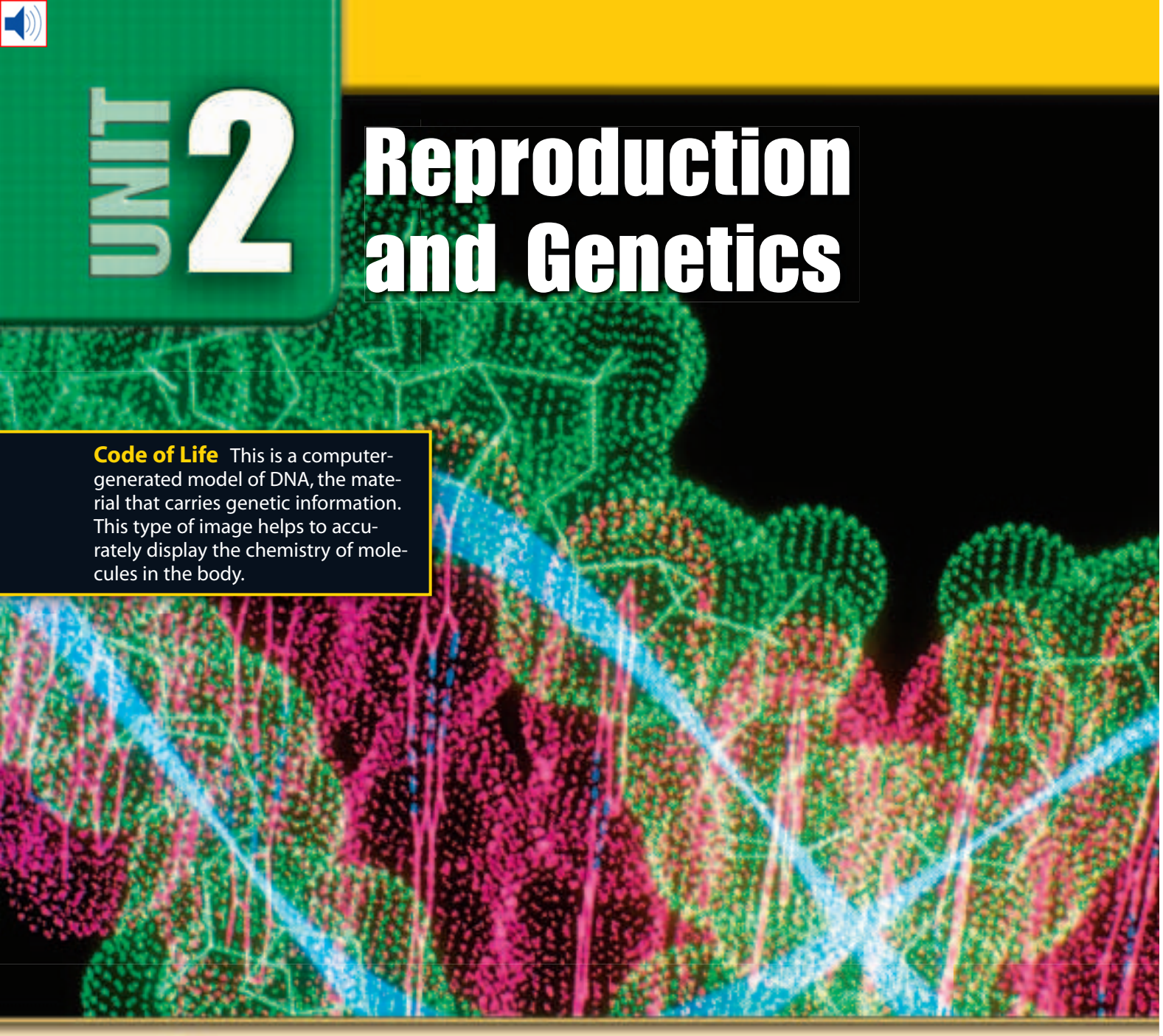
UNIT 2

Reproduction and Genetics

Code of Life This is a computer-generated model of DNA, the material that carries genetic information. This type of image helps to accurately display the chemistry of molecules in the body.



West Coast Events

10,000–9,000 Years Ago
People in Mexico and southward plant food crops using seeds and shoots from parent plants.

1870–1890
Luther Burbank works in Santa Rosa, California, developing more than 800 new strains of plants to improve the quality of food; he is known as the father of plant breeding.

A.D. 1 | 1700 | 1800 | 1900

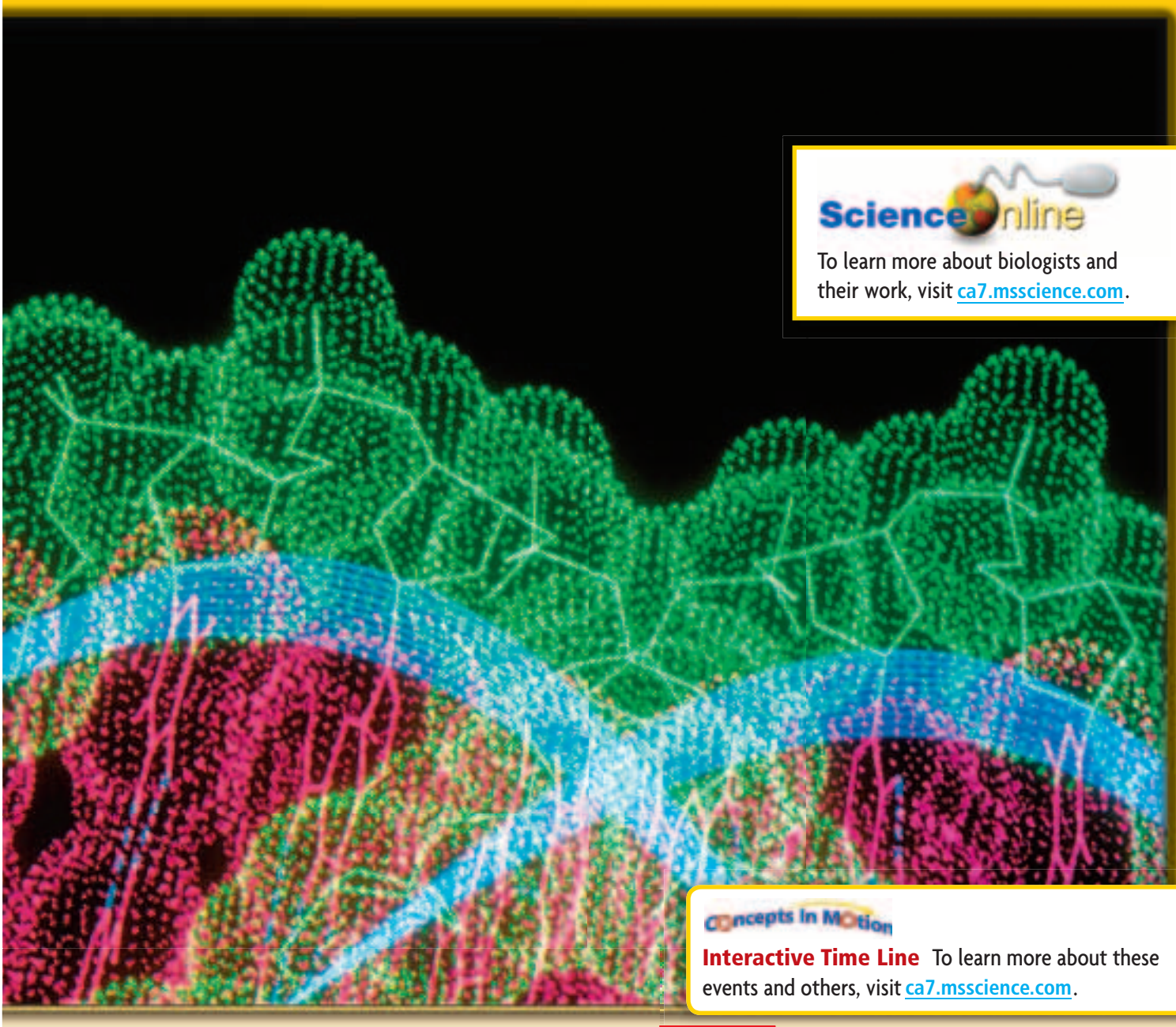
World Events

2,700 Years Ago
Greeks develop different varieties of plants by grafting (splicing part of one plant with part of another).

1791
James Weatherby publishes book of pedigrees of race horses in England, which becomes basis for recording pedigrees of other animals.

1890s
The invention of better microscopes allows several scientists to discover the basic facts of sexual reproduction.

CONTENTS



Science Online

To learn more about biologists and their work, visit ca7.msscience.com.

Concepts in Motion

Interactive Time Line To learn more about these events and others, visit ca7.msscience.com.

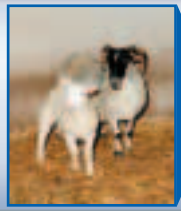
1997
The U.S. Department of Energy sets up Joint Genome Institute (JGI) to study DNA; JGI is operated by the University of California.

2001
Scientists in Washington identify a mutation that causes harmful drug responses in dogs.

2005
Scientists at UC Davis work on a bank of dog pedigrees based on DNA.

1950 1960 1970 1980 1990 2000 2010

1951, 1952, 1953
Rosalind Franklin has a photograph of DNA; Martha Chase and Alfred Hershey prove that DNA is the molecule of heredity; Francis Crick and James Watson model DNA.



1997
Scientists in Scotland announce the cloning of a sheep named Dolly.

February 2001
Scientists from around the world successfully map the human genome (all the genes of the human body).

CONTENTS

CHAPTER 3

Reproduction of Organisms

The BIG Idea

Different types of reproduction ensure the survival of different species.

LESSON 1 2.b, 7.b
Sexual Reproduction and Meiosis

Main Idea Meiosis maintains the chromosome number of a species from one generation to the next.

LESSON 2 2.a, 5.f, 7.b
Plant Reproduction

Main Idea A plant's life cycle includes a diploid generation that produces spores and a haploid generation that produces eggs and sperm.

LESSON 3 2.a, 2.b, 7.c
Animal Reproduction

Main Idea Animals have specialized structures for sexual reproduction.

LESSON 4 2.a, 7.a, 7.c, 7.d, 7.e
Asexual Reproduction

Main Idea Asexual reproduction produces offspring that are identical to the parent.

Who planted all of these flowers?

Some of these yellow poppies and purple lupines might have grown from seeds produced in flowers that bloomed here the previous year. Or, an animal passing by might have deposited some seeds in its wastes. Still other plants might have grown from parts of existing plant roots or stems.

Science Journal List four plants you familiar with that grow from seeds. List other ways you know of that plants can be grown.

CONTENTS

Launch Lab

10 minutes

How does reproduction happen?

When a photograph is reproduced, a copy is made. Does the same thing happen when an organism reproduces?

Procedure

1. Create a spider concept map about what you know about reproduction.
2. Write the word *reproduction* in the center circle and add examples of reproduction around it.

Think About This

- **Infer** Art and photographs can be reproduced. Does the same thing happen when an organism reproduces?
- **Compare** List ways that puppies are like their parents and ways they could be different from their parents.
- **Predict** Do plants have parents? Do bacteria have parents?
- **Analyze** Some organisms look like their parents, but others do not. How might this happen?

2.a, 7.d

Science Online

Visit ca7.msscience.com to:

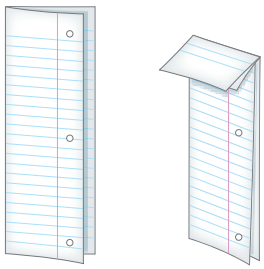
- view Concepts in Motion
- explore Virtual Labs
- access content-related Web links
- take the Standards Check

FOLDABLES™ Study Organizer

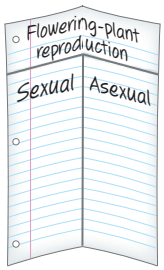
Plant Reproduction

Make the following Foldable about sexual and asexual reproduction in flowering plants.

STEP 1 **Fold** a sheet of paper in half lengthwise. **Fold** the top down about 3 cm from the top.



STEP 2 **Unfold** and draw lines along the folds as shown. **Label** the top and each column.



Reading Skill

Clarifying

As you read Lesson 2, list in the appropriate column the flowering-plant structures involved in each type of reproduction.

Get Ready to Read

New Vocabulary

1 Learn It! What should you do if you find a word you don't know or understand? Here are some suggested strategies:

1. Use context clues (from the sentence or the paragraph) to help you define it.
2. Look for prefixes, suffixes, or root words that you already know.
3. Write it down and ask for help with the meaning.
4. Guess at its meaning.
5. Look it up in the glossary or a dictionary.

2 Practice It! Look at the word *conifer* in the following passage. See how context clues can help you understand its meaning.

Context Clue
Examples of conifers are pines, firs, cypresses, redwoods, and yews.

Context Clue
Conifers are trees and shrubs with needlelike or scalelike leaves.

Context Clue
Most conifers are evergreen and can live for many years.

The most common gymnosperms are conifers. Conifers, such as **pines, firs, cypresses, redwoods, and yews,** are **trees and shrubs with needlelike or scalelike leaves.** Most conifers are **evergreen and can live for many years.** Bristlecone pines, shown in **Figure 11,** are among the oldest living trees on Earth.

—from page 137

3 Apply It! Make a vocabulary bookmark with a strip of paper. As you read, keep track of words you do not know or want to learn more about.

Reading Tip

Read a paragraph containing a vocabulary word from beginning to end. Then, go back to determine the meaning of the word.

Target Your Reading

Use this to focus on the main ideas as you read the chapter.

1. **Before you read** the chapter, respond to the statements below on your worksheet or on a numbered sheet of paper.
   - Write an **A** if you **agree** with the statement.
   - Write a **D** if you **disagree** with the statement.
2. **After you read** the chapter, look back to this page to see if you've changed your mind about any of the statements.
   - If any of your answers changed, explain why.
   - Change any false statements into true statements.
   - Use your revised statements as a study guide.

Before You Read A or D	Statement	After You Read A or D
	1 All living organisms have two parents.	
	2 Parents always pass their genetic material to their offspring.	
	3 Not all reproduction involves a sperm cell and an egg cell.	
	4 Meiosis is a type of cell division.	
	5 All plants reproduce by forming flowers.	
	6 All plants reproduce by forming seeds.	
	7 Some animal embryos develop inside the body of the mother.	
	8 All animal embryos develop inside eggs.	
	9 Some organisms have only one parent.	
	10 Plants can be cloned, but animals cannot.	

Science Online

Print a worksheet of this page at ca7.msscience.com.

LESSON 1

Science Content Standards

2.b Students know that sexual reproduction produces offspring that inherit half their genes from each parent.
7.d Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).

Reading Guide

What *You'll Learn*

- **Compare** a sexually produced offspring to its parents.
- **Explain** the importance of meiosis in sexual reproduction.
- **Sequence** meiosis.
- **Describe** the results of meiosis.

