriate wood for Solomon's temple? Answers will vary, but elicit that cedar is both beautiful and aromatic. The temple was built to exalt God, therefore requiring the best. **[BAT: 7b Exaltation of Christ]**

Answers

1. cycads, ginkgoes, gnetophytes, and conifers
2. conifers
3. by looking at the leaves

Activity Manual

Reinforcement, page 92

Review, page 93

This page reviews Lessons 73–74.

Assessment

Quiz 6-A

The quiz may be given any time after completion of this lesson.

Lesson 75

Student Text pages 146–49
Activity Manual page 94

Objectives

- Identify characteristics and examples of angiosperms
- Compare and contrast annual, biennial, and perennial plants
- Name some ways that angiosperms are used
- Compare monocotyledons and dicotyledons

Vocabulary

annual
biennial
perennial
cotyledon
dicotyledon
monocotyledon

Introduction

Direct the students who own pets to stand. Separate the students into groups according to their pets (dogs, cats, fish, turtles, etc.).

How can we separate the dog owners group into smaller groups? Divide into groups according to the type of dog owned, the age of the dog, the color of the dog, or the number of dogs owned.

Allow the students who own dogs to separate into smaller groups based on chosen characteristics. Make a flow chart for display showing the relationships of the groups.

Today we will be studying how scientists separate flowering plants into groups.

Teach for Understanding

Purpose for reading

How are perennials different from annuals?

How are monocotyledons different from dicotyledons?

Discussion

Which two features identify a plant as an angiosperm? produces flowers and fruit

What are three types of plants in the angiosperm category? Possible answers: trees, shrubs, and plants with green, flexible stems

How are the seeds of angiosperms protected? by an outer covering, or fruit

Are all flowers colorful and noticeable? no **Do all flowers have petals?** no

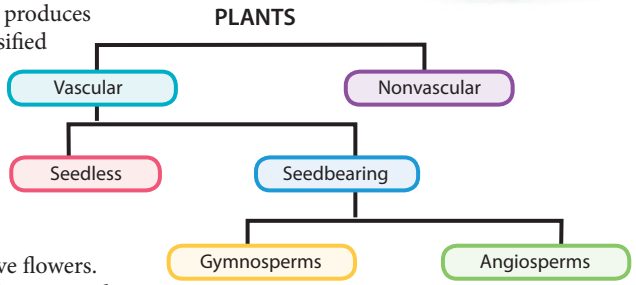
Why are angiosperm trees called broad-leafed trees? to distinguish them from conifers; Broad-leafed trees have leaves that are wide and flat, and conifers have needlelike or scalelike leaves.

What are some aquatic angiosperms? Possible answers: sea grasses, water lilies, cattails, and bulrushes

Can you think of a Bible character who was found hidden among some aquatic angiosperms? Moses. His mother hid him in the bulrushes.

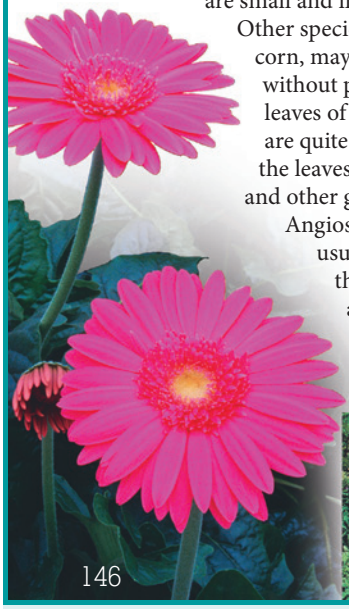
Angiosperms

What do soap, medicines, food, and clothing have in common? Each one of these can be made from some part of an angiosperm. Angiosperms can be as tall as an oak tree or as small as a blade of grass. They include peppers and tomatoes as well as roses and daisies. Any vascular plant that produces flowers and fruit is classified as an angiosperm. Although most angiosperms have flexible, green stems, angiosperms also include many woody shrubs and trees.



All angiosperms have flowers. When pollinated, the flowers produce seeds protected by an outer covering, or fruit. In some species, the flowers are small and inconspicuous. Other species, such as corn, may have flowers without petals. The leaves of angiosperms are quite different from the leaves of conifers and other gymnosperms. Angiosperm trees usually have leaves that are wide and flat. They are often called broad-leafed trees to distinguish them from conifers.

Scientists have identified more than 250,000 species of angiosperms. Though most angiosperms live on land, some are aquatic plants. Aquatic angiosperms are found in both salt water and fresh water. Some of the plants, such as sea grasses, are completely submerged. Others, such as water lilies, float on top of the water. Still others, such as cattails and bulrushes, grow along the edges of bodies of water.



SCIENCE BACKGROUND

Angiosperms
In an angiosperm, the ovary of the flower forms the fruit, or protective covering for the seed. This is discussed further in Chapter 12, *Plant and Animal Reproduction*. Sometimes angiosperms are called anthophytes.

Grouping plants
Plants do not always fit neatly into the categories of annual, biennial, and perennial. Their grouping often depends on where, when, and how they grow. Short-lived perennials, such as hollyhocks, are often mistaken for biennials. Biennials that begin growing indoors can sometimes act as perennials. Also, many biennials are sold as one-year-old plants that are ready to flower.

SCIENCE MISCONCEPTIONS

Flower differences
Make sure that students understand that not all flowers are noticeable or have petals. The parts of a flower are discussed in Chapter 12, *Plant and Animal Reproduction*.

An angiosperm that lives for only one growing season is called an **annual** (AN yoo ul). Annuals grow, flower, produce seeds, and then die all in the same growing season. Marigolds, tomatoes, and sunflowers are some examples of annuals. A **biennial** (by EN ee ul) needs two growing seasons to fully develop. In the first season, the plant produces leaves. It rests during the winter and then flowers, produces seeds, and dies in the second year. Parsley, carrots, cabbage, onions, and foxgloves are biennials.

