Lesson 2

Asexual Reproduction

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What is asexual reproduction, and why is it beneficial?
- How do the types of asexual reproduction differ?

Vocabulary

asexual reproduction p. 129
fission p. 130
budding p. 131
regeneration p. 132
vegetative reproduction p. 133
cloning p. 134

Multilingual eGlossary

PBL Go to the resource tab in ConnectED to find the PBL *It's in the Cards.*

Inquiry Plants on Plants?

Look closely at the edges of this plant's leaves. Tiny plants are growing there. This type of plant can reproduce without meiosis and fertilization.

Launch Lab

20 minutes

How do yeast reproduce?

Some organisms can produce offspring without meiosis or fertilization. You can observe this process when you add sugar and warm water to dried yeast.

1. Read and complete a lab safety form.
2. Pour 125 mL of water into a **beaker.** The water should be at a temperature of 34°C.
3. Add 5 g of **sugar** and 5 g of **yeast** to the water. Stir slightly. Record your observations after 5 minutes in your Science Journal.
4. Using a **dropper,** put a drop of the yeast solution on a **microscope slide.** Place a **coverslip** over the drop.
5. View the yeast solution under a **microscope.** Draw what you see in your Science Journal.

Think About This

1. What evidence did you observe that yeast reproduce?
2. **Key Concept** How do you think this process differs from sexual reproduction?

What is asexual reproduction?

Lunch is over and you are in a rush to get to class. You wrap up your half-eaten sandwich and toss it into your locker. A week goes by before you spot the sandwich in the corner of your locker. The surface of the bread is now covered with fuzzy mold–not very appetizing. How did that happen?

The mold on the sandwich is a type of fungus (FUN gus). A fungus releases enzymes that break down organic matter, such as food. It has structures that penetrate and anchor to food, much like roots anchor plants to soil. A fungus can multiply quickly in part because generally a fungus can reproduce either sexually or asexually. Recall that sexual reproduction involves two parent organisms and the processes of meiosis and fertilization. Offspring inherit half their DNA from each parent, resulting in genetic variation among the offspring.

In **asexual reproduction,** *one parent organism produces offspring without meiosis and fertilization.* Because the offspring inherit all their DNA from one parent, they are genetically identical to each other and to their parent.

Key Concept Check Describe asexual reproduction in your own words.

FOLDABLES

Fold a sheet of paper into a six-celled chart. Label the front "Asexual Reproduction," and label the chart inside as shown. Use it to compare types of asexual reproduction.

Fission	Mitotic cell division	Budding
Animal regeneration	Vegetative reproduction	Cloning

Types of Asexual Reproduction

There are many different types of organisms that reproduce by asexual reproduction. In addition to fungi, bacteria, protists, plants, and animals can reproduce asexually. In this lesson, you will learn how organisms reproduce asexually.

Fission

Recall that prokaryotes have a simpler cell structure than eukaryotes. A prokaryote's DNA is not contained in a nucleus. For this reason, mitosis does not occur and cell division in a prokaryote is a simpler process than in a eukaryote. *Cell division in prokaryotes that forms two genetically identical cells is known as* **fission.**

WORD ORIGIN

fission
from Latin *fissionem*, means "a breaking up, cleaving"