Why *It's Important*

If you know how cells divide for reproduction, it's easier to understand why offspring resemble their parents.

Vocabulary

sexual reproduction
egg
sperm
fertilization
zygote
meiosis
diploid
haploid

Review Vocabulary

eukaryote: an organism made of cells; each cell has a membrane-bound nucleus (p. 64)

Sexual Reproduction and Meiosis

Main Idea Meiosis maintains the chromosome number of a species from one generation to the next.

Real-World Reading Connection You have a better chance of seeing a wild California condor than your parents did when they were your age. In the 1980s, fewer than 20 of these birds were in the wild. Naturalists captured condors and helped them produce offspring. Some of these condor offspring now live in the wild, and the condor population is increasing.

What is sexual reproduction?

Many young organisms resemble their parents, such as the guinea pig pups shown in **Figure 1.** Like most animals, each guinea pig pup has two parents—a mother and a father. The genetic material that an organism receives from its parents determines what it looks like and how it functions.

Reproduction in organisms produces new offspring. **Sexual reproduction** is the production of an offspring that results when the genetic materials from two different cells combine. Half of the genetic material is contained in an **egg** cell. The other half is contained in a **sperm** cell. A process called **fertilization** (fur tuh luh ZAY shun) is the fusing together of a sperm cell and an egg cell. The new cell that forms is called a **zygote** (ZI goht). A zygote develops into a new organism.

Figure 1 These guinea pig pups are not identical because each one inherited a different mix of genetic material from its parents.

Carolyn A. McKeone/Photo Researchers

CONTENTS

Advantages of Sexual Reproduction

Sexual reproduction is the most common form of reproduction in eukaryotes. As you just read, offspring from sexual reproduction receive genetic material from two cells. Each guinea pig pup in **Figure 1** inherited genetic material from the same two parents. Each pup inherited a different mix of genetic material. In a population of guinea pigs, or any other species that reproduces sexually, no two individuals, except identical twins, have the same mix of genetic material. This means that each individual has a different set of traits. The variety of genetic traits in a population of the same species is known as genetic variation.

Reading Check How does genetic variation affect the survival of a species?

Genetic Variation When environmental conditions change, genetic variation can help a species survive. Imagine a population of California poppies, like those shown in **Figure 2.** During a drought, poppy plants with traits that enable them to grow in dry conditions are more likely to survive and produce seeds. Plants without these traits might not survive. Because their genetic makeups **vary,** the population of poppies would include a few plants that could survive a drought.

A lack of genetic variation can cause problems for a species. Suppose every plant in the poppy population had the same genetic traits. If none of those traits enabled the plants to survive hot, dry weather, the entire population might die out.

Selective Breeding Plant breeders and animal breeders often select a male organism and a female organism with certain preferred traits to be the parents of offspring. This method of sexual reproduction is called selective breeding. It produces groups of organisms with similar traits, such as the dogs shown in **Figure 3,** but reduces genetic variation. Offspring produced by selective breeding can also inherit health problems.

Visual Check **Figure 3** Why do these puppies resemble each other more than the guinea pig pups resemble each other?

Figure 2 Each California poppy plant in this population has a unique set of genetic information, making the population genetically varied.

ACADEMIC VOCABULARY

vary (VAYR ee)
(verb) to make different
Musicians vary the tempo as directed by the conductor.

Figure 3 The golden retriever is one of many dog breeds created by mating dogs that have similar genetic material.

Figure 4 Male sea urchins release sperm into the water at the same time that female sea urchins release millions of eggs. Male elephant seals might attack each other to become the dominant male that mates with female elephant seals.

Disadvantages of Sexual Reproduction

Because males produce sperm and females produce eggs, one of the disadvantages of sexual reproduction is getting egg and sperm together for fertilization. Some species, such as the sea urchin shown in **Figure 4,** produce millions of egg cells or sperm cells and release them into water. This increases the chances that a sperm will find an egg. Other organisms have specific methods that ensure fertilization.

Another disadvantage of sexual reproduction is the time needed for organisms to grow and develop until they can reproduce. For example, male elephant seals, as shown in **Figure 4,** do not mate until they are about 9–10 years of age. Humans are even older. Later in this chapter, you will read about types of reproduction that can happen before organisms grow and develop enough to reproduce sexually and do not require fertilization.

Science Use v. Common Use

reproduce

Science Use to produce living offspring. *Some plants can reproduce with only one parent plant.*

Common Use to copy. *The hardware store has a machine that can reproduce keys.*

Why is meiosis important?

You read in Chapter 1 that genetic material is part of the chromosomes in the nucleus of each eukaryotic cell. Sexual reproduction includes fertilization, which is the combining of the genetic material in a sperm cell and the genetic material in an egg cell. **Meiosis** (mi OH sus) is cell division that produces sperm or eggs from certain reproductive cells in an organism. Meiosis takes place only in eukaryotes that reproduce sexually.

Word Origin

meiosis

from Latin *meioun;* means *to lessen*

Reading Check What kinds of cells does meiosis produce?

Meiosis is important because it ensures that a species' offspring inherit the correct chromosome number. For example, tomatoes inherit 24 chromosomes, humans inherit 46 chromosomes, and chickens inherit 78 chromosomes. Without meiosis, the chromosome number would double with each generation. Instead of inheriting 46 chromosomes, children would inherit 92 chromosomes, their children would inherit 184, and so on.

CONTENTS

Maintaining Diploid Cells

Recall from Chapter 2 that homologous (huh MAH luh gus) chromosomes are similar in size, shape, and genetic material. A **diploid** cell in an organism contains pairs of chromosomes that equal the chromosome number of that organism's species. A diploid human cell has 23 pairs of homologous chromosomes. The chromosome number for humans is 46.

Homologous chromosomes are similar, but not identical. For example, each human chromosome in a homologous pair might contain genetic material for eye color. However, one chromosome might have blue eye-color information and the other brown eye-color information.

Creating Haploid Cells

Sperm and egg cells have half the chromosome number of the species. For example, a human sperm cell contains 23 chromosomes—one chromosome from each homologous pair of chromosomes. Similarly, a human egg cell contains 23 chromosomes. A cell that contains one chromosome from each homologous pair is called a **haploid** cell.

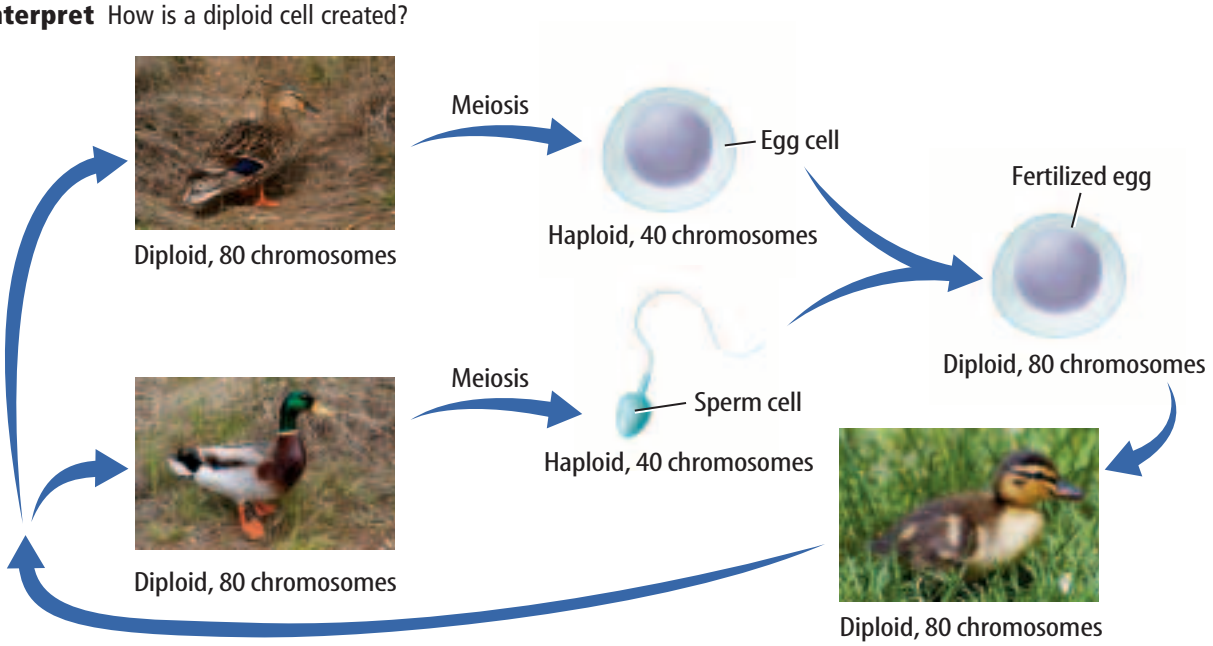
It's important for offspring to inherit the correct number of chromosomes for their species. Because an egg and a sperm are haploid, the chromosome number of offspring does not double, as described on the previous page. Meiosis ensures that fertilization creates a zygote with the correct number of chromosomes, as shown in **Figure 5.**

WORD ORIGIN

haploid
from Greek *haploeides;* means *single*

Figure 5 Meiosis ensures that the chromosome number of a species stays the same from one generation of offspring to the next.

Interpret How is a diploid cell created?



What are the phases of meiosis?

In Chapter 2, you read about the stages of mitosis—the division of a cell nucleus. Meiosis happens in a similar way. For example, before meiosis begins, a cell's chromosomes replicate, just as they do before mitosis. Recall that each replicated chromosome consists of two identical sister chromatids that are held together near their middles.

In mitosis, division of the nucleus and cytokinesis happen once. In meiosis, division of the nucleus and cytokinesis happen twice. These two processes are called meiosis I and meiosis II. Like mitosis, the phases of each process are called prophase, metaphase, anaphase, and telophase. Diagrams of the phases of meiosis I and meiosis II are shown in **Figure 6.**

Phases of Meiosis I

Prophase I The membrane surrounding the nucleus breaks apart. The replicated chromosomes condense and thicken. Then, unlike mitosis, homologous chromosomes line up close to each other.

Metaphase I The pairs of replicated homologous chromosomes form a line along the middle of the cell. Fibers of the cytoskeleton attach to each pair of sister chromatids.

Anaphase I Cytoskeleton fibers pull each pair of sister chromatids to opposite ends of the cell. Notice that the pairs of replicated homologous chromosomes separate, but not the sister chromatids. Sister chromatids stay together.

Telophase I A membrane forms around each group of replicated chromosomes. Then, the cytoplasm divides to form two daughter cells. Sister chromatids still are together.

Phases of Meiosis II

During meiosis II, the nucleus of each daughter cell formed during meiosis I divides. Then, each daughter cell divides.

Prophase II Chromosomes do not replicate before prophase II. They remain condensed and thickened.

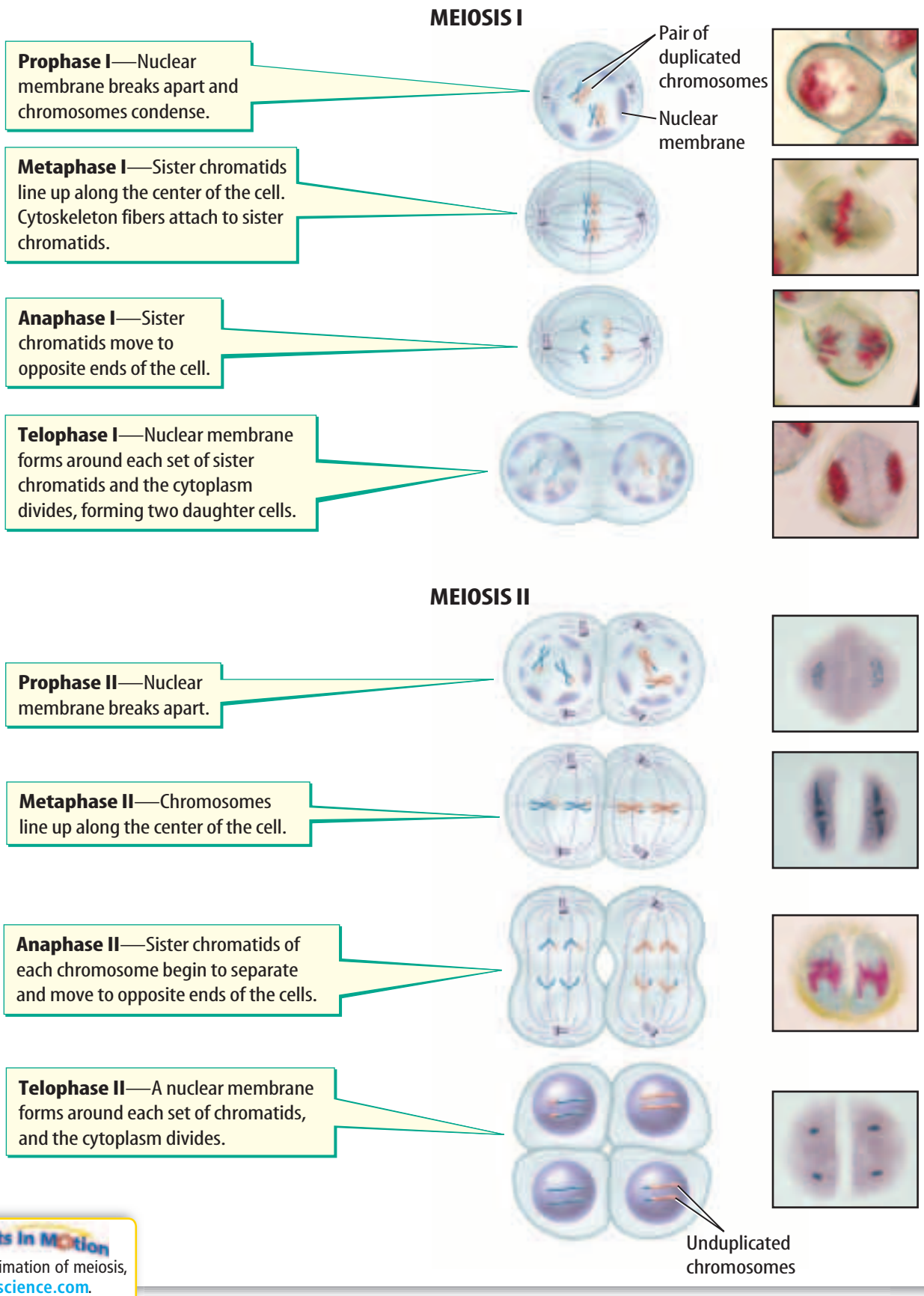
Metaphase II The cytoskeleton fibers move the replicated chromosomes to the middle of the cell.

Anaphase II The sister chromatids of each replicated chromosome separate and move toward opposite ends of the cell.

Telophase II A membrane forms around each set of chromatids, which now are called chromosomes. The cytoplasm divides, and meiosis II is complete.

Figure 6 Meiosis produces four haploid daughter cells from one diploid parent cell. Meiosis I separates homologous chromosome pairs. Meiosis II separates sister chromatids.