A **perennial** (puh REN ee ul) can live for three or more years. It grows, flowers, and produces new seeds year after year. Perennials include trees and bushes, such as oak trees and roses. However, plants such as spearmint and carnations are also perennials.

cacao tree and chocolate

We use angiosperms for many things. The most obvious use is for food, but many beverages are also made from angiosperms. Trees in the tropics provide some of the ingredients necessary for coffee, hot chocolate, and cola. Other angiosperms are used in medicines. The purple foxglove is used to make digitalis, a heart medicine. Aspirin, a medicine used to treat fever and inflammation, was once prepared from angiosperms. Even products such as rubber, cork, rope, and chewing gum are made from angiosperms.

foxglove and digitalis pills

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Discussion

Angiosperms are sometimes classified by the length of their growing season. What are those three classifications? annual, biennial, perennial

How are annuals and biennials different? Annuals grow, flower, and die in one growing season. Biennials need two growing seasons to fully develop.

When do carrot flowers form? the second year
Why? because carrots are biennials

What usually prevents us from seeing carrot flowers? Most garden carrots are pulled and eaten before the second year.

Why are flowers necessary? They produce seeds for new plants.

What name is given to plants that grow, flower, and produce seed year after year? perennials

What are some common perennials? Possible answers: trees, roses, spearmint, carnations

What are some ways that angiosperms are used? Possible answers: food, beverages, medicine, rubber, cork, rope, chewing gum

Why should man use plants to produce food and materials? God gave man dominion over the earth, meaning that man is to maximize the usefulness of the earth to the glory of God and for the benefit of mankind. Using plants to produce food benefits mankind.

DIRECT AN ACTIVITY

Classifying by growing season

Materials: seed packets, seed and bulb catalogs

Instruct the student to use seed packets and catalogs to plan a flower garden with twelve different varieties of flowers. One-fourth of the flowers should be annuals, one-fourth biennials, and the other one-half should be perennials.

Why would someone choose a perennial or biennial instead of an annual? Possible answer: Perennials and biennials do not need to be planted each year.

Discussion

Point out the addition of monocots and dicots to the classification diagram. Discuss the chart at the bottom of the page comparing monocots and dicots while reviewing these pages.

How are angiosperms usually classified? by their seed structure

What are cotyledons? the seed leaves that contain stored food for the new plant

How many cotyledons do dicots have? two

How many cotyledons do monocots have? one

How are the tubelike structures arranged in the stem of a dicot? in a ring shape

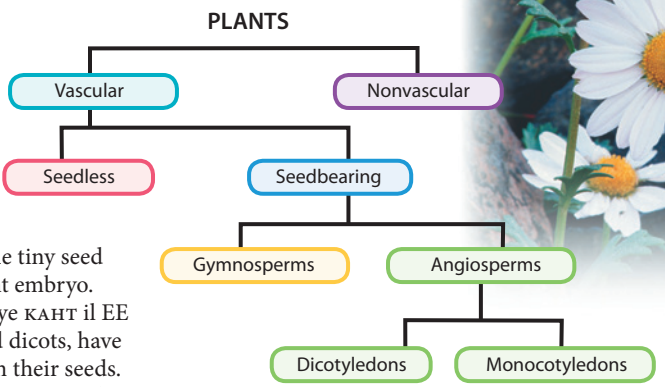
How does the arrangement of the tubelike structures affect the size of a dicot, such as an oak tree? Because the vascular bundles are in a ring shape, the stem (or trunk) of a dicot grows a little thicker each year.

What kind of leaves do dicots have? Dicot leaves are usually broad and have a network of veins.

What kind of roots does a dicot have? one long taproot with secondary roots branching off of it

How can you use an angiosperm's flower to identify the plant as a monocot or dicot? The flowers of dicots have petals in multiples of four or five. Monocots have petals in multiples of three or six.

Name some common dicotyledons. Possible answers: broad-leafed trees, roses, dandelions, cactuses, carrots, beans

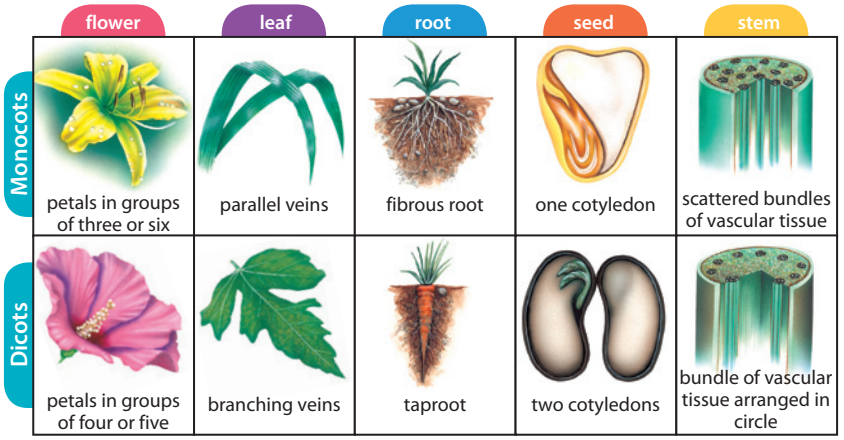


Scientists usually classify angiosperms by their seed structure. The seeds of angiosperms have stored food available in **cotyledons**, the tiny seed leaves of the plant embryo. **Dicotyledons** (dye KAHT il EE duns), also called dicots, have two cotyledons in their seeds. **Monocotyledons** (MAHN uh KAHT il EE duns), or monocots, have only one cotyledon in their seeds.

Dicotyledons

Most angiosperms are dicots. In addition to their seed structure, dicots also share other similar characteristics. Their tubelike structures are arranged in the shape of a ring. This arrangement allows the stems of dicots to grow thicker every year. Because of this, many dicots have woody stems.

Dicots' leaves are usually broad and flat and have a network of veins. As a dicot grows, its main root lengthens and smaller secondary roots branch off of it. An easy way to identify dicots is to observe their flowers. The flower of a dicot will have either four or five petals or petals in multiples of four or five.



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SCIENCE BACKGROUND

Cotyledon classification

Angiosperms are classified into monocots and dicots, depending on the number of cotyledons in the seed. Gymnosperms, however, are called *polycots* because their seeds have multiple cotyledons. The vascular structure of gymnosperms is also slightly different from that of angiosperms.

Types of roots

The types of roots, taproots and fibrous roots, will be discussed in Lesson 70.

Longest leaf

A monocot holds the record for having the longest leaf of any flowering plant. The leaves of the raffia palm can be as long as 20 m (65 ft). The raffia palm is found in Madagascar (a country in Africa). Its leaves are often used to make woven hats and baskets.

