

17.3

KEY CONCEPT

Both sexual and asexual reproduction involve cell division.

◀ BEFORE, you learned

- Cells go through a cycle of growth and division
- Mitosis produces two genetically identical cells

▶ NOW, you will learn

- About cell division and asexual reproduction
- How sexual reproduction and asexual reproduction compare

VOCABULARY

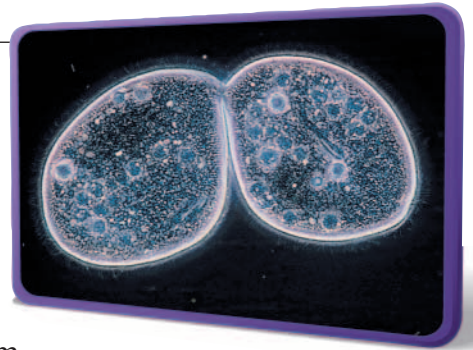
asexual reproduction p. 580
binary fission p. 581
regeneration p. 582

THINK ABOUT

How does cell division affect single-celled organisms?

In multicellular organisms, cell division functions in growth, repair, and development. But in unicellular organisms, each cell is itself an organism.

Unicellular organisms, like this paramecium, also undergo cell division. What are some possible results of cell division in unicellular organisms? How might they compare with the results of cell division in multicellular organisms?



Asexual reproduction involves one parent.

Mitosis and cytokinesis are the processes by which eukaryotic cells divide. In multicellular organisms, the daughter cells that result are separate cells but do not live independent lives. For example, new skin cells are part of skin tissue and cannot live independently. In multicellular organisms, mitosis and cytokinesis are not considered methods by which an organism reproduces.

Most unicellular organisms, and a few multicellular organisms, use cell division to reproduce, in a process called asexual reproduction. In **asexual reproduction**, one organism produces one or more new organisms that are identical to itself and that live independently of it. The organism that produces the new organism or organisms is the parent. Each new organism is an offspring. The offspring produced by asexual reproduction are genetically identical to the parent.

COMBINATION NOTES

Begin taking notes on the main idea: *Asexual reproduction involves one parent*. Be sure to include sketches of each method of reproducing.

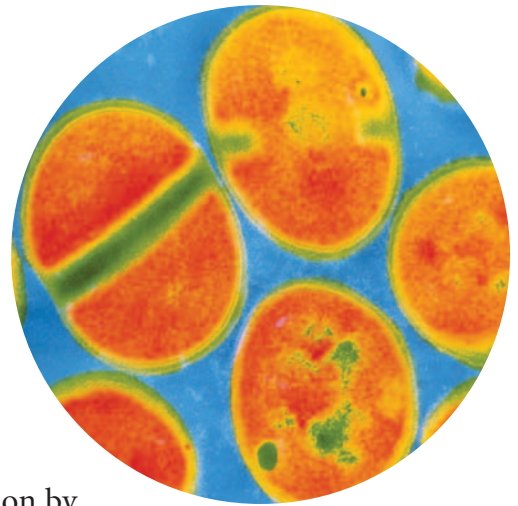
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Cell Division in Unicellular Organisms

Cell division and reproduction are the same thing in all single-celled organisms. However, the process of cell division in prokaryotes and in single-celled eukaryotes differs.

Binary fission is the form of asexual reproduction occurring in prokaryotes. Binary fission occurs when the parent organism splits in two, producing two completely independent daughter cells. Genetically, the daughter cells are exactly like the parent cell. Since all prokaryotic organisms are single-celled, cell division and reproduction by binary fission are the same process for them.

In single-celled eukaryotic organisms, however, reproduction by cell division involves mitosis and cytokinesis. The unicellular organism undergoes mitosis, duplicating and separating its chromosomes. Then its cytoplasm is divided through cytokinesis. The result is two separate, independent, and genetically identical offspring. Examples of single-celled eukaryotic organisms that reproduce by cell division include algae, some yeasts, and protozoans, such as paramecium.



