Chapter 24 Organizer

Reproduction in Plants

Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 24.1 **Life Cycles of Mosses, Ferns, and Conifers** National Science Education Standards UCP.1, UCP.2, UCP.3, UCP.5; A.1, A.2; C.1, C.5 (1 session)	1. **Review** the steps of alternation of generation. 2. **Describe** the life cycles of mosses, ferns, and conifers.	**MiniLab 24-1:** Growing Plants Asexually, p. 654 **Problem-Solving Lab 24-1,** p. 659 **BioTechnology:** Hybrid Plants, p. 680
Section 24.2 **Flowers and Flowering** National Science Education Standards UCP.1, UCP.2, UCP.5; A.1, C.4-6 (1 session, 1/2 block)	3. **Identify** the structures of a flower. 4. **Examine** the influence of photoperiodism on flowering.	**Problem-Solving Lab 24-2,** p. 663 **Inside Story:** Parts of a Flower, p. 665 **Investigate BioLab:** Examining the Structure of a Flower, p. 678
Section 24.3 **The Life Cycle of a Flowering Plant** National Science Education Standards UCP.1, UCP.2, UCP.3, A.1, A.2; C.1, C.4-6; E.1, E.2; F.3, F.6; G1-3 (2 sessions, 1 block)	5. **Describe** the life cycle of a flowering plant. 6. **Outline** the processes of seed and fruit formation and seed germination.	**Careers in Biology:** Greens Keeper, p. 673 **MiniLab 24-2:** Looking at Germinating Seeds, p. 677

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab

p. 678 microscope, microscope slide (2), coverslips (2), dropper, water, single-edged razor blade, colored pencils (red, green, and blue), hand lens, flower (complete)

MiniLabs

p. 654 potato, garlic clove, carrot, test tube, petri dish, beaker, toothpicks, water, paper, pencil

p. 677 microscope, corn kernels and bean seeds (germinating and ungerminated), paper towels, plastic zipper bags, single-edged razor blade

Alternative Lab

p. 674 canned kidney beans, paper cup, water, dried kidney beans, wax paper, labels, tetrazolium solution, dropper bottle

Quick Demos

p. 657 photomicrographs of gametophytes, metric ruler

p. 662 flower (rose or daffodil)

p. 668 peanut

p. 672 tomato, peach

Key to Teaching Strategies

- **L1** Level 1 activities should be appropriate for students with learning difficulties.
- **L2** Level 2 activities should be within the ability range of all students.
- **L3** Level 3 activities are designed for above-average students.
- **ELL** ELL activities should be within the ability range of English Language Learners.
- **COOP LEARN** Cooperative Learning activities are designed for small group work.
- **P** These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 24.1 **Life Cycles of Mosses, Ferns, and Conifers**	**Reinforcement and Study Guide,** pp. 105-106 L2 **Concept Mapping,** p. 24 L3 ELL **BioLab and MiniLab Worksheets,** p. 109 L2 **Content Mastery,** pp. 117-118, 120 L1	**Section Focus Transparency 58** L1 ELL **Basic Concepts Transparencies 38, 39, 40** L2 ELL **Reteaching Skills Transparencies 35, 36** L1 ELL
Section 24.2 **Flowers and Flowering**	**Reinforcement and Study Guide,** p. 107 L2 **Content Mastery,** pp. 117, 119-120 L1 **Inside Story Poster** ELL	**Section Focus Transparency 59** L1 ELL **Basic Concepts Transparencies 41, 42, 43** L2 ELL **Reteaching Skills Transparency 37** L1 ELL
Section 24.3 **The Life Cycle of a Flowering Plant**	**Reinforcement and Study Guide,** p. 108 L2 **Critical Thinking/Problem Solving,** p. 24 L3 **BioLab and MiniLab Worksheets,** pp. 110-112 L2 **Laboratory Manual,** pp. 171-178 L2 **Content Mastery,** pp. 117, 119-120 L1	**Section Focus Transparency 60** L1 ELL

Assessment Resources

- **Chapter Assessment,** pp. 139-144
- **MindJogger Videoquizzes**
- **Performance Assessment in the Biology Classroom**
- **Alternate Assessment in the Science Classroom**
- **Computer Test Bank**
- **BDOL Interactive CD-ROM,** Chapter 24 quiz

Additional Resources

- **Spanish Resources** ELL
- **English/Spanish Audiocassettes** ELL
- **Cooperative Learning in the Science Classroom** COOP LEARN
- **Lesson Plans/Block Scheduling**

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe

To order the following products, call Glencoe at 1-800-334-7344:

CD-ROM

NGS PictureShow: What It Means to Be Green

Curriculum Kit

GeoKit: Plants

Transparency Set

NGS PicturePack: What It Means to Be Green

Videodisc

STV: Plants

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life

CD-ROM ELL

Animation: *Life Cycle of a Moss*
Video: *Fern Development*
Animation: *Life Cycle of a Pine*
Exploration: *Angiosperm*
Video: *Blooming Flowers*

Videodisc Program

Double Fertilization
Fruit Formation
Seed Dispersal
Germination

Getting Started Demo

Show students pictures of reproductive structures of mosses, ferns, and conifers. Have students discuss ways they are similar.

Theme Development

Unity within diversity is explored in this chapter as the different reproductive strategies of major plant divisions are presented. The theme of **systems and interactions** is stressed in the study of the life cycles of various plants. **Evolution** is a theme that occurs throughout the chapter, especially as it relates to the coevolution of pollinators and flowers.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Chapter 24 Reproduction in Plants

What You'll Learn

- You will compare and contrast the life cycles of mosses, ferns, and conifers.
- You will sequence the life cycle of a flowering plant.
- You will describe the characteristics of flowers, seeds, and fruits.

Why It's Important

Plants are essential to Earth's biosphere. The fruits and seeds produced by flowering plants are a major food source for humans and animals, and critical for the survival of many species.

Getting Started

Looking at Flowers

Look closely at two different flowers. *How are they similar? How are they different?*

interNET CONNECTION To find out more about plants, visit the Glencoe Science Web Site. www.glencoe.com/sec/science

Animals often play an important role in pollinating flowering plants. Insects, including bees, transport pollen from flower to flower. Most nonflowering plants, such as mosses, rely on wind or water for the dispersal of spores.

Section 24.1 Life Cycles of Mosses, Ferns, and Conifers

You may have seen the fine yellow dust that covers everything when pine trees release their pollen. As annoying as this pollen may seem, it has a valuable function. It is an important stage in the life cycle of pine trees. Other plants have even more dramatic stages of their life cycles, such as exploding moss capsules and fern sporangia.

Male pine cone releasing pollen

SECTION PREVIEW

Objectives

Review the steps of alternation of generation.

Describe the life cycles of mosses, ferns, and conifers.

Vocabulary

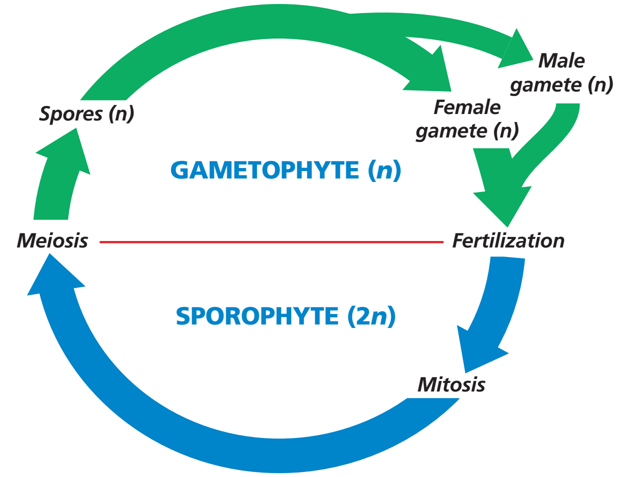
vegetative reproduction
protonema
megaspore
microspore
micropyle

Alternation of Generations

As you learned earlier, plants go through an alternation of generations during their life cycles. Remember that the two phases of the plant life cycle are the gametophyte stage and the sporophyte stage.

The cells of the sporophyte are all diploid. Certain cells of the sporophyte undergo meiosis and produce haploid spores. These spores grow, by mitotic division, into the gametophyte. The multicellular gametophyte that is formed is composed of haploid cells. Some cells of the gametophyte will differentiate and form haploid gametes. The female gamete is the egg, and the male gamete is the sperm. When a sperm fertilizes an egg, a diploid zygote is formed. This zygote divides by mitosis, producing a tiny sporophyte or embryo. The development of the embryo into a mature sporophyte allows the life cycle to begin again. *Figure 24.1* illustrates alternation of generations.

Figure 24.1
All plants exhibit an alternation of generations. The gametophyte *(n)* stage produces gametes. The sporophyte *(2n)* produces spores.



Prepare

Key Concepts

Alternation of generations is reviewed and the life cycles of mosses, ferns, and conifers are presented.

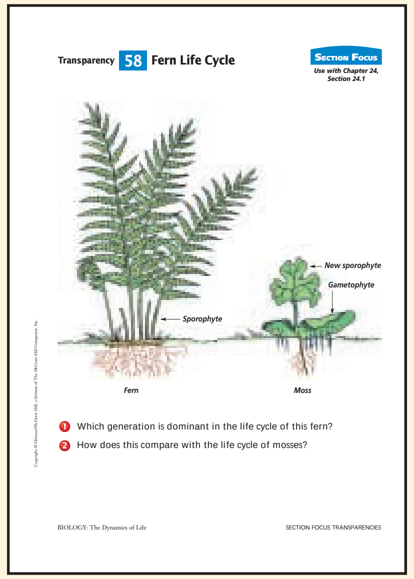
Planning

- Purchase garlic, carrots, and potatoes for MiniLab 24-1.
- Locate pictures of moss, fern, and conifer reproductive structures for Getting Started Demo.
- Locate pictures of moss, fern, and conifer gametophytes for the Quick Demo.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 58** on the overhead projector and have students answer the accompanying questions. L1 ELL



Resource Manager

Section Focus Transparency 58 and Master L1 ELL

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Meeting Individual Needs, p. 662; Building a Model, p. 669; Tech Prep, p. 675; Portfolio, p. 676

Visual-Spatial Biology Journal, p. 657; Meeting Individual Needs, pp. 658, 665, 672; Reteach, p. 660; Display, p. 664; Discussion, p. 666; Quick Demo, p. 668; Reinforcement, p. 668; Microscope Activity, p. 668; Portfolio, p. 670; Tech Prep, p. 672; Enrichment, p. 673

Intrapersonal Enrichment, p. 664; Project, p. 664

Linguistic Meeting Individual Needs, p. 655; Portfolio, pp. 656, 662; Biology Journal, pp. 663, 668; Extension, p. 666

Logical-Mathematical Quick Demo, p. 657

Assessment Planner

Portfolio Assessment
- Assessment, TWE, p. 657
- Portfolio, TWE, pp. 656, 662, 670, 676
- Alternative Lab, TWE, p. 675

Performance Assessment
- MiniLab, SE, pp. 654, 677
- MiniLab, TWE, pp. 654, 676
- Problem-Solving Lab, TWE, pp. 659, 663
- Assessment, TWE, pp. 666, 676, 677
- Alternative Lab, TWE, pp. 674-675
- BioLab, SE, pp. 678-679

Knowledge Assessment
- Section Assessment, SE, pp. 660, 666, 677
- Assessment, TWE, p. 669
- BioLab, TWE, p. 679
- Chapter Assessment, SE, pp. 681-683

Skill Assessment
- Assessment, TWE, p. 662

2 Teach

MiniLab 24-1

Purpose
Students will use several different plant parts to demonstrate the ability of plants to form new plants via asexual reproduction.

Process Skills
experiment, analyze information, collect data, compare and contrast, draw a conclusion

Teaching Strategies
■ Have students work in small groups to conserve materials.
■ Make sure that the original root end (blunt end) of the garlic clove is immersed in water. One garlic head should supply enough cloves for an entire class.
■ Both garlic and potato may be suspended over water using toothpicks as bracing. Small jars (baby food jars, plastic bathroom cups) may be used in place of beakers or test tubes.
■ Make sure that students identify their plants by placing labels on the jars and/or dishes.
■ Tell students to replace any lost water from the containers.
■ Some potatoes are chemically treated to inhibit growth of eyes. This may account for either slow or no new growth appearing within the two-week period.

Expected Results
All plant tissues will produce new growth. The garlic clove will show new root and stem/leaf growth. The carrot will show new leaves. The potato will show new stems and leaves.

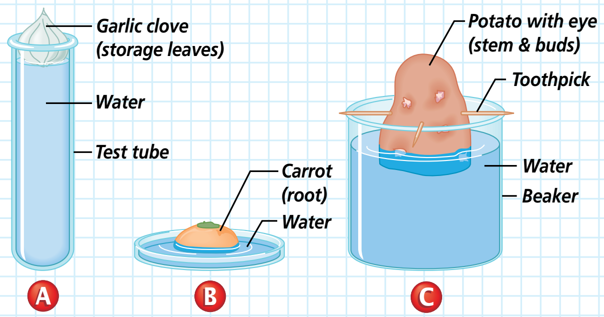
Analysis
1. a. The experimental procedure demonstrates that different plant parts can generate new growth.
b. The appearance of new growth occurred within several days.
c. Only one plant was used for each experimental setup.
2. Student answers may vary; they may include faster growth and that all offspring are identical to parent.

Assessment
Performance Provide students with a plant called Kalanchoe (available in most garden shops). Have them use leaves from the plant to grow new plants asexually. Have students conduct an experiment to determine what conditions stimulate the appearance of new plants along the leaf's edge. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC**, p. 25. L3

The basic pattern of this life cycle is the same for all plants. However, there are many variations on this pattern within the plant kingdom. For instance, recall that in mosses the gametophyte is bigger than the sporophyte. In others, such as flowering plants, the gametophyte is tiny, even microscopic. Most people have never even seen a female gametophyte of a flowering plant. Botanists usually refer to the bigger, more obvious plant as the dominant generation. The dominant generation lives longer and can survive independently of the other generation. In most plant species the sporophyte is the dominant plant.

MiniLab 24-1 Experimenting

Growing Plants Asexually Plants are capable of reproducing asexually. Reproductive cells such as egg or sperm are not needed in asexual reproduction. Plants are able to use structures such as roots, stems, and even leaves to produce new offspring.



Procedure
1. Prepare three different plant parts for study using diagrams A, B, and C as a guide.
2. Observe any changes that occur to your plants over the next two weeks.
3. Design a data table that will provide enough room for diagrams of your observations, the number of days since the start of the experiment should be included.
4. Make your initial diagrams of the plant parts today and label these diagrams as "Day 1."
5. Observations should be made every three days. Replace any lost water as needed.

Analysis
1. What experimental evidence do you have that:
 a. plants use a variety of structures for asexual reproduction?
 b. asexual reproduction is a rapid process?
 c. asexual reproduction requires only one parent?
2. Describe several advantages of asexual reproduction in plants.

Asexual reproduction

Most plants can also reproduce by a process called vegetative reproduction. **Vegetative reproduction** is asexual reproduction in plants where a new plant is produced from an existing vegetative structure. For instance, liverworts produce asexual structures called gemmae that fall off and develop into new plants, *Figure 24.2.* The new plants have the same genetic make-up as the original plant, as if they were cloned. You can learn more about asexual reproduction in the *MiniLab* shown here.

Life Cycle of Mosses

Mosses belong to one of the few plant divisions in which the gametophyte plant is the dominant generation. A haploid spore germinates to form a structure called a protonema. The **protonema** (proht uh NEE muh) is a small green filament of cells that develops into either a male or a female gametophyte. In some mosses, the gametophyte can produce both kinds of reproductive structures. Remember that the archegonium is the female reproductive structure in which eggs are produced and that sperm are produced in the antheridium.

The motile sperm are released from the antheridium and swim through a continuous film of rainwater or dew to the archegonium. The sperm fertilizes the egg inside the archegonium, forming a diploid zygote. The zygote divides by mitosis to form a new sporophyte. The sporophyte is a stalk with a capsule at the top. It grows out of the archegonium and remains attached to the gametophyte. The sporophyte receives meiosis and then gametes tion from the gametophyte. Meiotic division within the capsule produces haploid spores.

The capsule ripens, bursts, and releases the spores, which can be carried great distances by air currents. If the spore lands in a favorable environment, it germinates, completing the life cycle. Review the moss life cycle as you examine *Figure 24.3.*

Figure 24.2
Small cups filled with tiny gemmae have formed on the thallus of this liverwort.

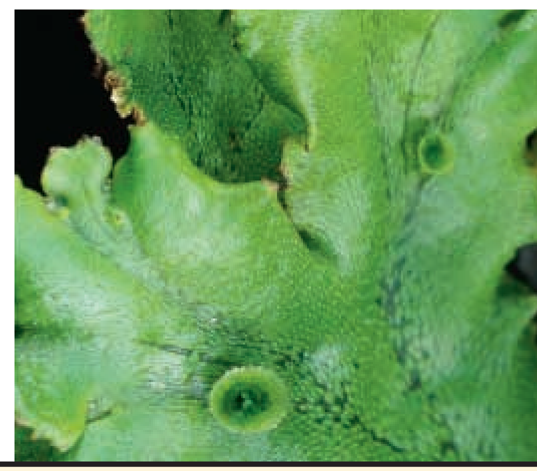
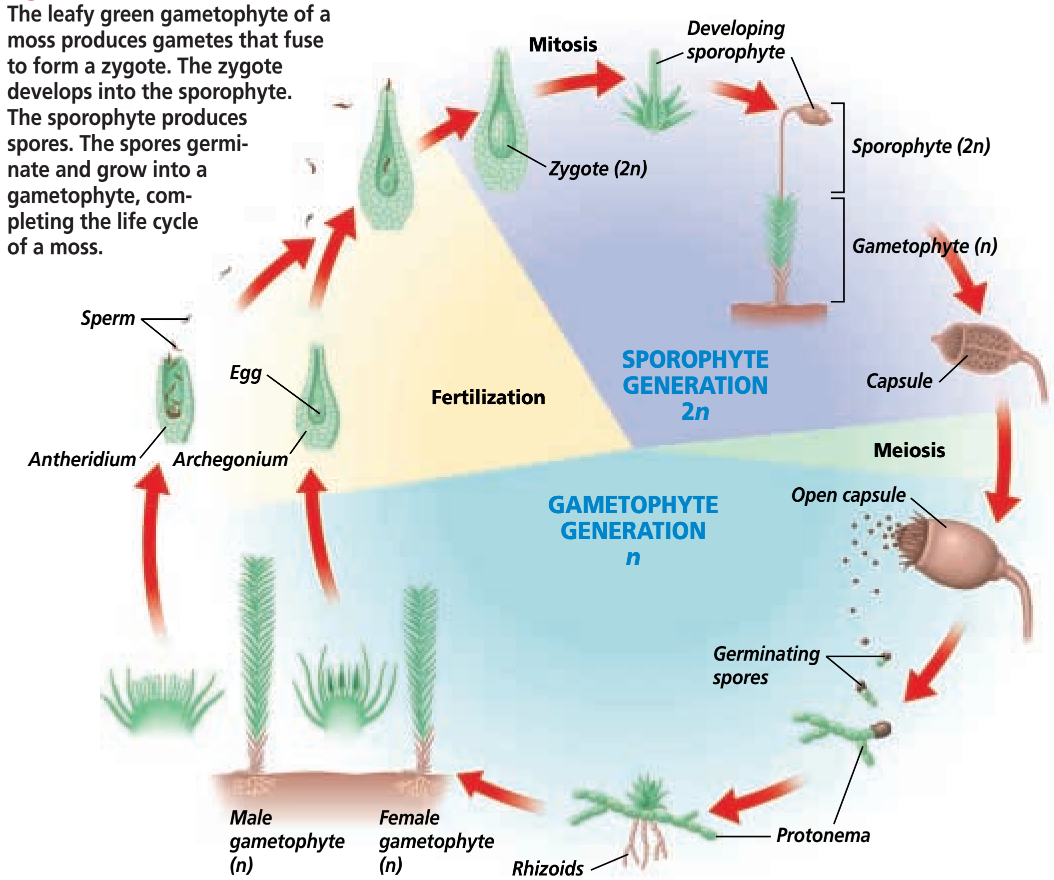


Figure 24.3
The leafy green gametophyte of a moss produces gametes that fuse to form a zygote. The zygote develops into the sporophyte. The sporophyte produces spores. The spores germinate and grow into a gametophyte, completing the life cycle of a moss.