Prefixes

LANGUAGE

A prefix added to the beginning of a word changes the meaning of the word.

The prefix *mono-* means "one." So *monocotyledon* means "one cotyledon."

Can you think of other words that have the prefix *mono-*? Possible answers: monotone, monocle, monochromatic, monopoly

The prefixes *di-* and *bi-* mean "two."

Which words from this lesson begin with these prefixes? dicot, biennial

Can you think of other words that have the prefix *bi-*? Possible answers: bicycle, biped, binary

Dicotyledons can be large or small. Broad-leafed trees are dicots. Dicots are the larger group of angiosperms.

Monocotyledons

Monocots also share similar characteristics in addition to their seed structure. Because their tubelike structures are not arranged in any particular order, monocot stems do not become thicker each year. Most monocots are small, with soft, green stems.

Monocots have long and narrow leaves with parallel veins. Many of them, such as bananas and pineapples, are used for food. Monocots also include about eight thousand species of grasses. Some of these grasses are cereal grains that we eat, such as rice, wheat, corn, and oats. Most monocots have many roots of similar size instead of a single main root with smaller branches.

Monocot flowers, such as daffodils and orchids, may be large and attractive. Others, such as the flowers on grasses, may be hardly noticeable. If the flower has petals, it will usually have three petals or be arranged in multiples of three.

QUICK CHECK

1. What are the three classifications of angiosperms according to their growing seasons?
2. How are the seeds of monocots and dicots different?

FANTASTIC FACTS

Have you ever thought much about grass? The grass, or turf, found on golf courses and sports fields is often a product of turf management. People in turf management study grasses, soils, fertilizers, insects, and landscaping. They maintain and manage athletic fields and parks as well as commercial and residential lawns.

DIRECT AN ACTIVITY

Recognizing monocots and dicots

Materials: pictures of various flowers

Provide the student with pictures of many different flowers that have petals, stems, and leaves visible, such as a daisy, daffodil, tulip, lily, geranium, snapdragon, morning glory, apple blossom, buttercup, iris, grass, or mint.

Allow the student to classify the pictures of the plants as either dicots or monocots. The student should be able to state a reason for each classification.

Discussion

How are the tubelike structures in a monocot arranged? not arranged in any particular order; scattered

Why do you think most monocots are smaller than dicots? Their stems do not grow thicker each year because their vascular bundles are scattered throughout the stem.

What kind of stems do most monocots have? soft, green stems

What kind of leaves do monocots usually have? Monocots have long and narrow leaves with parallel veins.

What kind of roots do most monocots have? many thin roots; fibrous roots

What are some common monocots? Possible answers: bananas, pineapples, grass, rice, wheat, corn, oats, daffodils, and orchids

Are most angiosperms monocotyledons or dicotyledons? dicotyledons

Discuss *Fantastic Facts.*

What is another name for the grass found on golf courses? turf

What kinds of subjects does someone in turf management study? grasses, soils, fertilizers, insects, and landscaping

Where are some places that turf management is used? Possible answers: athletic fields, golf courses, commercial and residential lawns

Answers

1. annual, biennial, perennial
2. Monocot seeds have one cotyledon. Dicot seeds have two cotyledons.

Activity Manual

Review, page 94

This page reviews Lesson 75.

Assessment

Quiz 6-B

The quiz may be given any time after completion of this lesson.

Objectives
• Create a visual illustrating how plants are classified

Materials
• See Student Text page

Vocabulary
taxonomy

Introduction
Review the main classification categories of plants as needed with questions such as the following.

What are the two main categories into which scientists classify plants? vascular and nonvascular

Into what two groups are vascular plants divided? seed-bearing and seedless

Into what two groups are seed-bearing vascular plants divided? gymnosperms and angiosperms

What are the four types of gymnosperms? cycads, gnetophytes, ginkgoes, and conifers

What are the two main groups of angiosperms? monocotyledons and dicotyledons

Teach for Understanding

Purpose for reading
The student should read all the pages before beginning the activity.

Procedure
Guide the student in deciding how to represent the categories of plant classification.

Remind him to complete the Activity Manual pages. This will help him remember to include necessary categories and pictures.

Use the questions in the Science Process Skills to discuss classifying.

Activity Manual
Activity, pages 95–96

Assessment
Rubrics
Select the prepared rubric, or design a rubric to include your chosen criteria.

ACTIVITY

Classification Check

Process Skills
- Observing
- Classifying
- Communicating

Taxonomy is the branch of science that deals with classifying organisms. A scientist who specializes in this branch of science is called a taxonomist. For this activity, you are the taxonomist. You must prepare a visual aid to show how scientists classify plants. It could be a mobile, a chart, a concept web, or any other method that you choose.

Purpose
Prepare and explain a classification visual.

Materials
pictures of various plants
materials of your choice
field guide
Activity Manual

Procedure
1. Plan a visual to show how scientists classify plants. Describe and sketch your plan in your Activity Manual.
2. Make a list of the materials that you will need and gather them.
3. Your classification visual should include these categories: vascular, nonvascular, seedless vascular, seed-bearing vascular, angiosperms, and gymnosperms.
4. Find a picture for each subcategory (mosses, liverworts, ferns, horsetails, club mosses, cycads, ginkgoes, gnetophytes, conifers, dicotyledons, and monocotyledons).
5. Use the field guide as needed to specifically identify each plant pictured. For example, you may find a picture of a pine tree to represent the conifers. Try to identify the species of the pine tree. Is it a white pine, lodgepole pine, or another species of pine?
6. Construct your classification visual and use it to explain plant classification to others.

Follow-up
- Add the scientific names, along with the common names, of the plants that you identify.

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TEACHER HELPS

Display
Completed projects make excellent classroom displays.

LANGUAGE

Taxonomy
The Greek word *taxis* means "arrangement." *Taxonomy* is the classification, or arrangement, of organisms according to specific criteria.

SCIENCE PROCESS SKILLS

Classifying

What would be the easiest characteristics to identify? Answers will vary.

Why would it be difficult to accurately classify some plants? Answers will vary, but elicit that they may look similar even though they actually are not.

Do you think you could identify plants by looking only at the outside of them? Why? Answers will vary, but elicit that in order to see some of the characteristics used to classify plants, you would need to split the plants open.