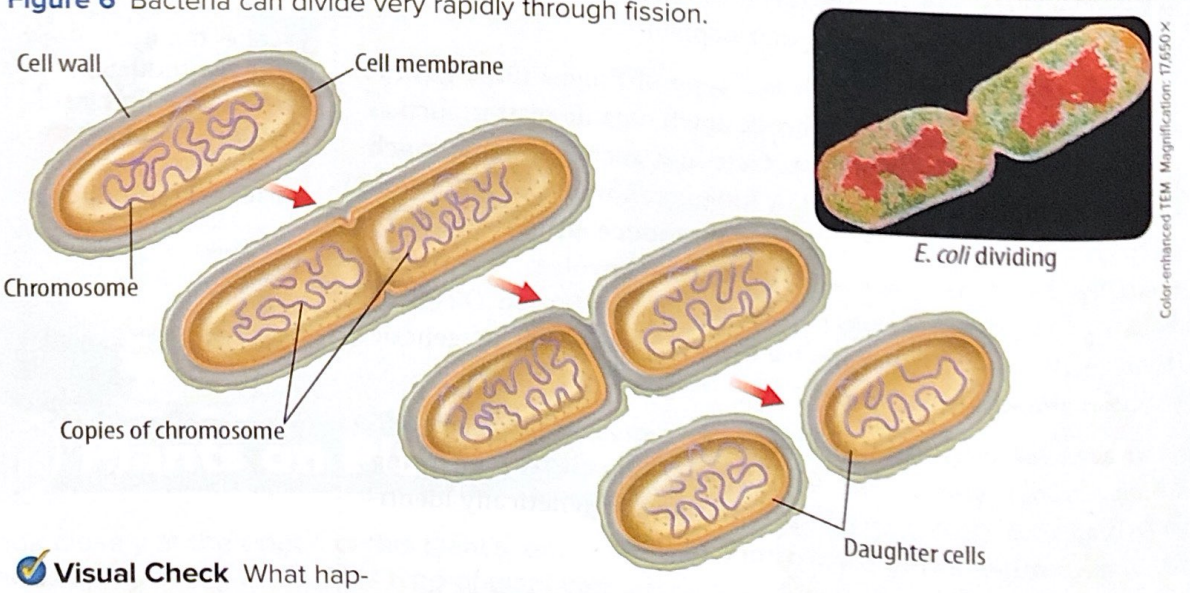
Fission begins when a prokaryote's DNA molecule is copied. Each copy attaches to the cell membrane. Then the cell begins to grow longer, pulling the two copies of DNA apart. At the same time, the cell membrane begins to pinch inward along the middle of the cell. Finally the cell splits and forms two new identical offspring. The original cell no longer exists.

As shown in **Figure 6,** *E. coli,* a common bacterium, divides through fission. Some bacteria can divide every 20 minutes. At that rate, 512 bacteria can be produced from one original bacterium in about three hours.

Reading Check What advantage might asexual reproduction by fission have over sexual reproduction?

Fission

Figure 6 Bacteria can divide very rapidly through fission.



Visual Check What happens to the original cell's chromosome during fission?

Mitotic Cell Division

Many unicellular eukaryotes reproduce by mitotic cell division. In this type of asexual reproduction, an organism forms two offspring through mitosis and cell division. In **Figure 7,** an amoeba's nucleus has divided by mitosis. Next, the cytoplasm and its contents divide through cytokinesis and two new amoebas form.

▲ **Figure 7** During mitotic cell division, an amoeba divides its chromosomes and cell contents evenly between the daughter cells.

Budding

In budding, *a new organism grows by mitosis and cell division on the body of its parent.* The bud, or offspring, is genetically identical to its parent. When the bud becomes large enough, it can break from the parent and live on its own. In some cases, an offspring remains attached to its parent and starts to form a colony. **Figure 8** shows a hydra in the process of budding. The hydra is an example of a multicellular organism that can reproduce asexually. Unicellular eukaryotes, such as yeast, can also reproduce through budding, as you saw in the Launch Lab.

Budding

Figure 8 The hydra bud has the same genetic makeup as its parent.

Bud forms.

Bud develops a mouth and tentacles.