Revealing Misconceptions
Students learned in previous chapters that the process of meiosis forms gamete cells. This is true for animals. However, in plants, spores are produced directly though meiosis and then gametes are formed through mitosis of these haploid cells.

Why the difference between plants and animals? Actually, there is no difference. Plants just have an added stage or step that results from alternation of generations. In this process, meiosis still forms haploid spore cells—the gametophyte generation—that remain haploid. The gametophyte is equivalent to one large male or female animal gamete.

Visual Learning
Figure 24.3 To reinforce the concept of diploid versus haploid, ask students to assign a specific chromosome number to each stage in Figure 24.3. Explain that the diploid number for this species is 18. L2

GLENCOE TECHNOLOGY
CD-ROM
Biology: The Dynamics of Life
Animation: *Life Cycle of a Moss*
Disc 3
VIDEODISC
Biology: The Dynamics of Life
Life Cycle of a Moss (Ch. 17)
Disc 1, Side 2, 1 min. 3 sec.

MEETING INDIVIDUAL NEEDS
English Language Learners/ Learning Disabled
Linguistic Have students review terms associated with alternation of generations by reinforcing the correlation between the name of each generation and its function. For example, *sporophytes* form *spores,* while *gametophytes* form *gametes.* L1 ELL

Resource Manager
BioLab and MiniLab Worksheets, p. 109 L2
Basic Concepts Transparency 38 and Master L2 ELL
Reteaching Skills Transparency 35 and Master L1 ELL

Revealing Misconceptions

Students frequently think the sori present on the underside of fern fronds are some kind of insect infestation. Explain that these structures produce spores.

Chalkboard Activity

Have students write a simple moss life cycle sequence on the board. Help them get started by showing them what the cycle may look like by providing them with this sample: sporophyte ⇒ spores by meiosis ⇒ protonema ⇒ etc.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Fern Development*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Fern Development (Ch. 18)
Disc 1, Side 2, 17 sec.

Resource Manager

Concept Mapping, p. 24 L3 ELL
Basic Concepts Transparency 39 and Master L2 ELL

Figure 24.4
Fern sporophytes are easily seen by a hiker walking through a forest. However, only the very observant person would be able to find a fern gametophyte.

A Most fern sporophytes grow 25 cm or taller.

B The clusters of sporangia on the underside of a fern frond are called sori. Each sporangium contains spores that are released, sometimes in dramatic fashion.

C The heart-shaped fern gametophyte is usually less than a centimeter across.

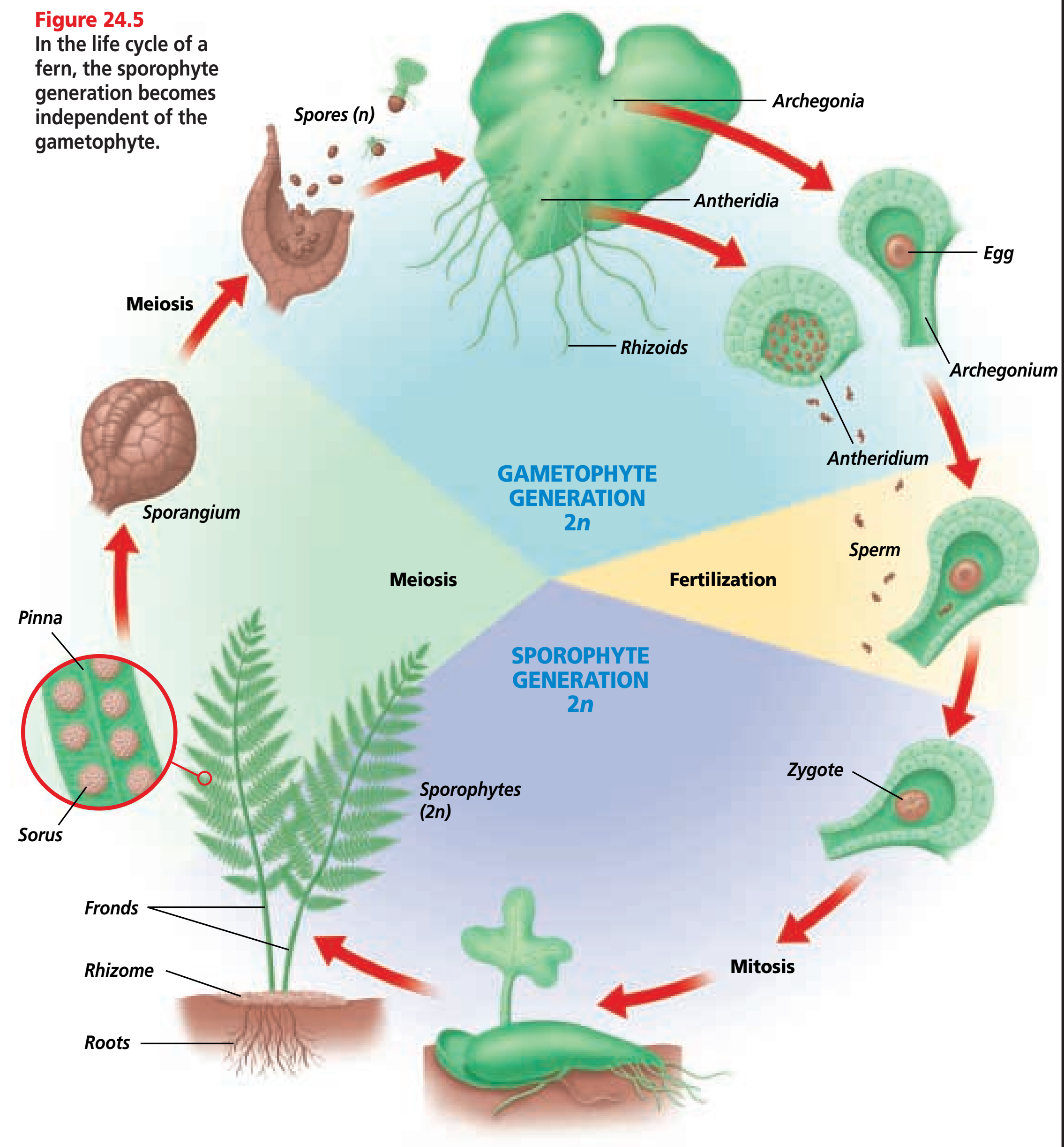
Some mosses also reproduce asexually by vegetative reproduction. They can break up into pieces when the plant is dry and brittle. With the arrival of wetter conditions, these pieces each become a whole plant.

Life Cycle of Ferns

Unlike mosses, the dominant stage of the fern life cycle is the sporophyte plant. The fern sporophytes include the familiar fronds you see in *Figure 24.4*. The fronds of the fern grow from the rhizome, which is the underground stem. On the underside of some fronds are the sori, which are clusters of sporangia. Meiotic division within the sporangia produces the spores. When environmental conditions are right, the sporangia burst to release haploid spores.

A spore germinates to form a heart-shaped gametophyte called a prothallus, as shown in *Figure 24.5*. The prothallus produces both archegonia and antheridia on its surface. The flagellated sperm released by the antheridium swim through a film of water to the archegonium where the egg is fertilized. The diploid zygote that is the product of this fertilization develops into the sporophyte. Initially, this developing sporophyte depends upon the gametophyte for its nutrition. However, once the sporophyte produces its green fronds, it can carry on photosynthesis and survive on its own. The prothallus disintegrates as the sporophyte matures, producing a strong rhizome that can support the fronds. If pieces of rhizome break away, new fern plants will develop from them by vegetative reproduction. New sporangia develop on the pinnae of the fronds, spores will be released, and the cycle will begin again. The life cycle of the fern is summarized in *Figure 24.5*.

Figure 24.5
In the life cycle of a fern, the sporophyte generation becomes independent of the gametophyte.



Quick Demo

Logical-Mathematical Give students pictures of moss, fern, and conifer gametophytes that have the magnification noted on the photo. Have them calculate the size of each gametophyte. The size of the drawing (in millimeters) divided by the magnification equals the size of the original gametophyte (in millimeters). Students will then be able to compare the size of the gametophytes. L3

Chalkboard Activity

Write the following terms on the chalkboard: spore, zygote, egg, sporophyte, and sperm. Have students identify whether each structure is haploid or diploid. L2

Assessment

Portfolio Have students prepare a biological key that will enable others to identify mosses, ferns, and conifers based on features of the plant life cycle, including reproductive parts. L2

Portfolio

Chemistry in Biology

Linguistic Have students do research and prepare a report about the role of chemotaxis in moss and fern reproduction. L3 P

Biology Journal

Fern Life Cycle

Visual-Spatial Have students diagram the stages of the fern life cycle in their journals for review. Encourage students to divide the diagram so that all sporophytes are on one side and all gametophytes are on the other. Have them label the diagram Sporophyte stages, Gametophyte stages. L1 ELL

Using Scientific Terms

Challenge students to use their knowledge of the prefixes *micro-* and *mega-* to describe the relative sizes of microspores and megaspores. *Microspores are smaller than megaspores.* Have students speculate why it is important for microspores to be small. *They develop into pollen grains that must be light enough to be dispersed by wind.* L2 ELL

Visual Learning

- Have students identify the haploid structures in Figure 24.8. *microspores, megaspores, pollen grains, egg*
- Have students identify the structures that make up the sporophyte and gametophyte generations. *Cones and embryo are sporophytes; all other structures are gametophytes.*

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Life Cycle of a Pine*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Life Cycle of a Pine (Ch. 20)
Disc 1, Side 2, 1 min. 37 sec.

The Life Cycle of Conifers

The dominant stage in conifers is the sporophyte generation. One of the more familiar conifer sporophytes is shown in ***Figure 24.6.*** The adult conifer produces male and female cones on separate branches of the tree. The cones contain spore-producing structures, or sporangia, on their scales. The female cones, which are larger than the male cones, develop two ovules on the upper surface of each cone scale. Each ovule contains a sporangium with a diploid cell that produces, by meiosis, four megaspores. A **megaspore** is a female spore that eventually becomes the female gametophyte. One of the four megaspores will survive and grow by mitotic cell divisions into the female gametophyte. The female gametophyte consists of hundreds of cells but is still dependent on the sporophyte for protection and nutrition. Within the female gametophyte are two or more archegonia, each containing an egg. The male cones have sporangia that undergo meiosis to produce male spores called **microspores.** Each microspore will develop into a male gametophyte, or pollen grain. Each pollen grain, with its hard, water-resistant outer covering, is a male gametophyte. Look at ***Figure 24.6*** to see examples of male and female conifer gametophytes.

In conifers, pollination is the transfer of the pollen grain from the male cone to the female cone. Pollination occurs when a windborne pollen grain falls near the opening in one of the ovules of the female cone. The pollen grain adheres to a sticky drop of fluid that covers the opening of the ovule. As the fluid evaporates, the pollen grain is drawn closer to an opening of the ovule called the **micropyle** (MI kruh pile). Although pollination has occurred, fertilization will not take place for at least a year. The pollen grain and the female gametophyte will mature during this time.

As the pollen grain matures, it produces a pollen tube that grows through the micropyle and into the ovule. A sperm cell from the male gametophyte is transported by the pollen tube to the egg, where fertilization occurs. The zygote, which is nourished by the female gametophyte, develops inside the ovule into an embryo with several cotyledons. The cotyledons nourish the developing sporophyte. The ovule provides the seed coat as the mature seed is produced.

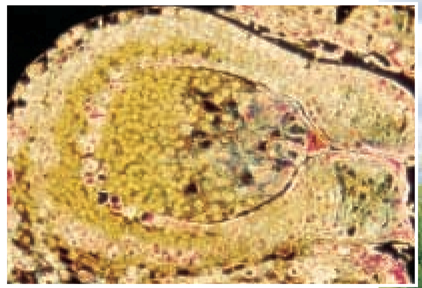
The seed is released when the female cone opens. When conditions are favorable, the seed germinates into a new, young sporophyte—a pine tree seedling, ***Figure 24.7.*** See if you can identify the stages of the life cycle in ***Figure 24.8.*** Use the *Problem-Solving Lab* on this page to further explore the life cycles of mosses, ferns, and conifers.

WORD Origin

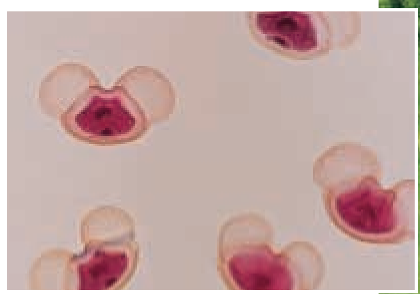
micropyle
From the Greek words *mikros,* meaning "small," and *pyle,* meaning "gate." The micropyle is the small opening at one end of the embryo sac.

Figure 24.6
In conifers, the sporophyte is immense compared with the microscopic gametophytes.

A This pine sporophyte can grow more than 25 meters tall.



B The female gametophyte in this pine ovule is less than 0.01 mm long.



C A pollen grain is so small it can be carried by the wind.

Problem-Solving Lab 24-1 — Making and Using Tables

What traits do mosses, ferns, and conifers share?
Sometimes it helps to organize information in a table. The advantage of a table is that it summarizes traits and shows similarities and differences in a simple format.

Analysis

Copy the following data table. Complete the table using "yes" and "no" answers.

Data Table

Trait	Moss	Fern	Conifer
Has alteration of generations			
Film of water needed for fertilization			
Dominant gametophyte			
Dominant sporophyte			
Sporophyte is photosynthetic			
Produces seeds			
Produces sperm			
Produces pollen grains			
Produces eggs			

Thinking Critically

1. Which two plant groups share the most characteristics? Which two share the fewest?
2. While on a woodland trail, would you easily observe:
   a. A pine gametophyte? Sporophyte? Explain.
   b. A fern gametophyte? Sporophyte? Explain.
3. Using information from your table, summarize the reproductive similarities and differences among mosses, ferns, and conifers.

Figure 24.7
Conifer seeds germinate into new, young sporophytes such as the pine tree seedling shown here.

Problem-Solving Lab 24-1

Purpose
Students will identify and categorize the similarities and differences among mosses, ferns, and pines by completing a chart.

Process Skills
compare and contrast, think critically, analyze information, apply concepts, predict

Teaching Strategies

- You may wish to photocopy the chart and pass out the copies to your students.
- Review the meaning of any terms used in the chart that may be unfamiliar to students.
- Allow students to work in small groups to complete the chart. Make sure they use their text as a reference to aid in verification of answers.
- Review student answers on the chart prior to them answering the questions.

Answers going down each column of the table.
Moss: *yes, yes, yes, no, yes, no, yes, no, yes*
Fern: *yes, yes, no, yes, yes, no, yes, no, yes*
Conifer: *yes, no, no, yes, yes, yes, yes, yes, yes*

Thinking Critically

1. Mosses and ferns share the most characteristics. Mosses and conifers share the least.
2. Both ferns and mosses require a film of water for fertilization. Therefore, both would most likely be found growing in damp or moist environments.
3. All three have alternation of generations and produce sperm and eggs. Both mosses and ferns need water for fertilization; conifers do not. Mosses have a dominant gametophyte; ferns and conifers have a dominant sporophyte. Conifers produce pollen grains and seeds; Mosses and ferns do not.

MEETING INDIVIDUAL NEEDS

Learning Disabled

Visual-Spatial Prepare individual cards with a drawing on each showing one single stage of the life cycle of the pine. Provide a packet of cards to students who are learning disabled. Have students arrange the cards in proper sequence to illustrate the complete life cycle for a typical pine. L1 ELL

Resource Manager

Reinforcement and Study Guide, pp. 105-106 L2
Content Mastery, p. 118 L1
Basic Concepts Transparency 40 and Master L2 ELL
Reteaching Skills Transparency 36 and Master L1 ELL

Assessment

Performance Have students attempt to grow fern gametophytes from spores. Instructions and spores are available through biological supply houses. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC,** p. 25. L3 ELL

3 Assess

Check for Understanding

Ask students to explain the relationships of the following word pairs. L2 ELL

a. gametophyte—sporophyte
b. antheridium—sperm
c. archegonium—egg
d. megaspore—microspore

Reteach

Visual-Spatial Divide the class into small groups and assign different groups the task of making flowcharts of the life cycles of mosses, ferns, and conifers. Have them put their flowcharts on the chalkboard or poster board for class discussion. L2 COOP LEARN

Extension

Have students research which animals use the cones of conifers as a food source. L3

Assessment

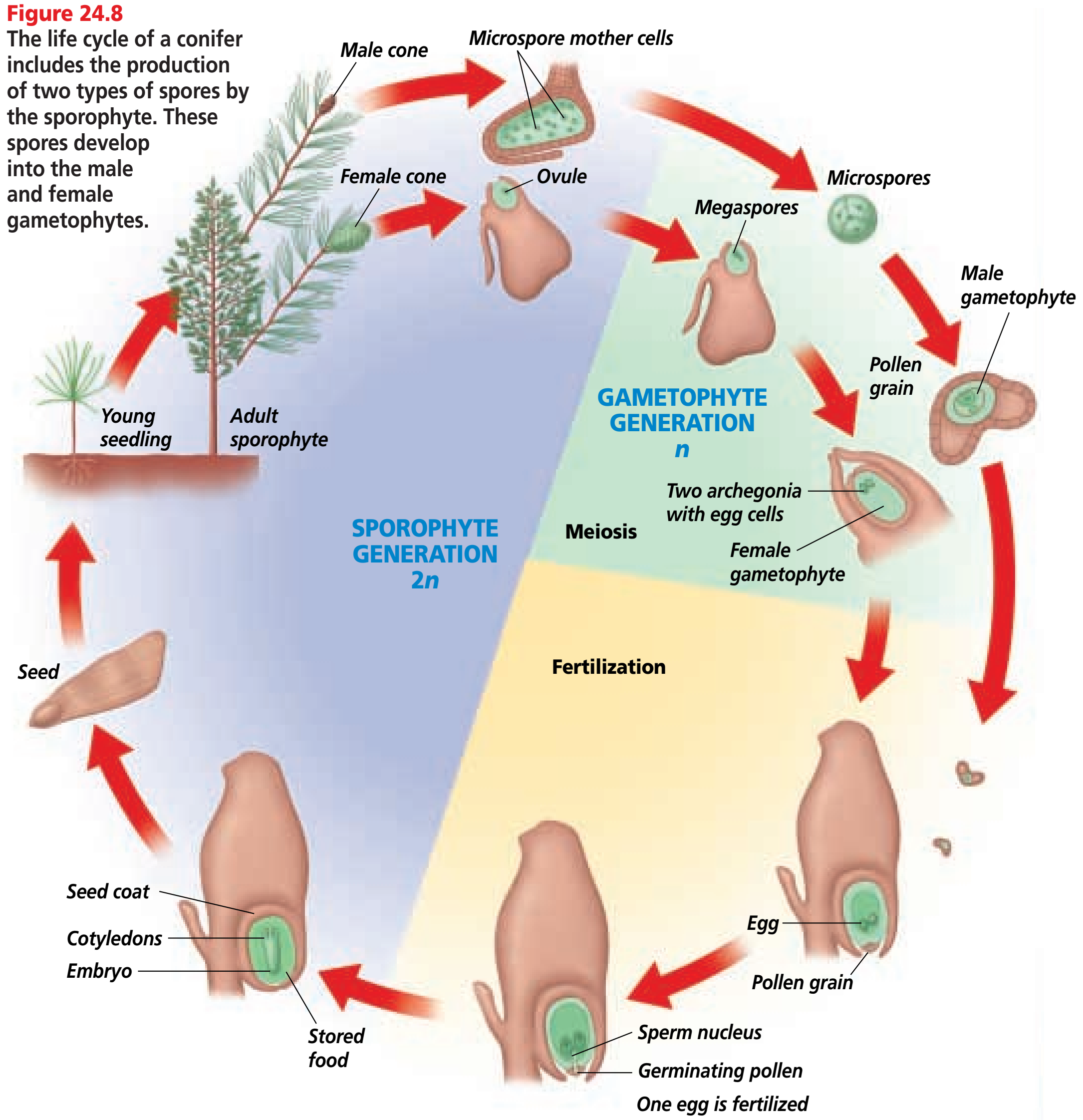
Knowledge Have students explain the role of water in moss, fern, and conifer reproduction. L2

4 Close

Biology Journal

Have students compare the gametophyte and sporophyte generations of mosses, ferns, and conifers. L2

Figure 24.8
The life cycle of a conifer includes the production of two types of spores by the sporophyte. These spores develop into the male and female gametophytes.