Identify other differences between meiosis I and meiosis II.



Concepts in Motion

To see an animation of meiosis, visit ca7.msscience.com.

MiniLab

00:20 minutes

What does meiosis look like?

How do chromosomes move during meiosis? Try this lab to model meiosis.

Procedure

1. Complete a lab safety form.
2. Use **Figure 6** for reference as you model meiosis.
3. Model each phase of meiosis I and meiosis II using **colored yarn** to represent chromosomes.
4. Use **scissors** to cut the lengths of yarn to create homologous chromosomes.
5. **Glue** your yarn chromosomes to **construction paper circles** provided by your teacher.

Analysis

1. **Explain** how your understanding of meiosis improved after you completed this lab.
2. **Evaluate** Is yarn a good material to use for modeling chromosomes during meiosis?
3. **Describe** ways in which this model worked well. List ways you could improve it.

2.b, 7.d

What are the results of meiosis?

As you read earlier, meiosis is similar to mitosis, but there are important differences. Some of the similarities and differences are listed in **Table 1.**

Both meiosis and mitosis begin with one diploid parent cell. Both meiosis and mitosis take place only in eukaryotic cells. Recall that eukaryotic cells are cells that contain a nucleus surrounded by a membrane.

In meiosis, the nucleus of the parent cell divides, then the two newly formed nuclei divide. Mitosis has only one division of a nucleus. Also, mitosis is usually followed by cytokinesis that results in two daughter cells of equal size. Sometimes when meiosis occurs for egg production, the cytoplasm divides unequally during meiosis I. This results in a small cell that breaks down and a large cell that undergoes meiosis II. In meiosis II, the cytoplasm divides unequally again. The larger cell becomes the egg and the smaller cell breaks down.

Visual Check **Table 1** What process produces genetically different daughter cells?

Table 1 Comparison of Meiosis and Mitosis

Characteristic	Meiosis	Mitosis
Number of chromosomes in parent cell	diploid	diploid
Type of parent cell	only certain reproductive cells in eukaryotic organisms	nearly all eukaryotic cells
Number of divisions of nucleus	2	1
Number of daughter cells produced	4	2
Chromosome number in daughter cells	haploid	diploid
Functions in the organism	• produces sperm and egg cells • maintains chromosome number for the species	• daughter cells genetically identical to each other and to the parent cell • growth, cell repair, some types of reproduction

Meiosis Summary

In this lesson, you learned that sexual reproduction includes fertilization—the fusion of a sperm cell with an egg cell. You also learned that fertilization produces a cell called a zygote. The zygote is a diploid cell, and an egg and a sperm are called haploid cells.

Sperm and egg cells are produced by meiosis. It is important to remember that all the eggs or sperm produced by an organism are different. Therefore, each zygote produced by sexual reproduction from the same parents will inherit different genetic material. This genetic variation can be important to the survival of a species. You will learn more about how meiosis promotes genetic diversity when you study genetics in Chapter 4.

LESSON 1 Review

Summarize

Create your own lesson summary as you organize an **outline.**

1. **Scan** the lesson. Find and list the first **red** main heading.
2. **Review** the text after the heading and list 2–3 details about the heading.
3. **Find** and list each **blue** subheading that follows the **red** main heading.
4. **List** 2–3 details, key terms, and definitions under each **blue** subheading.
5. **Review** additional **red** main headings and their supporting **blue** subheadings. List 2–3 details about each.

ELA7: W 2.5

Standards Check

Using Vocabulary

1. Distinguish *haploid* from *diploid*. 2.b
2. In your own words, write the definition for *meiosis*. 2.b

Understanding Main Ideas

3. Why is meiosis important in sexual reproduction?
   - **A.** It produces haploid daughter cells. 2.b
   - **B.** It produces diploid daughter cells.
   - **C.** It replicates chromosomes.
   - **D.** It produces four daughter cells.
4. How many chromosomes are in a sperm cell compared to a skin cell?
   - **A.** same number 2.b
   - **B.** half as many
   - **C.** three times as many
   - **D.** twice as many
5. **List** the phases of meiosis in the order they occur. 2.b
6. **Give an example** of how sexual reproduction increases genetic diversity. 2.b
7. **Simplify** meiosis into its basic events. 2.b

Applying Science

8. **Analyze** why meiosis is not the type of cell division that produces new skin cells. 2.b
9. **Suggest** why brothers who have the same parents are not identical. 2.b
10. **Organize Information** Copy the graphic organizer below and fill it in with details about meiosis I and meiosis II. 2.b

Meiosis I	
Meiosis II	

Science Online

For more practice, visit **Standards Check** at ca7.msscience.com.

LESSON 2

Science Content Standards

2.a Students know the differences between the life cycles and reproduction methods of sexual and asexual organisms.
5.f Students know the structures and processes by which flowering plants generate pollen, ovules, seeds, and fruit.
7.d Construct scale models, maps, and appropriately labeled diagrams to communicate scientific knowledge (e.g., motion of Earth's plates and cell structure).

Reading Guide

What *You'll Learn*

- **Explain** alternation of generations.
- **Summarize** reproduction in seedless plants.
- **Distinguish** between reproduction in flowerless and flowering plants.
- **Identify** the reproductive structures in a flower and **state** their functions.

Why *It's Important*

Learning how plants reproduce helps you understand important differences between plants and animals.

Vocabulary

spore	filament
pollen grain	pistil
ovule	stigma
seed	style
angiosperm	ovary
stamen	pollen tube
anther	fruit

Review Vocabulary

mitosis: a process in which the nucleus of the cell divides (p. 91)

Plant Reproduction

Main Idea A plant's life cycle includes a diploid generation that produces spores and a haploid generation that produces eggs and sperm.

Real-World Reading Connection In early spring, you might see cars or sidewalks covered with something that looks like yellow dust. Where did it come from? It came from some plants that are reproducing. As in all living things, reproduction is part of the life cycles of plants.

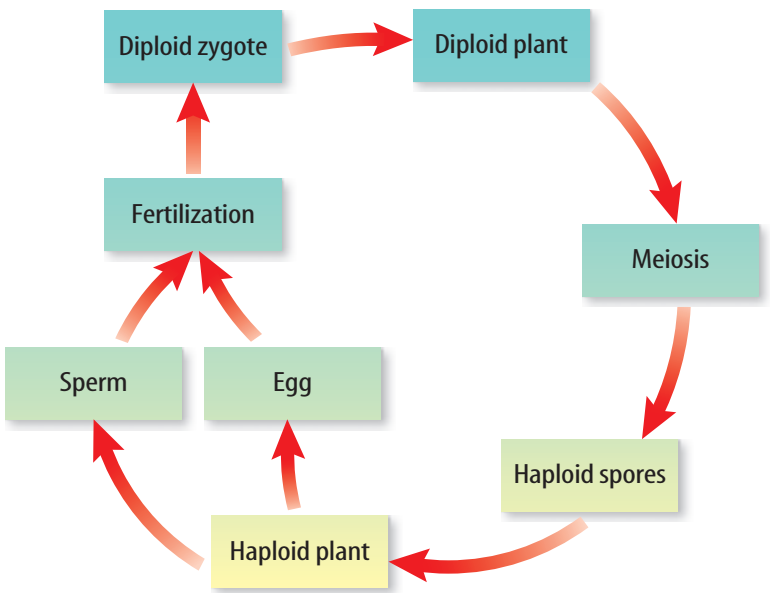
What is alternation of generations?

The human body is made primarily of diploid cells. The only human haploid cells are sperm or eggs. As a result, you will live your entire life as a diploid organism. To put it another way, your life cycle includes only a diploid stage.

That isn't true for all organisms. Some organisms, including plants, have two life stages called generations. One generation has primarily diploid cells. The other generation has only haploid cells. Organisms that alternate between diploid and haploid generations have an alternation of generations as shown in **Figure 7.**

Visual Check **Figure 7** Why does the haploid generation begin with meiosis?

Figure 7 The life cycles of all plants include an alternation of generations. The diploid generation begins with fertilization. The haploid generation begins with meiosis.



CONTENTS

The Diploid Generation

When you look at a tree or a flower, you're seeing part of the diploid generation of a plant. Meiosis occurs in certain cells in the reproductive structures of a diploid plant. The daughter cells produced from haploid structures are called **spores.** Spores grow by mitosis and cell division to form the haploid generation of a plant.

The Haploid Generation

In most plants, the haploid generation is tiny and lives surrounded by **specific** tissues of the diploid plant. In other plants, the haploid generation lives on its own. Certain reproductive cells of the haploid generation produce haploid sperm and/or eggs by mitosis and cell division. Fertilization takes place when a sperm and an egg fuse to form a diploid zygote. Through mitosis and cell division, the zygote grows into the diploid generation of the plant.

Reading Check How are the sperm and eggs produced by the haploid generation of a plant formed?

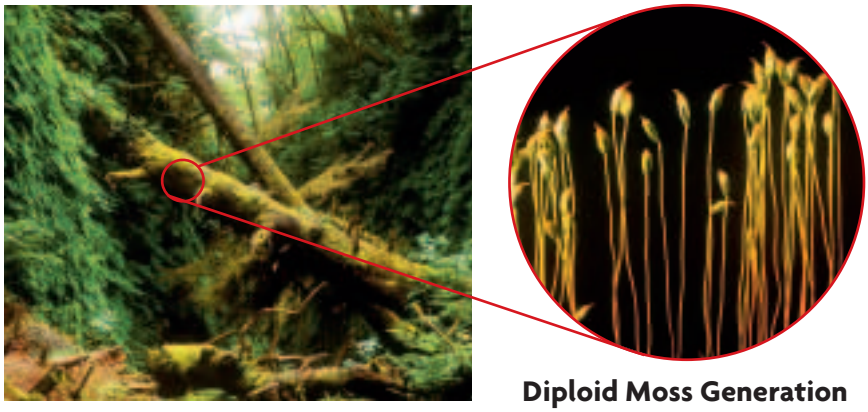
ACADEMIC VOCABULARY
specific (spih SIHF ihk)
(adj) relating to or being an example of a certain kind of thing
The race car needs a specific type of fuel.

How do seedless plants reproduce?

You've probably planted seeds and watched them grow into new plants. But, not all plants grow from seeds. The first land plants to inhabit Earth probably were seedless plants—plants that grow from haploid spores, not from seeds. The mosses and ferns in **Figure 8** are examples of seedless plants found on Earth today.

The life cycle of a moss is typical for some seedless plants. It begins with haploid spores that grow by mitosis and cell division into haploid plants. The tiny, green moss plants that carpet rocks, bark, and soil in moist areas are haploid plants. They have male structures that produce sperm and female structures that produce eggs. Fertilization results in a diploid zygote that grows by mitosis and cell division into the diploid generation. The diploid generation of mosses is tiny and not easily seen. It produces haploid spores by meiosis, and the cycle repeats.

Figure 8 Mosses and ferns usually grow in moist environments. Sperm must swim through a film of water to reach an egg.



Diploid Moss Generation

Figure 9 Pollen grains of one type of plant are different from those of any other type of plant.

Infer how scientists might use this characteristic of pollen grains.

How do seed plants reproduce?

Most of the land plants that cover Earth grew from seeds. Plants that grow from seeds are called seed plants. There are two groups of seed plants—flowerless seed plants and flowering seed plants.

Unlike seedless plants, the haploid generation of a seed plant is within diploid tissue. Separate diploid male and diploid female reproductive structures produce haploid sperm and haploid eggs that join during fertilization.

The Role of Pollen Grains

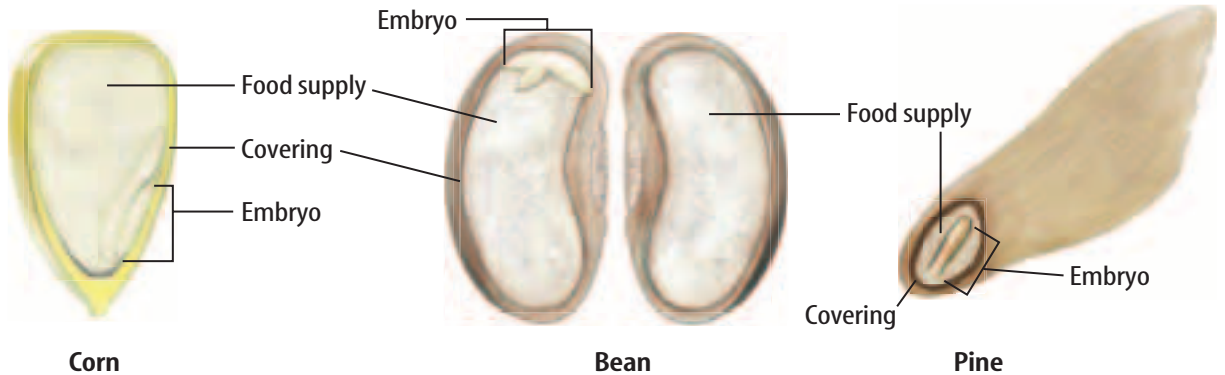
A **pollen** (PAH lun) **grain** forms from tissue in a male reproductive structure of a seed plant. Each pollen grain contains nutrients and has a hard, protective outer covering, as shown in **Figure 9.** Sperm cells form inside pollen grains. Wind, animals, gravity, or water currents can carry pollen grains to female reproductive structures. Plants cannot move to find a mate like most animals can. Recall reading about the yellow dust at the beginning of this chapter. That dust was pollen grains. Male reproductive structures produce a vast number of pollen grains. When pollen grains land on a female reproductive structure of a plant that is the same species as the pollen grains, **pollination** (pah luh NAY shun) occurs.

The Role of Ovules and Seeds

The female reproductive structure of a seed plant contains one or more **ovules.** A haploid egg develops inside each ovule. Following pollination, sperm enter the ovule and fertilization occurs.

A **seed,** as shown in **Figure 10,** develops from an ovule after fertilization. It consists of an embryo, a food supply, and a protective covering. The **embryo** (EM bree oh) is an immature diploid plant that developed from the zygote. A seed's food supply provides the embryo with nourishment for its early growth.

Figure 10 A seed contains a diploid plant embryo and a food supply protected by a hard outer covering.