Biophoto Associates/Photo Researchers

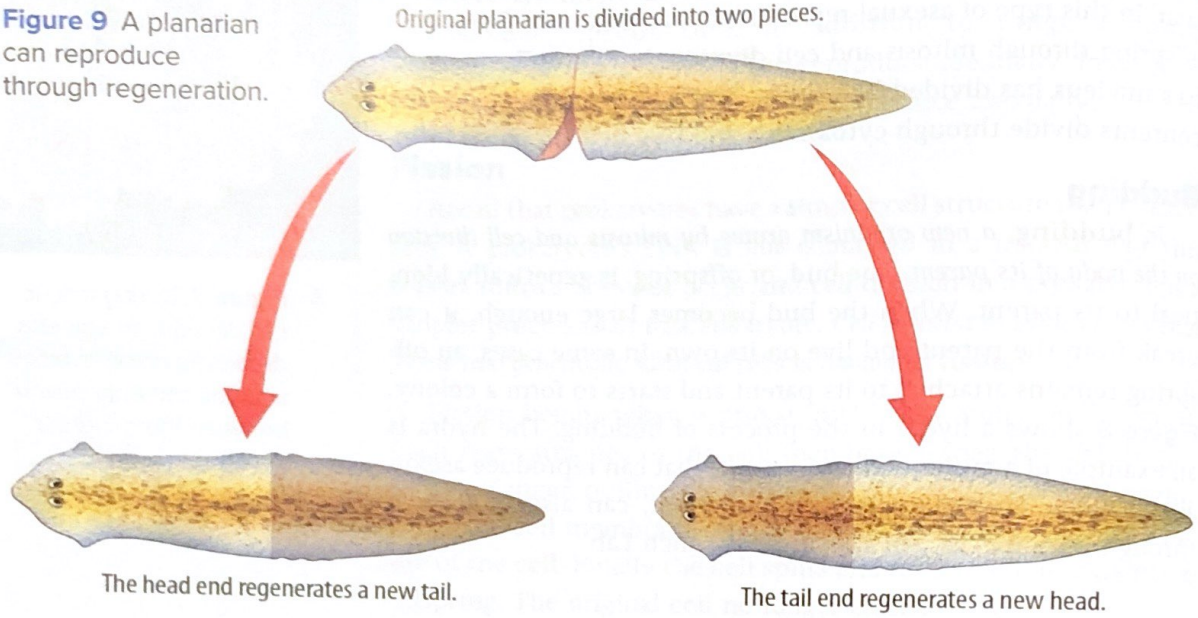


Figure 9 A planarian can reproduce through regeneration.

ACADEMIC VOCABULARY
potential
(noun) possibility

Animal Regeneration

Another type of asexual reproduction, **regeneration,** *occurs when an offspring grows from a piece of its parent.* The ability to regenerate a new organism varies greatly among animals.

Producing New Organisms Some sea stars have five arms. If separated from the parent sea star, each arm has the potential to grow into a new organism. To regenerate a new sea star, the arm must contain a part of the central disk of the parent. If conditions are right, one five-armed sea star can produce as many as five new organisms.

Sea urchins, sea cucumbers, sponges, and planarians, such as the one shown in **Figure 9,** can also reproduce through regeneration. Notice that each piece of the original planarian becomes a new organism. As with all types of asexual reproduction, the offspring is genetically identical to the parent.

Reading Check What is true of all cases of asexual reproduction?

Producing New Parts When you hear the term *regeneration,* you might think about a salamander regrowing a lost tail or leg. Regeneration of damaged or lost body parts is common in many animals. Newts, tadpoles, crabs, hydra, and zebra fish are all able to regenerate body parts. Even humans are able to regenerate some damaged body parts, such as the skin and the liver. This type of regeneration, however, is not considered asexual reproduction. It does not produce a new organism.

Vegetative Reproduction

Plants can also reproduce asexually in a process similar to regeneration. **Vegetative reproduction** *is a form of asexual reproduction in which offspring grow from a part of a parent plant.* For example, the strawberry plants shown in **Figure 10** send out long horizontal stems called stolons. Wherever a stolon touches the ground, it can produce roots. Once the stolons have grown roots, a new plant can grow–even if the stolons have broken off the parent plant. Each new plant grown from a stolon is genetically identical to the parent plant.

Vegetative reproduction usually involves structures such as the roots, the stems, and the leaves of plants. In addition to strawberries, many other plants can reproduce by this method, including raspberries, potatoes, and geraniums.

Figure 10 The smaller plants were grown from stolons produced by the parent plant.

Visual Check Which plants in the figure are the parent plants?

MiniLab

15 minutes

What parts of plants can grow?

You probably know that plants can grow from seeds. But you might be surprised to learn that other parts of plants can grow and produce a new plant.

1. Carefully examine the photos of vegetative reproduction.
2. Create a data chart in your Science Journal to record your observations. Identify which part of the plant (leaf, stem, etc.) would be used to grow a new plant.

Analyze and Conclude

1. **Explain** How is the vegetative reproduction you observed a kind of asexual reproduction?
2. **Infer** how farmers or gardeners might use vegetative reproduction.
3. **Key Concept** Describe a method you might use to produce a new plant using vegetative reproduction.