Lesson 77

Plant Products

EXPLORATION

Have you ever thought about the many different products that can be made from plants? Some products, such as furniture or food, might be obvious. But did you realize that lipstick, glue, fabric, and hair spray can also be made from plants and plant products? Scientists may have found other ways to make some products, such as aspirin and marshmallows, that were formerly made from plants. However, many medicines and other products that we use every day would never have been discovered without plants.

What to do

1. Listed below are some plants that are used in a variety of ways. Choose one of the plants.
2. Make a collage or display that shows several different uses for that plant. At least five products should be non-food-related. Try to find some very unusual uses for your plant.
3. Present your project to the class and be prepared to explain which part of the plant is used in each product.

olive	onion
soybean	sunflower
cotton	flax
stinging nettle	carnauba tree
Douglas fir	hazel tree
kapok tree	spruce
western red cedar	white pine

HISTORY

Historical plant uses
Vikings used plants for many different things. Club mosses were made into powder or lotion to treat skin diseases. Sphagnum moss was used at one time to treat wounds and as a bandage to absorb blood. The iris flower had many medicinal uses, such as for coughs, poisoning, toothaches, and swelling.

TEACHER HELPS

Display options
Displays can be assembled at home or put together in class.

Objectives

- Research products made from a given plant
- Prepare a display to demonstrate research results
- Present a display

Introduction

What do lipstick, the waxy shine of some apples, and some car waxes have in common? All of them can be made from the same plant.

Diapers, hair spray, and lotion are just a few products that also can be made from plants. In this exploration, you will choose one plant and find ways in which that plant is used.

Teach for Understanding

Purpose for reading

The student should read the page before beginning the exploration.

What to do

Provide encyclopedias or Internet access as needed for the student to research his plant. Remind him to document his sources as he lists products made from his plant. When possible, the student should also note which part of the plant is used to make each product.

Guide the student in deciding how to display the many different uses for the plant that he chose.

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Student Text pages 152–55
Activity Manual pages 97–98

Objectives

- Identify the two kinds of vascular tissue and describe their functions
- Summarize three main functions of a plant stem
- Compare and contrast herbaceous and woody stems
- Summarize three main functions of root systems
- Compare and contrast taproots, fibrous roots, and aerial roots

Vocabulary

xylem
phloem
vascular bundle
cambium
herbaceous
primary root
taproot
fibrous root

Introduction

Discuss some occupations, such as sanitation engineer, policeman, fireman, emergency medical technician, etc.

Why are these community occupations important? to keep communities clean; to help things run smoothly

What happens if someone does not do his assigned job? The job does not get done. Things do not go as smoothly. Someone else has to take the time to do the job.

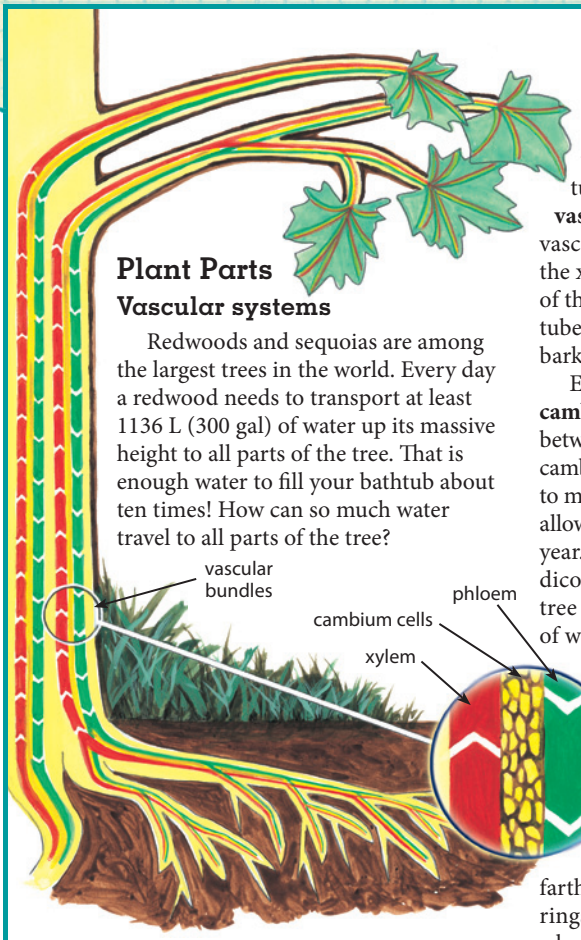
Just as different people in our community do specific jobs to help us out, different parts of plants have specific jobs, or functions. Today we will be studying some of these plant parts.

Teach for Understanding

Purpose for reading

What three types of cells are found in vascular bundles?

What are three kinds of roots?



Plant Parts

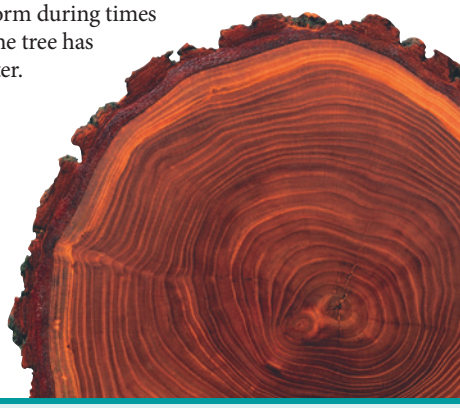
Vascular systems

Redwoods and sequoias are among the largest trees in the world. Every day a redwood needs to transport at least 1136 L (300 gal) of water up its massive height to all parts of the tree. That is enough water to fill your bathtub about ten times! How can so much water travel to all parts of the tree?

As we have already seen, most plants, including trees, have vascular systems. This system of tubes transports water, food, and nutrients throughout the plant.

Xylem (ZY lum) tubes carry water and minerals from the roots to the top of the plant. **Phloem** (FLO um) tubes carry sugars and food throughout the plant. These sugars move from where they were made or stored to wherever they are going to be used. These xylem and phloem tubes are grouped together in **vascular bundles**. For a dicot, these vascular bundles are positioned so that the xylem tubes are towards the inside of the stem or tree trunk. The phloem tubes are nearer the outside, or the bark, of a tree.

