Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at http://www.carolina.com

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Chapter 8 Organizer

Cellular Transport and the Cell Cycle

Teacher Classroom Resources

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| Products Available From National Geographic Society | To order the following products, call National Geographic Society at 1-800-368-2728: |
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Chapter 8

Cellular Transport and the Cell Cycle

What You’ll Learn
You will discover how molecules move across the plasma membrane.
You will sequence the stages of cell division.

Why It’s Important
Transportation of substances through the plasma membrane and cell reproduction are two important functions that help cells maintain homeostasis and keep you healthy.

GETTING STARTED

Observing Osmosis
Not the crispiness of a fresh piece of lettuce. Now place the lettuce in a salty solution, then in distilled water. Note the crispiness of the lettuce different in each solution? What do you think happened?

To find out more about cellular transport and the cell cycle, visit the Glencoe Science Web Site: www.glencoes.com/sec-science

Osmosis: Diffusion of Water
Although the plasma membrane of a cell can act as a dam or pump for water-soluble molecules that cannot pass freely through the membrane, it does not limit the diffusion of water. Recall that diffusion is the movement of particles from an area of higher concentration to an area of lower concentration. In a cell, water always tries to reach an equal concentration on both sides of the membrane. The diffusion of water across a selectively permeable membrane is called osmosis (oh-MOH sus). Regulating the water flow through the plasma membrane is an important factor in maintaining homeostasis within the cell.

What controls osmosis
If you add sugar to water, the water becomes sweeter as you add more sugar. As the number of sugar molecules increases, the number of water molecules decreases. If a strong sugar solution and a weak sugar solution are placed in direct contact, water molecules diffuse in one direction and sugar molecules diffuse in the other direction until all molecules are evenly distributed throughout.

If the two solutions are separated by a selectively permeable membrane that allows only water to diffuse across

Assessment Planner

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Alternative Lab, TWE, p. 203
BioLab, TWE, p. 204
Problem-Solving Lab, TWE, p. 218

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Assessment, TWE, p. 216

Section 8.1 Cellul...
Observing Osmosis

**Purpose:** Students will observe and measure the number of sugar molecules in the plain water beaker and the salt water beaker. Students should recognize that the freedom of random particle movement is the only difference.

**Materials**
- Measuring spoon
- Salt
- Graduated cylinder
- Beaker

**Procedure**
1. Place a potato cube into each beaker.
2. After 30 minutes, record the texture of the potato cubes and the other in the salt water beaker.
3. With a knife, cut two cubes of potato (without skin) that measure 2 cm on each side. Use caution when cutting the potato. Cut away from the body.
4. Using a balance, measure and record the mass of each potato piece. Then place one piece in the water beaker and the other in the salt beaker.
5. Record the texture of the potato cubes before soaking (turgid).
6. Cover the beakers with plastic wrap or aluminum foil and allow them to sit undisturbed for two days.
7. On the second day, carefully remove the potato cubes one at a time and blot them dry on the outside. Weigh the pieces and record their masses. Observe any changes in the texture of each cube.

**Analysis**
1. Describe what happened to the mass of each cube after soaking. The mass of the potato placed in salt water decreased, while the one in plain water increased.
2. Describe what happened to the texture of each cube after soaking. The potato in the salt water became softer than that in the plain water.
3. Explain the changes you observed in terms of osmosis. Water in the potato placed in salt water entered the potato because of the high salt concentration outside the cell.

**Quick Demo**
Demonstrate Brownian movement using a microprojector and a very dilute solution of India ink. The effects of collisions of water molecules with the membrane of a living cell can be seen when a wet mount is slightly focused and quickly refocused on the slide. Students should be able to see increased internal pressure.

**Assessment**
Knowledge: The kinetic theory of matter explains the transport of molecules from one place to another. Elicit what the major differences are, at the molecular level, among a solid, a liquid, and a gas. Students should recognize that the freedom of random particle movement is the only difference.

