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KEY CONCEPT

Cell division occurs in all organisms.

BEFORE, you learned

- Cells come from other cells
- Cells take in and release energy and materials
- In a multicellular organism, some cells specialize

NOW, you will learn

- How genetic material is organized in cells
- About the functions of cell division in multicellular organisms

VOCABULARY

DNA p. 74

chromosome p. 75

EXPLORE Cell Division

How is organization helpful?

PROCEDURE

- 1 Work with two other students. Obtain paired and unpaired groups of socks.
- 2 Two of the students put on blindfolds. One takes the paired group of socks and the other takes the unpaired group.
- 3 Each blindfolded student tries to separate his or her group of socks into two piles of single socks, one from each pair. The third student keeps track of time and stops the activity after 2 min.

MATERIALS

- 2 blindfolds
- socks
- stopwatch



WHAT DO YOU THINK?

Which group of socks was more accurately separated into two identical sets? Why?

REMINDER

Multicellular organisms are made up of eukaryotic cells. Most genetic material in eukaryotic cells is contained in the nucleus.

Cell division is involved in many functions.

Cell division occurs in all organisms, but performs different functions. Unicellular organisms reproduce through cell division. In multicellular organisms, all division is involved in growth, development, and repair.

You are probably bigger this year than you were last year. One characteristic of all living things is that they grow. Your body is made up of cells. Although cells themselves grow, most growth in multicellular organisms occurs when cells dividing produce new cells. In this chapter you will read about cell division in eukaryotic cells.

The genetic material of eukaryotic cells is organized in chromosomes.

The genetic material of a cell contains information needed for the cell's growth and other activities. When a cell divides into two new cells, each new cell receives a full set of genetic material. Most of the genetic material in cells is contained in a molecule called DNA.

DNA

The genetic material in cells is DNA—deoxyribonucleic acid (de-AHK-see-RY-boh-noo-KLEE-ihk). **DNA** is a chemical that contains information for an organism's growth, and functions. You read in chapter 1 that James Watson and Francis Crick worked with other scientists to build a model of DNA in 1953. They showed that DNA is made of two strands of molecules joined in a structure that resembles a twisted ladder or a double helix. You will learn more about DNA later in the unit.

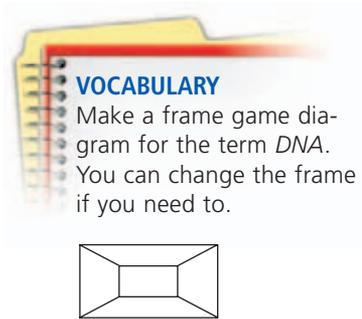


What is DNA?

A computer model of DNA shows its double helix structure.

DNA is made of two strands (shown in blue) twisted around each other.

The two strands are connected like a ladder by chemical "rungs" (shown in purple).



VOCABULARY

Make a frame game diagram for the term *DNA*. You can change the frame if you need to.

Chromosomes

In a eukaryotic cell, most of the cell's DNA is in the nucleus. During most of a cell's life cycle, DNA exists as a mass of loose strands. While the DNA is spread throughout the nucleus, the cell performs the functions needed for survival. During this time, the DNA is duplicated, or copied.

Before a cell divides, the DNA becomes wrapped around proteins like thread around a spool. The DNA is then further compacted into structures called **chromosomes** (KROH-muh-SOHMZ). As shown, a duplicated chromosome consists of two identical structures called chromatids that are held together near the center by a structure called a centromere.

Within each species of organism, the pattern and number of chromosomes formed is the same every time a cell divides. For example, humans have 46 chromosomes. Fruit flies, however, have 8 chromosomes, and corn plants have 20.