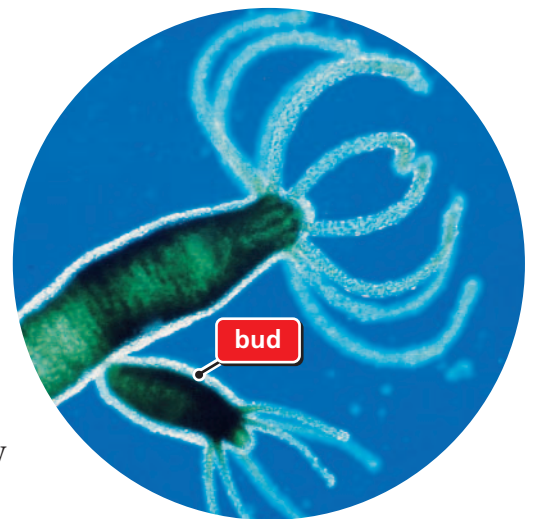
Binary fission results in two nearly equal, independent cells, as shown in these bacteria.

Budding

Both unicellular and multicellular organisms can reproduce by budding. Budding is a process in which an organism develops tiny buds on its body. Each bud forms from the parent's cells, so the bud's genetic material is the same as the parent's. The bud grows until it forms a complete or nearly complete new organism that is genetically identical to the parent.

In some budding organisms, buds can form from any part of the body. In other organisms, buds can be produced only by specialized cells in particular parts of the body. A new organism produced by budding may remain attached to its parent. Most often, when a bud reaches a certain size, it breaks free of the parent and becomes a separate, independent organism.

Some yeast and single-celled organisms reproduce asexually by budding. But budding is most notable in multicellular organisms. Hydras are freshwater animals that are famous for reproducing by budding. Among plants, the kalanchoe (KAL-uhn-KOH-ee) produces tiny buds from the tips of its leaves. Each kalanchoe bud that lands on a suitable growing surface will develop into a mature kalanchoe plant that is genetically identical to the parent plant.



Budding Hydras reproduce by pinching off small buds.



How is budding different in unicellular and multicellular organisms?

Regeneration

In certain multicellular organisms, specialized cells at the site of a wound or lost limb are able to become different types of tissues.

The process of new tissue growth at these sites is called **regeneration**.

Although one function of regeneration is the regrowth of damaged or missing body parts, in some organisms asexual reproduction is another function of regeneration.

Regeneration can be observed in many animals called starfish. If a starfish is cut in half, each half can regenerate its missing body parts from its own cells. The result is two complete, independent, and genetically identical starfish. Sometimes a starfish will drop off one of its limbs. The animal will eventually form a new limb. In these cases, regeneration is considered a form of asexual reproduction.

The growth of plants from cuttings is also a kind of asexual reproduction through regeneration. Cells near a cut made in a plant's stem begin to produce the missing part of the plant. Once the missing part is grown, the cutting can be planted in soil. The cutting will grow into a new, independent plant that is genetically identical to the plant from which the cutting was taken.



Describe the process of regeneration in starfish.

Asexual Reproduction and Health

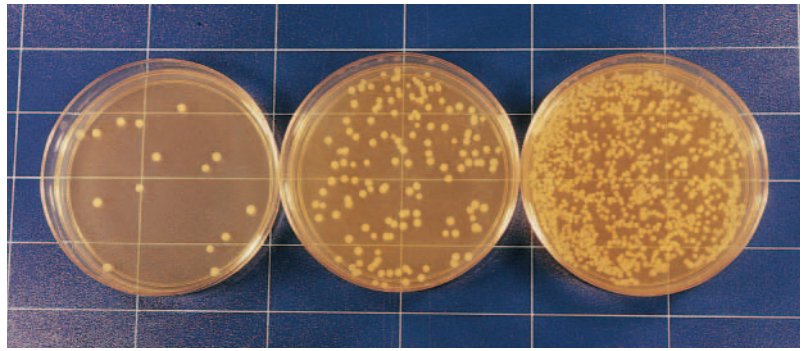
You have probably had the following experience. In the morning you feel fine. By afternoon, you have a strange feeling that something is not quite right, but you are well enough to function normally. You may even continue to feel well at dinner, and you eat heartily. Then, later that evening, it hits you. You're sick. That tickle in your throat has become a sore throat requiring a visit to the doctor and antibiotics. How did you get so sick so fast?