**Resource Manager**
Section Focus Transparency 18 and Video 203
Tech Prep Applications, pp. 13-14
Basic Concepts Transparency 8 and Video 203
Laboratory Manual, pp. 55-56

**Alternative Lab**
Observing Osmosis

**Purpose**
Students will observe and measure the effect of osmosis on a potato.

**Materials**
- Potato, two 100-ml beakers or paper cups, measuring spoon, salt, graduated cylinder, label, pen, stirring rod, balance, plastic wrap or aluminum foil, knife

**Procedure**
Give the following directions to students:
1. Label one beaker “water” and the other “salt.” Place 100 ml of water into each beaker.
2. Place 3 tablespoons of salt into the salt beaker and stir until the salt is dissolved.
3. With a knife, cut two cubes of potato (without skin) that measure 2 cm on each side. Use caution when cutting the potato. Cut away from the body.
4. Using a balance, measure and record the mass of each potato piece. Then place one piece in the water beaker and the other in the salt beaker.
5. Record the texture of the potato cubes before soaking (turgid).
6. Cover the beakers with plastic wrap or aluminum foil and allow them to sit undisturbed for two days.
7. On the second day, carefully remove the potato cubes one at a time and blot them dry on the outside. Weigh the pieces and record their masses. Observe any changes in the texture of each cube.

**Analysis**
1. Describe what happened to the mass of each cube after soaking. The mass of the potato placed in salt water decreased, while the one in plain water increased.
2. Describe what happened to the texture of each cube after soaking. The potato in the salt water became softer than that in the plain water.
3. Explain the changes you observed in terms of osmosis. Water in the potato placed in salt water entered the potato because of the high salt concentration outside the cell.
Analysis

1. Describe and compare the color of the iodine and starch at the start and end of the experiment.
2. Fast: Starch mixed with iodine forms a purple color. a. In which direction did the iodine move? What is your evidence? b. In which direction did the starch move? What is your evidence?
3. Explain how this experiment illustrates selective permeability.

Passive Transport

Water, lipids, and lipid-soluble substances are some of the few compounds that can pass through the plasma membrane by diffusion. The cell uses no energy to move these particles; therefore, this movement of particles across membranes by diffusion is called passive transport.

Passive transport of other substances that are not attracted to the phospholipid bilayer or are too large to pass through by diffusion can still occur by other mechanisms such as the substance is moving with the concentration gradient.

You can investigate passive transport by performing the MiniLab shown here.

Passive transport by proteins

Recall that transport proteins help substances move through the plasma membrane. These proteins function in a variety of ways to transport molecules and ions across the membrane.

The passive transport of materials across the plasma membrane with the aid of transport proteins is called facilitated diffusion. As illustrated in Figure 8.5, the transport proteins provide convenient openings for particles to pass through. Facilitated diffusion is a common method of moving sugars and amino acids across membranes. Facilitated diffusion, like simple diffusion, is driven by a concentration gradient; substances on both sides of the membrane are trying to reach equal concentrations.

Active Transport

A cell can move particles from a region of lower concentration to a region of higher concentration, but it must expend energy to counteract the force of diffusion that is moving the particles in the opposite direction. Movement of materials through a membrane against a concentration gradient is called active transport and requires energy from the cell.

How active transport occurs

In active transport, a transport protein called a carrier protein first binds with a particle of the substance to be transported. In general, each type of carrier protein has a shape that fits a specific molecule or ion. When the proper molecule binds with the protein, chemical energy allows the cell to change the shape of the carrier protein so that the particle to be moved is released on the other side of the membrane, something like the opening of a door. Once the particle is released, the protein's original shape is restored, as illustrated in Figure 8.6. Active transport allows particle movement into or out of a cell against a concentration gradient.

Transport of large particles

Some cells can take in large molecules, groups of molecules, or even whole cells.
they observe in the celery. Ask students to keep track of the role of osmosis in making pickles on an overhead. Students should refer to their journals the role of osmosis when placing them in water. Ask students to explain why celsc can be made firm again by placing them in water. Ask students to explain why celsc can be made firm again by placing them in water.

LS

1. The concentration of water on either side of the membrane and the permeability of the membrane.
2. In a hypotonic solution, water moves into the cell. In an animal cell, the extra water may cause the plasma membrane to burst. In a plant cell, the whole cell. Endocytosis is a process by which a cell surrounds and takes in material from its environment. This process does not pass directly through the membrane. Instead, it is engulfed and enclosed by a portion of the cell’s plasma membrane. That portion of the membrane then breaks away, and the resulting vacuole with its contents moves to the inside of the cell. Figure 7.7 shows the reverse process of endocytosis, called exocytosis. Exocytosis is the expulsion or secretion of materials out of the cell. Cells use exocytosis to expel wastes, such as indigestible particles, from the interior to the exterior environment. They also use this method to secrete substances, such as hormones produced by the cell. Because endocytosis and exocytosis both move masses of material, both require energy and are, therefore, both forms of active transport. With the various mechanisms the cell uses to transport materials in and out, cells must also have mechanisms to regulate size and growth.