Section Assessment

Understanding Main Ideas

1. Explain how vegetative reproduction can produce a new plant. Provide an example.
2. In what way is the sporophyte generation of a moss dependent on the gametophyte generation?
3. Describe the formation of the male gametophyte in a conifer.
4. What are two differences between the life cycle of a fern and that of a conifer?

Thinking Critically

5. Why is the term alternation of generations appropriate to describe the life cycle of a plant?

Skill Review

6. **Sequencing** Sequence the events in the life of a fern, beginning with the prothallus. For more help, refer to *Organizing Information* in the **Skill Handbook.**

Section

24.2 Flowers and Flowering

SECTION PREVIEW

Objectives

Identify the structures of a flower.

Examine the influence of photoperiodism on flowering

Vocabulary

petals
sepals
stamen
anther
pistil
ovary
photoperiodism
short-day plant
long-day plant
day-neutral plant

How would you choose flowers for a garden or a bouquet? Perhaps you would start with fragrant roses, jasmine, or gardenias. You might add color with tall spikes of gladioli, cushions of marigolds, bright daisies, or irises. Grasses would contribute a graceful shape, though their flowers may be so small they are easy to overlook. All of these flowers are beautiful to look at and some have delicate scents as well. In what other ways are all of these flowers alike?

Flowers display a variety of shapes and colors.

What Is a Flower?

The process of sexual reproduction in flowering plants takes place in the flower, which is a complex structure made up of several parts. Some parts of the flower are directly involved in fertilization and seed production. Other floral parts have functions in pollination. There are probably as many different shapes, sizes, colors, and configurations of flower parts as there are species of flowering plants. In fact, features of the flower are often used in plant identification.

The structure of a flower

Even though there is an almost limitless variation in flower shapes and colors, all flowers share a simple, basic structure. A flower is usually made up of four kinds of organs: sepals, petals, stamens, and pistils. The flower parts you are probably most familiar with are the petals. **Petals** are leaflike, usually colorful structures arranged in a circle around the top of a flower stem. **Sepals** are also leaflike, usually green, and encircle the flower stem beneath the petals.

Section 24.2

Prepare

Key Concepts

Flower anatomy and modifications are discussed in this section. The role of photoperiodism in anthophyte reproduction is explained.

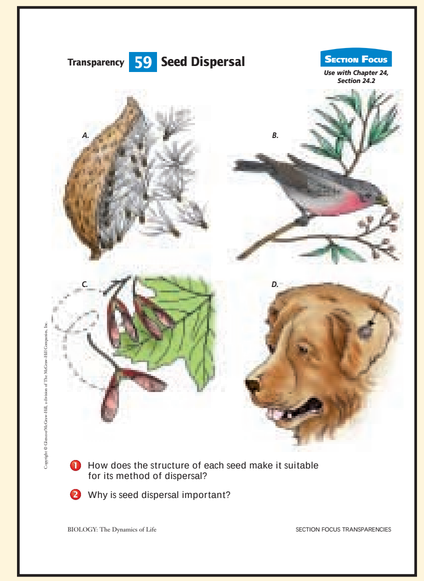
Planning

- Locate flowers for the Quick Demo.
- Purchase flowers for the BioLab.
- Locate flower model for Meeting Individual Needs.
- Collect pictures of different flowers for the CLOSE activity.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 59** on the overhead projector and have students answer the accompanying questions. L1 ELL



Section Assessment

1. Vegetative reproduction is when a new plant is produced from an existing vegetative structure. An example would be the growth of liverworts from the gemmae that fall off a parent plant.
2. The sporophyte depends upon the gametophyte for support and most of its nutrition.
3. The sporangia within the male pinecone produce microspores. The microspores develop into the male gametophyte or pollen grain.
4. The gametophyte is dominant in mosses, whereas the sporophyte is dominant in ferns. In ferns, the sporophyte can exist independently of the gametophyte but in mosses the sporophyte remains dependent upon the gametophyte.
5. The sporophyte generation alternates with the gametophyte generation in the life cycle.
6. Prothallus ⇒ forms egg and sperm ⇒ fertilization of egg by sperm forms a young sporophyte ⇒ sporophyte produces spores ⇒ spores germinate to each form a prothallus.

Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

2 Teach

Quick Demo

Display a flower such as a rose or daffodil. Elicit the function of the flower. *It is a reproductive structure.* Ask if grass also reproduces through flowers. *Most students will answer no.* Explain that grass is a flowering plant but is often not recognized as such because its flowers do not have showy petals.

INVESTIGATE BioLab The BioLab at the end of the chapter can be used at this point in the lesson.

Assessment

Skill Have students construct a chart that summarizes flower structures and the function of each part. Their chart should include petals, sepals, pistil, and stamens. L2

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Angiosperm*
Disc 3

Inside the circle of petals are the stamens. A **stamen** is the male reproductive structure of a flower. At the tip of the stamen is the **anther.** The anther produces pollen that contains sperm.

At the center of the flower, attached to the top of the flower stem, lie one or more pistils. The **pistil** is the female structure of the flower. The bottom portion of the pistil enlarges to form the **ovary,** a structure with one or more ovules, each containing one egg. As you read in the previous section, the female gametophyte develops inside the ovule. You can learn more about floral structure and practice your lab skills in the *BioLab* at the end of this chapter.

Modifications in flower structure

A flower that has all four organs—sepals, petals, stamens, and pistils—is called a complete flower. The morning glory and tiger lily shown in ***Figure 24.9*** are examples of complete flowers. A flower that lacks one or more organs is called an incomplete flower. For example, squash plants have separate male and female flowers. The male flowers have stamens but no pistils; the female flowers bear pistils but no stamens.

Figure 24.9
The diversity of flower forms is evidence of the success of flowering plants.

B The male flowers of the walnut tree form long catkins.

A The spotted petals of the tiger lily curl away from the reproductive structures at the center of the flower.

C The petals of the morning glory are fused together to form a bell shape.

D Thistles bear clusters of tiny, tubular flowers within a mass of spiny bracts.

E The location of corn tassels at the top of the plant aids in wind pollination.

Plants such as sweet corn that are adapted for pollination by wind rather than animal pollinators have no petals. ***Figure 24.9*** shows some examples of the variety in flower forms. Study the structure of a typical flower in the *Inside Story.* You can explore flower adaptations further in the *Problem-Solving Lab* shown here.

There is an amazing amount of diversity in the structures of anthophyte flowers, seeds, fruits, and vegetative structures. Anthophytes are divided into different divisions and classes based on these differences. The relationships among the different classes and divisions of anthophytes are shown in ***Figure 24.10.*** See if you can recognize any of the different divisions of plants.

Photoperiodism

The relative length of day and night has a significant effect on the rate of growth and the timing of flower production in many species of flowering plants. For example, chrysanthemums produce flowers only during the fall, when the days are getting shorter and the nights longer. A grower who wants to produce chrysanthemum flowers in the middle of summer drapes black cloth over the plants to artificially increase the length of night. The response of flowering plants to the difference in the duration of light and dark periods in a day is called **photoperiodism.**

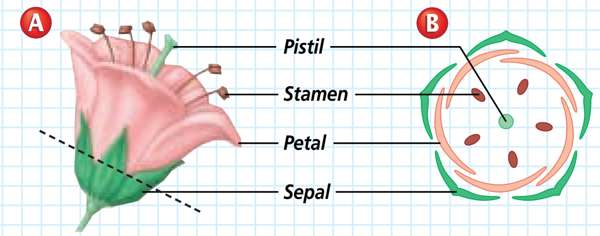
Plant biologists originally thought that day length controlled flowering. However, they now know that it is the length of the night, or dark period, that controls flowering. Plants can be placed in three categories depending on the conditions they require for flower production. Plants are either short-day plants, long-day plants, or day-neutral plants.

Problem-Solving Lab 24-2 — Interpreting Scientific Illustrations

How do flowers differ? There is considerable variation in flower shape. This variation occurs when certain flower parts are fused together, parts are rearranged, or when parts may be totally missing. However, with all the variation seen in flower shape, there are certain general patterns. Almost all dicot plants will have flower parts that are in fours or fives or multiples of these numbers. For example, a plant having eight or ten petals, sepals, and stamens would be a dicot. Almost all monocot plants have flower parts in threes or multiples of three.

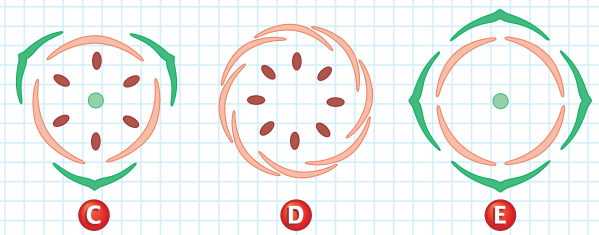
Analysis

Diagram A shows a flower with all of its parts labeled. Imagine that the flower has been cut along the dashed line. Diagram B is a diagrammatic cross-section view seen when looking down onto the cut edge of the bottom half. Diagram B is shown a little larger than A so that any details can be more clearly seen. The flower is from a dicot plant because there are five sepals, petals, and stamens.



Thinking Critically

1. Diagrams C, D, and E are diagrammatic cross-section views of flowers. Determine if diagram:
   a. C is a monocot or dicot. Explain.
   b. D is a monocot or dicot. Explain.
   c. E is a monocot or dicot. Explain.
2. Do diagrams A, C, D, and E show flowers that are complete or incomplete? Explain. Note: Complete flowers have sepals, petals, stamens, and pistils whereas incomplete flowers lack one or more of these parts.
3. Which flowers are capable of self-pollination? Explain.
4. Which flowers require cross-pollination? Explain.



Problem-Solving Lab 24-2

Purpose
Students will study and interpret diagrams of flower cross sections.

Process Skills
think critically, compare and contrast, interpret scientific illustrations

Teaching Strategies
- Review the basic anatomy of a flower before this activity.
- Make sure that students understand the differences between complete and incomplete flowers.
- Review the characteristics of monocots and dicots.
- Provide examples of flowers having floral structures in multiples of three, four, and five.
- Illustrate a "cross-section" cut using a cucumber as an example.

Thinking Critically

1. a. monocot; flower parts in threes
   b. dicot; flower parts in four or multiples of four
   c. dicot; flower parts in fours or multiples of four
2. A and C are complete flowers as all flower parts are present. D and E are incomplete flowers as D is missing sepals and E is missing a pistil.
3. A, C, and D as they have both stamens and pistils. Both male and female flower parts are needed for self-fertilization
4. E requires cross-pollination as it does not have a pistil.

Assessment

Performance Have students make a sketch of diagrams C through D and label the flower parts. Have them make a cross-section diagram of the female flower of E. Use the Performance Task Assessment List for Scientific Drawing in **PASC,** p. 55. L2 ELL

Meeting Individual Needs

Visually Impaired

Kinesthetic Purchase or borrow a large flower model. Allow visually impaired students to manipulate the model as you name and describe the function of each part. Have the student then tell you if the part is male, female, or neither in terms of flower function. L1 ELL

Portfolio

Flower Modifications

Linguistic Have students collect pictures of flowers showing different structural modifications. Next to each picture have the students write a brief paragraph describing the adaptive value of the modification. L2 P

Biology Journal

Keeping a Plant Diary

Linguistic Have students imagine that they are a chrysanthemum. It is springtime and they have just started growing. Ask them to describe what they look like, explain why they are not forming flowers, and indicate the relative lengths of day and night. Have students repeat the process for each of the other seasons. L1

Resource Manager

Reteaching Skills Transparency 37 and Master L1 ELL
Basic Concepts Transparency 41 and Master L2 ELL
Section Focus Transparency 59 and Master L1 ELL

Enrichment

Intrapersonal Advise students that the light that triggers flower production does not have to reach the plant's flower buds, but must reach and be detected by the leaves. Have students design an experiment to prove that it is the leaf that must be stimulated by light for the plant to achieve flowering. Suggest that it is possible to place parts of the plant behind light barriers while other parts of the same plant are exposed to light. L3

Reinforcement

Explain to students that lily growers get their greenhouse plants to flower early in spring by subjecting the plant to artificial lighting that simulates longer days and shorter nights. Ask students if lilies are short-day plants or long-day plants. *long-day*

Display

Visual-Spatial Using Figure 24.10 as a guide, have students create a giant fan diagram on the wall or on a bulletin board. Ask them to bring in pictures of monocots and dicots to add to the display. L2 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Blooming Flowers*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Blooming Flowers (Ch. 21)
Disc 1, Side 2, 26 sec.

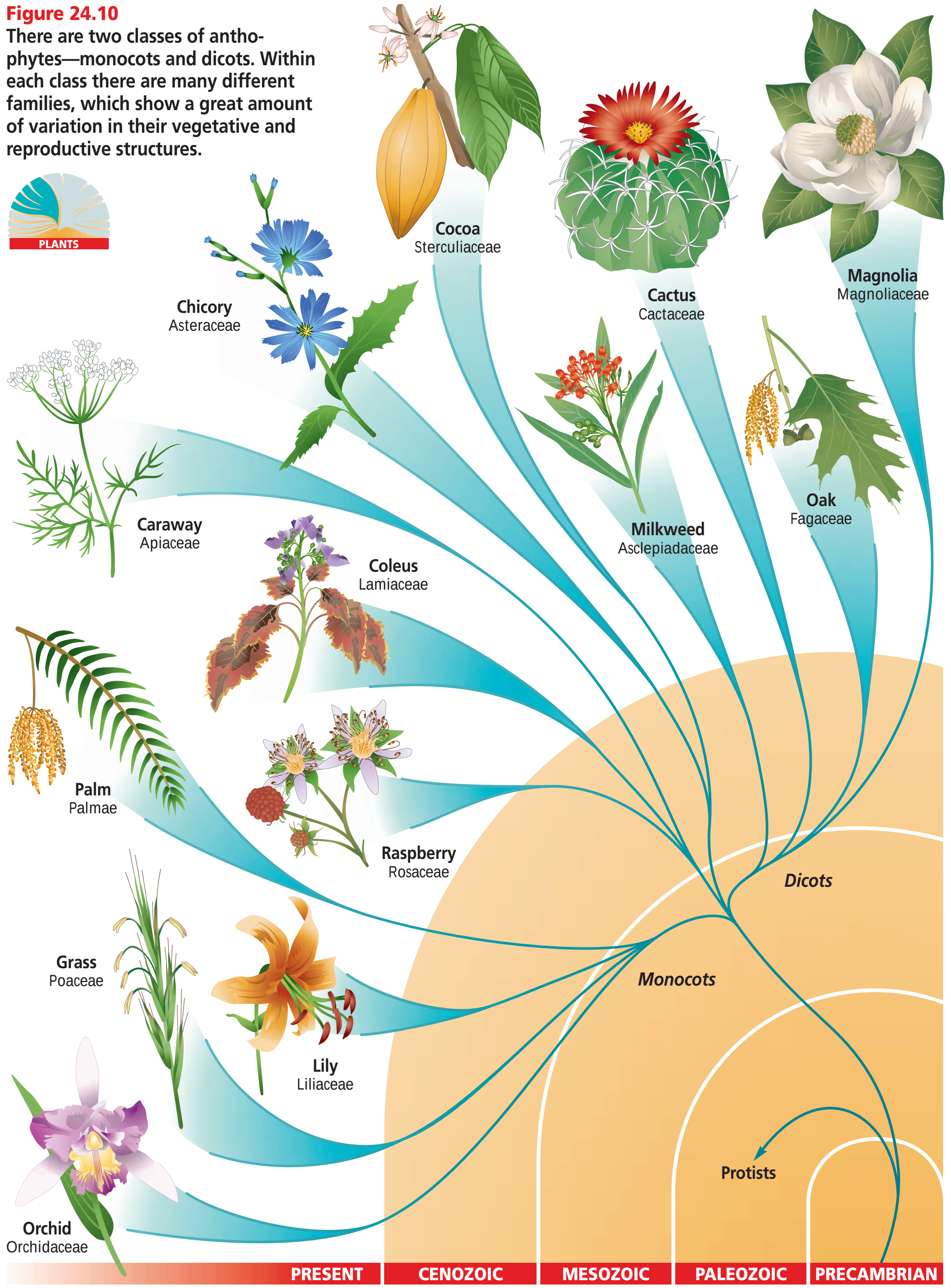


Figure 24.10
There are two classes of anthophytes—monocots and dicots. Within each class there are many different families, which show a great amount of variation in their vegetative and reproductive structures.

PROJECT

Are Bees the Best?