Eye of Science/Photo Researchers

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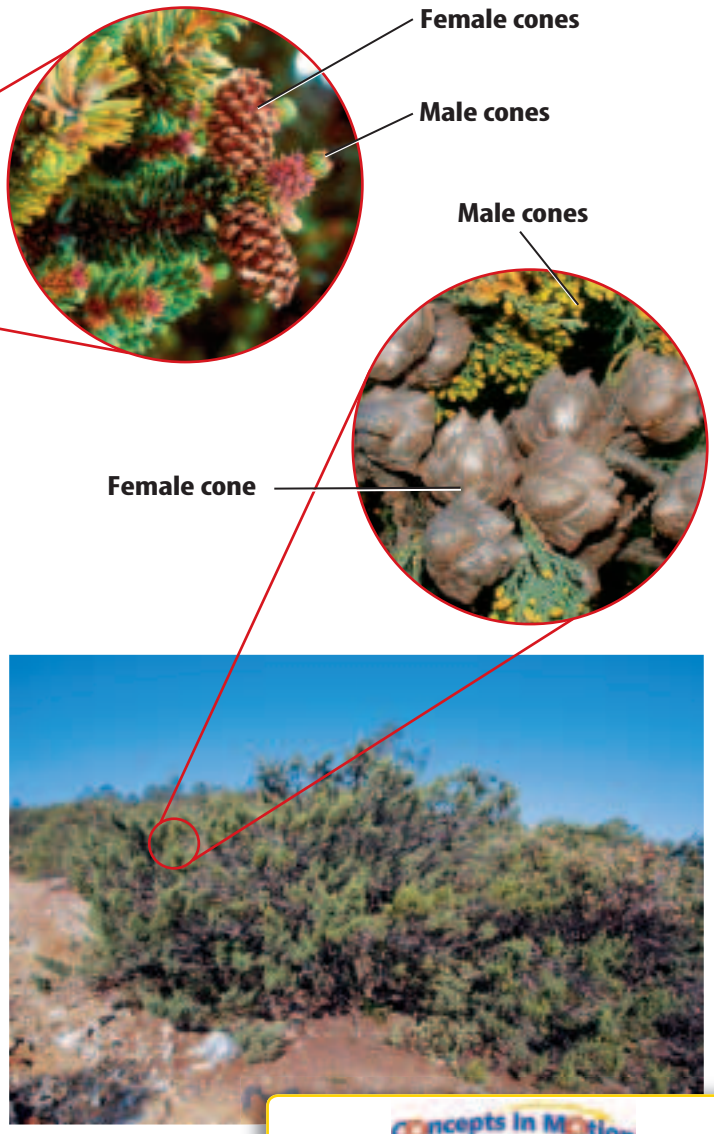

Western Bristlecone Pine
Inyo National Forest, CA

Macnab Cypress
Colusa County, CA

Figure 11 Pollen-producing male cones usually are smaller than female cones. Seeds form at the base of each scale on a female cone.

Concepts in Motion
To see an animation of gymnosperm reproduction, visit ca7.msscience.com.

How do flowerless seed plants reproduce?

Flowerless seed plants are also known as gymnosperms (JIHM nuh spurmz). The word *gymnosperm* means "naked seed" and gymnosperm seeds are not surrounded by a fruit. The most common gymnosperms are conifers. Conifers, such as pines, firs, cypresses, redwoods, and yews, are trees and shrubs with needle-like or scalelike leaves. Most conifers are evergreen and can live for many years. Bristlecone pines, such as the one shown in **Figure 11,** are among the oldest living trees on Earth.

Cones are the male and female reproductive structures of conifers. They contain the haploid generation. Male cones are papery and produce pollen grains. Female cones are woody, berry-like, or soft and produce eggs. Seeds form as part of the female cone.

MiniLab

00:20 minutes

What's in a flower?

Sexual reproduction in flowering plants involves male and female parts of flowers. Can you discover which parts are which?

Procedure

1. Complete a lab safety form.
2. Obtain a **flower** from your teacher.
3. Examine it with a partner. Make a sketch. Label your sketch according to **Figure 12.**
4. Using a **scalpel**, carefully cut the flower in half lengthwise.

5. Repeat steps 2–4 with **another type of flower.**

Analysis

1. **Compare and contrast** the structures in the two flowers.
2. **Predict** the function of each structure.

5.f, 7.d

How do flowering seed plants reproduce?

Do you enjoy the fragrance of roses or the bold colors of lilies? These are examples of flowering seed plants, also known as **angiosperms** (AN jee uh spurmz). Most of the plants you see around you are angiosperms. Fruits and vegetables come from angiosperms. Many animals depend on angiosperms for food.

Reproduction and the Flower

Reproduction of an angiosperm begins in a flower. A typical flower has male and female reproductive organs surrounded by petals, as shown in **Figure 12.** Most flowers have several male reproductive organs but only one female reproductive organ. Some flowers have only male or only female organs.

The male reproductive organ of a flower is the **stamen.** Pollen grains form at the tip of the stamen, in a structure called the **anther.** The **filament** is a long stalk that supports the anther and connects it to the base of the flower.

The female reproductive organ of a flower is the **pistil.** At the tip of the pistil is the **stigma,** where pollen can land. The stigma is at the top of a long tube called the **style.** At the base of the style is the **ovary.** Inside the ovary is usually one or more ovules. As you read earlier in this lesson, each ovule eventually will contain a haploid egg.

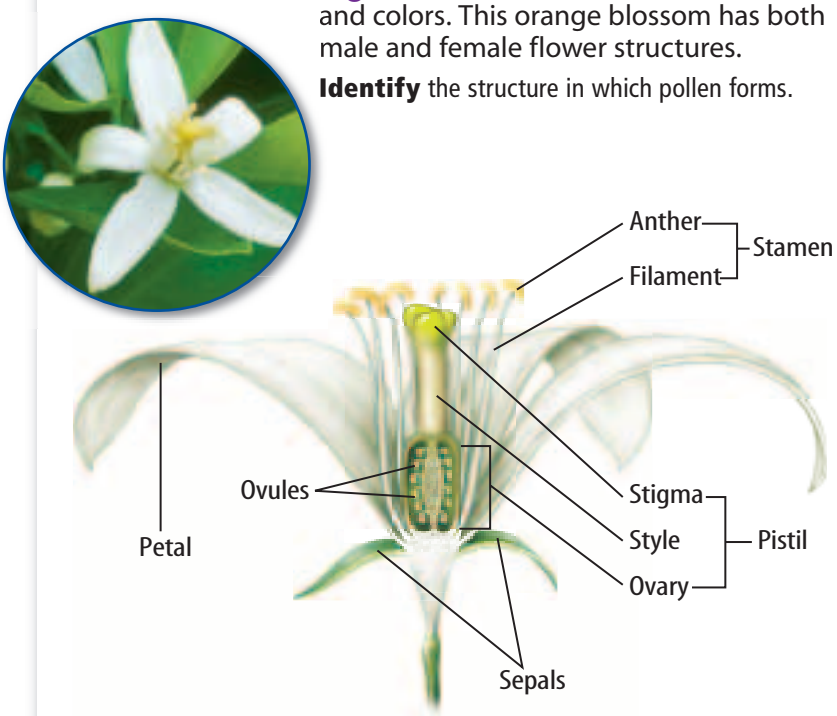

Figure 12 Flowers come in many shapes and colors. This orange blossom has both male and female flower structures.

Identify the structure in which pollen forms.

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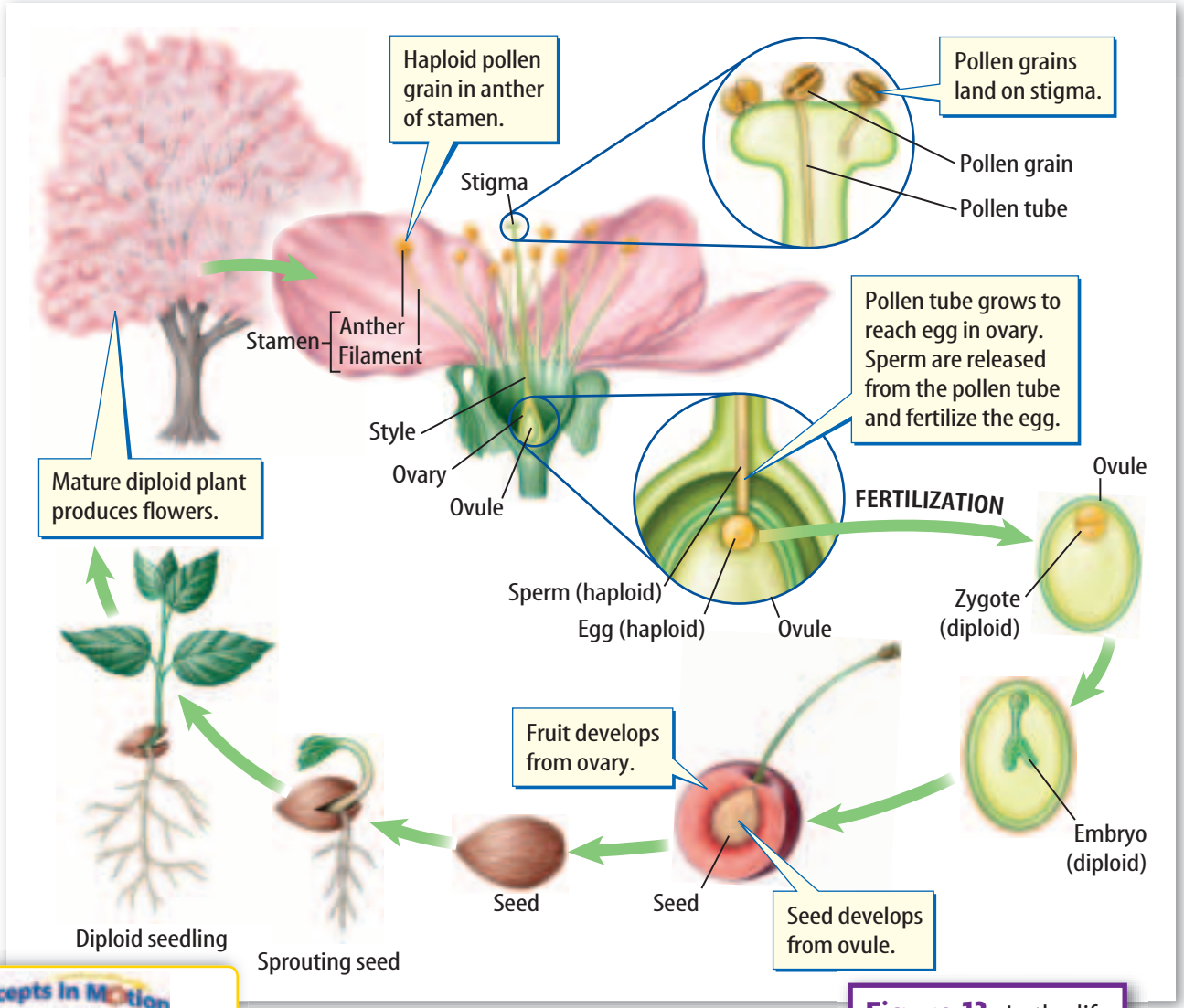


Concepts in Motion
To see an animation of the angiosperm life cycle, visit ca7.msscience.com.

Figure 13 In the life cycle of a flowering plant, the haploid generation grows and develops inside the diploid plant.

What is an angiosperm's life cycle?

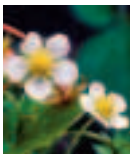
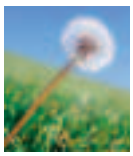
A typical life cycle for an angiosperm is shown in **Figure 13.** Pollen grains travel by wind, gravity, water, or an animal from the anther to the stigma, where pollination occurs. A **pollen tube** grows from the pollen grain into the stigma, down the style, to the ovary at the base of the pistil. Sperm develop from a haploid cell in the pollen tube. When the pollen tube enters an ovule, the sperm are released and fertilization takes place.

Reading Check Do sperm develop before or after pollination?

As you read earlier, the zygote that results from fertilization develops into an embryo. Each ovule and its embryo will become a seed. The ovary, and sometimes other parts of the flower, will develop into a **fruit** that contains one or more seeds. The seeds can grow into new, genetically related plants that produce flowers, and the cycle repeats.

Word Origin
angiosperm
angio- from Greek *angeion*, means a *vessel*; and
-sperm from Greek *sperma*, means *seed*

Table 2 Flowers, Fruits, and Seeds of Common Plants

Plant	Flower	Fruit	Seed
Pea			
Corn			
Strawberry			
Dandelion			

Concepts in Motion
Interactive Table To organize information about flowers, fruits, and seeds, visit ca7.msscience.com.

Visual Check **Table 2** Which of the fruits has seeds on the outside?

Fruit and Seed Dispersal

Fruits and seeds, including the peas, corn, and strawberries shown in **Table 2,** are important sources of food for people and animals. In most cases, seeds of flowering plants are contained inside fruits. Green pods are the fruits of a pea plant. The peas nestled inside a peapod are the seeds. A cob is the fruit of a corn plant. The kernels on a cob are the seeds. Strawberries have tiny seeds on the outside of the fruit. We usually think of fruits as juicy and edible, like an orange or a watermelon. However, some fruits are hard and dry, and not particularly edible. Each parachutelike structure of a dandelion is a dry fruit.

Fruits help protect seeds and help scatter or disperse them. For example, some fruits, like that of a dandelion, are light enough to float on air currents. When an animal eats a fruit, the fruit's seeds can pass through the animal's digestive system with little or no damage. Imagine what happens when an animal, such as the mouse shown in **Figure 14,** eats blackberries. The animal digests the juicy fruit, but deposits the seeds on the soil with its wastes. By the time that this happens, the animal might have traveled some distance away from the blackberry bush. This means that the animal helped to disperse the seed away from the blackberry bush.

Visualizing Seed Dispersal

Figure 14 Wind, water, gravity, and animals help disperse plant seeds.

▲ Some seeds are inside of dry fruits that have tiny hooks. These hooks can attach to fur, feathers, or clothing and as a result, the seeds inside the fruit move to new locations.

▲ Some animals, such as this squirrel, bury or hide fruits and seeds far from the parent plant. If not found and eaten, the seed can sprout.

Pressure ▶ builds within the seedpods of a jewelweed plant until the pod explodes. This propels the seeds far from the parent plant.

◀ A coconut is a type of seed that can float. Floating seeds are often carried many kilometers from the parent plant.

▲ The seeds of fruits usually are not damaged when they pass through an animal's digestive tract. When the animal excretes the seeds with its wastes, the seeds are usually moved to a location far from the parent plant.

Contributed by National Geographic

Plant Reproduction Summary

In this lesson, you learned that plants reproduce sexually. All plant life cycles include an alternation of generations—they alternate between a haploid generation and a diploid generation. Most of the plants you see around you, including trees, flowers, and grasses, are the diploid generation.

Familiar mosses are haploid plants that grew from a haploid spore. The diploid stage is small and often overlooked. Ferns are diploid plants. The haploid stage is small and rarely seen. Conifers and flowering plants are diploid seed plants. The haploid stage of seed plants is surrounded by diploid tissue. Seed plants reproduce by forming seeds. In conifers, seeds form as part of a female cone. In flowering plants, seeds form as part of a flower.

LESSON 2 Review

Summarize

Create your own lesson summary as you write a **newsletter.**

1. **Write** this lesson title, number, and page numbers at the top of a sheet of paper.
2. **Review** the text after the **red** main headings and write one sentence about each. These will be the headlines of your newsletter.
3. **Review** the text and write 2–3 sentences about each **blue** subheading. These sentences should tell *who, what, when, where,* and *why* information about each headline.
4. **Illustrate** your newsletter with diagrams of important structures and processes next to each headline.