READING TIP

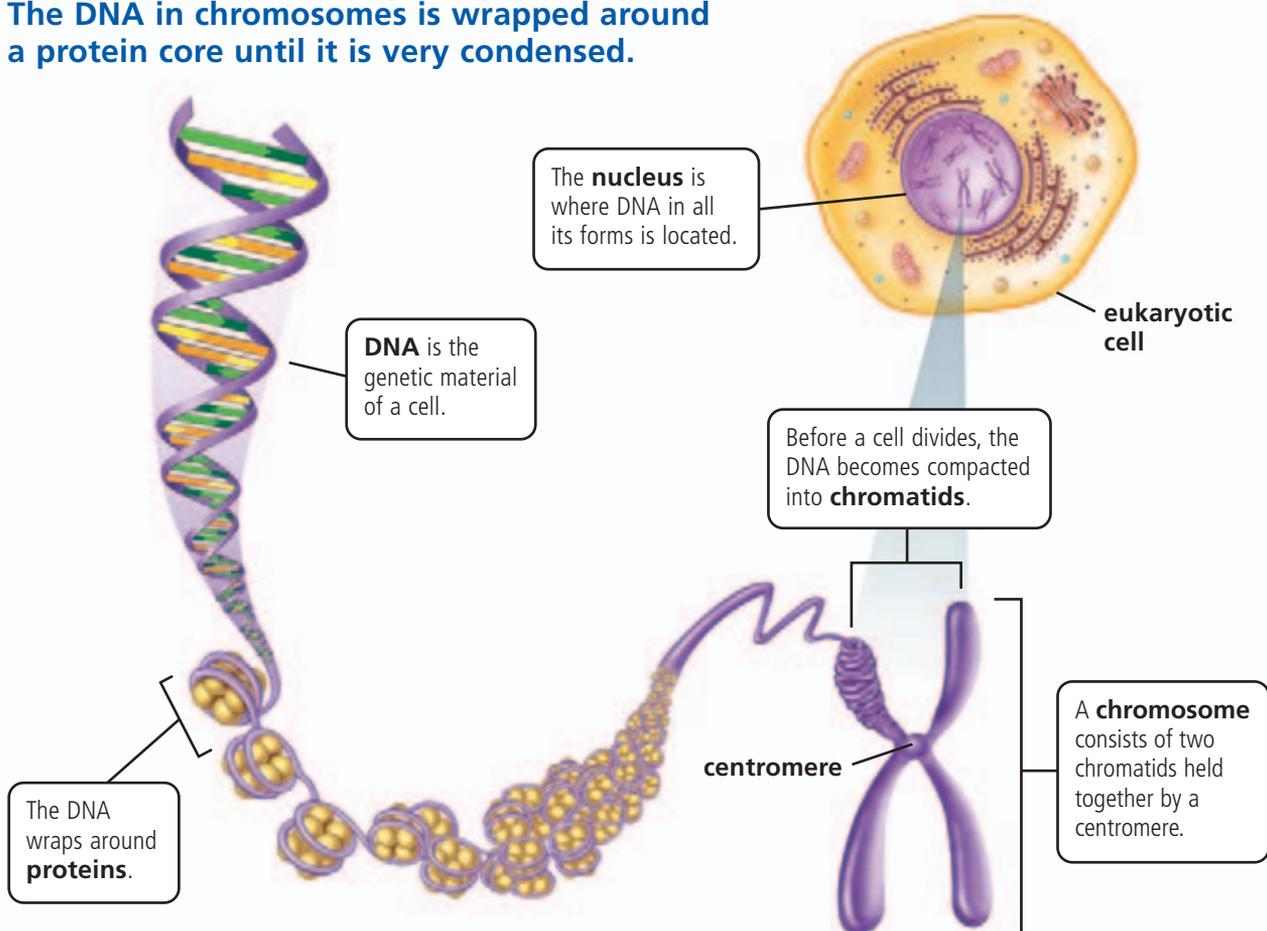
Compare the diagram of DNA with the computer model on page 74.

CHECK YOUR READING

Describe the relationship between DNA and chromosomes.

Organization of Genetic Material

The DNA in chromosomes is wrapped around a protein core until it is very condensed.



INVESTIGATE Chromosomes

How does DNA form chromosomes?

PROCEDURE

- 1 Select four pieces of yarn of different colors and four craft sticks. Push the yarn together into a loose ball. Observe how much space it takes up and how the individual pieces are organized.
- 2 Wrap each piece of yarn around a craft stick. Wrap the yarn so that the coils are tightly packed but do not overlap.

WHAT DO YOU THINK?

- What did you observe about the loosely balled yarn?
- What does the loosely balled yarn represent?
- What does the yarn on the craft sticks represent?
- Why does the yarn on the craft sticks take up less space than the ball of yarn?

CHALLENGE How does the yarn's being wrapped on the craft sticks make it easier to separate the different colors?

SKILL FOCUS
Modeling

MATERIALS

- yarn
- craft sticks

TIME
20 minutes



Cell division is involved in growth, development, and repair.

COMBINATION NOTES

Remember to take notes and draw sketches to help you understand the main idea: *Cell division is involved in growth, development, and repair.* Be sure to include the red heads in your notes.



Multicellular organisms vary greatly in size and complexity. You may not think that you have much in common with an ant or an oak tree. Actually, you share many characteristics with these organisms. One of the most important characteristic is that both you and they are made of trillions of cells. But, like most organisms, you and they started out as single cells. In multicellular organisms, cell division is essential for three major functions: growth, development, and repair.

Through cell division, a single cell becomes two cells. Those two cells divide into four, and the four cells divide into eight, and so on. A multicellular organism grows because cell division increases the number of cells in it. As the organism develops and its cells divide, many of the cells become specialized, and most of them continue to divide.

Even when growth and development appear to stop, cell division is still occurring. When an organism ages or is injured, the worn-out or damaged cells need to be replaced by new cells formed when healthy cells divide. For example, the cells that make up the lining of your throat have a short life span—two to three days. Living throat cells are constantly dividing and replacing the cells that have died.