Intrapersonal Members of the *Brassica* genus can be pollinated with cotton swabs, paint brushes, and dried bees. Have students design an experiment to determine whether or not bees are the most efficient pollinators. L3

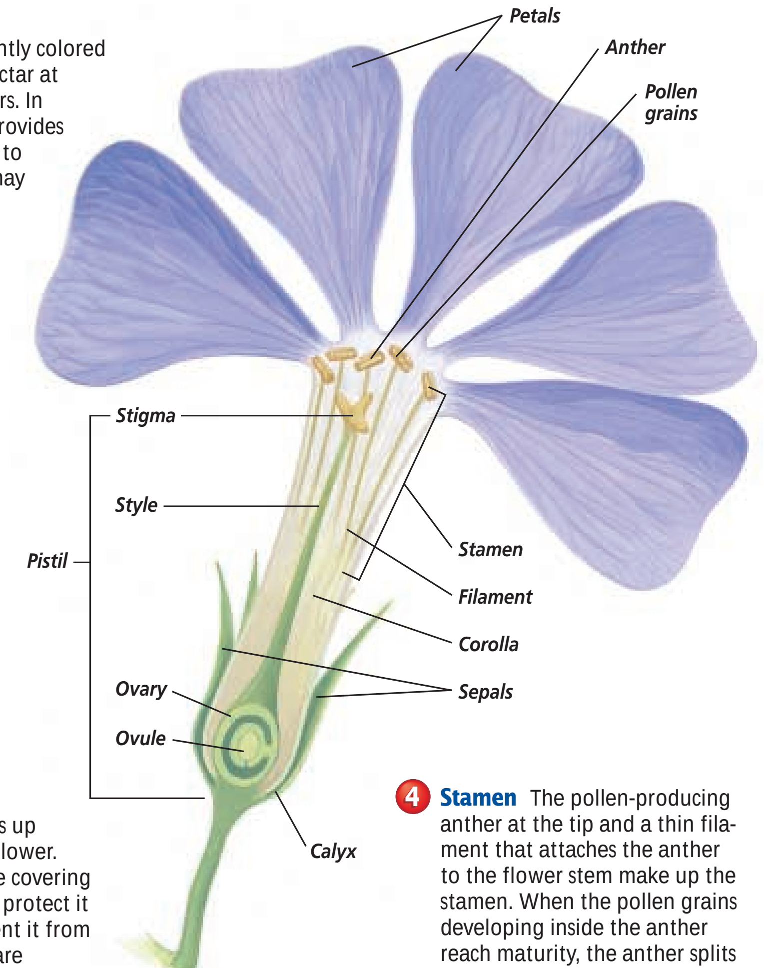
INSIDE STORY

Parts of a Flower

Blue phlox

Of the four major organs of a flower, only two—the stamens and pistils—are fertile structures directly involved in seed development. Sepals and petals support and protect the fertile structures and help attract pollinators. The structure of a typical flower is illustrated here by a phlox flower.

Critical Thinking ***How are different flower shapes important to a plant's survival?***



1. **Petals** These are usually brightly colored and often have perfume or nectar at their bases to attract pollinators. In many flowers, the petal also provides a surface for insect pollinators to rest on while feeding. Petals may be fused to form a tube, or shaped in ways that make the flower more attractive to pollinators.

2. **Stigma** At the top of the pistil is this sticky or feathery surface on which pollen grains land and grow. The style is the slender stalk of the pistil that connects the stigma to the ovary. The pollen tube grows down the length of the style to reach the ovary. The ovary, which will eventually become the fruit, contains the ovules. Each ovule, if fertilized, will become a seed.

3. **Sepals** A ring of sepals makes up the outermost portion of the flower. The sepals serve as a protective covering for the flower bud, helping to protect it from insect damage and prevent it from drying out. Sepals sometimes are colored and resemble petals.

4. **Stamen** The pollen-producing anther at the tip and a thin filament that attaches the anther to the flower stem make up the stamen. When the pollen grains developing inside the anther reach maturity, the anther splits open to release them.

MEETING INDIVIDUAL NEEDS

English Language Learners/ Learning Disabled

Visual-Spatial Have students create a table with the heads Male, Female, Neither male nor female. Ask students to list the following structures beneath the appropriate head: stamen, pistil, anther, calyx, corolla, ovary, stigma, petal, sepal, pollen, egg, ovule, style. L1 ELL

Resource Manager

Reinforcement and Study Guide, p. 107 L2 ELL
Content Mastery, p. 119 L1

INSIDE STORY

Purpose

To describe flower anatomy and identify the role flower parts play in reproduction.

Teaching Strategies

- Ask students to explain why stamens and pistils are described as the fertile structures in a flower. *These structures are involved in the production of egg and sperm.* Elicit what role is played by flower organs that are not important in fertilization. *These organs attract pollinators or protect young or immature fertile flower parts.* L2

Visual Learning

- Ask students to use the captions to explain how the following pairs of terms are related: (a) sepals and calyx; (b) petals and corolla; (c) stamen and anther; (d) stigma and style; (e) ovary and ovule. L1

Critical Thinking

The shape of a flower may promote different pollination methods. For example, tubular flowers are probably pollinated by animals.

Chalkboard Activity

Write the following phrases on the chalkboard: contains chlorophyll, contains anthocyanin, where meiosis takes place, contains gametophyte, is part of the sporophyte, contains diploid cells, forms spores, forms microspores, forms megaspores. Ask students to identify the flower organ or organs described by each phrase. L2

3 Assess

Check for Understanding

Ask students to explain the relationships of the following word groups. L2 ELL

a. stamen—anther
b. pistil—stigma—ovary
c. ovary—ovule

Reteach

Obtain a flower model. As you point out structures on the model, have students name each structure and explain its function. L1

Extension

Linguistic Have students determine the meaning of the terms androecium, gynoecium, and perianth. Have them assign the term sterile or nonsterile to each flower part. L3

Assessment

Performance Provide students with a diagram of a typical flower. Have them label the parts of the flower and identify reproductive parts. L1

4 Close

Discussion

Visual-Spatial Show students pictures of flowers with different structural modifications. Have them point out the different flower parts and speculate as to the advantage of the modification. L2

Figure 24.11
Photoperiodism refers to a plant's sensitivity to the changing length of night.

A Short-day plants, such as pansies (above) and goldenrod, flower in late summer and fall or early spring.

B Spinach and lettuce (above) are long-day plants that flower in midsummer.

C Most plants are day-neutral. Flowering in cucumbers (above), tomatoes, and corn is not influenced by a dark period.

> **Word Origin**
> **photoperiodism**
> From the Greek words *photos*, meaning "light," and *periodos*, meaning "a period." The flowering response of a plant to periods of dark and light is photoperiodism.

Short-day plants are induced to flower by exposure to a long night. These are plants that usually form flower buds in the fall when the days are getting shorter and the nights are long, as shown in ***Figure 24.11A.*** Flowering occurs in the spring, as in crocuses, or in the fall as in strawberry plants. **Long-day plants** flower when days are longer than the nights, as shown in ***Figure 24.11B.*** Examples of these are carnations, petunias, potatoes, and garden peas. Most plant species are **day-neutral plants,** which means temperature, moisture or environmental factors other than day length control their flowering times, as shown in ***Figure 24.11C.*** The photoperiodism of flowers may ensure that a plant produces its flowers at a time when there is an abundant population of pollinators. This is important because pollination is a critical event in the life cycle of a flowering plant.

Section Assessment

Understanding Main Ideas

1. Compare and contrast sepals and petals.
2. Describe the male and female parts of a flower.
3. Explain why squash flowers are considered incomplete flowers.
4. How does photoperiodism influence flowering?

Thinking Critically

5. In the middle of the summer a florist receives a large shipment of short-day plants. What must the florist do to induce flowering?

Skill Review

6. **Comparing and Contrasting** Explain why the structure of wind-pollinated flowers is often different from that of insect pollinated flowers. For more help, refer to *Organizing Information* in the **Skill Handbook.**

Section

24.3 The Life Cycle of a Flowering Plant

Transferring pollen from anther to stigma is just one step in the life cycle of a flowering plant. How does pollination lead to the development of seeds encased in fruit? How do sperm cells in the pollen grain reach the egg cells in the ovary? These steps in the reproductive cycle of anthophytes take place without water—an evolutionary step that enabled flowering plants to occupy nearly every environment on Earth.

Bee orchid *Ophrys speculum* and ovary of a flower (inset)

> **SECTION PREVIEW**
> **Objectives**
> **Describe** the life cycle of a flowering plant.
> **Outline** the processes of seed and fruit formation and seed germination.
> **Vocabulary**
> polar nuclei
> double fertilization
> endosperm
> dormancy
> germination
> radicle
> hypocotyl

The Life Cycle of an Anthophyte

The life cycle of flowering plants is similar to that of conifers in many ways. In both coniferophytes and anthophytes, the gametophyte generation is contained within the sporophyte. Many of the reproductive structures are also similar. However, anthophytes are the only plants that produce flowers and fruits. ***Figure 24.12*** summarizes the life cycle of flowering plants.

Development of the female gametophyte

In anthophytes, the female gametophyte is formed in the ovule within the ovary. In the ovule, a cell undergoes meiosis, producing haploid megaspores. One of these megaspores will produce the female gametophyte. The other three spores die. In most flowering plants, the megaspore divides by mitosis three times, producing eight nuclei. These eight nuclei are the embryo sac or female gametophyte. Six of the nuclei are contained within six haploid cells, one of which is the egg cell. The two remaining nuclei, which are called **polar nuclei,** are both in one cell. This cell, the central cell, is located at the center of the embryo sac. The egg cell is near the micropyle. The other five cells are arranged as shown in ***Figure 24.13.***

Section 24.3

Prepare

Key Concepts

The formation of anthophyte gametophytes, pollination, and double fertilization are presented. Seed and fruit development are then discussed. The section ends with an explanation of seed dispersal and seed germination.

Planning

- Purchase peanuts for the Quick Demo.
- Find flowers for Assessment.
- Purchase bean seeds for the Tech Prep.
- Purchase beans and tetrazolium chloride for the Alternative Lab.
- Purchase tomato and peach for the Quick Demo.
- Purchase corn and bean seeds for MiniLab 24-2.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 60** on the overhead projector and have students answer the accompanying questions. L1 ELL

Section Assessment

1. Both are leaflike structures. Petals are bright colors. Sepals are usually green.
2. The male part is the stamen, which consists of the anther and filament. The female part is the pistil, which contains the ovary and ovules.
3. Squash flowers are incomplete because they do not have both pistils and stamens.
4. Flowering is controlled by photoperiodism. For example, short-day plants flower when the days are short and nights are long.
5. The florist should cover the greenhouse with tarps each afternoon to shorten the day and lengthen the night.
6. Wind-pollinated flowers are small and lack petals. Insect-pollinated flowers have brightly colored petals and nectar.

Resource Manager

Section Focus Transparency 60 and Master L1 ELL

Quick Demo

Visual-Spatial Show students the tiny sporophyte inside a peanut. It is the structure with two tiny leaves. **CAUTION:** *Do not allow students to eat the peanuts as some students may be allergic to them.*

Reinforcement

Visual-Spatial Provide students with a black line drawing of the life cycle of a flowering plant. Using colored pencils, have them shade in the gametophyte stage and the sporophyte stage in two different colors. L1 ELL

Microscope Activity

Visual-Spatial Have students view prepared slides of *Lilium* ovaries. Ask students to draw and label an ovule. L1

Resource Manager

Basic Concepts Transparency 42 and Master L2 ELL

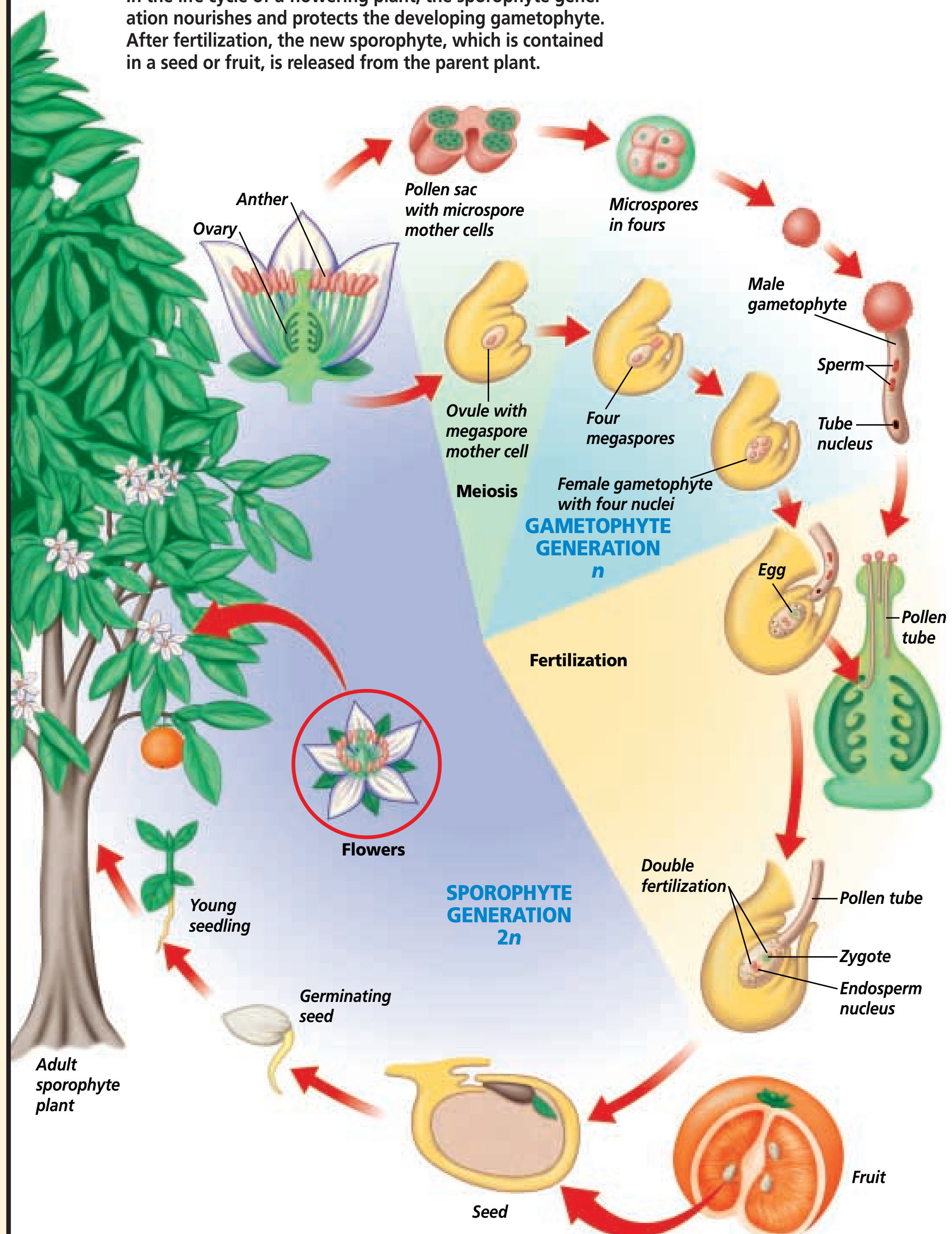


Figure 24.12
In the life cycle of a flowering plant, the sporophyte generation nourishes and protects the developing gametophyte. After fertilization, the new sporophyte, which is contained in a seed or fruit, is released from the parent plant.

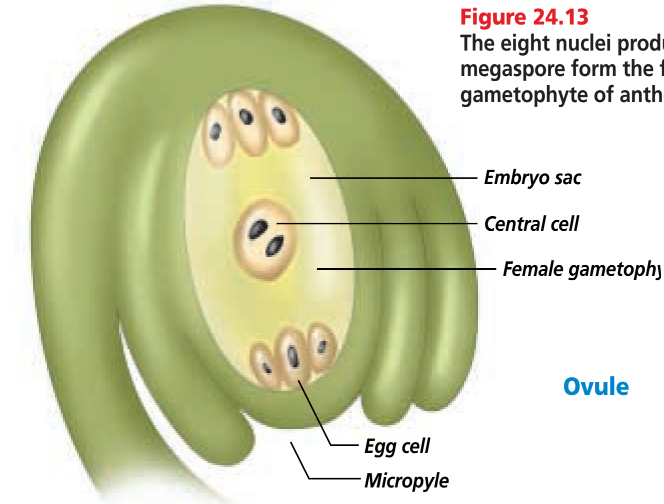


Figure 24.13
The eight nuclei produced by the megaspore form the female gametophyte of anthophytes.

Development of the male gametophyte

The formation of the male gametophyte begins in the anther, as seen in *Figure 24.14.* Haploid microspores are produced by meiosis within the anther. The microspores each divide into two cells. A thick, protective wall surrounds these two cells. This two-celled structure is the immature male gametophyte, or pollen grain. The cells within the pollen grain are the tube cell and the generative cell. When the pollen grains are mature the anther splits open. Depending on the type of flower, the pollen may be carried to the pistil by wind, water, or animals.

Pollination

In anthophytes, pollination is the transfer of the pollen grain from the

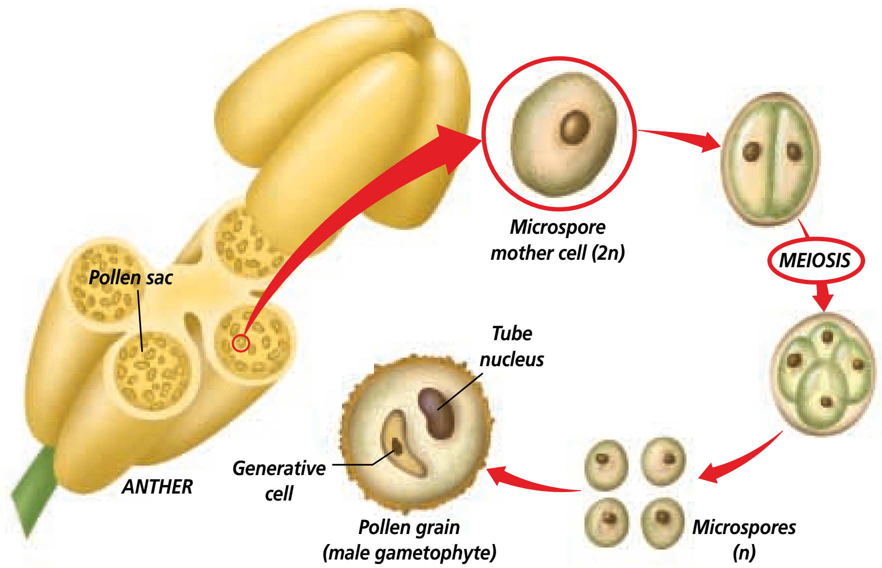


Figure 24.14
Meiotic division of each of many cells within the anther produces four microspores. These microspores develop into the male gametophyte or pollen grain

Building a Model

Kinesthetic Use a plastic sandwich bag to represent a female gametophyte. Place three small balls of clay of the same color within the bag and explain that each ball represents a haploid nucleus. (One is the egg and the other two are the central cell.) Introduce two small balls of clay of a different color to the bag. Explain that each ball represents the two sperm nuclei that enter the female gametophyte. Fuse one sperm with the egg and explain that this represents the zygote, which is now diploid. Fuse the other three nuclei. Explain that this represent the triploid nucleus that forms endosperm. Point out that together the fusing of the clay illustrates double fertilization. L1

Assessment

Knowledge Show students a flower pistil that has been cut open to reveal the ovary. Ask them to point to where the following occur: growth of pollen tube, development of female gametophyte, and double fertilization. L2

Biology Journal

Flowering Plant Life Cycle

Linguistic Have students write a paragraph in their journal outlining the steps of a flowering plant's life cycle. Encourage them to illustrate the concepts with drawings. L2

Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Reinforcement

Ask students to explain how a plant can reproduce sexually if its flowers are incomplete. Pollen from the male flower can be carried to the female flower by wind, insects, or other animals.

Tying to Previous Knowledge

Ask students to answer the following questions. (a) Why is pollen needed for fertilization? *It contains sperm cells.* (b) Why must the pollen that fertilizes a flower be from the same species as the female flower? *Chromosome numbers and alleles must be identical for fertilization to occur.* (c) What will happen if pollen lands on the wrong species of flower? *No pollen tube will form and fertilization will not occur.*

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *Pollination*
Disc 3

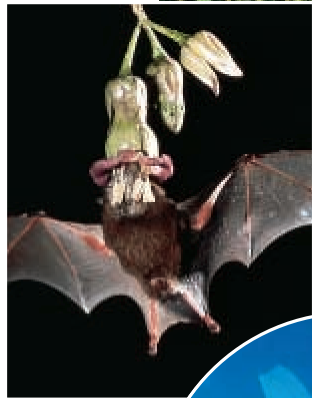
NATIONAL GEOGRAPHIC

VIDEODISC
STV: Plants
What is a Seed?
Unit 4, Side 3, 3 min.
Germination

Figure 24.15
The shape, color, and size of a flower reflect its relationship with a pollinator.