Cell Size Limitations

Although a giant cell will never threaten a city, cells do come in a wide variety of sizes. Some cells, such as red blood cells, measure only 8 micrometers (µm) in diameter. Other cells, such as nerve cells in large animals, can reach lengths of up to 1 m but with small diameters. The cell with the largest diameter is the yolk of an ostrich egg measuring 8 cm. Most living cells, however, are between 2 and 200 µm in diameter. Considering this wide range of cell sizes, why then can’t most organisms be just one giant cell?

Diffusion limits cell size

You know that the plasma membrane allows a steady supply of nutrients such as glucose and oxygen to enter the cell and allows wastes to leave. Within the bounds of the plasma membrane, these nutrients and wastes move by diffusion. Although diffusion is a fast and efficient process over short distances, it becomes slow and inefficient as the distances become larger. For example, a mitochondrion at the center of a hypothetical cell with a diameter of 20 cm would have to wait months before receiving molecules entering the cell. Because of the slow rate of...
The discovery of chromosomes

Most interesting to the early biologists was their observation that just before cell division, several, long, thread-like structures suddenly appeared in the nucleus. Scientists also noticed that these structures seemed to vanish as mysteriously as they appeared soon after division of a cell. These structures, which contain DNA and become darkly colored when stained, are called chromosomes (KRoh muh somz). Eventually, scientists learned that chromosomes are the carriers of the genetic material that is copied and passed from generation to generation of cells. This genetic material is crucial to the identity of the cell.

Cell Reproduction

Recall that the cell theory states that all cells come from preexisting cells. Cell division is the process by which new cells are produced from one cell. Cell division results in two cells that are identical to the original, parent cell. Old cells on the sides of your feet and on the palms of your hands are being shed and replaced, and in your eye, hair grows and grows and grows and grows... New cells are produced as tadpoles become frogs, and as an iris vine grows and wraps around a garden trellis. All organisms grow and change, worn-out tissues are repaired or are replaced by newly produced cells.

What does this mean for cells? How does the surface area-to-volume ratio affect cell function? If cell size doubled, the cell would require eight times more nutrients and would have eight times more waste to excrete. The surface area, however, would increase by a factor of only four. Thus, the plasma membrane would not have enough surface area to transport oxygen, nutrients, and wastes. The cell would either starve to death or be forced out of the building by waste products. You can investigate surface area-to-volume ratios yourself in the Problem-Solving Lab shown here.

Because cell size can have dramatic and negative effects on a cell, cells must have some method of maintaining optimum size. In cells that develop before they become too large to function properly, Cell division accomplishes other purposes, too, as you will read next.

Problem-Solving Lab 8-1

Drawing Conclusions

What happens to the surface area of a cell as its volume increases? One reason cells are small is that, as they grow, their volume increases faster than their surface area.

Analysis

Look at the cubes shown below. Note the size and magnitude of difference in surface area and volume among the cubes.

Thinking Critically

1. How many small cubes (1 mm) do you think it would take to fill the largest cube (4 mm)?
2. Relating this example to cells, describe how a cell is affected by its size.
3. Explain how a small change in cell size can have a huge impact on the cell and its normal functions.

Performance Task Assessment

Problem-Solving Lab 8-1

Purpose

Students will compare the increase in volume of an object with the increase in its surface area.

Background

Cell volume increases much faster than cell surface area. In cells, this fact contributes to cell size limitation because cells do not have sufficient surface area to accommodate the influx of nutrients to support the volume of a large size.

Process Skills

measure in SI, use numbers, recognize cause and effect, interpret data, analyze

Teaching Strategies

Ask students if they have ever wondered why cells can’t continue to grow larger and larger to become giant cells. Then ask them to consider the fact that most living cells do not grow beyond a certain size. More resources are needed by organelles and more waste is produced. As the cell grows, it reaches a point where the surface area is not large enough to transport resources and wastes to allow the cell to survive.

