

Modeling a Cell

OBJECTIVES

Students construct a model to help them visualize the three-dimensional structure of an animal cell.

The students

- ▶ review the parts of a cell and compare a cell membrane and a nuclear membrane
- ▶ discuss the function of nuclear pores
- ▶ make a model to help them visualize the parts of a cell
- ▶ compare the structures of plant and animal cells and summarize the functions of plant and animal cell parts, using a poster
- ▶ explain how cellular processes are essential to the survival of the organism as a whole

SCHEDULE

About 40 minutes

VOCABULARY

cell wall
chloroplast
mitochondria
model
nuclear pores
respiration
vacuole

MATERIALS

For each student

- 1 Activity Sheet 4

For each team of four

- 5 beads
6 buttons, assorted
1 sphere, plastic, large
1 sphere, plastic, small

For each team of eight

- 1 microslide strip
1 microslide viewer

For the class

- 1 roll cellophane, yellow
1 pkg macaroni
8 photographs, Animal Cell
1 poster, Visualizing Cells
1 scissors*
1 roll string*
1 roll tape, masking

*provided by the teacher

PREPARATION

- 1 Make a copy of Activity Sheet 4 for each student.
- 2 Cut eight 15-inch lengths of cellophane, one for each team of four.
- 3 Each team of four will also need several pieces of macaroni, the beads and buttons, and access to the masking tape.
- 4 Preview the microslide image of nuclear pores (image 4).
- 5 If tags and ties are present on small spheres, remove tags, but leave the ties in place to prevent loss of pieces.

BACKGROUND INFORMATION

Most cells are surrounded by a membrane that lets some, but not all, substances into and out of the cell. Water and carbon dioxide are examples of small molecules that can pass through. Once past the membrane, these molecules enter what is called the cytoplasm. The cytoplasm, which is gooey or jellylike, contains a dense, spherical object called the nucleus, which is also surrounded by a membrane. The nuclear membrane has **pores** that allow the movement of larger molecules across it. DNA, which directs all cell activities, is found in the nucleus. One important kind of organelle is a ribosome. Ribosomes appear as small black dots in the cytoplasm. In plant cells, a stiff **cell wall** surrounds the cell membrane and helps support and protect the cell. Made of a tough carbohydrate called cellulose, cell walls keep their shape long after a cell dies.

Also present in some plant cells, but absent in animal cells, are **chloroplasts**. Chloroplasts help plants make their own food from water, carbon dioxide, and sunlight. Most chloroplasts are found in leaf cells. Chloroplasts get their green color from chlorophyll—a pigment, or coloring, that plants use to take in the energy from sunlight.

Vacuoles are organelles found in both plant and animal cells. Vacuoles store food and water. They also store wastes until they can be excreted, or removed from the cell.

Mitochondria are another type of organelle found in both plant and animal cells. Mitochondria (s. mitochondrion) release energy from food in a process called **respiration**. During respiration, the mitochondria use oxygen to break down stored glucose into carbon dioxide, water, and energy. The plant or animal can then use this energy to perform life functions.

You may wish to have students include all the objects they see in the photograph of the animal cell in the cell **models** they construct.

▼ Activity Sheet 4

Modeling a Cell

1. Draw a picture of your cell model in the space below. Label each of its parts, including *nucleus, nuclear membrane, cytoplasm, cell membrane, organelles, and ribosome.*

Student drawings should resemble Figure 4-1 and include indicated labels.

2. Compare and contrast your model and a real cell.

a. How is your cell model similar to an actual cell?

Possible answers: Both have the same parts. Both have a semitransparent cytoplasm.

b. How is your cell model different from an actual cell?

Possible answers: The cell model is much bigger than an actual cell. The cytoplasm in the model is a solid, but in an actual cell it is jellylike.

Guiding the Activity

- 1 Ask the students, **What are the cell parts that you have learned?**
- 2 Write the word *model* on the board. Ask, **What is a model?**

What are some ways that models are used?

How could you make a model to represent an animal cell and its parts?
- 3 Tell the students that they will use two different-sized, separable plastic spheres to make a model cell. Tell them that although cells can have many shapes, such as flat, square, or rectangular, for the purposes of this activity, a sphere will make a good general model.

Distribute one large and one small sphere to each team of four. Ask, **Which sphere should represent the nuclear membrane and which should represent the cell membrane?**
- 4 Ask, **What do you notice is similar about the cell and its nucleus?**
- 5 Tell the students that the cell membrane and the nuclear membrane are similar, and both allow only certain substances to pass in and out. Write the term *nuclear pores* on the board. Tell the students that the nuclear membrane has special openings, called **nuclear pores**, that allow larger substances to pass into and out of the nucleus.

Additional Information

nucleus, nuclear membrane, cytoplasm, cell membrane, organelles, and ribosomes

*A **model** is a small representation of something much larger or a large representation of something very small.*

Models are used to help people visualize and understand the actual object. For example, architects use models to show what the structure they are designing will look like after it is built. Children play with model cars, trucks, trains, and houses.