ELA7: W 2.5

Standards Check

Using Vocabulary

Complete the sentences using the correct term.

fruit anther spores

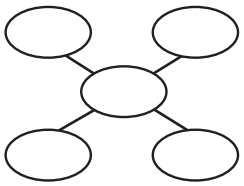
1. The diploid generation of a plant produces haploid _____ that grow to become the haploid generation. 5.f
2. The flower part in which pollen grains form is the _____. 5.f
3. Angiosperm seeds are part of a(n) _____. 5.f

Understanding Main Ideas

4. Which is NOT used to define alternation of generations? 2.a
   - **A.** chromosome
   - **B.** diploid
   - **C.** haploid
   - **D.** spore
5. **State** the functions of a reproductive structure flower. 5.f
6. **Compare** the life cycles of flowerless seed plants and flowering seed plants. 2.a

Applying Science

7. **Assess** What criteria would you use to assess the reproductive success of a plant? 2.a
8. **Organize Information** Draw a graphic organizer similar to the one below to list the female parts of a flower. Write "female flower parts" in the center oval. 5.f



Science Online

For more practice, visit **Standards Check** at ca7.msscience.com.

LESSON 3

Science Content Standards

2.a Students know the differences between the life cycles and reproduction methods of sexual and asexual organisms.
2.b Students know that sexual reproduction produces offspring that inherit half their genes from each parent.
7.c Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

Reading Guide

What *You'll Learn*

- **Explain** the role of male and female reproductive organs.
- **Differentiate** between internal and external fertilization.
- **Compare and contrast** embryo development in animals.

Why *It's Important*

Learning how animals reproduce will help you understand human reproduction.

Vocabulary

gonad
testes
ovary
metamorphosis

Review Vocabulary

organ: structure of an organism made of different types of tissues that work together (p. 104)

Animal Reproduction

Main Idea Animals have specialized structures for sexual reproduction.

Real-World Reading Connection Have you ever found a cluster of tiny, beadlike things on the underside of a leaf? What could they be? They might be eggs laid by a butterfly, a ladybug, or some other insect. Eggs are an important part of the life cycle of all animals.

What are animal reproductive organs called?

Animals often have external physical characteristics that distinguish males from females. For example, it's fairly easy to tell the difference between the male and female animals shown in **Figure 15.** In mammals and birds, males are often larger or more colorful than females.

Lions

Peacocks

Figure 15 Male and female animals often have different physical characteristics. A lion has a ruff of fur around his neck and is larger than the lioness. A peacock has larger and more colorful tail feathers than a peahen.

Compare Which of these animals are male and which are female? How do you know?

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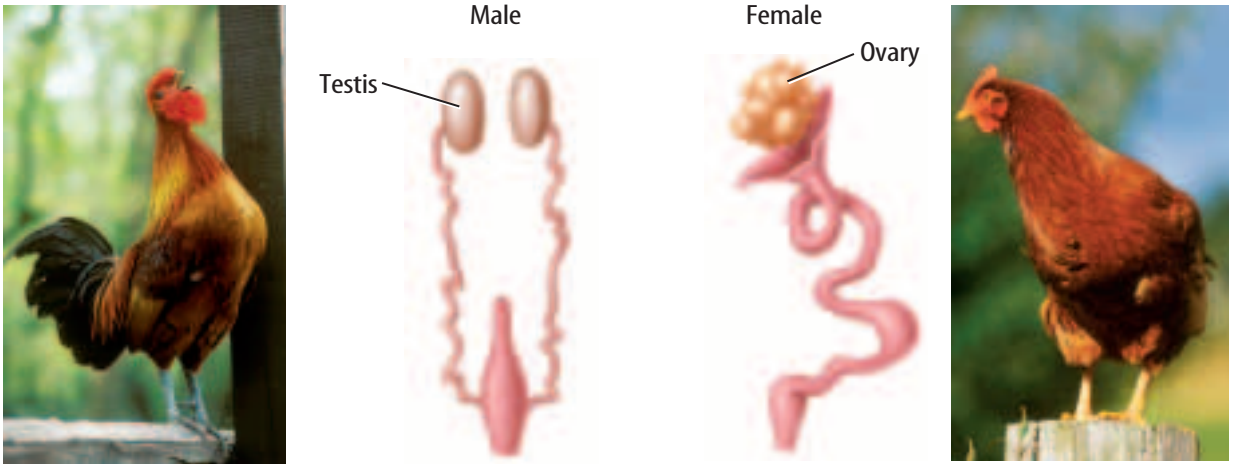

Figure 16 Sperm cells are produced by meiosis in the testes of male animals. Meiosis in one or two ovaries of female animals produces egg cells.

ACADEMIC VOCABULARY
network (NET wurk)
(noun) a system of lines or channels that connect with each other. *The capillaries, veins, and arteries form a network for moving blood.*

Male Reproductive Organs

The reproductive systems of animals include specialized reproductive organs called **gonads** that produce sperm or eggs. **Figure 16** shows the reproductive systems of male and female chickens. Male animals have gonads called **testes** that produce sperm. Testes contain a **network** of coiled tubes in which sperm cells form. Sperm have tails that enable them to swim through fluid to reach an egg cell. Most male animals have two testes located inside the body cavity.

Reading Check What type of cell forms in the testes?

Vertebrate animals—animals with backbones—have an additional adaptation that contributes to successful sexual reproduction. Glands near the testes produce fluid that nourishes sperm and helps them travel from the testes to the eggs of a female.

Female Reproductive Organs

Female animals have gonads called **ovaries.** Most female animals have two ovaries except female birds, which have only one ovary. Ovaries produce egg cells. Eggs are larger than sperm and cannot move on their own. Many female mammals are born with all the eggs they will ever have. You will read more about the testes and ovaries of humans in Chapter 13.

How does animal fertilization occur?

As you read earlier in this chapter, sexual reproduction requires fertilization—the fusion of a haploid egg cell and a haploid sperm cell that forms a diploid zygote. The way in which a sperm reaches the egg differs among animal species.

Internal Fertilization

When fertilization happens inside the body of an organism, it is called internal fertilization. For many animals, the male has a specialized structure that can deposit sperm in or near a female's reproductive system. The sperm swim to the egg or eggs. Earthworms, spiders, insects, reptiles, birds, and mammals have internal fertilization.

Internal fertilization ensures that an embryo, which develops from a fertilized egg, is protected and nourished until it leaves the female's body. This protection increases the chance that the embryo will survive, develop into an adult, and reproduce.

External Fertilization

A female toad, like the one shown in **Figure 17,** deposits unfertilized eggs under water. A male toad releases his sperm above the eggs as she lays them. Fertilization that occurs in the environment, outside of an animal's body, is called external fertilization. In most cases, the female animal releases eggs into water at about the same time a nearby male animal releases sperm into the water. When a sperm reaches an egg, fertilization takes place. Animals that reproduce using external fertilization include jellyfishes, clams, sea urchins, sea stars, many species of fish, and amphibians.

Most animals that reproduce using external fertilization do not care for the fertilized eggs or for the newly hatched young. As a result, eggs and young are exposed to predators and other dangers in the environment, reducing their chances of surviving. Successful reproduction of animals with external fertilization requires that a large numbers of eggs be produced. This helps to ensure that at least a few offspring will survive to become adults that reproduce. For example, a female California red abalone, a species of sea snail, produces about 2.5 million eggs in one breeding season.

Figure 17 For organisms that have external fertilization, mating behaviors, such as that of the toads shown here, help make certain that eggs are fertilized as soon as possible after they leave the body of the female.

Infer why a female toad releases large numbers of eggs into the water.

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Figure 18 In most mammals, the embryo develops inside the body of the mother. The duck-billed platypus is an exception. Each duck-billed platypus embryo develops inside an egg laid in a nest. It hatches and is cared for by the mother.

Compare How does the size of a duck-billed platypus egg compare with the size of a chicken egg?

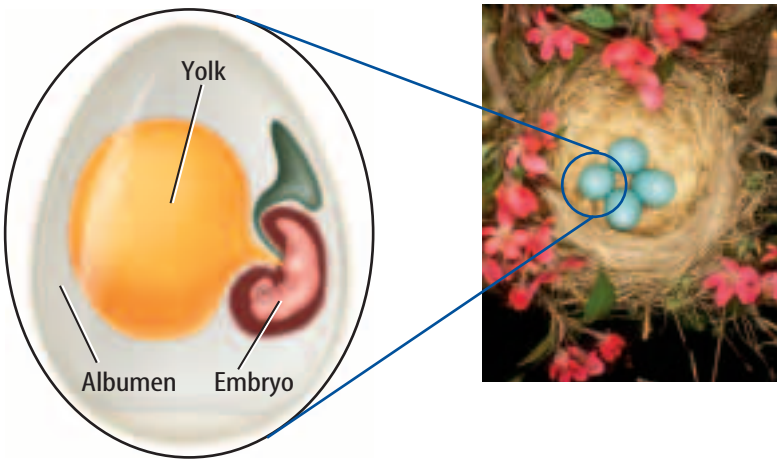
How do animal embryos develop?

The zygote produced by fertilization is only the beginning of an animal's life. The zygote grows by mitosis and cell divisions and becomes an embryo—the next stage in an animal's life. A growing embryo needs nourishment and protection from predators and other dangers in the environment. Different animals have different ways of supplying the needs of an embryo. In some animals, the embryo develops outside the body of the mother. In others, the embryo develops inside the mother.

External Development

The duck-billed platypus, as shown in **Figure 18,** is an example of an animal whose embryos develop outside the mother. Animals that develop outside the mother usually are protected inside an egg. In most instances, one embryo develops inside each egg. Most eggs contain a yolk that provides food for the developing embryo. Some kind of covering surrounds the egg. The covering protects the embryo, helps keep it moist, and discourages predators. Eggs laid by lizards, snakes, and other reptiles have a tough, leathery covering. A tough, jellylike substance usually surrounds eggs laid under water. As shown in **Figure 19,** bird eggs, like those of a robin, have a hard covering called a shell.

Figure 19 A female robin usually lays four eggs in a nest. Each egg contains an embryo and a yolk that supplies food for the growing embryo.



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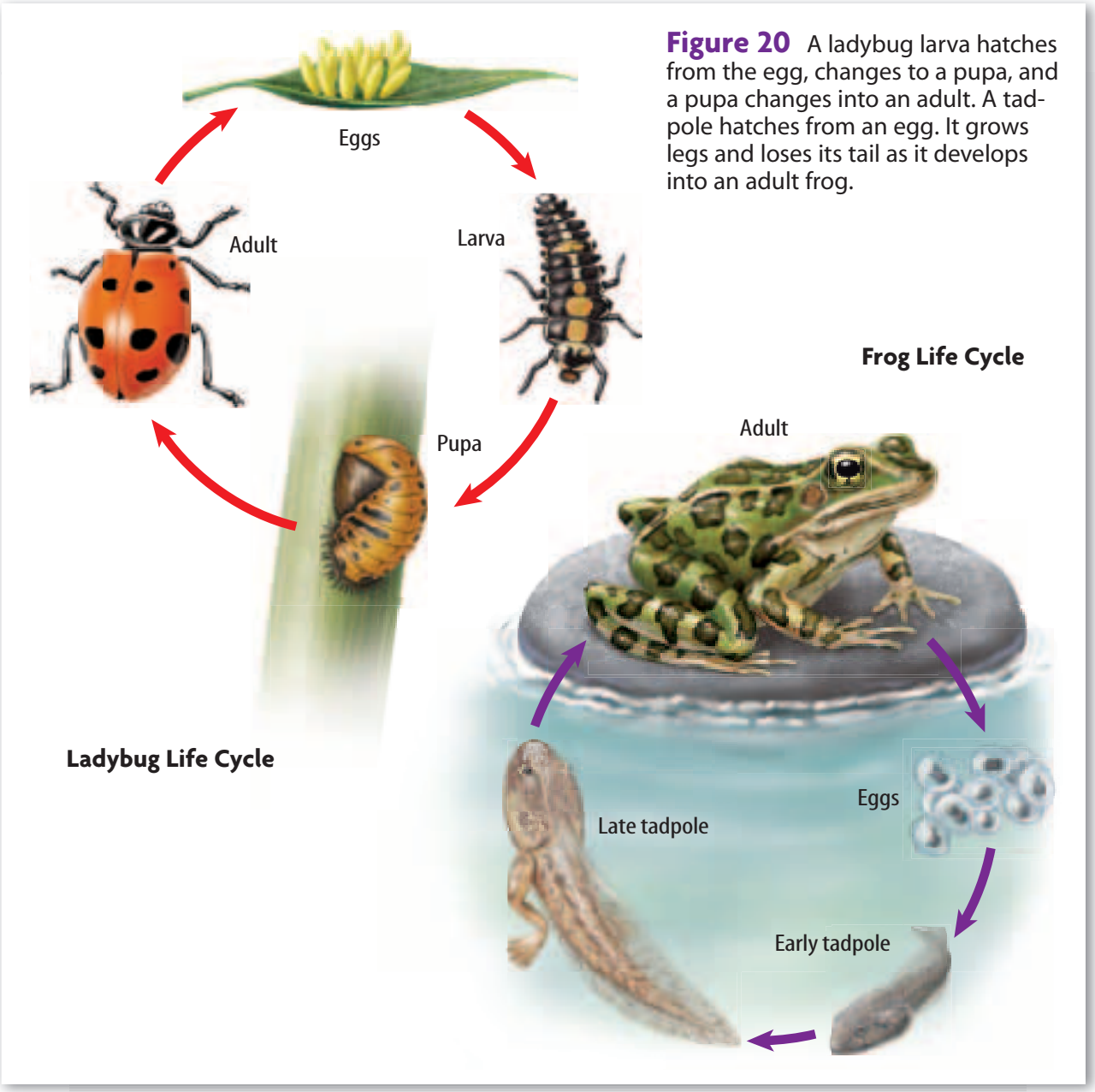


Figure 20 A ladybug larva hatches from the egg, changes to a pupa, and a pupa changes into an adult. A tadpole hatches from an egg. It grows legs and loses its tail as it develops into an adult frog.

Metamorphosis Some animals—including amphibians and many animals without backbones—go through more than one phase of development. **Metamorphosis** is a developmental process in which the form of the body changes as an animal grows from the egg to an adult.

The metamorphosis of a ladybug beetle and the metamorphosis of a frog are shown in **Figure 20.** A ladybug beetle goes through four stages during its development—egg, larva, pupa, and adult. The tadpole is the larval stage of a frog. Larva and adult forms often have different lifestyles. The larva of the frog lives only in the water. The adult frog can live on land or water.

Reading Check What developmental process does a tadpole go through as it becomes a frog?

Word Origin
metamorphosis
from *meta-* (Greek, means *change*) and *morphe* (Greek, means *form*)

DataLab

00:30 minutes

How fast do they grow?