Each vascular bundle has a layer of **cambium** (KAM bee um) cells tucked in between the xylem and phloem. These cambium cells divide and reproduce to make more xylem and phloem, allowing the tree to grow wider each year. Because the vascular bundles of dicots form a ring, each year that the tree grows wider a new circle, or ring, of wood is added to the tree. You can tell the approximate age of a tree by counting the number of rings that the tree has. These annual rings also provide information about the climate and the tree's health. If the tree has received plenty of water, the rings are wider and farther apart. However, narrow rings form during times when the tree has less water.



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SCIENCE BACKGROUND

Stem growth
Stems show both primary and secondary growth. Changes in the height and length of a stem are primary growth. Secondary growth refers to the increase in the width of the stem.

Tree trunks
The cambium cells are the only living cells in a tree trunk. Even the wood in a living tree is made up of dead cells. In the center of the trunk is the pith, a food storage area. The pith is surrounded by the heartwood, which consists of old layers of xylem that no longer transport water and nutrients. The heartwood adds additional strength and support to the tree.

Sequoia trees
The bark of sequoias can be as much as 79 cm (31 in.) thick, and the trees can have branches as large as 2.4 m (8 ft) in diameter.

SCIENCE MISCONCEPTIONS

Tubers
Even though both the sweet potato and the white potato are referred to as tubers, they come from different parts of the plants. A white potato is actually an underground stem, but a sweet potato is part of the plant's root.


flower with herbaceous stem

TRY IT YOURSELF

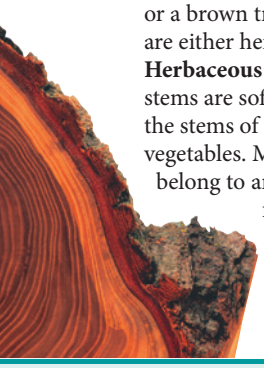
You can make a "leaf skeleton" that shows the tubes in a leaf. Choose a leaf and cover it with water in a bucket or pan. The water will speed up the rotting process of the leaf. Change the water every few days. Be careful not to tear your leaf. After a few weeks the green part of the leaf will rot away, leaving only the veins, or tubes, in the leaf. Then you will have a "leaf skeleton."

Stems

Scientists define a stem as any part of the plant that will grow leaves, shoots, or buds rather than roots. Even though stems come in many different widths and textures, every stem has the same two important jobs. Stems provide support to hold the plants upright, and they also provide for the transportation of food, water, and minerals. Some stems even help store food. The baked or mashed potatoes that you may have eaten were actually the *tuber*, or food storage stem, of the potato plant.

Stems can be above or below ground. They do not always look the same as a typical green stem or a brown tree trunk. Most stems are either herbaceous or woody. **Herbaceous** (hur BAY shuhs) stems are soft and green, like the stems of most flowers and vegetables. Most herbaceous stems belong to annual plants and live for only one growing season. However, some perennials, such as tulips and daffodils, also have herbaceous stems. When cold weather comes, these stems die and then grow from the roots again in the spring.

Woody stems are usually found in plants that have been growing for at least two years. A type of bark or cork forms a layer on the outside of the stem. This protective layer helps the plant resist diseases, insects, and extreme temperatures. A layer of cambium cells just underneath the bark keeps producing new layers of bark. Old outer bark cells are shed as new cells take their place.




flower with woody stem

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DIRECT A DEMONSTRATION

Demonstrate how water travels through a stem

Materials: fresh white carnation, water, food coloring, one or two cups or vases

Note: Some colors will work better than others for this demonstration. Red or green may work better than violet.

Pour about 250 mL of water into the cup(s). Add twenty to thirty drops of liquid food coloring (or about ½ tsp of paste food coloring) to the water. If using paste, stir until dissolved. Hold the carnation under water and snip the end of the stem at an angle. This provides a fresh opening to allow the coloring to be absorbed. If desired, split the stem of the carnation for several centimeters so that it can be placed in two different containers of colored water at the same time. Place the stem of the carnation in the cup(s). Observe the flower after thirty minutes or at a later time. Within twenty-four hours, the carnation will have absorbed as much of the coloring as it will. You could make a new cut on the stem and repeat the process with a different color.

TECHNOLOGY

Finding the age of a tree

Scientists do not have to cut a tree down to determine its age. With a borer, a scientist can drill into a tree and bring out a small sample of wood, about 4 millimeters in diameter. The hole is then sealed to protect the health of the tree. The sample shows the rings and other features the scientist needs. Scientists use computers to help track and record data as well as to detect possible patterns in the weather and environment.

Discussion

What is the purpose of a vascular system? to transport food, water, and nutrients to all parts of a plant

Discuss the diagram of the parts of a plant.

What three types of cells are found in vascular bundles? xylem, phloem, and cambium

Which part of the vascular system carries water? xylem **In which direction do the xylem tubes usually transport water?** up from the roots to the top of the plant

What does the phloem transport? sugars and food

How are the xylem and phloem grouped in a plant? in vascular bundles

In a dicot, how are these vascular bundles positioned? The xylem is closer to the center of the stem, and the phloem is toward the outer part of the stem.

What is between the xylem and phloem cells? cambium

What is the purpose of the layer of cambium cells? It divides and reproduces to make more xylem and phloem tubes.

What is different about tree rings formed during periods of drought and those formed when rainfall is plentiful? Narrow rings form when water is scarce. When the tree receives plenty of water, the rings are wider and farther apart.

How do scientists define a stem? any part of the plant that will grow leaves, shoots, or buds rather than roots

What are the two main jobs of a stem? to support the plant and to transport food, water, and minerals

What is another job that some stems do? store food

What are underground stems that store food called? tubers

How are herbaceous stems different from woody stems? Herbaceous stems are soft and green. Woody stems have a protective layer of bark or cork on the outside of the stem.

Do most herbaceous stems belong to annuals or perennials? annuals

What is the purpose of the bark on a woody stem? It helps protect the plant from diseases, insects, and extreme temperatures.

Discussion

What are four jobs of a plant's roots? to anchor the plant in the soil, support the stem, absorb water and nutrients, and help transport water and food

What do some roots store for the plant? starches and sugars

What are some common roots that we eat? Possible answers: beets, sweet potatoes, radishes, and carrots

What will happen to a plant if its roots are diseased or injured? The entire plant will suffer.