Growth

In general, a large organism does not have larger cells than a small organism; it simply has many more cells than the small organism. When you were small, your body contained fewer cells than it has now. By the time you reach adulthood, your body will be made up of about 100 trillion cells.

Individual cells grow in size, but there are limits to the size that cells can reach. As you learned in Chapter 2, cells need a high ratio of surface area to volume in order to function. As a cell grows, that ratio decreases. When the cell divides into two smaller cells, the ratio of surface area to volume for each cell increases.

Another limit on cell growth is related to the amount of information a cell needs from its DNA. As the cell grows, more processes are needed for it to function, so its demand for instructions from DNA increases. However, the amount of DNA in the cell remains constant.

CHECK YOUR READING Describe how the number of cells in a multicellular organism changes as the organism grows?

Development

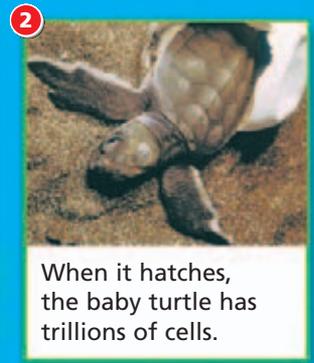
Although multicellular organisms begin as single cells, they grow into larger organisms through cell division. However, cell division alone does not allow organisms to develop. If cell division were the only process occurring in cells, all multicellular organisms would end up as spheres of identical cells. But during development, cells become specialized to perform particular functions.

These cells may take on shapes or structures that help them to perform their functions. Some cells might become layered skin cells, while others might become long, thin nerve cells. These cells still have the same set of genetic material as all the other cells in an organism's body, but as the organism develops they specialize.

CHECK YOUR READING Give two examples of specialized cells from the paragraph above.

Growth and Development

Organisms, like this sea turtle, grow and develop through cell division.

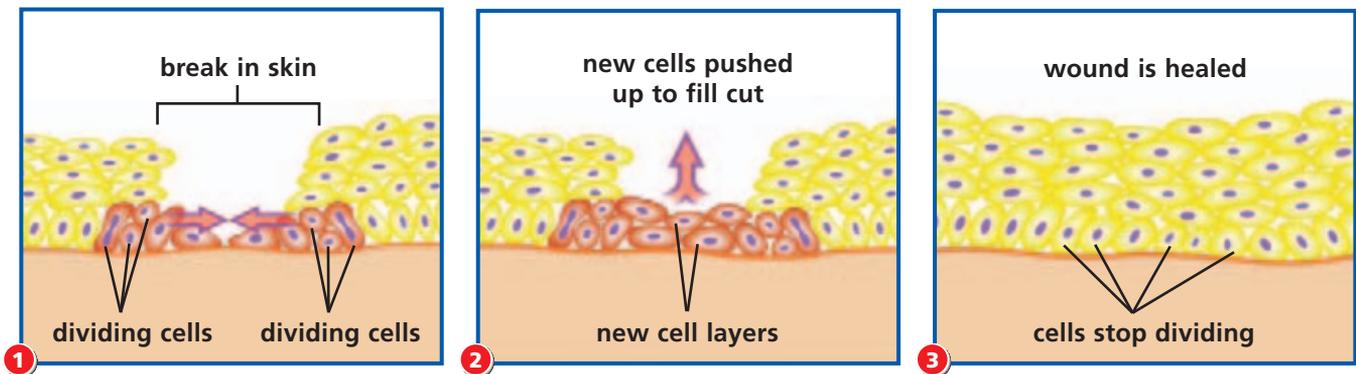


READING TIP

Connect what you have read about growth and development with the series of sea turtle photographs above.

Repair

You may have cut yourself at one time or another. Perhaps you have even broken a bone in your arm or leg. The body repairs injuries like these by means of cell division. For example, when your skin is cut, skin cells on either side of the cut make new cells to heal the wound. You can see the process of healing in the diagram below.



1 Cells in the lower layer begin to divide quickly and move into the break.

2 New cells begin to fill the area as cells continue to divide.

3 Cells stop their rapid dividing once the break is filled.

As cells age and die, they need to be replaced. In the human body—which is made up of about 200 different types of cells—cells are replaced at different rates. Your skin cells wear out quickly, so they need to be replaced often. Every minute or so, your skin loses about 40,000 cells, which are replaced with new ones. In contrast, most of the cells in your brain live a long time and do not divide very often.



What role does cell division play in healing the body?

3.1 Review

KEY CONCEPTS

1. Why is cell division important?
2. How is genetic material organized in eukaryotic cells?
3. Explain how cell division is involved in the growth, development, and repair of an organism.

CRITICAL THINKING

4. **Summarize** Explain how DNA changes form before a eukaryotic cell divides.
5. **Infer** Why do you think that injuries to the skin generally heal faster than injuries to the brain?

CHALLENGE

6. **Apply** Describe the stages of development in a multicellular organism that is familiar to you.