You could have picked up bacteria in school that morning. Perhaps another student coughed, spreading the bacteria that cause strep throat. A population of bacteria, like populations of other organisms that reproduce asexually through binary fission, increases in number geometrically. Two cells become 4, which become 8, which become 16, and so on.



Learn more about asexual reproduction.

The reason you get sick so fast is that for many bacteria the generation time is very short. Generation time is the time it takes for one generation to produce offspring—the next generation. In fact, some types of bacteria can produce a new generation of cells in less than 30 minutes. In about an hour the number of bacteria can increase to four times the starting number.



Asexual reproduction
These bacteria are quickly multiplying through asexual reproduction.

Although all offspring are genetically identical, the rare genetic random change does occasionally occur during cell division. The rapid reproduction rate makes it more likely that some offspring will have a random genetic change, which may be beneficial.

INVESTIGATE **Asexual Reproduction**

Which parts of plants can reproduce?

Some organisms can regenerate offspring from any part of their body. Others can regenerate offspring from only one specialized body part. In this activity, you will discover if a houseplant regenerates from various parts.

PROCEDURE

- 1 Obtain a plant part (leaf, stem, stem with leaf, or root) from your teacher. Also get one flowerpot filled with potting soil.
- 2 Dip the plant part in water and set it into the soil, about 1 in. deep, but make sure that most of the plant part is above the level of the soil. Water the soil lightly.
- 3 Place all the class's pots on the same window sill. Observe your plant part every day for two to three weeks. Record your observations.

WHAT DO YOU THINK?

- Which plant parts, if any, were able to regenerate a new plant?
- What can you conclude about the ability of different plant parts to grow into new plants?

CHALLENGE How does the plant in the experiment compare with the kalanchoe plant you read about in the text? What accounts for plants' different abilities to produce viable offspring?

SKILL FOCUS

Drawing
conclusions

MATERIALS

- houseplant
- flowerpot
- soil
- water

TIME
15 minutes



Sexual reproduction involves two parent organisms.

Reproduction of multicellular organisms often involves sexual reproduction as well as asexual cell division. The table shows some differences between asexual and sexual reproduction.

Comparing Asexual and Sexual Reproduction	
Asexual Reproduction	Sexual Reproduction
Cell Division	Cell division and other processes
One parent organism	Two parent organisms
Rate of reproduction is rapid	Rate of reproduction is slower than rate for asexual reproduction
Offspring identical to parent	Offspring have genetic information from two parents

If you grow a plant from a cutting, the new plant will be identical to the parent. However, plants that grow from seeds contain genetic material from two parents. Plants growing from seeds and animals growing from eggs are examples of organisms that reproduce through sexual reproduction.

Cell division is part of both sexual and asexual reproduction. The process of mitosis produces cells identical to the parent cells. The diversity of life on Earth is in part possible because of the combining of genetic materials from two parents in sexual reproduction. In the next chapter, you will read about cell processes involved in sexual reproduction.



CHECK YOUR READING

List two major differences between asexual and sexual reproduction.

17.3 Review

KEY CONCEPTS

1. How does binary fission relate to cell division?
2. What is a bud, and where does it form on an organism that reproduces asexually?
3. Compare sexual and asexual reproduction.

CRITICAL THINKING

4. **Predict** Do you think prokaryotes undergo regeneration? Why or why not?
5. **Compare and Contrast** How is binary fission in prokaryotic organisms similar to and different from mitosis and cytokinesis in single-celled eukaryotic organisms?

CHALLENGE

6. **Synthesize** Some bacteria can exchange pieces of genetic material with one another through a process called conjugation. What effect might this exchange have on the offspring of the bacteria that underwent conjugation?