A The butterfly uses its long proboscis to sip nectar that bees and flies cannot reach.

B The wind-pollinated flowers of this ragweed plant are small and green and lack structures that would block wind currents.



C Bats sip nectar from night-blooming flowers with a strong, musty odor, such as bananas and some cacti.

D Flowers pollinated by hummingbirds are often tubular and colored bright red or yellow but may have little scent.

E The ultraviolet markings of some flowers guide insects to a flower's nectar.

anther to the pistil. Plant reproduction is most successful when the pollination rate is high, which means that the pistil of a flower receives enough pollen of its own species to fertilize the egg in each ovule. Many anthophytes have elaborate mechanisms that help ensure that pollen grains are deposited in the right place at the right time. Some of these are shown in *Figure 24.15.* Although it may seem wasteful for wind-pollinated plants to produce such large amounts of pollen, it does help ensure pollination. Most anthophytes pollinated by animals produce nectar, which serves as a valuable, highly concentrated food for visitors to the flowers. Nectar is a liquid made up of proteins and sugars. It usually collects in the cuplike area at the base of the petals. Animals such as insects and birds brush up against the anthers while trying to get to the nectar. The pollen that attaches to them can be carried to another flower, resulting in pollination. Some insects also gather pollen to use as

food. By producing nectar and attracting animal pollinators, animal-pollinated plants are able to promote pollination without producing large amounts of pollen.

Some nectar-feeding pollinators are attracted to a flower by its color or scent or both. Some of the bright, vivid flowers attract pollinators such as butterflies and bees. Some of these flowers have markings that are invisible to the human eye but are easily seen by insects. Flowers that are pollinated by beetles and flies have a strong scent but are often dull in color.

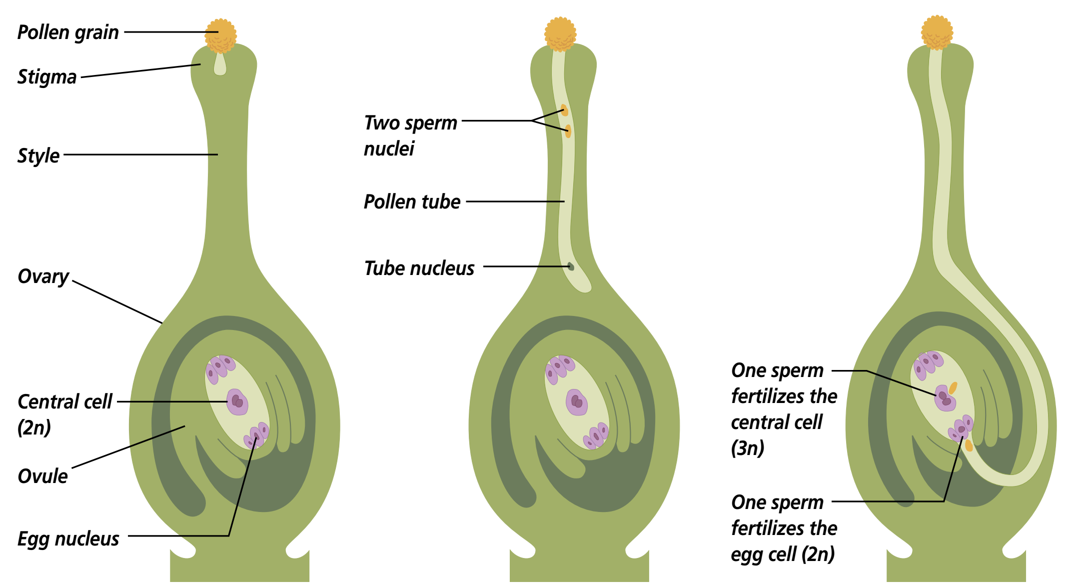
Many flowers have structural adaptations that favor cross-pollination. This results in greater genetic variation because the sperm from one plant fertilizes the egg from another. For example, the flowers of certain species of orchids resemble female wasps. The male wasps visit the flower and attempt to mate with it and become covered with pollen, which is deposited on orchids it may visit in the future.

Fertilization

Once a pollen grain has reached the stigma of the pistil, several events take place before fertilization occurs. Inside each pollen grain are two haploid cells, the tube cell and the generative cell. The tube cell nucleus directs the growth of the pollen tube down through the pistil to the ovary, as shown in *Figure 24.16.* The generative cell divides by mitosis, producing two haploid sperm cells. The sperm cells are transported by the pollen tube through a tiny opening in the ovule called the micropyle.

Within the ovule is the female gametophyte, composed of eight haploid cells. One of the sperm unites with the egg cell forming a diploid zygote, which begins the new sporophyte generation. The other sperm cell fuses with the central cell, which contains the polar nuclei, to form a cell with a triploid ($3n$) nucleus. This process, in which one sperm fertilizes the egg and the other sperm joins with the central cell, is called **double fertilization.**

Figure 24.16
In flowering plants, the male gametophyte grows through the pistil to reach the female gametophyte. Double fertilization involves two sperm cell nuclei. One sperm cell unites with the egg nucleus and the other sperm cell unites with the diploid central cell of the female gametophyte.



Revealing Misconceptions

Students may believe that "hay fever" is an allergy to hay. However, hay fever is an allergic reaction to the protein present in pollen. Often, the pollen is produced by plants that bloom in the early fall or spring.

Enrichment

There are many different mechanisms to ensure pollination. Tell students about the carrion flowers that have a fragrance similar to rotting flesh that attracts its pollinators—flies and beetles. One species of aquatic plant releases its pollen in a "pollen boat" that floats on the water's surface until it slides down the dimple created by the surface tension around nearby flowers.

Concept Development

Corn has male and female flowers found on different parts of the same plant. Have students explain what a corn tassel is, where the female corn flower is located, and what corn silk is. *The corn tassel is composed of all the stamens of many male flowers. The corn silk is composed of all the styles of many female flowers. The corn kernels on the cob are fertilized fruits of the plant.*

Portfolio

Cross- and Self-Pollination

Visual-Spatial Have students prepare a series of drawings that explain the concepts of cross-pollination and self-pollination. Instruct students to include proper labels and titles for the drawings. Non-artistic students may be provided with a flower outline that they can trace for their diagrams. L2 ELL P

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Double Fertilization (Ch. 24)
Disc 1, Side 2, 49 sec.

CD-ROM
Biology: The Dynamics of Life
Animation: *Double Fertilization*
Disc 3

Quick Demo

Show students a tomato and a peach. Ask how the two plant parts are alike and how they differ. *Students may suggest that both have seeds but that one is a fruit and one is a vegetable.* Ask students to provide definitions for *fruit* and *vegetable.* Use their definitions to point out that a tomato is a fruit. If students are still not sure of the relationship, ask how the seeds got inside the two structures and what was present on the plant before the tomato or peach appeared.

Concept Development

Show students an apple. Explain that an apple is a "false fruit." Explain that unlike most fruits, which form from the ovary wall, the fleshy part of an apple forms from the swollen receptacle.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Fruit Formation*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Fruit Formation (Ch. 25)
Disc 1, Side 2, 39 sec.

WORD Origin

endosperm
From the Greek words *endon,* meaning "within," and *sperma,* meaning "seed." The endosperm is storage tissue found in the seeds of many anthophytes.

Double fertilization is unique to anthophytes and is illustrated in *Figure 24.16.* The triploid nucleus will divide many times, eventually forming the endosperm of the seed. The **endosperm** is food storage tissue that supports development of the embryo in anthophyte seeds.

Many flowers contain more than one ovule. Pollination of these flowers requires that at least one pollen grain land on the stigma for each ovule contained in the ovary. In a watermelon plant, for example, hundreds of pollen grains are required to pollinate a single flower if each ovule is to be fertilized. You are probably familiar with the hundreds of watermelon seeds that are the result of this process.

Seeds and Fruits

The embryo contained within a seed is the next sporophyte generation. The formation of seeds and the fruits that enclose them help ensure the survival of the next generation.

Seed formation

After fertilization takes place, most of the flower parts die and the seeds begin to develop. The wall of the ovule becomes the hard seed coat, which may aid in dispersal and helps protect the embryo until it begins growing into a new plant. Inside the ovule, the zygote divides and grows into the plant embryo. The triploid central cell develops into the endosperm.

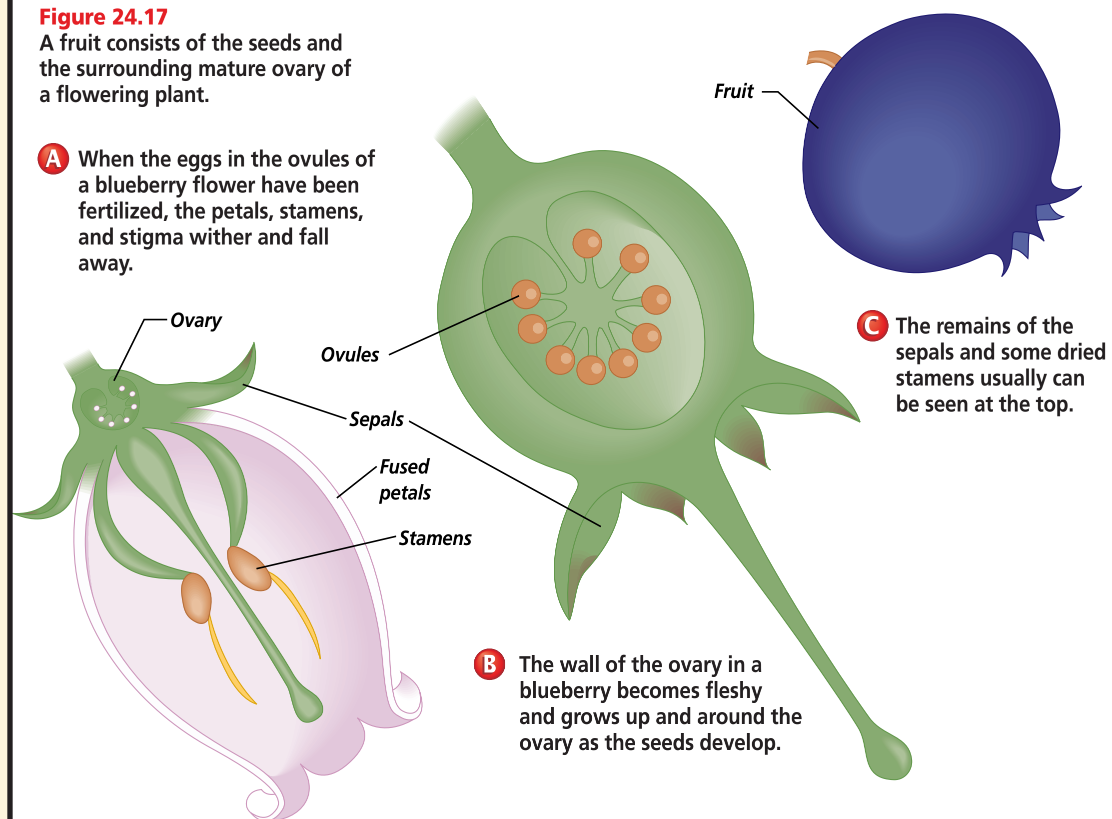


Figure 24.17
A fruit consists of the seeds and the surrounding mature ovary of a flowering plant.

A When the eggs in the ovules of a blueberry flower have been fertilized, the petals, stamens, and stigma wither and fall away.

B The wall of the ovary in a blueberry becomes fleshy and grows up and around the ovary as the seeds develop.

C The remains of the sepals and some dried stamens usually can be seen at the top.

Fruit formation

As the seeds develop, the surrounding ovary enlarges and becomes the fruit. A fruit is the structure that contains the seeds of an anthophyte. *Figure 24.17* shows how the fruit of a blueberry develops from the ovary inside the flower.

A fruit is as unique to a plant as its flower, and many plants can be identified by examining the structure of their fruit. You are familiar with plants that develop fleshy fruits, such as apples, grapes, melons, tomatoes, and cucumbers. Other plants develop dry fruits such as peanuts, sunflower "seeds," and walnuts. In dry fruits, the ovary around the seeds hardens as the fruit matures. Some plant foods that we call vegetables or grains are actually fruits, as shown in *Figure 24.18.* Can you think of any vegetables that are actually fruits? For example, tomatoes are fleshy fruits that are often referred to as vegetables.

CAREERS IN BIOLOGY

Greens Keeper

Do you like to work outside? Is golf your favorite sport? Then you already know the value of a velvety green fairway, which is the first requirement in becoming a greens keeper.

Skills for the Job

A greens keeper maintains both the playing quality and the beauty of a golf course. Beginning keepers usually learn on-the-job and spend their days mowing the greens. Greens keepers who want to manage large crews will need a two- or four-year degree in turf management and a certificate in grounds management. They must be thoroughly familiar with different types of grasses and know how weather and wear affect them so they can keep fairways smooth and perfectly green. Other careers in turf management including caring for the grounds of shopping centers, schools, sports playing fields, cemeteries, office buildings, and other locations.

interNET CONNECTION For more careers in related fields, be sure to check the Glencoe Science Web Site.
www.glencoe.com/sec/science

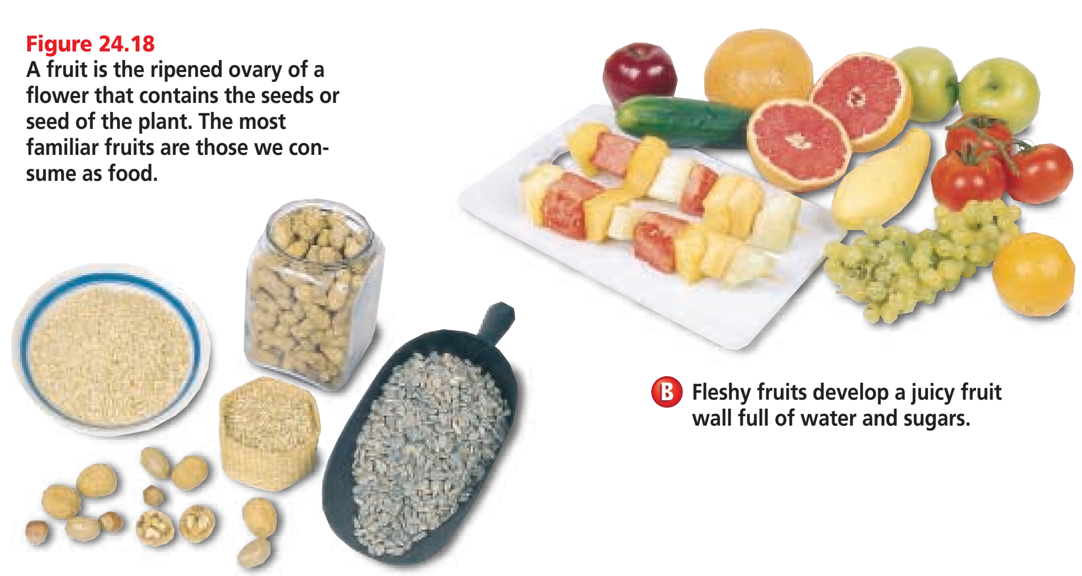


Figure 24.18
A fruit is the ripened ovary of a flower that contains the seeds or seed of the plant. The most familiar fruits are those we consume as food.

A Dry fruits have dry fruit walls. The ovary wall may start out with a fleshy appearance, as in hickory nuts or bean pods, but when the fruit is fully matured, the ovary wall is dry.

B Fleshy fruits develop a juicy fruit wall full of water and sugars.

CAREERS IN BIOLOGY

Career Path

Courses in high school: biology, botany, chemistry, mathematics
College: two- or four-year degree to become a crew supervisor
Other education sources: on-the-job training

Career Issue

With so many issues and problems in today's world, ask students if they think anyone should be concerned about the quality of a golf course. Have them explain the reasons for their opinions.

For More Information

For more information on becoming a greens keeper, students can write to:

Professional Grounds Management Society
120 Cockeysville Road, Suite 104
Hunt Valley, MD 21031

Enrichment

Visual-Spatial Have students research the type of fruits: cypsela, berry, pome, follicle, legume, capsule, and aggregate. Ask them to create a visual that defines each fruit type and shows examples of each. L3

MEETING INDIVIDUAL NEEDS

English Language Learners

Visual-Spatial Have students prepare a table with the heads Haploid, Diploid, and Triploid across the top. Ask them to group the following terms, phrases, or numbers beneath their correct head: sperm, 3*n*, pollen tube nucleus, egg, *n*, endosperm, central cell, fertilized egg, 2*n*. L1 ELL

TECHPREP

Fruits and Fiber

Visual-Spatial Have students prepare a chart comparing the amount of fiber in five fruits. They should explain why a high fiber diet is considered beneficial. L2

Cultural Diversity

The History of Chocolate

Theobroma cacao is a native tree from Central America. After flowering, it produces large pods that contain about 40 cacao beans. Because of its seeds, cacao was domesticated by the Mayas and Aztecs who turned the seeds into a rich brown drink called chocolate. Researchers are suspicious that the chemicals in chocolate, theobromine and methylxanthin, may have an addictive quality. This may explain why some individuals crave chocolate and chocolate products.

Tying to Previous Knowledge

Ask students to define the term polyploidy. Explain that it is estimated that between 35 and 50% of all flowering plants are polyploid. The most common polyploid condition is tetraploid or $4n$. Tetraploids are often bigger or more vigorous that the diploid plant and thus are more desirable for agriculture and/or horticulture.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Seed Dispersal*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Seed Dispersal (Ch. 26)
Disc 1, Side 2, 1 min. 9 sec.

Resource Manager

Basic Concepts Transparency 43 and Master L2 ELL
Laboratory Manual, pp. 171-178 L2

Figure 24.19
A wide variety of seed-dispersal mechanisms have evolved among flowering plants.

A The ripe pods of violets snap open with a pop, which sends a shower of small seeds in all directions.

B Clinging fruits, like those of the cocklebur and burdock, are covered by hooks that stick to the fur or feathers of passing animals or the clothes of passing humans.

C Wind-dispersed seeds have adaptations that enable them to be held aloft while they drift away from their parent.

Seed dispersal

A fruit not only protects the seeds inside it, but also may aid in dispersing those seeds away from the parent plant and into new habitats. The dispersal of seeds, ***Figure 24.19,*** is important because it reduces competition for sunlight, soil, and water between the parent plant and its offspring. Animals such as raccoons, deer, bears, and birds help distribute many seeds by eating dry or fleshy fruits. They may carry the fruit some distance away from the parent plant before consuming it and spitting out the seeds. Or they may eat the fruit, seeds and all. Seeds that are eaten may pass through the digestive system unharmed and are deposited in the animal's wastes. Squirrels, birds, and other nut gatherers may drop and lose some of the seeds they collect, or even bury them only to forget where. These seeds can then germinate far from the parent plant.

Plants, such as water lilies and coconut palms that live in or near water produce fruits or seeds with air pockets in the walls, which enable them to float and drift away from the parent plant. The ripened fruits of many plants split open to release seeds designed for dispersal by the wind or by clinging to animal fur. Orchid seeds are so tiny that they resemble dust grains or feathers and are easily blown about by the wind. The fruit of the poppy flower forms a seed-filled capsule that releases sprinkles of tiny seeds like a salt shaker as it bobs about in the wind. Tumbleweed seeds are scattered by the wind as the whole plant rolls along the ground.