Possible materials for making cell models include modeling clay, balloons, or dough.

The nuclear membrane has to be the smaller sphere in order to fit into the larger sphere. The larger sphere represents the cell membrane.

Students should be able to state that both the nucleus and the cell itself are surrounded by a membrane. If not, make sure that they understand this.

Guiding the Activity

Additional Information

6 Distribute a microslide strip and a viewer to each team of eight. Tell the students that they will now observe a microslide image of a cell magnified 50,000x to show the nuclear membrane with nuclear pores (image 4). Instruct the students to look at the area near the arrows to see the tiny pores. After they have viewed the pores, refresh the students' memories by asking, **What important information is contained in the nucleus?**

Note: Students should leave the microslide strip in its sleeve. This will make it easy to pass through the slot in the microslide viewer eyepiece.

The C on the microslide indicates the cytoplasm. The N indicates the nucleus.

The information used in making proteins is in the nucleus.

7 Ask, **Why are proteins important?**

Proteins determine the characteristics of body features.

8 Have the students return their attention to the plastic spheres. Ask, **How might you model the cytoplasm?**

Accept reasonable suggestions, which may include using gelatin, cotton balls, crumpled-up paper, and so forth.

9 Distribute one piece of cellophane, the beads, the assorted buttons, and macaroni to each team of four. Ask, **What cell parts do you think are represented by each of these objects?**

Students should be able to say that the cellophane will represent the cytoplasm. They may or may not be able to infer that the beads will represent ribosomes and the buttons and macaroni the other organelles.

Ask, **How is the cellophane like and unlike the cytoplasm?**

Like the cytoplasm, the cellophane is semitransparent and provides a way for the model organelles to stay in place. Real cytoplasm, however, is jellylike.

10 Have the students construct their cell models. To begin, tell them to open the larger sphere. Instruct them to crumple up the cellophane, nest the smaller sphere in the middle of the cellophane, and put the whole thing into one of the hemispheres. They should then add the small beads, assorted buttons, and macaroni to the crumpled cellophane. Have them close up the model and affix a piece of masking tape with their names on it to the outside of the sphere (see Figure 4-1).

Note: The spheres have small plastic protrusions on each of their hemispheres. You may either ignore or remove these pieces. You may want to leave the pieces on the large sphere so that the completed models can be attached to pieces of string and displayed in the classroom.

Guiding the Activity

Distribute **Activity Sheet 4** to each student. Have students complete step 1. Review their drawings.

11 Pass out the photographs of the animal cell used in Activity 3. Have the students compare the cell in the photograph with their model. Lead the class in a discussion about the ways in which their cell models are an accurate representation of a real cell and the ways in which they are not. Ask students to complete step 2 on their activity sheets to reinforce the outcome of the discussion.

12 Display the **Visualizing Cells poster** in the classroom where all students can see it. Tell students that the poster shows drawings of three types of cells, a bacterial cell, an animal cell (which students' cell models represent), and a plant cell.

Have students compare the animal cell illustration on the poster with the animal cell photograph.

Additional Information



▲ *Figure 4-1. The completed cell model.*

Among other things, the students may note that the cellophane is solid while cytoplasm is actually jellylike or that the shape of the model is too perfect.

You may wish to tell students that bacteria are single-celled organisms that they will learn more about in a later activity (Activity 11).

Students may observe similarities in the presence and locations of the cell membrane, cytoplasm, nuclear membrane, nucleus, and ribosomes. They may also observe differences in the size, shape, color, and presentation of cellular parts. They may ask about other cell structures on the poster that they have not yet learned about. Depending on your schedule and the needs of your class, you may wish to have students investigate the functions of these additional cell structures through print materials or other available media.

Guiding the Activity

13

Using the poster, ask students to compare the major parts that make up plant and animal cells.

Write the term *cell wall* on the board. Tell students that a **cell wall** is a stiff structure that covers the cell membrane of some cells. Ask, **Which of the three cells shown on the poster has a cell wall?**

Tell students that the cell wall protects and provides support and structure for bacterial and plant cells.

Write the word *chloroplast* on the board. Tell students that plant cells have an organelle that bacterial and animal cells do not. This organelle is called a chloroplast. Have a volunteer point out the chloroplasts in the cytoplasm of the plant cell pictured on the poster.

Explain that, unlike animals, plants make their own food in a process called photosynthesis. **Chloroplasts** are the structures in which this food is produced. Chloroplasts contain chlorophyll, a green pigment that absorbs the energy from sunlight. This energy is used to power the chemical reactions involved in the food-making process known as photosynthesis.

To summarize, ask, **What are two main structures that make a plant cell different from an animal cell?**

What are the functions of these two structures?

Additional Information

Students should realize that plant and animal cells have many structures in common, such as a cell membrane, nucleus, ribosomes, and other organelles.

The bacterial cell and the plant cell both have cell walls. The animal cell does not have a cell wall.

Unlike animal cells, plant cells have cell walls and chloroplasts.