Cloning

Fission, budding, and regeneration are all types of asexual reproduction that can produce genetically identical offspring in nature. In the past, the term *cloning* described any process that produced genetically identical offspring. Today, however, the word usually refers to a technique developed by scientists and performed in laboratories. **Cloning** *is a type of asexual reproduction performed in a laboratory that produces identical individuals from a cell or from a cluster of cells taken from a multicellular organism.* Farmers and scientists often use cloning to make copies of organisms or cells that have desirable traits, such as large flowers.

SCIENCE USE V. COMMON USE

culture

Science Use the process of growing living tissue in a laboratory

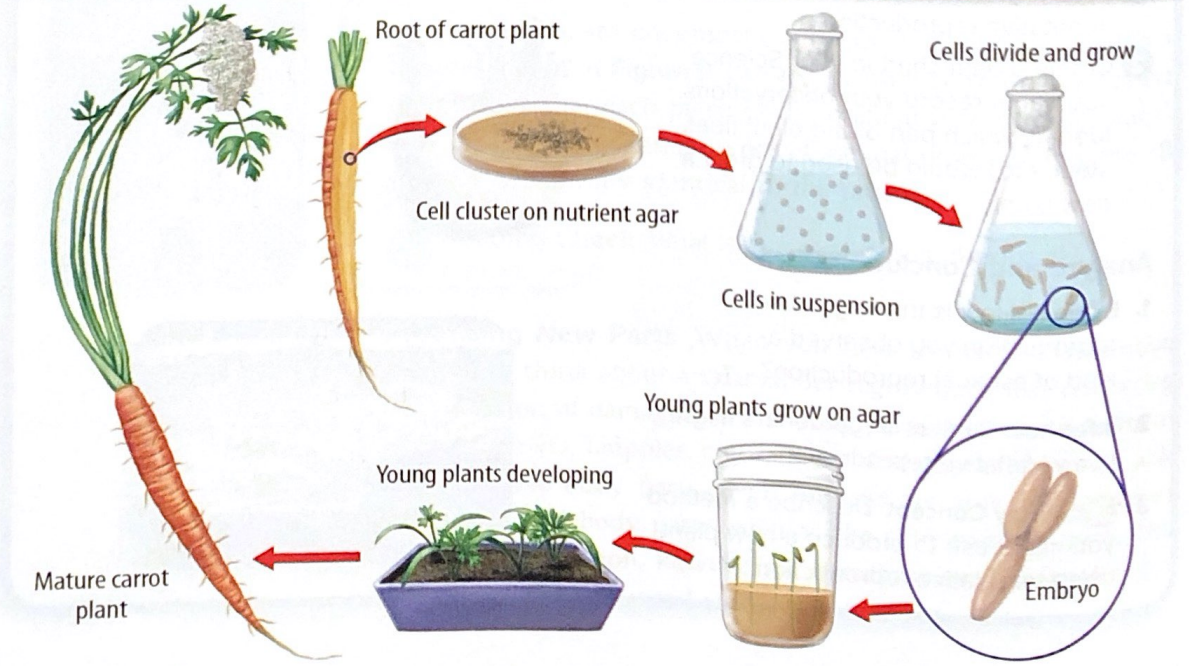
Common Use the social customs of a group of people

Plant Cloning Some plants can be cloned using a method called tissue **culture,** as shown in **Figure 11.** Tissue culture enables plant growers and scientists to make many copies of a plant with desirable traits, such as sweet fruit. Also, a greater number of plants can be produced more quickly than by vegetative reproduction.

Tissue culture also enables plant growers to reproduce plants that might have become infected with a disease. To clone such a plant, a scientist can use cells from a part of a plant where they are rapidly undergoing mitosis and cell division. This part of a plant is called a meristem. Cells in meristems are disease-free. Therefore, if a plant becomes infected with a disease, it can be cloned using meristem cells.

Figure 11 New carrot plants can be produced from cells of a carrot root using tissue culture techniques.

Plant Cloning



Animal Cloning In addition to cloning plants, scientists have been able to clone many animals. Because all of a clone's chromosomes come from one parent (the donor of the nucleus), the clone is a genetic copy of its parent. The first mammal cloned was a sheep named Dolly. **Figure 12** illustrates how this was done.

Scientists are currently working to save some endangered species from extinction by cloning. Although cloning is an exciting advancement in science, some people are concerned about the high cost and the ethics of this technique. Ethical issues include the possibility of human cloning. You might be asked to consider issues like this during your lifetime.