Seed germination

At maturity, seeds are fully formed. The seed coat dries and hardens, enabling the seed to survive conditions that are unfavorable to the parent plant. The seeds of some plant species must germinate immediately or die. However, the seeds of some plant species can remain in the soil until conditions are favorable for growth and development of the new plant. This period of inactivity in a mature seed is called **dormancy.** The length of time a seed remains dormant can vary from one species to another. Some seeds, such as willow, magnolia, and maple remain dormant for only a few weeks after they mature. These seeds cannot survive harsh conditions for long periods of time. Other plants produce seeds that can remain dormant for remarkably long periods of time, ***Figure 24.20.*** Even under harsh conditions, the seeds of desert wildflowers and some conifers can survive dormant periods of 15 to 20 years. Scientists discovered ancient seeds of the East Indian Lotus, *Nelumbo nucifera*, in China, which they have radiocarbon dated to be more than a thousand years old. Imagine their amazement when these seeds germinated!

Requirements for germination

Dormancy ends when the seed is ready to germinate. **Germination** is the beginning of the development of the embryo into a new plant. The absorption of enough water and the presence of oxygen and favorable temperatures usually end dormancy, but there may be other requirements. Water is important because it activates the embryo's metabolic system. Once metabolism has begun, the seed must continue to receive water or it will die. Just before the seed coat breaks open, the plant embryo begins to respire rapidly. Many seeds germinate best at temperatures between 25°C and 30°C. Arctic species germinate at lower temperatures than do tropical species. At temperatures below 0°C or above 45°C, most seeds won't germinate at all.

Some seeds have special requirements for germination, ***Figure 24.21.*** For example, some germinate more readily after they have passed through the acid environment of an animal's digestive system. Others require a period of freezing temperatures, as do apple seeds, extensive soaking in saltwater, as do coconut seeds, or certain day lengths. Recall that the seeds of some conifers will not germinate unless they have been exposed to fire. The same is true of

Figure 24.20
Seeds can remain dormant for long periods of time. Lupine seeds like these may germinate after remaining dormant for decades.

Figure 24.21
The seeds of the desert tree *Cercidium floridum* have hard seed coats that must be cracked open in order to germinate. This occurs when the seeds tumble down rocky gullies in sudden rainstorms.

TECHPREP

Water and Seed Germination

Kinesthetic Water must be absorbed by seeds prior to germination in a process called imbibition. The volume change that occurs during imbibition can be measured through water displacement.

Place 50 mL of water in a graduated cylinder. Add 10 bean seeds. The new level of water less the original volume equals the volume of the 10 seeds. Remove the seeds from the cylinder and soak them in water overnight. The following day, add 50 mL of water to the graduated cylinder. Add the soaked beans and calculate their new volume. Have students use the water-displacement technique to calculate the percent of volume change that occurs through imbibition. L2 ELL

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Germination*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Germination (Ch. 27)
Disc 1, Side 2, 25 sec.

Alternative Lab

Respiring Seeds

Purpose
To compare the rate of respiration in germinating and nongerminating seeds.

Materials
canned kidney beans, paper cup, water, dried kidney beans, wax paper, labels, tetrazolium solution in dark dropper bottles (add 1 g of 2,3,5-triphenyl tetrazolium chloride to 100 mL distilled water)

Procedure
Give the following directions to students.

1. Soak ten kidney bean seeds overnight in water. The next day, split each seed in half. Split ten canned kidney bean seeds in half.
2. Place all seeds split-side up onto two sheets of wax paper. Mark each paper with a label indicating seed treatments.
3. Add a drop of tetrazolium to each cut surface. Wait 20-30 minutes. Record in which seeds and where in the seeds a pink color appears. Note: Tetrazolium can be diluted and discarded down the sink, but the bean seeds cannot be discarded in the sink. Caution students to use care when working with chemicals.

Analysis
1. Tetrazolium indicates cell respiration when it turns pink. Which seed treatment carried on cell respiration? Why? *Uncanned seeds are germinating and require energy; canned seeds are dead.*
2. The darker the pink color, the greater the rate of respiration. Which seed part carries on the greatest rate of respiration? Why? *Embryo; rapid growth requires more energy.*

Assessment

Portfolio Design an experiment to determine how many seeds in a seed packet are alive. Use the Performance Task Assessment List for Designing an Experiment in **PASC,** p. 23. L3

MiniLab 24-2

Purpose
To compare dormant and germinating monocot and dicot seed embryos.

Process Skills
observe and infer, compare and contrast

Safety Precautions
Advise students to use caution with razor blades and always to cut away from the body.

Teaching Strategies
- Soak some seeds 24 hours and others 72 hours prior to use. After the 72-hour seeds have been soaking for 24 hours, wrap them in moist paper towels and place them in sealed plastic bags.
- Advise students to lay the corn on its flat side while cutting.

Expected Results
Germinating seeds have larger embryos.

Analysis
1. Labels should include cotyledon(s), embryo.
2. Diagrams of dicot should include cotyledons, embryo, epicotyl, radicle, plumule, and hypocotyl. Diagrams of monocot should include only cotyledon and embryo.
3. Monocot has one cotyledon, small embryo, is slow to germinate, and its embryo parts are hard to differentiate. Dicot seed has two cotyledons, larger embryo, and easily seen embryo parts.

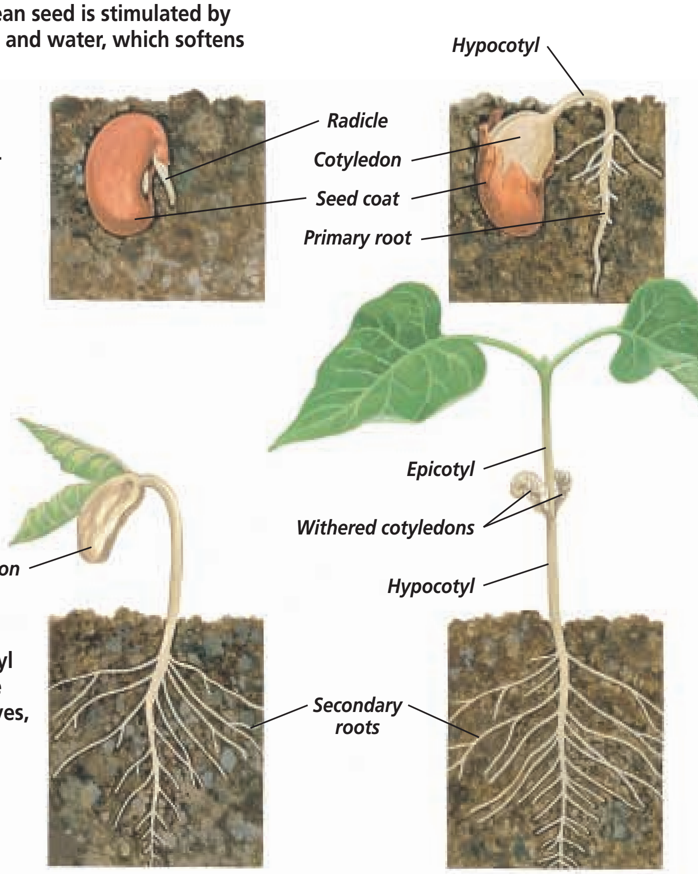
Assessment
Performance Provide students with seeds. Have students classify each seed after removing the seed coat. Use the Performance Task Assessment List for Making and Using a Classification System in **PASC**, p. 49. L2

Figure 24.22
Many wildflowers require fire for their seeds to germinate. This is especially true in prairie environments where fires are periodically set to induce the germination of prairie wildflower seeds.

certain wildflower species, including lupines and gentians, ***Figure 24.22.***

The germination of a typical dicot embryo is shown in ***Figure 24.23.*** Once the seed coat has been softened by water, the embryo starts to emerge from the seed. The first part of the embryo to appear is the embryonic root called the **radicle** (RAD ih kul). The radicle grows down into the soil and develops into a root. The portion of the stem nearest the seed is called the **hypocotyl** (HI poh kaht ul). In some plants, the first part of the stem to push above ground is an arched portion of the hypocotyl. As the hypocotyl continues growing, it straightens, bringing with it the cotyledons and the plant's first leaves. As the stem grows larger and the leaves turn green, the plant can produce its own food through photosynthesis. To learn more about germinating seeds, try the *MiniLab* shown here.

Figure 24.23
Germination of a bean seed is stimulated by warm temperatures and water, which softens the seed coat.



A The radicle will become the primary root.

B The hypocotyl is the first part of the stem to appear.

C As the hypocotyl straightens, the plant's first leaves, the cotyledons, are exposed to sunlight.

D As new leaves mature, the cotyledons wither and fall away.

Vegetative reproduction

The roots, stems, and leaves of plants are called vegetative structures. When these structures produce a new plant, it is called vegetative reproduction. Vegetative reproduction is common among anthophytes. Some modified stems of anthophytes, such as potato tubers, can produce a new plant. Potatoes will grow new stems from their "eyes" or buds. Farmers make use of this feature when they cut potato tubers into pieces and plant them. The buds on these sections grow new shoots that produce entire new plants.

Although cloning animals is a relatively new phenomenon, gardeners have relied for years on cloning to reproduce plants. Using vegetative reproduction to grow numerous plants from one plant it is frequently referred to as vegetative propagation. Some plants, such as geraniums, can be propagated by planting cuttings, which are pieces of the stem or a leaf that has been cut off another plant. Even smaller pieces of plants can be used to grow plants by tissue culture. Tiny pieces of plants are placed on nutrient agar in test tubes or petri dishes. The plants produced by cuttings and tissue cultures contain the same genetic makeup as the original plants. Therefore, they are botanical clones.

MiniLab 24-2 Observing

Looking at Germinating Seeds Seeds are made up of a plant embryo, a seed coat, and in some plants, a food-storage tissue. Monocot and dicot seeds differ in their internal structures.

Corn seed germination

Procedure
1. Obtain from your teacher a soaked, ungerminated corn kernel (monocot), a bean seed (dicot), and corn and bean seeds that have begun to germinate.
2. Remove the seed coats from each of the ungerminated seeds, and examine the structures inside. Use low-power magnification. Locate and identify each structure of the embryo and any other structures you observe.
3. Examine the germinating seeds. Locate and identify the structures you observed in the dormant seeds.

Analysis
1. Diagram the dormant embryos in the soaked seeds, and label their structures.
2. Diagram the germinating seeds, and label their structures.
3. List at least three major differences you observed in the internal structures of the corn and bean seeds.

Section Assessment

Understanding Main Ideas
1. What is the relationship between the pollination of a flower and the production of one or more seeds?
2. What part of an anthophyte flower becomes the fruit?
3. Describe the process of double fertilization in anthophytes.
4. Explain how the production of nectar could enhance the pollination of a flowering plant.

Thinking Critically
5. Describe the formation of the female gametophyte in a flowering plant.

Skill Review
6. **Making and Using Tables** Make a table that indicates whether each structure of a flower is involved in pollination, fruit formation, seed production, or seed dispersal. For more help, refer to *Organizing Information* in the **Skill Handbook.**

3 Assess

Check for Understanding
Have students explain how the words in each of the following pairs are related. L2
a. pollen tube—double fertilization
b. epicotyl—hypocotyl
c. dormancy—germination

Reteach
Have students indicate when or where in the life cycle each term in the Check for Understanding applies. L2

Extension
Have students research the mechanism responsible for roots growing down and stems growing up. L3

Assessment
Performance Provide students with a sliced peach or cherry half and a sliced open flower. Have them locate and name the following structures: ovule before and after fertilization, ovary before and after fertilization, embryo. L1

4 Close

Discussion
Watermelons have numerous black seeds and some small white seeds. Ask students to speculate what the small white seeds found in a watermelon might be. *They are unfertilized ovules.* L2

Resource Manager

Reinforcement and Study Guide, p. 108 L2 ELL
BioLab and MiniLab Worksheets, p. 110 L2
Content Mastery, pp. 117, 119-120 L1

Portfolio

Modeling Seed Dispersal
Kinesthetic Provide students with a strip of Velcro, a piece of fabric, cotton batting, tape, string, clay, stiff paper, and scissors. Have them use the materials to prepare models that show different means of seed dispersal. Models may imitate attaching to animal fur or floating in air. L1 ELL

Section Assessment

1. Pollination transports sperm to the female gametophyte. Inside the ovule, the sperm cells are involved in double fertilization. One pollen grain is required for the production of each seed.
2. the ovary wall
3. Double fertilization occurs when one sperm unites with the egg cell, forming the 2*n* zygote and the other sperm cell fuses with the central cell to form a 3*n* cell.
4. Nectar is a source of nutrition for animal pollinators such as insects and bats; they get pollen on them as they try to reach the nectar. As these animals travel from flower to flower, they cross-pollinate the flowers.
5. In the ovule, meiosis produces four haploid megaspores. One of these megaspores will undergo three mitotic divisions, producing eight nuclei. These eight nuclei make up the embryo sac or female gametophyte.
6. pollination: anther, stamen, stigma; fruit formation: ovary, and ovule; seed production: ovule, egg; seed dispersal: ovary

INVESTIGATE BioLab

Time Allotment
One class period

Process Skills
observe and infer, use the microscope, compare and contrast, interpret data

Safety Precautions
- Some students may be allergic to the chemicals used in preserved specimens.
- Caution students against rubbing their eyes with their hands because of the preservative. Always have students wash their hands thoroughly after handling preserved specimens.
- Handle the razor blade with extreme caution. Always cut away from the body.

PREPARATION

Alternative Materials
- Do not use composite species of flowers such as sunflower, daisy, or dandelion.
- Preserved slides that show eggs within the ovule are available from supply houses.
- Preserved flowers are available at any time of the year from biological supply houses. A disadvantage to such flowers is that the preservative tends to discolor flower parts, especially petals and sepals, which will appear dull green.

INVESTIGATE BioLab

Examining the Structure of a Flower

Flowers are the reproductive structures of anthophytes. Seeds that develop within the flower are carried inside a fruit. Seeds provide an extremely important form of reproduction in flowering plants. Flowers come in many colors and shapes. Often their colors or shapes are related to the manner in which pollination takes place. The major organs of a flower include the petals, sepals, stamens, and pistils. Some flowers are incomplete, which means they do not have all four kinds of organs. You will study a complete flower.

PREPARATION

Problem
What do the parts of a flower look like? How are they arranged?

Objectives
In this BioLab, you will:
- **Observe** the structures of a flower.
- **Identify** the functions of flower parts.

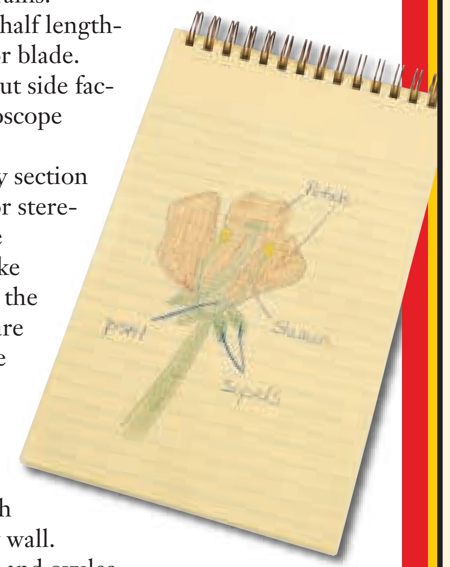
Materials
flower—any complete flower that is available locally, such as phlox, lily, or tobacco flower
hand lens (or stereomicroscope)
colored pencils (red, green, blue)
2 microscope slides
microscope
single-edged razor blade
2 coverslips
dropper
water

Safety Precautions
Always wear goggles in the lab. Handle the razor blade with extreme caution. Always cut away from you. Use caution when working with a microscope and slides. Wash your hands with soap and water after handling plant material.

Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

PROCEDURE

1. Examine your flower. Locate the sepals and petals. Note their numbers, size, color, and arrangement on the flower stem.
2. Remove the sepals and petals from your flower by gently pulling them off the stem. Locate the stamens, each of which consists of a thin filament with a pollen-filled anther on the tip. Note the number of stamens.
3. Locate the pistil. The stigma at the top of the pistil is often sticky. The style is a long, narrow structure that leads from the stigma to the ovary.
4. Place an anther from one of the stamens onto a microscope slide and add a drop of water. Cut the anther into several pieces with the razor blade. **CAUTION:** ***Always take care when using a razor blade.***
5. Examine the anther under low and high power of your microscope. The small, dotlike structures are pollen grains.
6. Slice the ovary in half lengthwise with the razor blade. Mount one half, cut side facing up, on a microscope slide.
7. Examine the ovary section with a hand lens or stereomicroscope. The many, small, dotlike structures that fill the two ovary halves are ovules. Each ovule contains an egg cell that is not visible under low power. A tiny stalk connects each ovule to the ovary wall.
8. Identify the ovary and ovules.
9. Make a diagram of the flower, labeling all its parts. Color the female reproductive parts red. Color the male reproductive parts green. Color the remaining parts blue.



ANALYZE AND CONCLUDE

1. **Observing** How many stamens are present in your flower? How many pistils, ovaries, sepals, and petals?
2. **Comparing and Contrasting** Make a reasonable estimate of the number of pollen grains in the anther and the number of ovules in an ovary of your flower.
3. **Interpreting Data** Which produces more? Pollen grains by one anther? Ovules produced by one ovary? Give a possible explanation for your answer.

Going Further

Project Use a field guide to identify common wildflowers in your area. Most field identifications are made on the basis of color, shape, numbers, and arrangement of flower parts. If collecting is permitted, pick a few common flowers to press and make into a display of local flora.

interNET CONNECTION To find out more about flowers, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

INVESTIGATE BioLab

ANALYZE AND CONCLUDE

1. Stamens, petals, and sepals will be in multiples of 3 if a monocot, multiples of 4 or 5 if a dicot. One pistil and ovary will be present.
2. thousands of pollen grains, 10 to 100 ovules
3. Yes; the flower increases the probability of a pollen cell landing on the correct stigma by producing and releasing a large number of pollen grains.

Assessment

Knowledge Provide students with diagrams of a flower other than that used in this BioLab. Have them label and indicate the general function of all important structures. Use the Performance Task Assessment List for Making Observations and Inferences in **PASC,** p. 17. L1

Going Further

Provide students with a composite flower such as a sunflower or daisy. Have them determine the locations of the individual florets and their various flower parts. L2

PROCEDURE

Teaching Strategies
- When preparing the anther wet mount, it may be helpful for students to squash the preparation using their thumb and a piece of lens paper over the coverslip. Advise students to press down firmly to avoid cracking the coverslip, or use plastic coverslips for this wet mount.
- Eggs will not be visible; students should not attempt to observe ovules under the microscope in order to observe egg cells.
- Students can work in groups of two to three for this BioLab.
- Show students how to remove the petals and sepals.
- You may wish to appoint certain students as lab helpers. These students can be called upon by their classmates for help and guidance.
- If necessary, review proper use of the stereomicroscope.

Data and Observations
Student diagrams, when colored properly, should show the petals and sepals as blue, pistil as red, and stamens as green.

Resource Manager

BioLab and MiniLab Worksheets, pp. 111-112 L2

BIO Technology

Purpose
Students explore old and new methods of plant hybridization.