A human fetus develops for nine months inside its mother. Most human babies weigh less than ten pounds at birth. How fast does a baby grow before it's born?

Data

Examine the table below. It shows data about how the mass of a human fetus increases as it grows inside its mother.

Increase in Mass of a Human Fetus

Age of Fetus	Mass of Fetus
16 weeks	180 g
20 weeks	300 g
24 weeks	680 g
28 weeks	1,135 g
32 weeks	1,680 g
36 weeks	2,500 g
40 weeks	3,360 g

Source: http://www.dcdoctor.com/pages/rightpages_wellnesscenter/pregnancy/fetaldevelopment.html

Data Analysis

1. **Graph** the growth of the fetus.
2. **Describe** your graph. Did the fetus grow the same rate for each four-week period?
3. **Estimate** the mass of the fetus at 8 weeks, at 18 weeks, and at 38 weeks.
4. **Evaluate** Could you estimate other points on the graph by looking at the graph line? Explain why or why not.

2.a, 7.c

Try at Home

Internal Development

The embryos of some animals, including most mammals, develop inside the mother. These embryos get nourishment from the mother. An organ or tissue transfers nourishment from the mother to the embryo. Other embryos, such as those of some snakes, insects, and fishes, develop in an egg with a yolk while it is inside the mother. For these animals, the yolk, not the mother, provides nourishment for the developing young. The young hatch from the eggs while they are inside the mother and then leave the mother's body.

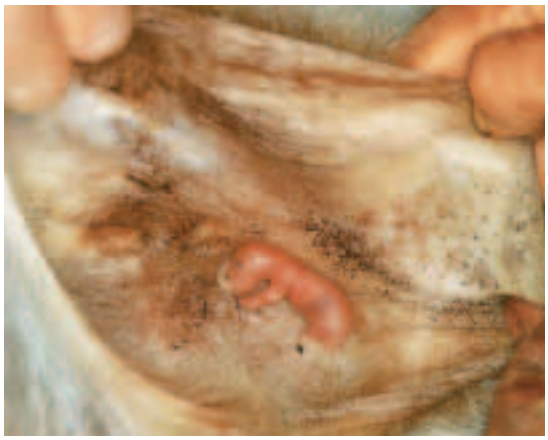
Reading Check

Where does an embryo that develops in an egg inside the mother get its nourishment?

Gestation

The length of time between fertilization and birth of an animal is called gestation. Gestation varies from species to species and usually relates to the size of the animal at birth—the smaller the animal, the shorter its gestation. For example, gestation for a mouse is about 21 days; a dog, about 60 days; humans, about 266 days; and an elephant, about 600 days. A kangaroo is an exception. Gestation for a kangaroo is 35 days. A kangaroo is only about 2.5 cm long at birth, as shown in **Figure 21.**

Figure 21 A newborn kangaroo crawls into a pouch on the mother's body. It feeds and grows inside the pouch until it is large enough to live on its own.



Animal Reproduction Summary

In this lesson, you learned how animals reproduce sexually. Males produce sperm in organs called testes. Females produce eggs in organs called ovaries. Internal fertilization takes place inside the female's reproductive system. External fertilization takes place outside the female, in the environment. Embryos that develop inside the body of the female are nourished and protected until they leave the female's body at birth. Embryos that develop outside the body of the female most often develop inside an egg. An egg has a protective covering and a yolk that provides nourishment to the developing embryo.

LESSON 3 Review

Summarize

Create your own lesson summary as you design a **visual aid.**

1. **Write** the lesson title, number, and page numbers at the top of your poster.
2. **Scan** the lesson to find the **red** main headings. Organize these headings on your poster, leaving space between each.
3. **Design** an information box beneath each **red** heading. In the box, list 2–3 details, key terms, and definitions from each **blue** subheading.
4. **Illustrate** your poster with diagrams of important structures or processes next to each information box.

ELA7: W 2.5

Standards Check

Using Vocabulary

1. Distinguish between *testes* and *ovaries.* 2.a
2. In your own words, write the definition for *metamorphosis.* 2.a

Understanding Main Ideas

Use the image below to answer question 3.

3. How would you describe the organ system above? 2.a

   A. asexual **C.** female
   B. embryo **D.** male

4. What are the haploid cells that form in female animals? 2.b

   A. testes **C.** eggs
   B. ovaries **D.** sperm

Applying Science

5. **Hypothesize** why snake eggs have leathery shells. 2.a
6. **Predict** whether an animal that reproduces by external fertilization is more likely to live in water or on land. Explain your reasoning. 2.a
7. **Organize Information** Copy the graphic organizer below and list types of animal development mentioned in this lesson. 2.a

Science Online

For more practice, visit **Standards Check** at ca7.msscience.com.

Applying Math

Life Span Conversions

2.a

MA7: NS 1.0, MG 1.1

Life spans vary greatly among species of insects. Insect life spans are sometimes given in days, weeks, months, and years. In order to make a comparison of life spans among insects, the average life spans must be in the same unit.

Example

How many times longer does the green lacewing live than the housefly?

What you know:

- Life span of the green lacewing: 30 days
- Life span of the housefly: 1 week

What you need to find:

- How many times longer does the green lacewing live than the housefly?

1 First convert both life spans to the same unit.

- The green lacewing life span is measured in days. The housefly life span is measured in weeks.
- Choose to convert the larger unit, weeks, into the smaller unit, days. Now find how many days are in 1 week. There are 7 days in 1 week.

2 Now you have both insect life spans measured in the same units to compare. The green lacewing life span is 30 days, and the housefly life span is 7 days. To find how many times greater the green lacewing life span is than the housefly life span, divide 30 by 7.

30 ÷ 7 is about 4.3.

Answer: The green lacewing lives about 4.3 times longer than the housefly.

Insect Life Spans

Species	Average Life Span
Housefly	1 week
Green lacewing	30 days
Mountain pine beetle	1 year
Angular-winged katydid	360 days
Australian walking stick	8 months
Common earwig	355 days
Darkling beetle	11 years
Honey bee queen	4 years
Honey bee drone	5 weeks
Madagascar hissing cockroach	2 years (in captivity)
Oregon silverspot butterfly	3 months
Vietnamese walking stick	6 months

Practice Problems

1. How many times longer does the honey bee queen live than the honey bee drone?
2. How many times longer does the Australian walking stick live than the Vietnamese walking stick?

Science Online
For more math practice, visit Math Practice at ca7.msscience.com.

LESSON 4

Science Content Standards

2.a Students know the differences between the life cycles and reproduction methods of sexual and asexual organisms.
Also covers: 7.a, 7.c, 7.d, 7.e

Reading Guide

What *You'll Learn*

- **Define** asexual reproduction.
- **Differentiate** between regeneration and cloning.
- **Compare** an asexually produced offspring to its parent.

Why *It's Important*

Learning about asexual reproduction will help you understand how cloning and other techniques determine genetic traits of organisms.

Vocabulary

asexual reproduction
fission
budding
regeneration
cloning

Review Vocabulary

prokaryote: organism made of a cell that does not have a membrane-bound nucleus (p. 64)

Asexual Reproduction

Main Idea Asexual reproduction produces offspring that are identical to the parent.

Real-World Reading Connection Have you ever joked about wanting to clone yourself? That way, you could enjoy time with your friends while your clone does chores and homework. Do any organisms reproduce by making exact copies of themselves?

What is asexual reproduction?

When we think of reproduction, we usually think of sexual reproduction. Recall that sexual reproduction occurs when a sperm and egg fuse, and it usually requires two parents. However, many organisms have only one parent. **Asexual reproduction** is the production of offspring by one parent without a sperm and an egg joining. Asexual reproduction results in offspring that are genetically identical to the parent organism. The poinsettias shown in **Figure 22** were produced by asexual reproduction.

Advantages of Asexual Reproduction

Unlike sexual reproduction, asexual reproduction does not require a mate. Therefore, an asexually reproducing organism does not have to spend time and energy finding a mate. Also, to reproduce a number of offspring asexually takes less time than to reproduce the same number of offspring sexually. Since parent and offspring are genetically identical, both are equally well adapted to the same environmental conditions.

Figure 22 Asexual reproduction makes it possible for a grower to produce hundreds of genetically identical poinsettias for the holiday season.

Age fotostock/SuperStock

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Disadvantages of Asexual Reproduction

The major disadvantage of asexual reproduction is the lack of genetic variation. Recall that genetic variation in a population increases the chances that a few individuals will survive a change in the environment. Imagine a population of poinsettia plants growing in a greenhouse, like those shown in **Figure 22.** Suppose a greenhouse worker unknowingly plants the poinsettias in soil contaminated with disease-causing bacteria. Because the poinsettias are genetically identical, the disease might affect all of them. The entire poinsettia population might be destroyed.

Another disadvantage of asexual reproduction involves genetic changes, or mutations, that can occur. A harmful mutation in cells of an organism will be passed to asexually reproduced offspring. This could affect the offspring's ability to survive.

Reading Check What are two disadvantages of asexual reproduction?

What are the types of asexual reproduction?

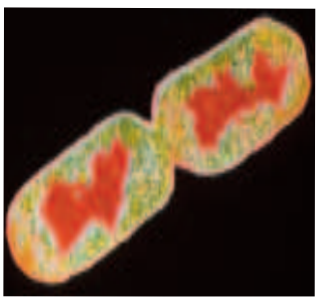
There are many types of asexual reproduction. However, each type involves cell division. Prokaryotes, or bacteria, reproduce asexually by cell division that does not involve mitosis. Eukaryotes reproduce asexually by mitosis and cell division.

WORD ORIGIN
fission
from Latin *fissionem;* means *a breaking up, cleaving*

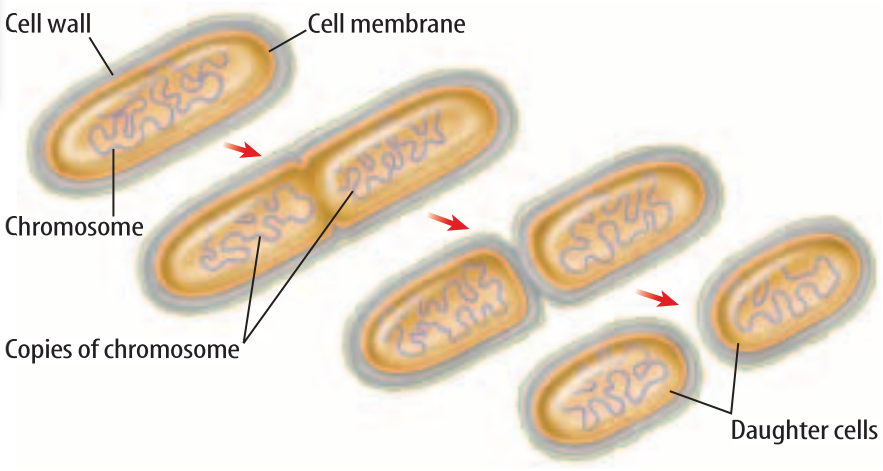
Fission

A bacterium has a small, circular DNA chromosome but no nucleus. Bacteria reproduce asexually by a process called **fission,** as shown in **Figure 23.** Fission produces two genetically identical cells. Asexual reproduction by fission can occur rapidly. *E. coli,* a species of bacteria found in human intestines, can reproduce asexually every twenty minutes.

Figure 23 During fission, a bacterium grows while its DNA is replicated. When the DNA has replicated and the cell is about twice its original size, the two DNA copies separate. The cell membrane grows inward and the cell divides in half to produce two identical daughter cells.



Color-enhanced TEM Magnification: 17,650×



CNRI/Photo Researchers

CONTENTS

Figure 24 Diatoms belong to a group of single-celled, eukaryotic organisms called protists. They live in water and make their own food through photosynthesis.

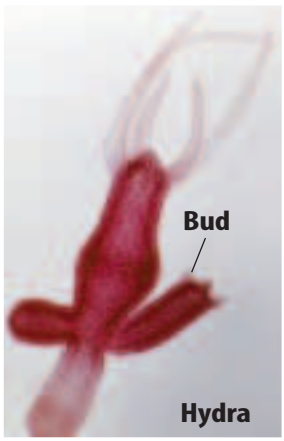
Mitotic Cell Division

Some single-celled eukaryotes, such as the diatom in **Figure 24,** reproduce asexually by mitotic cell division—mitosis followed by cell division. Recall from Chapter 2 that mitosis and cell division produce two genetically identical cells from one cell. Asexual reproduction in a single-celled eukaryote also produces two identical cells, except that each cell is an individual organism.

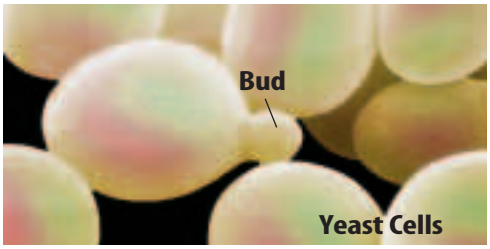
Budding

Yeasts are single-celled eukaryotes that are related to mushrooms and other fungi. As shown in **Figure 25,** yeast cells reproduce by **budding**—a type of asexual reproduction in which a new organism forms on the parent organism. The new organism is called a bud and forms by mitosis and cell division. It is genetically identical to the parent and eventually separates from the parent to live on its own.

Some multicellular animals, such as freshwater hydra also shown in **Figure 25,** can reproduce by budding. Notice how the bud grows from the stalk of the parent hydra. Like many multicellular eukaryotes, including plants, hydras can reproduce both sexually and asexually.



LM Magnification: 10×



Color-enhanced SEM Magnification: 10,000×

Figure 25 This yeast cell is budding. The bud of the hydra looks like a smaller version of the parent.

Compare the genetic makeup of the hydra bud to the hydra parent.

MiniLab

00:25 minutes

How do yeast reproduce?

What happens when you add sugar and warm water to dried yeast?

Procedure

1. Complete a lab safety form.
2. Pour 125 mL of **34°C water** into a cup or beaker.
3. Add 5 g of **sugar** and 5 g of **yeast** to the water. Stir slightly. Record your observations after 5 min.
4. Using an **eyedropper**, put a drop of yeast solution on a **microscope slide.** Place a **coverslip** over the drop.
5. View the yeast solution under a **microscope.** Draw what you see.

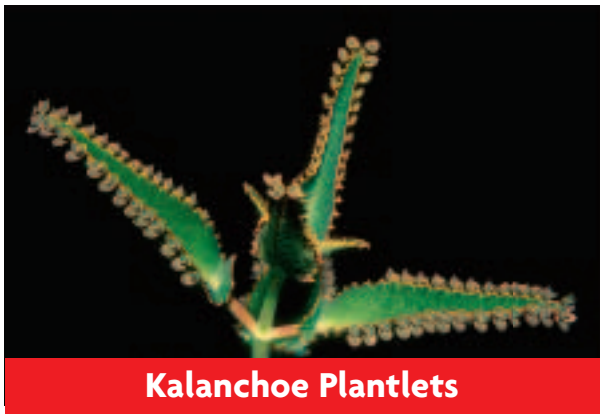
Analysis

1. **Describe** evidence of yeast reproduction.
2. **Identify** the process you observed under the microscope.