What is the first root that emerges from a seed? primary root

Why is it called a primary root? Answers may vary but should include that *primary* means "first."

What are three kinds of roots? taproots, fibrous roots, aerial roots

What is a taproot? a long root that grows straight down into the soil

Which group of angiosperms usually have taproots? dicots

What is the purpose of root hairs? They allow the root to touch more soil and absorb more moisture and nutrients. They also help to anchor the plant.

Which kinds of plants often have fibrous roots? most monocots and some gymnosperms

Both taproots and fibrous roots develop from a primary root. How are they different? A taproot is the primary root that has continued to grow and enlarge. After the primary root stops growing, a fibrous root has many thinner roots grow out from it in all directions.

Discuss *Fantastic Facts*.

How large was the fibrous root system of the rye plant? about 611 km (380 mi)

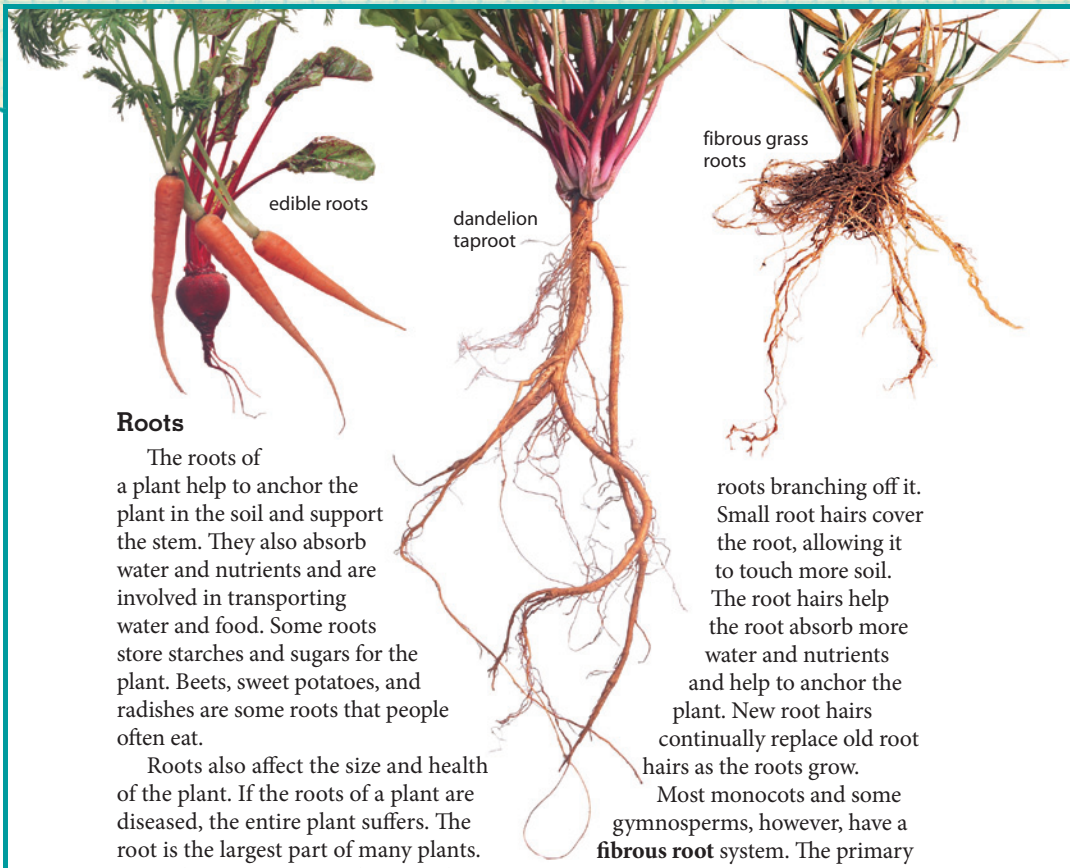
How many root hairs did scientists think this rye plant had? fourteen billion

Do you think they actually counted each one? no

How do you think scientists arrived at that number? Possible answer: They probably divided the root hairs into sections and counted the number of hairs in one section, then multiplied the number of hairs by the number of sections.

Aerial roots do not touch the soil. How do the roots of these plants get moisture? They absorb moisture from the air or from the surface to which they are attached.

Where are plants with aerial roots often found? in rain forests or other areas of high humidity



Roots

The roots of a plant help to anchor the plant in the soil and support the stem. They also absorb water and nutrients and are involved in transporting water and food. Some roots store starches and sugars for the plant. Beets, sweet potatoes, and radishes are some roots that people often eat.

Roots also affect the size and health of the plant. If the roots of a plant are diseased, the entire plant suffers. The root is the largest part of many plants. Since the roots can stretch out underground, some plants may have roots that spread out for thousands of square meters.

The first root that emerges from a seed is called the **primary root**. For most dicots, this root continues to grow and enlarges into the taproot. The **taproot** continues to grow straight down into the soil and may have secondary roots branching off it. Small root hairs cover the root, allowing it to touch more soil. The root hairs help the root absorb more water and nutrients and help to anchor the plant. New root hairs continually replace old root hairs as the roots grow.

Most monocots and some gymnosperms, however, have a **fibrous root** system. The primary root stops growing, and the plant develops many thin roots that spread out in all directions. These thin roots branch and divide again and again. Fibrous roots are usually found near the top of the soil, but some sections branch downward to absorb water and minerals. Roots like these help to anchor soil in place and prevent erosion.

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SCIENCE BACKGROUND

Taproot or fibrous roots

If a plant that normally has a taproot suffers an injury to its root early in its development, that plant may develop fibrous roots instead of a taproot. The type of soil and amount of moisture in the soil also affects root development. Some plant nurseries sell trees whose taproots have been changed to fibrous roots. The fibrous roots are easier to transplant than a taproot would be.

Branches of botany

Botany is the study of plants. Many branches of science deal with botany. *Dendrochronology* includes studying tree ring patterns to identify periods of drought and changes in climate. *Agriculture* deals with the study of crops related to food. *Agronomy* includes the study of soil as well as crop management. *Taxonomy* is the branch of science that deals with the classification and naming of organisms.