Background
Seed saver organizations encourage home gardeners and farmers to grow open-pollinated, or nonhybrid, varieties of vegetables and flowers. These natural varieties can reliably be reproduced from seed pollinated in the wild by wind, insects, or birds. Many growers like to raise heirloom varieties of nonhybrids that are becoming rare because an increasing number of hybrid varieties are offered every year. Open-pollinated varieties help maintain genetic diversity in plant populations. Seeds produced by hybrids are either sterile or tend to revert to unwanted characteristics of the parent generation.

Teaching Strategies
- Review with students Mendel's experiments with garden peas and the genetic crosses discussed in Chapter 10.
- Point out that plant breeders don't necessarily know whether a desired characteristic is regulated by one gene or many genes. This is one reason why field trials of many different crosses are often required to obtain hybrid varieties with specific characteristics.

Investigating the Technology
To ensure that a new crop will have the characteristics of the hybrid, a farmer must purchase seeds from the plant breeder each time a new crop is planted. Seed for the desired hybrid can be obtained only by cross-pollinating the same line of parent plants. F1 hybrids produce offspring with variable characteristics, not necessarily those of the hybrid. For examples, see the Punnet squares and discussion of F2 hybrids in Chapter 10.

BIO Technology: Hybrid Plants

If you've looked through any seed catalogs lately, you may have noticed phrases like "new this season!" or "improved yield," or "sweeter-tasting." Sometimes the designation "F_1" is given beside the names of some plant varieties. All of these plants are hybrids that have been produced in experiments conducted by plant breeders.

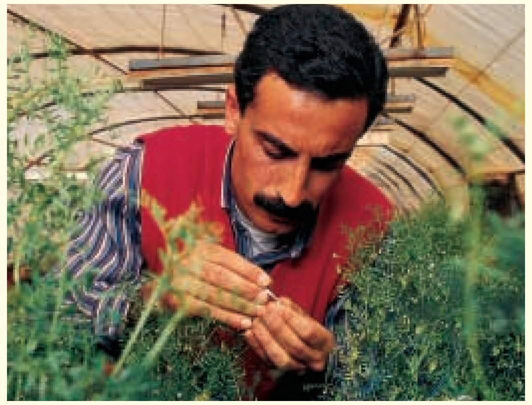
For thousands of years, humans have influenced the breeding of plants, especially food crops and flowers. Today's plant breeders create hybrid strains with a variety of desired characteristics, such as more colorful or fragrant flowers, tastier fruit, higher yields, or increased resistance to disease.

The perfect ear of corn The first step in creating a hybrid is the selection of parent plants with desirable characteristics. A breeder might select a corn plant that ripens earlier in the season or one that can be sown earlier in the spring because its seeds germinate well in cool, moist soil.

The next step is to grow several self-pollinated generations of each plant to form a true-breeding line that always shows the desired characteristic. To do this, each plant must be prevented from cross-pollinating with other corn. The female flowers, called silks, grow near the middle of the corn stalk. The breeder covers each flower to prevent wind-borne pollen from fertilizing it. The pollen-producing male tassels are removed and the breeder uses their pollen to hand-pollinate each flower.

Once each true-breeding line has been established, the real experimentation begins. Breeders cross different combinations of true-breeding lines to see what characteristics the resulting F_1 hybrids will have. These trials show which of the true-breeding lines reliably pass their desired characteristic to hybrid offspring, and which crosses produce seeds that the breeder can market as a new, improved variety of corn.

Applications for the future
Cell culture and genetic engineering technologies are new plant breeding techniques. Protoplast fusion removes the cell walls from the



Technician performing hybridization studies

cells of leaves or seedlings, then uses electricity or chemicals to fuse cells of two different species. Some of these fused cells have been successfully cultured in the lab and grown into adult plants, though none have produced seeds.

Recombinant DNA technology has been used to insert specific genes into the chromosomes of a plant. This technique helps produce plants that are resistant to frost, drought, or disease.

Investigating the Technology

Analyzing Concepts Why do seed companies recommend not saving seeds from hybrid varieties to plant the following year? (Hint: The offspring of self-pollinated hybrids constitute the F_2 generation.)

interNET CONNECTION To find out more about hybrid seeds, visit the Glencoe Science Web Site. **www.glencoe.com/sec/science**

Chapter 24 Assessment

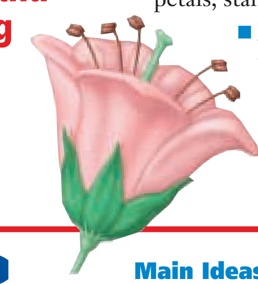
Summary

Section 24.1 Life Cycles of Mosses, Ferns, and Conifers

Main Ideas
- In mosses, a gametophyte forms archegonia and antheridia. The gametophyte is dominant.
- In ferns, the prothallus forms archegonia and antheridia. The sporophyte is dominant.
- In conifers, cones produce spores that form male or female gametophytes. The pollen grain produces sperm, which fertilizes the egg. The embryo is protected by a seed.

Vocabulary
megaspore (p. 658)
micropyle (p. 659)
microspore (p. 658)
protonema (p. 655)
vegetative reproduction (p. 654)

Section 24.2 Flowers and Flowering



Main Ideas
- Flowers are made up of four organs: sepals, petals, stamens, and pistils.
- Photoperiodism affects the timing of flower production.

Vocabulary
anther (p. 662)
day-neutral plant (p. 666)
long-day plant (p. 666)
ovary (p. 662)
petals (p. 661)
photoperiodism (p. 663)
pistil (p. 662)
sepals (p. 661)
short-day plant (p. 666)
stamens (p. 662)

Section 24.3 The Life Cycle of a Flowering Plant

Main Ideas
- The male gametophyte is produced by a microspore in the anther. The female gametophyte is produced by a megaspore in the ovule.
- Sperm are transported by a pollen tube to the ovule, where fertilization takes place.
- In double fertilization, one sperm joins with the egg to form a zygote. The second sperm joins the central cell to form endosperm.
- The ovary wall becomes the fruit.
- Fruits and seeds are modified for dispersal.
- Seeds can stay dormant for long periods of time.

Vocabulary
dormancy (p. 675)
double fertilization (p. 671)
endosperm (p. 672)
germination (p. 675)
hypocotyl (p. 676)
polar nuclei (p. 667)
radicle (p. 676)

Understanding Main Ideas

1. Pollen and nectar produced by flowers provide ________ for butterflies and bees.
   a. protection c. shelter
   b. food d. fruit
2. Flowers that are dull in color and have no nectar yet have a strong scent might be pollinated by ________.
   a. bees c. beetles
   b. butterflies d. hummingbirds

Main Ideas
Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary
To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site. **www.glencoe.com/sec/science**

THE PRINCETON REVIEW *All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.*

Understanding Main Ideas
1. b
2. c

Going Further
Ask students to compare and contrast modern methods of creating hybrids with the techniques used by Gregor Mendel in his experiments with garden peas during the 1800s. L2

Internet Address Book
interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

GLENCOE TECHNOLOGY
VIDEOTAPE
MindJogger Videoquizzes
Chapter 24: *Reproduction in Plants*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager
Chapter Assessment, pp. 139-144
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 24 quiz

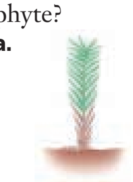
3. b
4. d
5. a
6. c
7. b
8. d
9. d
10. a
11. endosperm
12. pistil
13. gametes
14. antheridia, archegonia
15. microspores
16. dormancy
17. ovary
18. short, long
19. micropyle
20. vegetative propagation

Applying Main Ideas

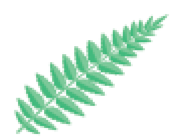
21. Seeds store food intended for use by the embryo plant.
22. Seeds will remain alive until water becomes available for germination.

3. Moss gametophytes are _______ and form gametes by _______.
   a. diploid; meiosis c. diploid; mitosis
   b. haploid; mitosis d. haploid; meiosis
4. By eating fruit, mammals help _______.
   a. fertilize flowers c. photoperiodism
   b. nastic movement d. disperse seeds
5. While feeding, butterflies and bees carry pollen from flower to flower, causing _______.
   a. pollination c. germination
   b. dormancy d. photoperiodism
6. The heart-shaped structure formed by a developing fern spore is called a _______.
   a. protonema c. prothallus
   b. sporophyte d. frond
7. Which of the following plants do NOT produce pollen?
   a. pine tree c. apple tree
   b. mosses d. corn
8. Which of the following is a fern gametophyte?

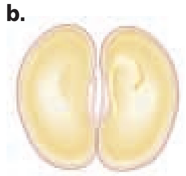
a.



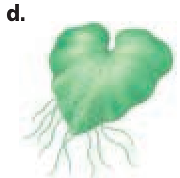
c.



b.



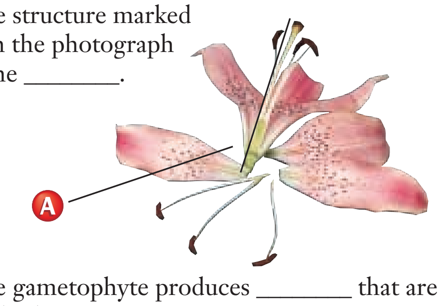
d.



Test-Taking Tip (The Princeton Review)

Plan Your Work and Work Your Plan
Set up a study schedule for yourself well in advance of your test. Plan your workload so that you do a little each day rather than a lot all at once. The key to retaining information is to repeatedly review and practice it.

9. A(n) _______ is one that has all four organs: sepals, petals, stamens, and pistils.
   a. short-day plant c. incomplete flower
   b. long-day plant d. complete flower
10. The response of flowering plants to the difference in the duration of light and dark periods in a day is called _______.
   a. photoperiodism c. pollination
   b. nastic movement d. dormancy
11. A triploid cell resulting from double fertilization becomes the _______.
12. The structure marked A in the photograph is the _______.



13. The gametophyte produces _______ that are haploid.
14. In ferns, sperm released by the _______ fertilize eggs in the _______.
15. Male pinecones produce _______ that will develop into the male gametophyte, or pollen grain.
16. The period of inactivity in a mature seed is called _______.
17. After pollination, a pollen tube grows downward through the pistil to the _______.
18. A short-day plant is more likely to flower when the days are _______ and the nights are _______.
19. During fertilization in anthophytes, the two sperm cells enter the ovule through an opening called the _______.
20. Growing new plants from cuttings or tissue culture is called _______.

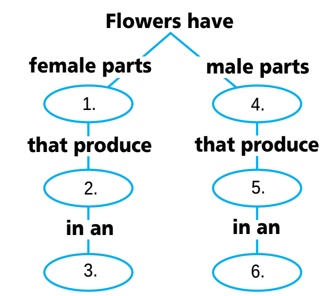
Applying Main Ideas

21. You eat peas, beans, corn, peanuts, and cereals. Why are seeds a good source of food?

22. How does dormancy contribute to the survival of a plant species in a desert ecosystem?
23. In what ways can the relationship between the gametophyte and sporophyte in seed plants be regarded as good for the gametophyte?
24. Explain why a scientist might hypothesize that the eating habits of herbivorous mammals affected the evolution of fruits in flowering plants.

Thinking Critically

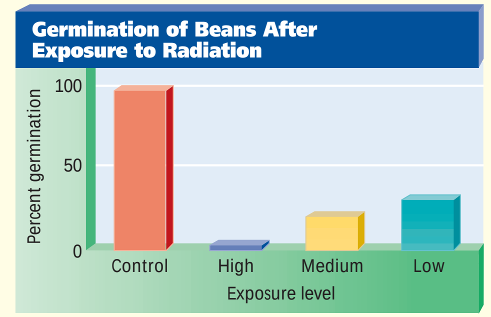
25. **Observing and Inferring** A plant species produces heavy, spiked pollen grains. What conclusion can you draw about the plant's pollination method?
26. **Comparing and Contrasting** Compare and contrast the formation of a moss sporophyte and a fern sporophyte.
27. **Formulating Hypotheses** Form a hypothesis that explains why the primary root is the first part of the plant to emerge from a germinating seed.
28. **Concept Mapping** Complete the concept map by using the following vocabulary terms: pistil, microspore, anther, stamen, ovary, megaspores.



CD-ROM
For additional review, use the assessment options for this chapter found on the *Biology: The Dynamics of Life Interactive CD-ROM* and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

The graph below provides data from an experiment that tests the effects of ionizing radiation on the germination of seeds.



Using a Graph Use the graph to answer the following questions.

1. Which group of beans had the highest percentage of germination?
   a. control
   b. high-exposure level
   c. medium-exposure level
   d. low-exposure level
2. As the radiation dose increases, germination _______.
   a. increases c. stops
   b. decreases d. is not affected
3. When beans are given a low dose of radiation, _______ germinate.
   a. 25 percent c. none
   b. 50 percent d. 100 percent
4. When beans are given a medium dose of radiation, _______ germinate.
   a. 12.5 percent c. 37.5 percent
   b. 25 percent d. 50 percent
5. **Designing an Experiment** Design an experiment on bean plants in which the following hypothesis is tested: Bean plants exposed to ionizing radiation will not grow as tall as those that are not exposed.

23. The gametophyte is protected and nourished by the sporophyte.
24. Mammals may have selected only certain fruits for their diet and thus aided in dispersal and survival of these species.

Thinking Critically

25. The plant is probably pollinated by animals.
26. The moss and fern sporophytes both develop from a diploid zygote in the archegonium of the gametophyte. The moss sporophyte will remain dependent upon the gametophyte, whereas the fern sporophyte will eventually survive on its own.
27. The primary root anchors the seed and obtains needed water from the soil for further growth and development of the plant.
28. 1. Pistil; 2. Megaspores; 3. Ovary; 4. Stamen; 5. Microspores; 6. Anther

Assessing Knowledge & Skills

1. a
2. b
3. a
4. a
5. Bean plants that have just emerged from the soil are divided into four groups: one the control that is not irradiated, another given a high dose, another given a medium dose, and another a low does of radiation. The heights of the plants are measured and recorded for the duration of the experiment.

National Science Education Standards UCP.1, UCP.2, UCP.5, C.4, C.5, C.6, F.4

Prepare

Purpose

This BioDigest can be used as an introduction to or an overview of the structures and functions of plants. If time is limited, you may wish to use this unit summary to teach about plants in place of the chapters in the Plants unit.

Key Concepts

Students learn about the characteristics of the major plant divisions. They are introduced to the alternation of generations; the distinctions between non-seed and seed plants; pollination and fertilization; and the adaptive value of flowers, seeds, and fruits.

1 Focus

Bellringer

Visual-Spatial Bring an assortment of live plants into the classroom, including mosses, horsetails, and club mosses, if available. Include a small potted pine or other conifer, and several potted flowering plants. Ask students to observe each plant and make a list of its characteristics in their journals. L1

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Life Cycle of a Moss*
Disc 3

For a **preview** of the plant unit, study this BioDigest before you read the chapters. After you have studied the plant chapters, you can use the BioDigest to **review** the unit.

Plants

Earth is virtually covered with plants. Plants provide food and shelter for multitudes of organisms. Through the process of photosynthesis, they transform the radiant energy of sunlight into chemical energy in food and release oxygen to the atmosphere. All plants are multicellular eukaryotes. Plant cells are surrounded by a cell wall made of cellulose.

Mosses often grow in masses that form thick carpets

Non-Seed Plants

Non-seed plants reproduce by forming spores. A spore is a haploid (*n*) reproductive cell, produced by meiosis, which can withstand harsh environmental conditions. When conditions become favorable, a spore can develop into the haploid, gametophyte generation of a plant. A spore will become either a female or male gametophyte.

Mosses, Liverworts, and Hornworts

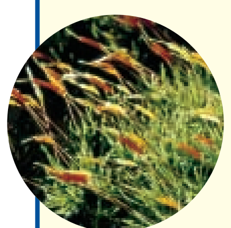
Mosses, liverworts, and hornworts are three divisions of non-seed, nonvascular plants that live in cool, moist habitats. Because they have no vascular tissues to move water and nutrients from one part of the plant to another, they cannot grow more than a few inches tall.

VITAL STATISTICS

Non-Seed Plants
Numbers of species:
Bryophyta—mosses, 20 000 species
Lycophyta—club mosses, 1000 species
Sphenophyta—horsetails, 15 species
Pterophyta—ferns, 12 000 species
Anthocerophyta—hornworts, 100 species
Hepatophyta—liverworts, 6500 species

FOCUS ON ADAPTATIONS

Alternation of Generations



The leafy gametophyte is haploid. The spore stalks and capsules are diploid.

The life cycle of most plant species alternates between two stages, or generations. The sporophyte generation produces spores, which develop into the gametophyte generation. The gametophyte produces gametes. In nonvascular plants, the gametophyte is larger and more conspicuous than the sporophyte. In vascular plants, the sporophyte dominates. The gametophyte of a vascular plant is extremely small and may remain buried in the soil or inside the body of the sporophyte.

Gametophyte Generation

A gametophyte is haploid (*n*) and produces eggs and sperm. In mosses, the gametophyte is the familiar soft, green growth that covers rotting logs or moist soil. The tiny moss gametophytes produce male and female branches. Sperm cells produced by the male branches must swim through rain or dew to reach the egg cells produced by the female branches. Fertilization takes place inside the female reproductive organ and a diploid (2*n*) zygote is produced.

Club Mosses

Club mosses are non-seed plants in the division Lycophyta. They possess vascular tissue and are found primarily in moist environments. Species that exist today are only a few centimeters high, but they are otherwise similar to fossil Lycophytes that grew as high as 30 m and formed a large part of the vegetation of Paleozoic forests.

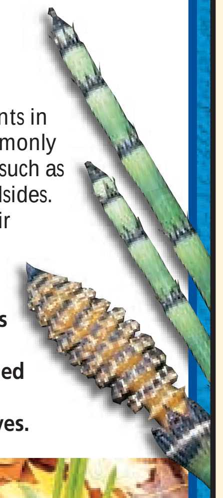
Ferns

Ferns, division Pterophyta, are the most well-known and diverse of the non-seed vascular plants. They have leaves called fronds that grow up from an underground stem called the rhizome. Ferns are found in many different habitats, including shady forests, stream banks, roadsides, and abandoned pastures.

Fern spores develop in clustered structures called sori, usually found on the undersides of fronds.

Horsetails

Horsetails are non-seed vascular plants in the division Sphenophyta. They are commonly found growing in areas with damp soil, such as stream banks and sometimes along roadsides. Present-day horsetails are small, but their ancestors were treelike.

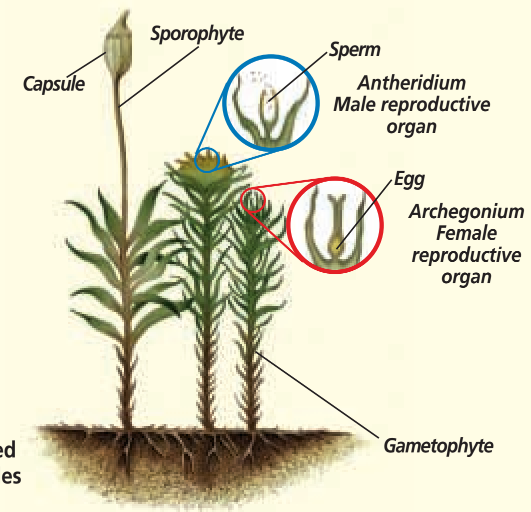


The hollow, jointed stems of horsetails are surrounded by whorls of scalelike leaves.

As in all vascular plants, the sporophyte of this club moss is the dominant generation. Spores develop at the base of special leaves that form cone-shaped structures called strobili.