2.a, 7.a, 7.c, 7.d

Figure 26 New, genetically identical plants grow from the horizontal stems, or runners, of strawberry plants. A kalanchoe plant forms so many plantlets that it is known as the maternity plant.

Strawberry Plants



Kalanchoe Plantlets

ACADEMIC VOCABULARY

differentiate (dih fuh REN chee ayt)
(verb) to show a difference between two or more things.
Students must be able to differentiate meiosis from mitosis.

Plant Cuttings

In Lesson 3, you read how plants reproduce sexually. Many plants can also reproduce asexually. If you cut a green stem from a houseplant and place it in water, roots and leaves can grow, producing a new plant. A new plant grown from a stem cutting is genetically identical to the parent plant. Poinsettias, like those in **Figure 22,** can be grown from stem cuttings. Depending on the type of plant, leaf cuttings or root cuttings can also be used to grow a new plant.

Some plants propagate themselves asexually. The kalanchoe plant shown in **Figure 26** has produced tiny plantlets at the edges of its leaves. These plantlets can fall to the ground, take root, and produce new plants. A strawberry plant, as shown in **Figure 26,** produces new plants along horizontal stems that grow on the surface of the ground.

Figure 27 Sea stars can reproduce asexually by regeneration.

Identify the kind of cell division that takes place when a sea star regrows missing body parts.

Animal Regeneration

Recall from Chapter 2 that the process in which cells in an embryo become different types of cells is called cell differentiation. But as you just read, some plant cells can dedifferentiate—change from a differentiated cell type and grow into other cell types. You also read in Chapter 2 that **differentiated** human cells cannot change and grow into other cell types. However, some animals have cells that can change into other cell types.

Producing New Animals Asexual reproduction that produces new animals from pieces of an animal's body is called **regeneration.** The sea star shown in **Figure 27** can asexually reproduce by regeneration. If it is broken into pieces, each piece can grow the missing parts. The new organisms are genetically identical.

CONTENTS

Producing Body Parts Sometimes, the term *regeneration* is used to describe growth that replaces a missing part of an animal. For example, if a sea star just loses part of an arm, it can regrow that lost part. The regrowth of a body part is not an example of asexual reproduction, because a new individual is not created.

Word Origin

regeneration
from Latin *regeneratus;* means *make over*

What is cloning?

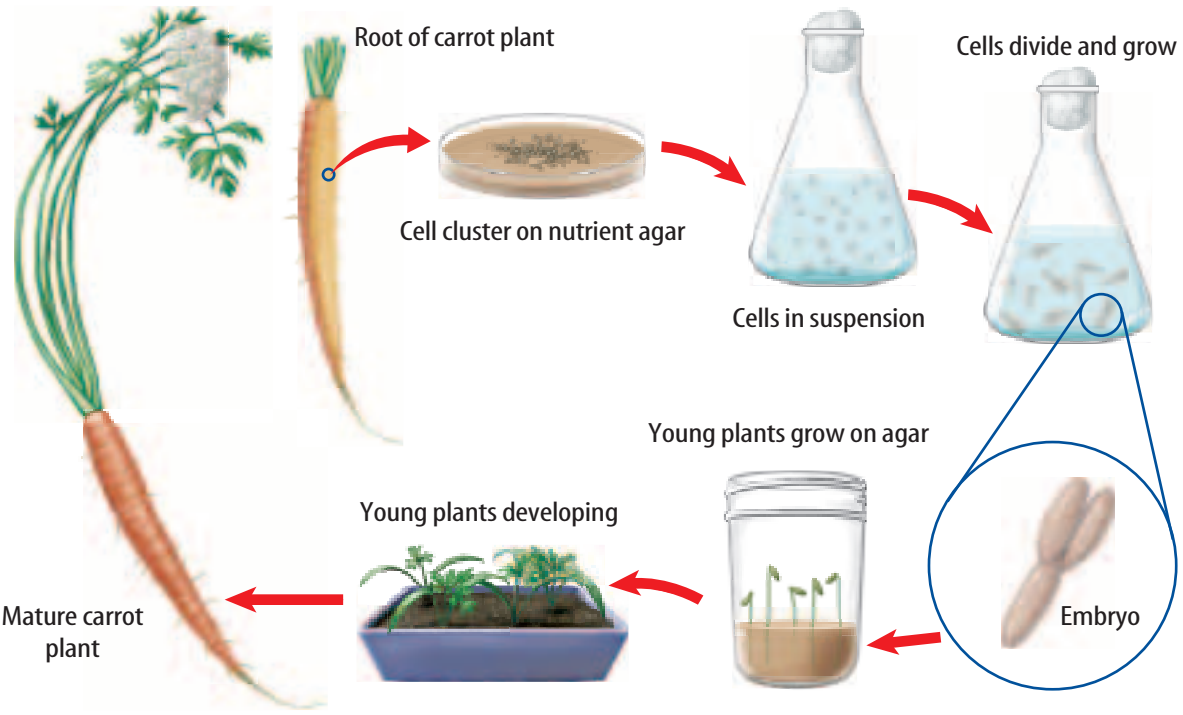
Fission, budding, and regeneration are all types of asexual reproduction that produce genetically identical offspring in nature. In the past, the term *cloning* described any process that produced genetically identical offspring. Today, however, **cloning** usually refers to a method of asexual reproduction developed by scientists and performed in laboratories. Cloning produces identical individuals from a cell or from a cluster of cells taken from a multicellular organism.

Reading Check Give two different meanings for *cloning.*

Plant Cloning

Plant tissue culture is a cloning technique that enables scientists to produce genetically identical plants from a few plant cells grown in a test tube, as shown in **Figure 28.** Plant tissue culture can be used to produce thousands of identical plants from a plant that has desirable genetic traits, such as high nutritional value or rapid growth.

Figure 28 New carrot plants can be produced from cells of a carrot root using tissue culture techniques.



Animal Cloning

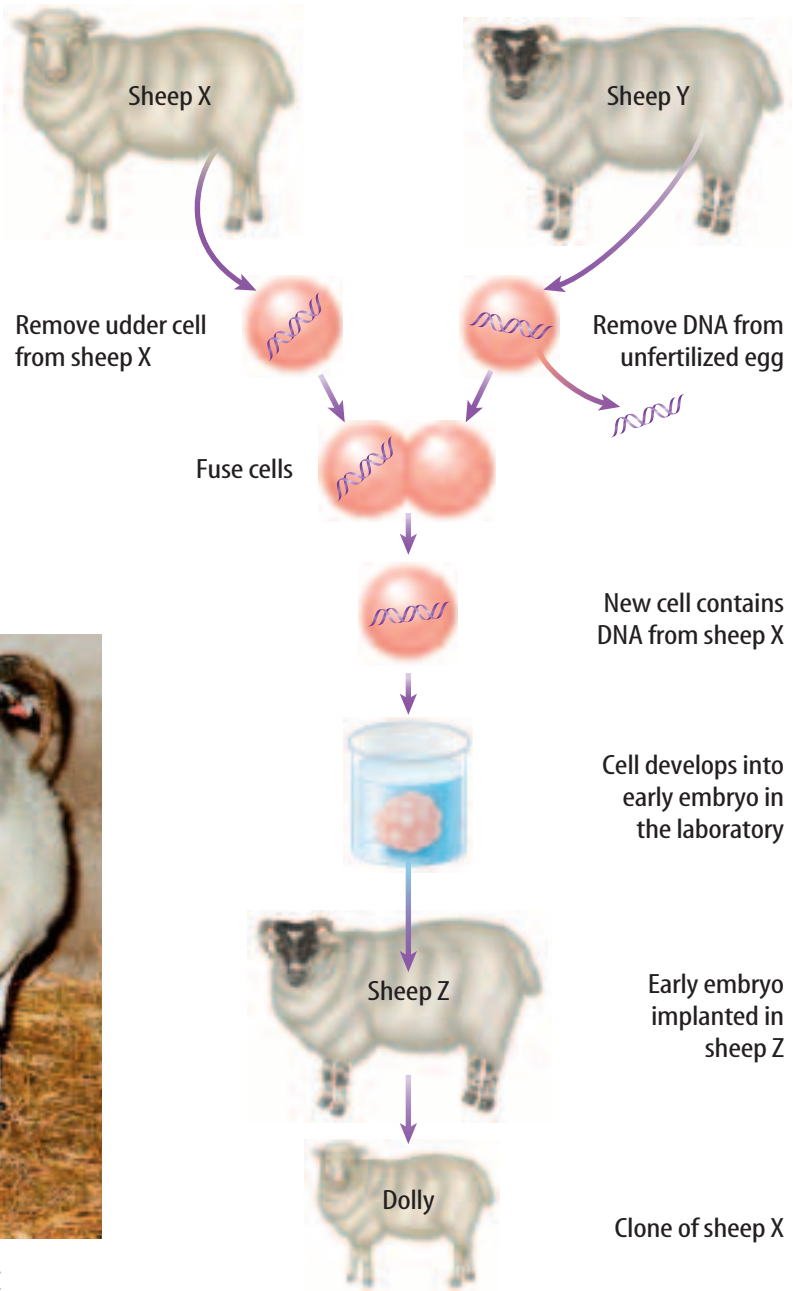
The first animal to be successfully cloned from an adult cell was a sheep. In 1996, scientists in Scotland cloned a female sheep that they named Dolly. **Figure 29** illustrates the reproductive methods used to make Dolly. Since then, scientists have cloned other animals, including mice, cows, and a horse.

Although several cloned animals have been produced successfully, they often are not as healthy as animals produced by sexual reproduction. Some animal clones, including Dolly, have had a much shorter life span than animals produced by sexual reproduction. Animal cloning raises ethical issues that people are concerned about. For example, many people think the cloning of humans should never be allowed. You might be asked to consider issues like this during your lifetime.

Roslin Institute

Figure 29 Scientists used three different sheep to produce the cloned sheep known as Dolly.

Infer how the genetic makeup of Dolly compares to the genetic makeup of sheep Y.



Dolly Sheep Z

Asexual Reproduction Summary

In this lesson, you read that many organisms reproduce asexually, which means they have only one parent. Offspring from asexual reproduction have genetic material that is identical to the genetic material of the parent. Bacteria reproduce asexually by fission, which is a type of cell division. Some eukaryotes, including yeast, reproduce asexually by budding. Other eukaryotes reproduce asexually by mitosis and cell division. Parts of plants, such as stem cuttings or root cuttings, can grow into new plants. In some animals, a body part can regenerate and form a new individual. Cloning is a scientific process that produces offspring genetically identical to one parent organism.

LESSON 4 Review

Summarize

Create your own lesson summary as you design a **study web.**

1. **Write** the lesson title, number, and page numbers at the top of a sheet of paper.
2. **Scan** the lesson to find the **red** main headings.
3. **Organize** these headings clockwise on branches around the lesson title.
4. **Review** the information under each **red** heading to design a branch for each **blue** subheading.
5. **List** 2–3 details, key terms, and definitions from each **blue** subheading on branches extending from the main heading branches.

ELA7: W 2.5

Standards Check

Using Vocabulary

Match these terms with the correct definition.

cloning
regeneration

1. the growth of a new individual from a broken-off portion of another animal's body 2.b
2. a method of asexual reproduction developed by scientists and performed in laboratories 2.b

Understanding Main Ideas

3. Which term does not apply to asexual reproduction?

   A. budding **C.** cloning 2.b
   B. fission **D.** fertilization

4. How do prokaryotes reproduce?

   A. budding **C.** fission 2.b
   B. cloning **D.** regeneration

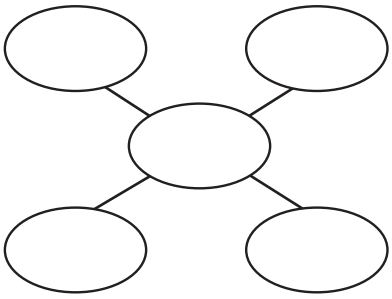
5. **Discuss** advantages and disadvantages of asexual reproduction. 2.b

6. **Distinguish** between fission and budding. 2.b

Applying Science

7. **Debate** how the use of animal cloning might affect the food industry. 2.b

8. **Organize Information** Draw a graphic organizer similar to the one below to list the types of asexual reproduction. Write *Asexual Reproduction* in the center oval. 2.b



Science Online

For more practice, visit **Standards Check** at ca7.msscience.com.

Lab

00:45 minutes

Plant Propagation

Materials

coleus seeds
coleus plants
packaged potting soil
containers
clear plastic wrap
room-temperature water

Safety Precautions

Science Content Standards

2.a Students know the differences between the life cycles and reproduction methods of sexual and asexual organisms.
7.a Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
7.c Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.
7.e Communicate the steps and results from an investigation in written reports and oral presentations.

Problem

You know that plants can reproduce both sexually and asexually. Coleus plants are easy to reproduce both ways: from seeds and from stem cuttings. In this lab, you will get a chance to try both methods.

Form a Hypothesis

Which method of propagating plants do you think will be the most successful? Which one will grow faster? Which one will have a lower rate of failure? Write two hypotheses.

Collect Data and Make Observations

1. Read and complete a lab safety form before you begin.
2. Design and construct a data table to record your daily observations and the measured height of the seedlings and cuttings.

Part A

3. Obtain three seeds from your teacher.
4. Plant the seeds in a container of damp potting soil, as directed by your teacher.
5. Loosely cover the top of the container with a piece of clear plastic wrap. Place the containers in a bright location, away from cold or hot drafts of air and away from direct sun.
6. Each day, remove the plastic wrap so that you can sprinkle the top of soil with room-temperature water, and then replace the plastic wrap.
7. Every other day, measure the height of the seedlings and record this data and other observations in your data table.

CONTENTS

Part B

8. Cut a stem of the plant just below the third set of leaves, as shown in the photo to the right.
9. Remove the bottom set of leaves.
10. Place the cutting into a container of damp potting soil. The spot on the stem where the leaves were attached must be below the soil's surface.
11. Repeat steps 1–3 twice.
12. Sprinkle the top of the soil daily with room-temperature water.
13. Every other day, measure the height of the cuttings and record this data and other observations in your data table.

Analyze and Conclude

1. **Identify** which trial was sexual reproduction and which one was asexual.
2. **Describe** the growth of the seedlings and cuttings.
3. **Graph** the average growth of the three seedlings over the observation period.
4. **Graph** the average growth of the three cuttings over the observation period.
5. **Evaluate** your hypotheses. Were they correct? Explain why or why not. How would you adjust your hypotheses if you were going to do another experiment?
6. **Error Analysis** Which of your trials worked better? Use scientific explanations to explain your results.