Not all plants have taproots or fibrous roots, though. Some plants have **aerial roots** that never touch the soil. These plants are most often found in rain forests or in other areas of high humidity. Orchids and Spanish moss are examples of plants with aerial roots. Their roots absorb moisture from the air or from the surface to which they are attached. These two plants use other plants and objects for support and height. Since they do not use the supporting plant for food, they are not considered parasites. Mistletoe, however, is at least a partial parasite. Although it contains chlorophyll and makes some of its own food, its branches tap into the branches of the tree that supports it. It absorbs water and minerals from the tree.

Many evolutionists believe that one type of plant evolved into another more sophisticated type. For example, an evolutionist might claim that seedless plants, such as ferns, evolved into gymnosperms and that gymnosperms evolved into angiosperms. However, we know from God's Word that this did not happen. All of the different plants that exist simply showcase God's magnificent designs. God created each plant with exactly what it needs for survival. Our God, Who cares and provides for plants, also provides all things needful for humans (Matt. 6:28–34).

QUICK CHECK

1. What two kinds of vascular tubes are bundled together?
2. How do scientists define a stem?
3. What is the difference between a taproot and a fibrous root?

FANTASTIC FACTS

Fibrous root systems can be quite extensive! One rye plant that was about 51 cm (20 in.) tall was found to have about 611 km (380 mi) of roots. Scientists counted at least fourteen billion root hairs on these roots. If these root hairs could have been spread out flat, they would have probably covered an area the size of two or three houses.

Orchids have aerial roots.

BIBLE

God's care
God provides exactly what each plant needs to grow. Read Matthew 6:28–34 and discuss how God also cares for humans. [Bible Promise: H. God as Father]

Discussion

What is humidity? the amount of moisture or water vapor in the air

What are some examples of plants that have aerial roots? Possible answers: orchids, Spanish moss

Why are plants with aerial roots not considered parasites? They do not use the supporting plant for food.

How was *parasite* defined in Chapter 5? an organism that lives on or in another organism

Why is mistletoe considered a partial parasite? It does make some of its own food, but it also grows into the branches of the tree it is on and absorbs water and minerals from the tree.

Many evolutionists believe that plants evolved in stages over billions of years. How do we know that this could not have happened? God's Word tells us that God created all plants on Day 3 of Creation.

Scientists have also discovered fossil evidence that proves that "higher order plants," such as angiosperms, existed at the same time as nonvascular and seedless vascular plants. Guide the student in concluding that "higher order plants" did not take billions of years to develop, but were created at the same time as "lower forms."

Answers

1. xylem and phloem
2. A stem is any part of the plant that will grow leaves, shoots, or buds rather than roots.
3. A taproot grows straight down in the ground and may have secondary roots branching off it. For fibrous roots, the primary root stops growing, and many thin roots grow out in all directions.

Activity Manual

Reinforcement, page 97

Review, page 98

This page reviews Lessons 75 and 78.

Assessment

Quiz 6-C

The quiz may be given any time after completion of this lesson.

Objectives
- Measure the circumference, height, and crown of a tree and calculate the tree's point value
- Create a graph to show relationships
- Interpret graphs
- Compare data

Materials
- See Student Text page

Introduction

This activity uses the English measuring system because the point value system for trees is based on the English system.

How would you measure the height of a person?
Possible answers: Using a ruler, start at the person's foot and measure up to the top of his head. Have the person stand against a wall or tape, and make a mark on the wall at the top of his head. Then use a ruler to measure from the floor to the mark.

Rulers cannot be used to measure every distance. Sometimes you may need to measure something that is not flat. At other times it is not possible to get from one end to the other end of an object to measure it. In today's activity, we will learn one way to calculate the size of a tree.

Teach for Understanding

Purpose for reading
The student should read all the pages before beginning the activity.

ACTIVITY

How Big Is My Tree?

Process Skills
- Measuring
- Observing
- Inferring
- Communicating
- Collecting, recording, and interpreting data

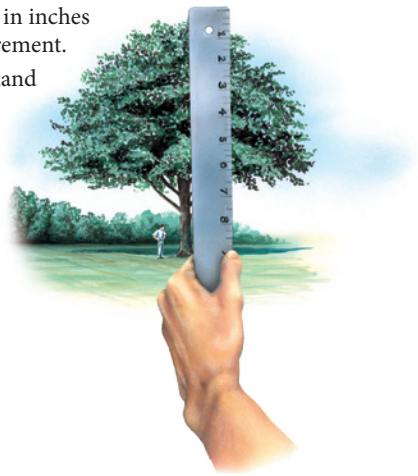
Is your tree the biggest in your state? Many states have a registry of the biggest trees that grow there naturally. These trees are listed by species and ranked according to a point system. Measurements of a tree's circumference, height, and crown are needed to calculate the point value for that tree. How can you measure the height of a tree if you cannot reach the top? How can you measure the crown, or upper part of the tree where the branches and leaves grow? In this activity you will measure the size of a tree while keeping both feet firmly on the ground.

Problem
How can you measure the circumference, height, and crown of a tree?

Materials
string 15–20 ft long
yardstick or tape measure
12 in. ruler
4 short sticks or pencils
calculator
tree field guide or encyclopedia (optional)
Activity Manual

Procedure
Note: This activity uses English rather than metric measurements.

1. Choose a tree that you would like to measure. Identify it as a gymnosperm or an angiosperm. Record your classification in your Activity Manual.
2. Measure the circumference of your tree. Use string to measure the circumference of your tree in inches at 4½ feet above the ground. Record your measurement.
3. Measure the height of your tree. Have a partner stand at the base of the tree. With your arm straight out in front of you, hold one end of the ruler so the other end points up. Line up the point where the top of your hand is on the ruler so that it is even with the base of the tree. Back away from the tree until the top of the tree appears to be even with the top of the ruler. The top of your hand should be even with the base of the tree. Rotate your hand until the ruler lies horizontally.