Sporophyte Generation

The zygote develops into an embryo, which grows into the sporophyte generation of the moss. The sporophytes grow out of the tip of the female branches of the gametophyte and consist of capsule-topped stalks. Cells inside each capsule undergo meiosis to form haploid (*n*) spores.



The green, leafy growth of this moss is the gametophyte. The brown stalks topped with spore-filled capsules are the sporophyte.

2 Teach

Microscope Activity

Visual-Spatial Have students view mosses, liverworts, and hornworts with a stereomicroscope. Ask students to describe their observations orally or in writing in their journals. If possible, supply sporophytes and gametophytes with male and female reproductive structures and ask students to compare the characteristics of these structures and generations. L2

Quick Demo

Visual-Spatial If horsetails grow in your area, bring several stems into the classroom. Show students that the stems come apart fairly easily at the nodes, and that the stems are hollow. Have them examine the strobili, if these are present. Point out that the silica in the stems gives horsetails a scouring-pad quality and is the source of the common name "scouring rush."

Quick Demo

Visual-Spatial Show students young fern fiddleheads and sori on the under-side of a fern frond. In the spring, fiddleheads are sometimes available in specialty markets as a food item. If a live fern is available, show students the underground stem (rhizome) from which roots grow down and fronds grow up.

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Quick Demo, p. 686; Meeting Individual Needs, p. 686
Visual-Spatial Microscope Activity, p. 685; Quick Demo, p. 685; Visual Learning, p. 687
Interpersonal Project, p. 688
Linguistic Visual Learning, p. 688; Extension, p. 689
Naturalist Biology Journal, p. 687

Assessment Planner

Performance Assessment
Assessment, TWE, p. 687
Knowledge Assessment
Assessment, TWE, p. 688
BioDigest Assessment, SE, p. 689
Skill Assessment
Assessment, TWE, p. 689

Quick Demo

Kinesthetic Bring to class and allow students to handle several varieties of conifer cones. Include male cones if available. Tell students the common name and/or Latin name of the tree each cone is from. Ask students to record their observations of each species in their journals. L1

Guest Speaker

TECH PREP

Have a pharmacist or physician visit the class to discuss plants that are important in the production of medicines.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Life Cycle of a Pine*
Exploration: *Classifying Pines*
Disc 3

Resource Manager

Reinforcement and Study Guide, pp. 109-110 L2
Content Mastery, pp. 121-124 L1

Seed Plants

A seed is a reproductive structure that contains a sporophyte embryo and a food supply enclosed in a protective coating. The food supply nourishes the young plant during the first stages of growth. Like spores, seeds can survive harsh conditions. The seed develops into the sporophyte generation of the plant. Seed plants include conifers and flowering plants.

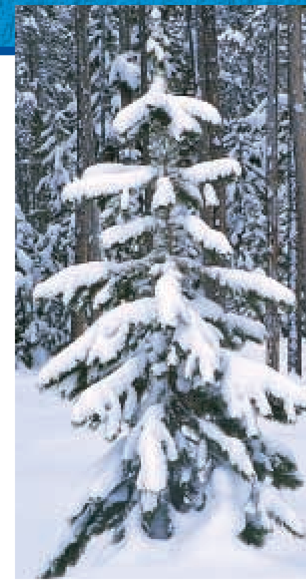
Conifers

Conifers, division Coniferophyta, produce seeds, usually in woody strobili called cones, and have needle-shaped or scale-like leaves. Conifer seeds are not enclosed in a fruit. Most conifers are evergreen plants, which means they bear leaves all year round.

Seeds of conifers develop at the base of each woody scale of female cones.

Adapted for Cold and Dry Climates

Conifers are common in cold or dry habitats throughout the world. Conifer needles have a compact shape and a thick, waxy covering that helps reduce evaporation and conserve water. Conifer stems are covered with a thick layer of bark that insulates the tissues inside. These adaptations enable conifers to carry on life processes even when temperatures are below freezing.



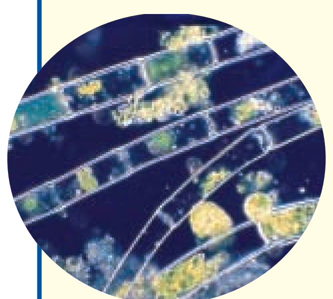
The leaves and branches of conifers are flexible. They bend under the weight of snow and ice, allowing any buildup to slide off before it becomes heavy enough to break the branch.

Vital Statistics

Conifers
Examples: Pine, spruce, fir, larch, yew, redwood, juniper.
Numbers: 400 species.
Size range: Giant sequoias of central California, to 99 m tall, the most massive organisms in the world; coast redwoods of California, to 117 m, the tallest trees in the world.

Focus on Adaptations

Moving from Water to Land

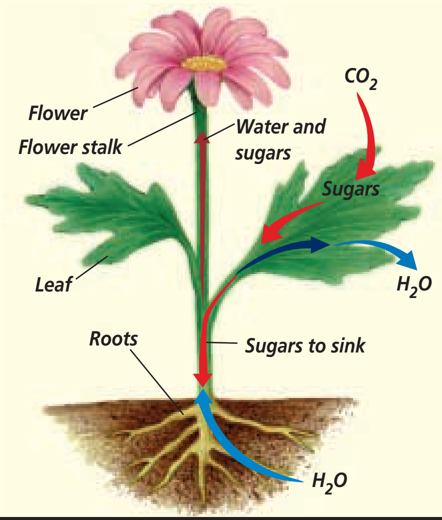


Plants probably evolved from filamentous green algae.

All plants probably evolved from filamentous green algae that lived in the nutrient-rich waters of Earth's ancient oceans. An ocean-dwelling alga can absorb water and dissolved minerals directly into its cells. As land plants evolved, new structures developed for absorbing and transporting water and minerals from the soil to all the aerial parts of the plant.

Nonvascular Plants In nonvascular plants, water and nutrients must travel from one cell to another by the relatively slow processes of osmosis and diffusion. As a result, nonvascular plants are limited to environments where plenty of water is available.

Vascular Plants The stems of most plants contain vascular tissues made up of tubelike, elongated cells through which water, food, and other materials move from one part of the plant to another. One reason vascular plants can grow larger than nonvascular plants is because vascular tissue is a much more efficient method of internal transport than osmosis and diffusion. In addition, vascular tissues include thickened fibers that can support taller upright growth.



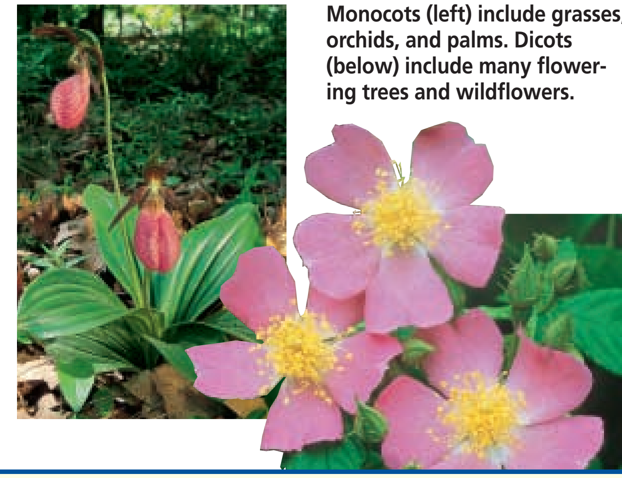
An unbroken column of water travels from the roots in xylem tissues. Sugars formed by photosynthesis travel around the plant in phloem tissues.

Flowering Plants

The flowering plants, division Anthophyta, form the largest and most diverse group of plants on Earth today. They provide most of the food eaten by humans. Anthophytes produce flowers and develop seeds enclosed in a fruit.

Monocots and Dicots

The Anthophytes are classified into two classes: the monocotyledons and the dicotyledons. Cotyledons, or "seed leaves," are contained in the seed along with the plant embryo. Monocots have a single seed leaf that absorbs food for the embryo. The two seed leaves of dicots store food for the embryo.

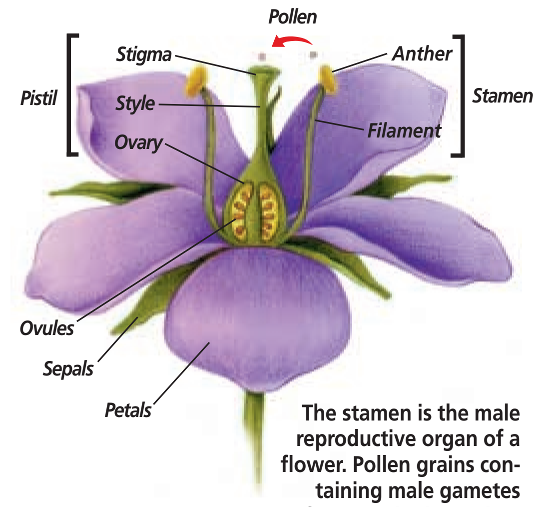


Monocots (left) include grasses, orchids, and palms. Dicots (below) include many flowering trees and wildflowers.

Flowers

Flowers are the organs of reproduction in anthophytes. Sepals enclose the flower bud and protect it until it opens; petals, which are often brightly colored or perfumed, attract pollinators. Inside the circle of petals are the pistil and stamens.

The pistil is the female reproductive organ. Inside the ovary at the base of the pistil are the ovules. Ovules contain the female gametophyte generation of the plant. Female gametes—egg cells—form in each ovule.



The stamen is the male reproductive organ of a flower. Pollen grains containing male gametes form inside the anther.

Meeting Individual Needs

Visually Impaired

Kinesthetic As part of the Bellringer demonstration, have students with visual impairments handle the plants. Break off small parts for them to handle. Ask them to describe what they feel as partners write down their observations. Make sure students don't injure themselves by handling the plants. L1

NATIONAL GEOGRAPHIC

VIDEODISC
STV: Plants, *What Is a Seed?*
Unit 4, Side 3, 13 min. 45 sec.
What Is a Seed? (In its entirety)

Biology Journal

Identifying and Classifying Plants

Naturalist Have students collect pictures of different types of plants. They should identify the plants and classify them as vascular or nonvascular and nonseed or seed producing. L2 ELL

Assessment

Performance Have students collect branches or leaves of local trees and use field guides to identify them. The lesson can be extended by trading botanical specimens with teachers in other areas. L2

Visual Learning

Visual-Spatial Explain to students that monocots have leaves with parallel veins and flower parts in multiples of three. Dicots have leaves with netted veins and flower parts in multiples of four or five. Have students use these characteristics to classify photographs or cut flowers brought into the classroom. Extend the lesson by having students discuss the sizes and shapes of the flowers and their adaptations for pollination. L1

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Water Uptake in Roots*
Exploration: *Angiosperm*
Disc 3

BioDigest

Assessment

Knowledge Ask students to compare and contrast pollination and fertilization in conifers and flowering plants. *In conifers, pollen is carried by wind to the female cone. In flowers, pollen may also be transported by animals. In flowers, the pollen is carried to the stigma. In both conifers and flowers, the pollen grows a tube through which the sperm travels to reach the ovary. In both, sperm and egg unite to form a zygote that develops into a seed.*

Knowledge

After students have observed flowers and fruits from the same plants, ask them to discuss which parts of the flower become which parts of the fruit, and to identify the parts of the flower that wither away and do not form part of the fruit. *The ovary swells to become the fruit. The ovule may be visible around the seeds, as in apples. The sepals may be visible on the blossom end of the fruit. Petals, pistil, and stamen wither away.*

Visual Learning

Linguistic Bring into the classroom several different fruits, including both dry and fleshy varieties. If possible, bring fruits that develop from some of the flowers used in the above activity. Have students examine the exterior of each fruit, then cut it open to observe the arrangement of seeds. Ask students to describe their observations in their journals. L1

BioDigest

Pollen

In seed plants, the sperm are enclosed in the thick-coated pollen grains, which are the male gametophyte generation of the plant. Pollen is one of the important adaptations that has enabled seed plants to live in a wide variety of land habitats.

Pollinators

Flowers can be pollinated by wind, insects, birds, and even bats. Some flowers have colorful or perfumed petals that attract pollinators. Flowers may also contain sweet nectar, as well as pollen, which provides pollinators with food.

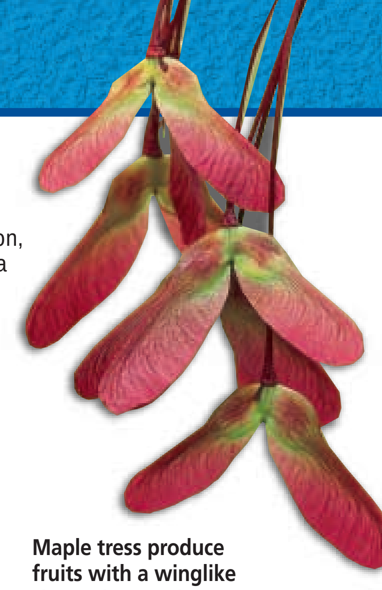
Plants that depend on the wind to carry pollen from anther to stigma tend to have small, inconspicuous flowers. The flowers of grasses and this alder are pollinated by the wind.

Plants that depend on insects for pollination may be brightly colored and fragrant. Pollen rubs off on the bee that visits a flower to feed on nectar. When it moves to another flower, some of the pollen may rub off onto the stigma.

Many plants produce fruits that are eaten by animals.

Fruit

Following fertilization, the ovary develops into a fruit with seeds inside. Some flowering plants develop fleshy fruits, such as apples, melons, tomatoes, and squash. Other flowering plants develop dry fruits, such as peanuts, almonds, or sunflowers. Fruits also help protect seeds until they are mature. Fruits also help scatter seeds into new habitats.

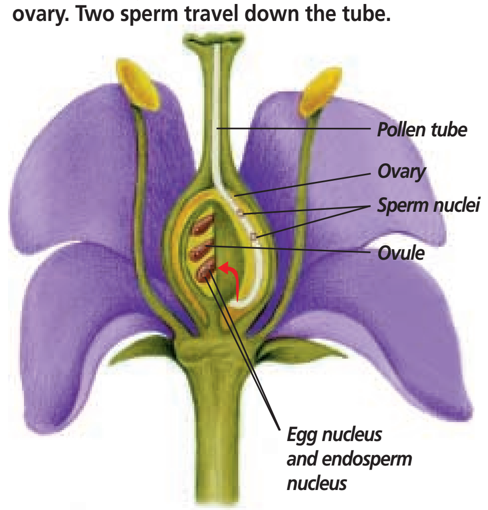


Maple tress produce fruits with a winglike shape that can be carried long distances by the breeze.

Vital Statistics

Flowering Plants
Examples: Grasses, oaks, maples, palms, irises, orchids, roses, beans.
Numbers: 230 000 species (60 000 monocots; 170 000 dicots).
Size range: A few millimeters to 75 m.

Pollen is carried to the stigma of a flower. The pollen grain grows a tube down the style to the ovary. Two sperm travel down the tube.

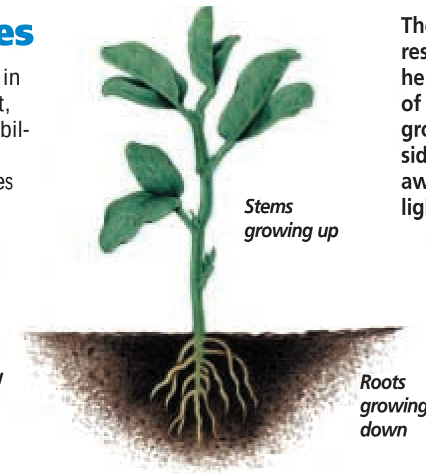


In a process called double fertilization, one of the sperm fertilizes the egg and the other unites with the endosperm nucleus.

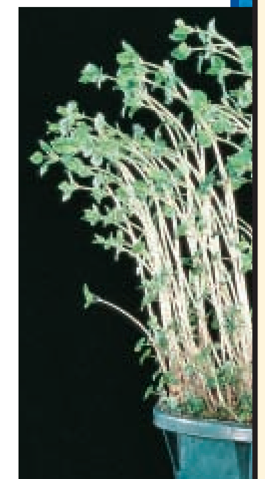
BioDigest

Plant Responses

Plants respond to changes in their environment such as light, temperature, and water availability. Chemicals called hormones control some of these responses by increasing cell division and growth.



Roots exhibit positive geotropism. Stems show a negative geotropic response.



The phototropic response shown here is the result of increased cell growth on the side of the stem away from the light.

BioDigest Assessment

Understanding Main Ideas

1. Which of the following is a Bryophyte?
   a. moss c. club moss
   b. horsetail d. conifer
2. The term for a mature fern leaf is ________.
   a. leaf c. frond
   b. scale d. needle
3. Nonvascular plants would most likely be found growing ________.
   a. in sandy desert soil
   b. on an ocean beach
   c. on a snowy mountain slope
   d. in a shady, moist environment
4. Which plant group has leaves adapted for life in cold environments?
   a. Anthophyta c. Pterophyta
   b. Sphenophyta d. Coniferophyta
5. Dicots have ________.
   a. one cotyledon
   b. two cotyledons
   c. needlelike leaves
   d. spores borne in cone-shaped strobili
6. Reproductive structures of conifers are ________.
   a. flowers c. fruits
   b. cones d. sori
7. Mosses, ferns, and club mosses are alike because they require ________.
   a. water for fertilization
   b. adaptations for conserving water
   c. insects for pollination
   d. warm, sunny habitats
8. Lycophytes, sphenophytes, and coniferophytes have specialized leaves that form reproductive structures known as ________.
   a. sori c. cones
   b. flowers d. strobili
9. Vascular plants do not include the ________.
   a. Lycophytes c. Sphenophytes
   b. Bryophytes d. Pterophytes
10. Which plant group produces flowers and seeds enclosed in a fruit?
   a. Anthophyta c. Pterophyta
   b. Coniferophyta d. Lycophyta

Thinking Critically

1. Compare the spore-bearing structures of ferns with the seed-bearing structures of conifers.
2. Why do vascular plants have an adaptive advantage over nonvascular plants?
3. Describe three ways in which seeds may be dispersed.

BioDigest

3 Assess

Check for Understanding

Have students explain the difference between the terms in each of the following word pairs. L2
a. seed—spores
b. vascular—nonvascular
c. cone—fruit
d. monocot—dicot

Reteach

Have students name plants that are or produce structures, listed in the word pairs of the Check for Understanding. Ask them to explain why each plant is representative of the term. L2

Extension

Linguistic Have students research one plant division of their choice and present a brief oral report to the class. L3

Assessment

Skill Have students prepare a chart that shows the different types of plants and their major characteristics. L2

4 Close

Activity

Have students prepare questions about the major characteristics of plants and write them on the chalkboard. Have the class discuss each question.

PROJECT

Street-Tree Census

Interpersonal Have students conduct a street-tree census in their community. They can analyze the results of the census and submit a class report to the community government with suggestions on locations where additional trees could be planted. L3
COOP LEARN

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *Double Fertilization*
Animation: *Fruit Formation*
Exploration: *Pollination*
Disc 3

BioDigest Assessment

Understanding Concepts

1. a
2. c
3. d
4. d
5. b
6. b
7. a
8. d
9. b
10. a

Thinking Critically

1. Ferns produce spores in sori on fronds. Conifers develop seeds at the base of scalelike leaves that form cones.
2. Vascular plants are not limited to moist environments because they do not have to rely on osmosis and diffusion for transport of water and nutrients. Also, vascular tissue provides support so the plants can grow larger.
3. Seeds may be blown away by the wind. They may be carried by water when they fall in the ocean or in streams. They may also be transported by animals who eat the fruit and discard the seeds, or by animals who pass seeds through their digestive systems and deposit them with their droppings.