Communicate

WRITING in Science

Take your plants from this experiment and plant them in a public garden, near a retirement home, or in an outdoor space that needs cheering up. Remember to water them regularly. Putting some bark or leaf mulch around your plants will help keep them moist. Create a sign that explains how the plants were produced. With permission, post your sign near your plants.

Real World Science

Science & Career

Lions and Tigers and Bears, Oh My!

Animals can have infections, sprain joints, or need medicines and vaccines. Instead of a physician, a veterinarian cares for animals. Veterinarians often help female animals with the delivery of their young. Some veterinarians take care of small domestic animals, like cats or dogs, but large animals need care too. Large-animal vets spend time caring for farm animals, like horses and cows, or zoos animals, such as lions, tigers, and bears.

Work in pairs. Pretend you're a news reporter interviewing a large-animal veterinarian. Ask about his or her day on the job, including the kinds of problems he or she encountered, and how he or she fixed them.

Science & Technology

Producing Disease-Free Plants

Plant tissue culture is used to produce disease-free plants. When a virus enters a plant, it usually infects the entire plant. However, scientists have learned that the rapidly reproducing cells at the tips of stems remain disease-free in a virus-infected plant. Using tissue culture techniques, scientists can reproduce virus-infected plants without transferring the virus to the new plants.

Visit **Technology** at ca7.msscience.com to research plant tissue culture. Write a paragraph about how tissue culture technology helps farmers and other plant growers. **ELA7:** W 1.2

Science & History

Ernest Everett Just and Parthenogenesis

Ernest Everett Just was an African-American scientist who became well-known for his research into cell fertilization and embryology at the beginning of the twentieth century. Just was interested in learning about the structure of healthy cells as a means of curing disease. He also studied parthenogenesis (par thuh noh JEH nuh sus)—how some embryos can develop without fertilization.

How can an organism develop from an unfertilized egg? Visit **History** at ca7.msscience.com to research parthenogenesis. Compile a class list of organisms that undergo parthenogenesis.

Science & Society

ANIMAL CLONING—*Yes or No?*

Since 1996, several types of mammals have been cloned using the process that created Dolly, the sheep. The process uses genetic material from adult cells, which allows animal breeders to create clones that have traits observed in the adult animal. These calves—Dot and Ditto—are clones of an adult cow.

Animal cloning is controversial. Write an editorial for or against animal cloning. Use scientific evidence to support your position.

ELA7: W 2.4

SPL/Photo Researchers

CHAPTER 3

Standards Study Guide

The BIG Idea Different types of reproduction ensure the survival of different species.

Lesson 1 Sexual Reproduction and Meiosis

2.b, 7.b

Main Idea **Meiosis maintains the chromosome number of a species from one generation to the next.**

- Sexual reproduction includes the fusion of a sperm cell with an egg cell to produce a new organism.
- Meiosis is cell division that produces sperm and egg cells.
- Meiosis maintains a constant number of chromosomes from one generation of sexually produced offspring to the next.

- **diploid** (p. 129)
- **egg** (p. 126)
- **fertilization** (p. 126)
- **haploid** (p. 129)
- **meiosis** (p. 128)
- **sexual reproduction** (p. 126)
- **sperm** (p. 126)
- **zygote** (p. 126)

Lesson 2 Plant Reproduction

2.a, 5.f, 7.b

Main Idea **A plant's life cycle includes a diploid generation that produces spores and a haploid generation that produces eggs and sperm.**

- The life cycle of all plants includes an alternation of generations.
- Angiosperms are flowering plants that produce seeds enclosed in a fruit.

- **angiosperm** (p. 138)
- **anther** (p. 138)
- **embryo** (p. 137)
- **filament** (p. 138)
- **fruit** (p. 139)
- **ovary** (p. 138)
- **ovule** (p. 137)
- **pistil** (p. 138)
- **pollen grain** (p. 136)
- **pollen tube** (p. 139)
- **pollination** (p. 137)
- **seed** (p. 137)
- **spore** (p. 135)
- **stamen** (p. 138)
- **stigma** (p. 138)
- **style** (p. 138)

Lesson 3 Animal Reproduction

2.a, 2.b, 7.c

Main Idea **Animals have specialized structures for sexual reproduction.**

- Animals have specialized organs, called gonads, for sexual reproduction.
- In some animal species, fertilization happens outside the body; in other species, fertilization happens inside the body.
- In some animal species, embryos develop outside the mother; in other species, embryos develop inside the mother.

- **gonad** (p. 144)
- **metamorphosis** (p. 147)
- **ovary** (p. 144)
- **testes** (p. 144)

Lesson 4 Asexual Reproduction

2.a, 7.a, 7.c, 7.d, 7.e

Main Idea **Asexual reproduction produces offspring that are identical to the parent.**

- Asexual reproduction requires only one parent.
- Types of asexual reproduction include fission, budding, mitosis, and cloning.

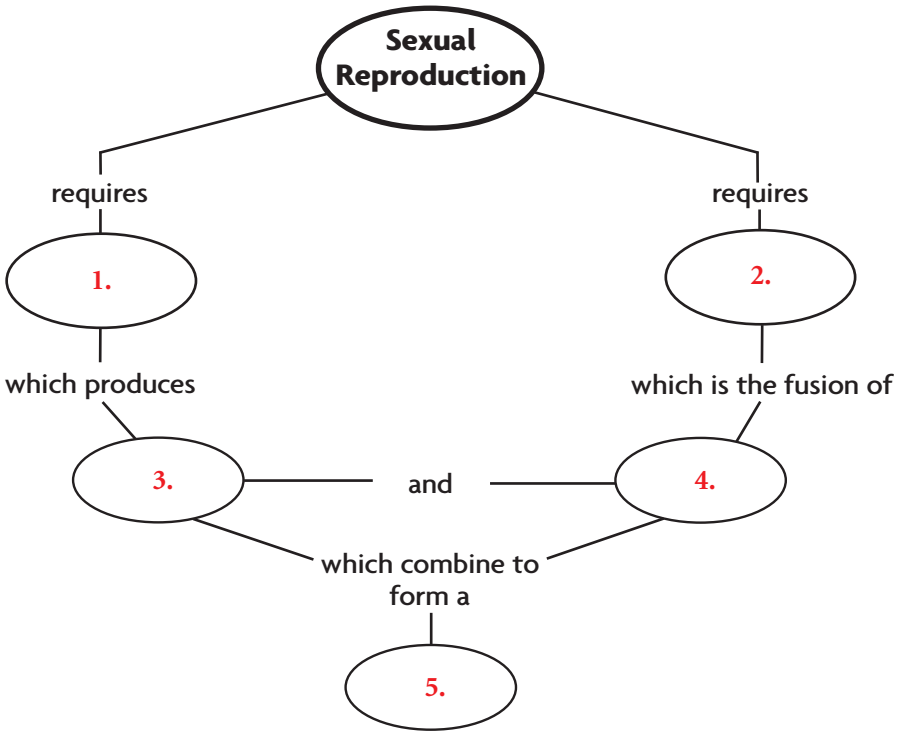
- **asexual reproduction** (p. 151)
- **budding** (p. 153)
- **cloning** (p. 155)
- **fission** (p. 152)
- **regeneration** (p. 154)

STUDY TO GO

Download quizzes, key terms, and flash cards from ca7.msscience.com.

Linking Vocabulary and Main Ideas

Use vocabulary terms from page 162 to complete this concept map.



Using Vocabulary

Write the vocabulary term that best matches each phrase.

6. process that produces haploid cells from a diploid cell

7. process that produces a diploid cell from two haploid cells

8. cells that have two of each chromosome

9. generation of a plant that produces eggs and sperm

10. part of the flower that will become a fruit

11. produces sperm

12. asexual reproduction used by prokaryotes

13. produces a new individual from a part of an animal or plant

14. method scientists use to make identical offspring from adult cells

Understanding Main Ideas

Use the image below to answer question 1.

1. What phase of meiosis is pictured above? 2.a
- **A.** anaphase I
- **B.** anaphase II
- **C.** metaphase I
- **D.** metaphase II

2. Which organism can reproduce asexually by dedifferentiation of cells? 2.b
- **A.** diatom
- **B.** bacterium
- **C.** plant
- **D.** yeast

3. Which term describes the daughter cells produced by meiosis? 2.a
- **A.** identical
- **B.** diploid
- **C.** homologous
- **D.** haploid

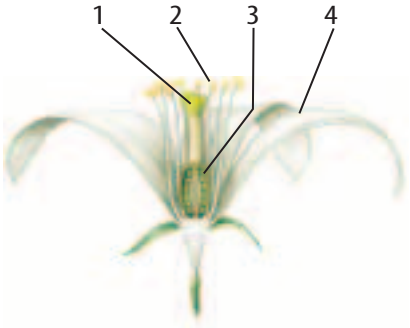
4. Which reproductive structure grows into the haploid generation of a plant? 5.f
- **A.** cone
- **B.** seed
- **C.** sperm
- **D.** spore

5. What type of plant produces fruit? 5.f
- **A.** conifer
- **B.** seedless
- **C.** gymnosperm
- **D.** angiosperm

6. Which term describes the development of a tadpole into an adult frog? 2.b
- **A.** alternation of generations
- **B.** fertilization
- **C.** meiosis
- **D.** metamorphosis

7. What method of asexual reproduction involves the regrowth of missing body parts from part of an organism? 2.b
- **A.** budding
- **B.** fission
- **C.** cloning
- **D.** regeneration

Use the image below to answer questions 8–10.



8. What is the name of structure number 1? 5.f
- **A.** anther
- **B.** filament
- **C.** stigma
- **D.** style

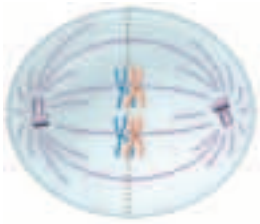
9. Where is pollen produced? 5.f
- **A.** 1
- **B.** 2
- **C.** 3
- **D.** 4

10. Which part of the flower becomes a seed? 5.f
- **A.** 1
- **B.** 2
- **C.** 3
- **D.** 4

Applying Science

11. **Distinguish between** mitosis and meiosis. 2.a

Use the image below to answer question 12.



12. **Predict** how many chromosomes each daughter cell of the cell above will have at the end of meiosis. 2.a

13. **Compare** gymnosperms and angiosperms. 5.f

14. **Compare** external fertilization and internal fertilization. 2.b

15. **Predict** why most frog species enter water to reproduce. 2.b

16. **Suggest** why animals that reproduce by external fertilization produce more eggs than animals that reproduce by internal fertilization. 2.b

17. **Predict** how the success of plants in a particular environment would be affected if the plants could not reproduce asexually. 2.b

18. **Hypothesize** why bacteria are able to reproduce much more quickly than humans and other multicellular eukaryotic organisms. 2.b

19. **Defend** Some lizards can grow a new tail if theirs breaks off. Is this asexual reproduction? Defend your answer. 2.b

20. **Evaluate** Yeasts are commonly used to make bread. How might the bread-making process be affected if yeast could reproduce only sexually? 2.b

21. **Infer** why seedless plants depend on water for fertilization, but seed plants do not. 2.a

22. **Develop** a concept map to identify if a plant is a gymnosperm, an angiosperm, or a seedless plant. 2.a

WRITING in Science

23. **Write** one paragraph describing the similarities and differences of sexual reproduction and asexual reproduction. ELA7: W 1.2

Applying Math

Use the table below to answer questions 24–27.

Insect Life Spans

Species	Average Life Span
Mountain pine beetle	1 year
Angular-winged katydid	360 days
Common earwig	355 days
Darkling beetle	11 years
Madagascar hissing cockroach	2 years (in captivity)
Oregon silverspot butterfly	3 months

24. How much longer does the darkling beetle live than the mountain pine beetle? MA7: NS 1.0, MG 1.1

25. How much longer does the Madagascar hissing cockroach live than the angular-winged katydid? MA7: NS 1.0, MG 1.1

26. How much longer does the common earwig live than the Oregon silverspot butterfly? MA7: NS 1.0, MG 1.1

27. How much longer does the mountain pine beetle live than the Oregon silverspot butterfly? MA7: NS 1.0, MG 1.1

1 **A new plant can grow from a white potato, as shown below.**

How does the genetic material of the new plant above compare to that of the potato?

A identical

B different

C greater

D less 2.a

2 **Which term describes this type of reproduction?**

A fission

B budding

C regeneration

D cloning 2.a

3 **Which is the correct sequence for sexual reproduction?**

A sex cells, zygote, fertilization, meiosis

B zygote, sex cells, meiosis, fertilization

C fertilization, meiosis, zygote, sex cells

D meiosis, sex cells, fertilization, zygote 2.a

4 **Which describes what happens to chromosomes during meiosis?**

A Homologous chromosomes separate, then they replicate in meiosis II.

B Replicated homologous chromosome pairs separate in meiosis I, then sister chromatids separate during meiosis II.

C Sister chromosomes separate during meiosis I.

D Homologous chromosomes stay together during meiosis I and meiosis II. 2.b

5 **Bacteria reproduce by asexual reproduction, as shown below.**

What is the term used for this type of asexual reproduction?

A fission

B budding

C regeneration

D cloning 2.a

6 **Which term means the joining of a sperm and an egg?**

A pollination

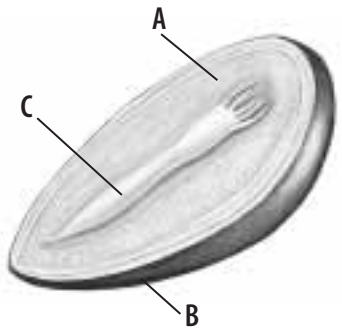
B mitosis

C fertilization

D meiosis 2.b

CONTENTS

Use the diagram below to answer questions 7 and 8.



7 **What does structure C represent?**

A stored food

B embryo

C ovary

D seed covering 5.f

8 **Which part(s) of this seed will grow into the new plant?**

A A

B C

C A and C

D C and B 5.f

9 **What is the term used to describe the process of when a plant's sperm-producing structure lands on the female reproductive structure of the same type of plant?**

A pollination

B mitosis

C fertilization

D meiosis 5.f

10 **Which is the correct sequence in the life cycle of a beetle?**

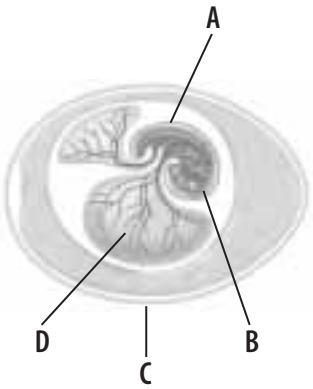
A larva, adult, egg, pupa

B egg, larva, pupa, adult

C pupa, egg, adult, larva

D adult, pupa, larva, egg 2.a

Use the diagram below to answer questions 11 and 12.



11 **Which letter represents the yolk?**

A A

B B

C C

D D 2.a

12 **Which letter represents the developing organism?**

A A

B B

C C

D D 2.a