Key Concept Check Compare and contrast the different types of asexual reproduction.

Animal Cloning

Dolly Sheep Z

Phototake/AP Images

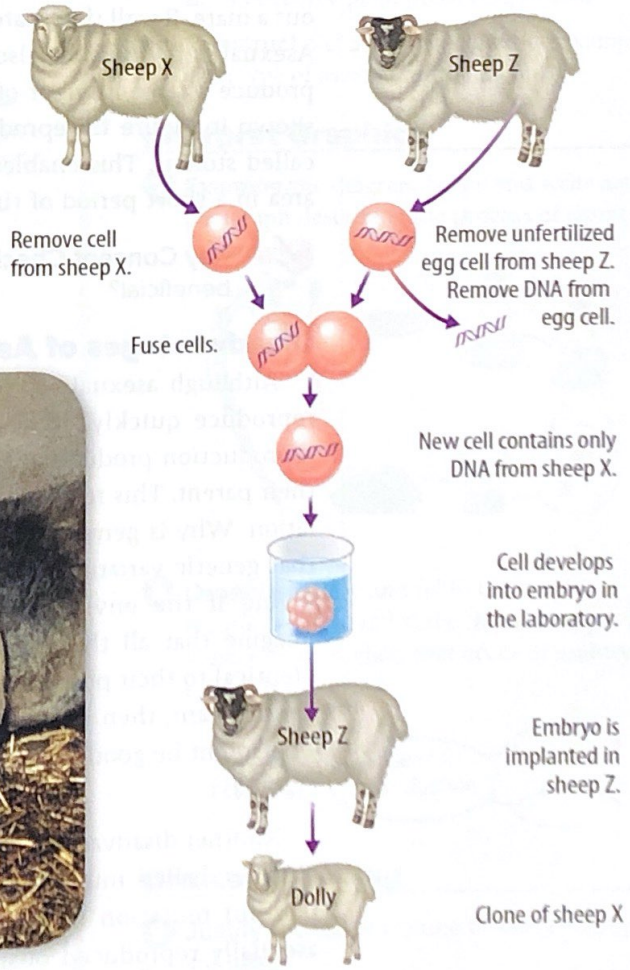


Figure 12 Scientists used two different sheep to produce the cloned sheep known as Dolly.

Figure 13 Crabgrass can spread quickly because it reproduces asexually.

Advantages of Asexual Reproduction

What are the advantages to organisms of reproducing asexually? Asexual reproduction enables organisms to reproduce without a mate. Recall that searching for a mate takes time and energy. Asexual reproduction also enables some organisms to rapidly produce a large number of offspring. For example, the crabgrass shown in **Figure 13** reproduces asexually by underground stems called stolons. This enables one plant to spread and colonize an area in a short period of time.

Key Concept Check How is asexual reproduction beneficial?

Disadvantages of Asexual Reproduction

Although asexual reproduction usually enables organisms to reproduce quickly, it does have some disadvantages. Asexual reproduction produces offspring that are genetically identical to their parent. This results in little genetic variation within a population. Why is genetic variation important? Recall from Lesson 1 that genetic variation can give organisms a better chance of surviving if the environment changes. Think of the crabgrass. Imagine that all the crabgrass plants in a lawn are genetically identical to their parent plant. If a certain weed killer can kill the parent plant, then it can kill all the crabgrass plants in the lawn. This might be good for your lawn, but it is a disadvantage for the crabgrass.

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

Lesson 2 Review

Online Quiz

Virtual Lab

Summary

In asexual reproduction, offspring are produced without meiosis and fertilization.

Cloning is one type of asexual reproduction.

Asexual reproduction enables organisms to reproduce quickly.

FOLDABLES

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

4. Cloning produces identical individuals from one cell.
5. All organisms have two parents.
6. Asexual reproduction occurs only in microorganisms.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

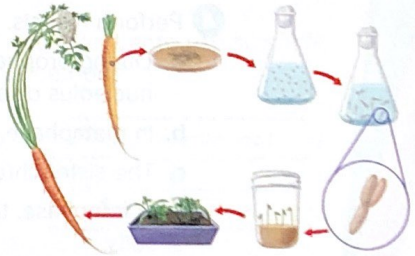
1. In _____ _____, only one parent organism produces offspring.
2. **Define** the term *cloning* in your own words.
3. **Use the term** *regeneration* in a sentence.