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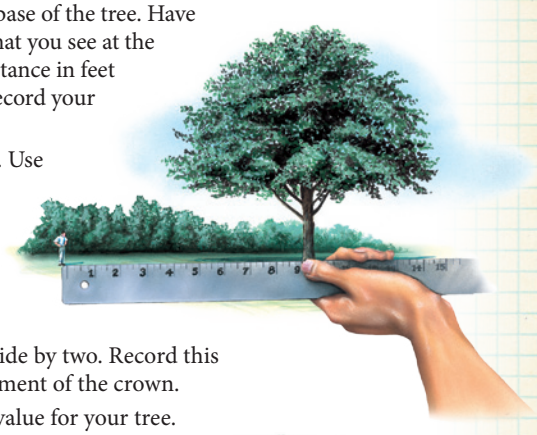
TEACHER HELPS

For one student
Direct the student to measure more than one tree. The more trees that the student measures, the more data he will have to analyze.

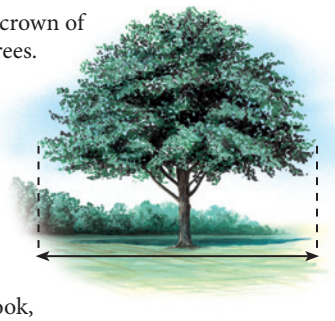
Tree variety
Encourage groups to measure different sizes and kinds of trees to get the best information for their comparisons. If possible, at least two groups should measure trees of different sizes, but of the same species. At least one person in the group should record the measurements for circumference, height, and crown as they are measured.

Measuring options
There are many ways to measure the height of very tall objects. The student could research and try some of these methods and then compare the results.

Your hand should still be at the base of the tree. Have your partner walk to the place that you see at the end of the ruler. Measure the distance in feet from the tree to your partner. Record your measurement.



4. Measure the crown of your tree. Use the sticks to mark the places on the ground where the ends of the branches reach overhead. Mark the widest and narrowest spread of branches. Measure in feet both distances. Add the measurements together and divide by two. Record this number as the average measurement of the crown.
5. Calculate and record the point value for your tree.
6. Compare the circumference, height, and crown of your tree to the measurements of other trees. Record and graph your information.



Conclusions

- Do you think that thinner trees are younger or older than thicker trees of the same species? Why?

Follow-up

- In an encyclopedia, field guide, or tree book, look up the annual growth and mature size of your tree or its species.
- Compare the point value of your tree with other big trees in your state or around the country.

SCIENCE PROCESS SKILLS

Measuring

How was the measuring done for this activity different from some other measuring? Answers will vary, but lead to the idea that it was less exact because the student could not physically measure the tree.

Do you think that different people would get different measurements of the same tree? yes **Why?** because they may measure differently

How could you minimize error? Possible answer: Measure the tree several times and find the average measurement of the tree.

Procedure

Guide the student in choosing a tree and measuring the circumference of that tree. It may help for the student to notice where 4½ feet high is on his own body to help him remember to measure the circumference of the tree at 4½ feet. Provide time for each group to measure the height and crown of the trees.

After measurements are recorded, provide time for each group to calculate the point value for their tree. Record each group's data on a chart for display. Allow time for each student to copy the chart onto his Activity Manual page. Instruct each student to graph the information using the three grids provided in his Activity Manual.

Use the questions in the Science Process Skills to discuss meaning.

Conclusions

Do you think thinner trees are younger or older than thicker trees of the same species? younger **Why?** The circumference of a tree usually increases as the tree ages.

Using the graphs that you made, what general relationship do you see between the height and circumference? The taller the tree is, the greater the circumference is.

Rank measured trees of the same species according to their point values. Would it be a valid comparison to compare point values of all the trees measured? probably not **Why?** because they probably are not all of the same species

Activity Manual

Activity, pages 99–100

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Student Text page 158
Activity Manual pages 101–2

Objectives
- Recall concepts and terms from Chapter 6
- Apply knowledge to everyday situations

Introduction
Material for the Chapter 6 Test will be taken from Student Text page 158 and Activity Manual pages 93–94, 98, and 101–2. You may review any or all of the material during the lesson. Questions similar to Solve the Problem or the ones in Thinking It Through on Activity Manual pages 101–2 may appear on the test.

You may choose to review Chapter 6 by playing "Build a Flower" or a game from the Game Bank on the Teacher's Toolkit CD.

Teaching for Understanding
Diving Deep into Science
Information on this page reflects the vocabulary and concepts the student should know for the test.

Solve the Problem
In order to solve the problem, the student must apply material he has learned. The student should attempt the problem independently. The answer for this Solve the Problem is based on the material on Student Text pages 154–55. Answers will vary and may be discussed.

Activity Manual
Review, pages 101–2
These pages require written responses to application questions.

Lesson 81

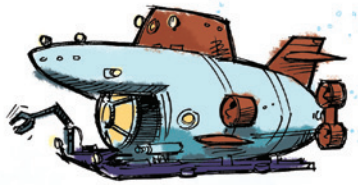
Objective
- Demonstrate knowledge of concepts taught in Chapter 6

Assessment
Tests, Chapter 6

DIVING DEEP INTO SCIENCE

Words to Know
vascular plant
nonvascular plant
rhizoids
rhizomes
frond
fiddlehead
annual
biennial
perennial
cotyledon
xylem
phloem
cambium
herbaceous
primary root
taproot
fibrous root
aerial root

Key Ideas
Ways plants can be classified
Characteristics and examples of nonvascular plants
Categories and examples of vascular plants
Differences between angiosperms and gymnosperms
Examples and uses of conifers
Examples of products made from plants
Compare monocotyledons and dicotyledons
Describe parts of a plant's vascular system
Compare taproots and fibrous roots



Solve the Problem
Tanya's father said he would pay her two dollars for every bucket of dandelion weeds that she removed from the yard. So Tanya went to work. She pulled up each plant, including its broad leaves and a few thin roots. There wasn't a dandelion left in the yard. A week later, however, there were dandelions growing everywhere Tanya had pulled them. Tanya's father asked, "Tanya, did you dig up the dandelions or just pull them up?" Why did Tanya's method not work?

Dandelions have long taproots. Tanya only removed the parts of the plants showing above the ground and thin roots (secondary roots). If the taproots are not removed, the plants will continue to grow.

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Review Game
Build a Flower

Divide the class into two teams. Draw a completed flower as an example. Ask each team questions. If the team answers correctly, a member of the team may draw a portion of the flower. The drawing is completed with these steps: root, stem, one leaf, add veins, second leaf, add veins, circle for flower head, add a petal until the flower has five petals. The first team to draw a complete flower wins.