Cell walls provide support and protection, and chloroplasts are organelles in which plants make their own food.

Guiding the Activity

14

Tell students that cells perform many life processes that allow the organism as a whole to live and grow. Organelles perform specific functions to help carry out these life processes. Explain that cellular processes are essential to the survival of an organism as a whole.

Ask, **How do plants get the food they need to survive and grow?**

What organelles in a plant cell perform this function?

Point out that animals also need food to live. Elicit that animals get their food from eating plants or other animals that have eaten plants.

Write the word *vacuole* on the board. Tell students that storing food and water is an important cellular process. Ask students to locate the central vacuole in the cytoplasm of the plant cell on the poster. Explain that a **vacuole** is an organelle that stores food and water. Vacuoles also store wastes until they can be moved out of the cell.

15

Write the words *mitochondria* and *respiration* on the board. Ask students to locate the mitochondria in the cytoplasm of the plant and animal cells on the poster. Explain that organelles called **mitochondria** release the energy from stored food. Then the cell can use the energy. This process is called **respiration**.

Ask, **Why are cellular processes such as photosynthesis, respiration, and storage of food, water, and wastes essential to the survival of an organism as whole?**

Tell students that you will be leaving the poster on display as a reference as you continue your investigations.

Additional Information

Plants make their own food through photosynthesis.

Chloroplasts are the organelles in which photosynthesis takes place.

Plant cells have a large central vacuole for storing the food they make for themselves. Animal cells also have vacuoles, though they are not shown on the poster.

Because respiration happens at the cellular level, it can also be referred to as cellular respiration.

If individual cells did not perform these functions, the body parts or plant parts they make up would not function properly. Soon the whole organism would die.

REINFORCEMENT

To demonstrate the concept of nuclear pores, bring to class two strainers or colanders, one with very tiny holes and the other with larger holes. Explain that the nuclear membrane contains pores and so is like the strainer with the large holes. The cell membrane, on the other hand, allows only much smaller molecules to pass through. Therefore, it is like the strainer with the tiny holes.

SCIENCE NOTEBOOKS

Have students place their completed activity sheets in their science notebooks.

CLEANUP

Have students return the microslide strips and viewers to the kit. Have them store their cell models in a safe place, as they will be used in later activities. Return the photographs of the animal cell to the kit. Leave the Visualizing Cells poster on display in the classroom.

SCIENCE AT HOME

Encourage students to draw an analogy between their homes and a living cell. Have them describe which parts of their homes act as the cell membrane, the cytoplasm, the nucleus, the nuclear membrane, and the nuclear pores. What “organelles” can be found in the “cytoplasm” of their homes, and what is the function of each?

Connections

Science Challenge

History of genetics. Suggest that students research the rediscovery of Mendel’s work in the 1890s by Hugo De Vries in Holland, Carl Correns in Germany, and Erich von Tschermak in Austria. Working separately, these scientists discovered Mendel’s 1865 paper describing his experiments, applied his research to their own investigations with plants, and published their discoveries in 1900. When British scientist William Bateson read about Mendel’s work in De Vries’s paper, he realized that Mendel had discovered the mechanism of heredity, which Bateson himself had been investigating. By applying Mendel’s methodology to his own studies of trait inheritance in poultry, Bateson proved that Mendel’s theories applied to animals as well as plants. Bateson’s discoveries and his enthusiastic support of Mendel’s work spurred further scientific investigation.

Science Extension

Provide a wide variety of common objects and craft materials that could be used to construct flat or three-dimensional models of cells. Encourage students to be creative. For example, a cell and its nucleus could be represented by large and small petri dishes or by a clear plastic bag filled with gelatin or clear liquid soap with a small ball floating in it. Discuss each model’s strong points—the ways in which it most closely resembles a real cell.

Science and the Arts

Many life science and biology textbooks published in recent years contain dramatic illustrations of cells that suggest their three-dimensional structure. Have students look through books to find such illustrations. Suggest that they consult a professional artist or an art teacher to find out what techniques were used to produce the illustrations.

Science and Careers

Tell students that some professional artists specialize in creating scientific and medical illustrations for textbooks and reference books. Encourage interested students to research the field of medical illustration. Invite a medical illustrator to visit the class to describe his or her work and the training and education required. Ask the illustrator to bring samples of illustrations he or she has created and some of the materials used to produce them.

Science and Social Studies

Ask students to find out who first used the word *cell* to refer to the units of which all living things are made, and why the person chose that word. (The term was coined in 1665 by English scientist Robert Hooke when he viewed a slice of cork with the compound microscope he had constructed and was reminded of monks’ small rooms, called cells, in a monastery.)

Science, Technology, and Society

Have students research the development of microscopes, from the primitive devices invented in the 1590s and used as toys to the more complex instruments of the 1870s that first enabled scientists to observe the inner structures of cells to today’s powerful scanning electron microscopes. Make sure students recognize the critical role that microscopes played in scientists’ growing knowledge of cell structures and processes.