Understand Key Concepts

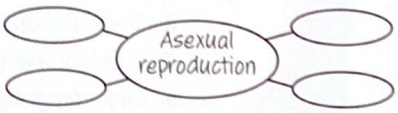
4. **State** two reasons why asexual reproduction is beneficial.
5. Which is an example of asexual reproduction by regeneration?
   - **A.** cloning sheep
   - **B.** lizard regrowing a tail
   - **C.** sea star arm producing a new organism
   - **D.** strawberry plant producing stolons
6. **Construct** a chart that includes an example of each type of asexual reproduction.

Interpret Graphics

7. **Examine** the diagram below and write a short paragraph describing the process of tissue culture.



8. **Organize** Copy and fill in the graphic organizer below to list the different types of asexual reproduction that occur in multicellular organisms.



Critical Thinking

9. **Justify** the use of cloning to save endangered animals.

(t)=Steven P. Lynch; (c)Phototake/AP Images; (b)Nigel Cattlin/Science Source

Lab

40 minutes

Mitosis and Meiosis

Materials

pool noodles

Safety

During cellular reproduction, many changes occur in the nucleus of cells involving the chromosomes. You could think about these changes as a set of choreographed moves like you would see in a dance. In this lab you will act out the moves that chromosomes make during mitosis and meiosis in order to understand the steps that occur when cells reproduce.

Ask a Question

How do chromosomes change and move during mitosis and meiosis?

Make Observations

1. Read and complete a lab safety form.
2. Form a cell nucleus with four chromosomes represented by students holding four different colors of pool noodles. Other students play the part of the nuclear membrane and form a circle around the chromosomes.

3. The chromosomes duplicate during interphase. Each chromosome is copied, creating a chromosome with two sister chromatids.
4. Perform mitosis.
   a. During prophase, the nuclear membrane breaks apart, and the nucleolus disappears.
   b. In metaphase, duplicated chromosomes align in the middle of the cell.
   c. The sister chromatids separate in anaphase.
   d. In telophase, the nuclear membrane reforms around two daughter cells.
5. Repeat steps 2 and 3. Perform meiosis.
   a. In prophase I, the nuclear membrane breaks apart, the nucleolus disappears, and homologous chromosomes pair up.
   b. In metaphase I, homologous chromosomes line up along the center of the cell.
   c. During anaphase I, the pairs of homologous chromosomes separate.
   d. In telophase I, the nuclear membrane reforms.
   e. Each daughter cell now performs meiosis II independently. In prophase II, the nuclear membrane breaks down, and the nucleolus disappears.
   f. During metaphase II, duplicated chromosomes align in the middle of the cell.

g. Sister chromatids separate in anaphase II.

h. In telophase II, the nuclear membrane reforms.

Form a Hypothesis

5 Use your observations to form a hypothesis about the results of an error in meiosis. For example, you might explain the results of an error during anaphase I.

Test your Hypothesis

7 Perform meiosis, incorporating the error you chose in step 6.

8 Compare the outcome to your hypothesis. Does your data support your hypothesis? If not, revise your hypothesis and repeat steps 6–8.

Analyze and Conclude

9 **Compare and Contrast** How are mitosis and meiosis I similar? How are they different?

10 BIG **The Big Idea** What is the difference between the chromosomes in cells at the beginning and the end of mitosis? At the beginning and end of meiosis?

11 **Critique** How did performing cellular replications using pool noodles help you understand mitosis and meiosis?

Communicate Your Results

Create a chart of the changes and movements of chromosomes in each of the steps in meiosis and mitosis. Include colored drawings of chromosomes and remember to draw the cell membranes.

Inquiry Extension

Investigate some abnormalities that occur when mistakes are made during mitosis or meiosis. Draw a chart of the steps of reproduction showing how the mistake is made. Write a short description of the problems that result from the mistake.

Lab Tips

- ☑ Figure out where the boundaries of your cell are before you start.
- ☑ Review the phases of mitosis and meiosis before beginning to act out how the chromosomes move during each process.

Remember to use scientific methods.