Portfolio

Performance and Other Skills

Students should write a summary of the MiniLab, including the Analysis questions, for their journals. Use the Performance Task Assessment List for Lab Report in PASC, p. 47.

Visual Learning

Figure 8.8

This giant amoeba, Pelomyxa, is several millimeters in diameter. It can grow up to 1000 nuclei.

Figure 8.9

Surface area-to-volume ratio is one of the factors that limits cell size. Note how the surface area and volume change as the sides of a cell double in length from 1 mm to 2 mm. Calculate the change in surface area and volume as the cell doubles in size again to 4 mm on a side.

Surface Area Demonstration

In a few small boxes and one large box that is approximately the same size as the small boxes combined during preparation, have students to figure out which set will need more paper, the large box or the small boxes each wrapped separately. Then, the students should wrap all of the boxes, then unwrap them to demonstrate the difference in the amounts of paper needed. Students should see how the volumes of the large box and the set of small boxes are approximately equal, but the total surface area is much larger for the set of small boxes than for the large box. Have them include illustrations and a summary of the demonstration in their portfolios.

Figure 8.10

Volume and surface area are related. As the cell grows, it doubles its volume faster than its surface area.

Problem-Solving Lab 8-1

What happens to the surface area of a cell as its volume increases? One reason cells are small is that, as they grow, their volume increases faster than their surface area.

Analysis

Look at the cubes shown below. Note the size and magnitude of difference in surface area and volume among the cubes.

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Process Skills

measure in SI, use numbers, recognize cause and effect, interpret data, analyze

Teaching Strategies

Ask students if they have ever wondered why cells can’t continue to grow larger and larger to become giant cells. Then ask them to consider the fact that most living cells do not grow beyond a certain size. More resources are needed by organelles and more waste is produced. As the cell grows, it reaches a point where the surface area is not large enough to transport resources and wastes to allow the cell to survive.
The cell cycle is divided into interphase, when most of the cell’s metabolic functions are carried out and the chromosomes are replicated, and mitosis, when nuclear division occurs, leading to the formation of two daughter cells. The division of the cytoplasm, called cytokinesis, follows mitosis.

Critical Thinking: During which stage of the interphase does a cell spend most of its time? Why?

- **Mitosis**
  - When interphase is complete, the cell undergoes mitosis. Mitosis consists of four stages (Figure 8.1) that result in the formation of two daughter cells with identical copies of the DNA. Following mitosis, the cytoplasm divides, separating the two daughter cells.

- **G2**
  - The chromosomes shorten and thinner, and protein synthesis is in high gear. In this stage, most of the protein synthesis needed for mitosis and the cell organizes and prepares for mitosis. In animals, the centrosome pair replicates and prepares to form the mitotic spindle.

### Cell Cycle

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<td>Begins with the G1 stage. At this point, the chromosomes are not visible under the light microscope because they are uncoiled. Protein synthesis is rapidly occurring at the cell grove and develops.</td>
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<tr>
<td>Mitosis</td>
<td>The chromosomes become tightly packed. Cytokinesis occurs as the cell divides, separating the two daughter cells.</td>
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<tr>
<td>G1</td>
<td>The cell has just completed mitosis. It is now ready to reenter the cell cycle. During this stage, the cell organizes and prepares for mitosis.</td>
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<tr>
<td>S</td>
<td>The chromosomes are formed, each containing a complete set of chromosomes. Interphase can be divided into three stages: G1, S, and G2.</td>
</tr>
<tr>
<td>G2</td>
<td>The chromosomes become more condensed and thicker. Protein synthesis is in high gear. In this stage, most of the protein synthesis needed for mitosis and the cell organizes and prepares for mitosis.</td>
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### Assessment

**Performance**

Have students write three questions related to this lab in their journals. Use the Performance Task Assessment List for Asking Questions in PASC, p. 19.

**Critical Thinking**

- Which part of the cell cycle is most variable in length?
- Why do you think the cycle of some types of cells is faster than others?
- How does the length of the cell cycle vary?

### Cultural Diversity

Jane Cooke Wright

Discus with students the role of African-American scientists Jane Cooke Wright in the development of chemotherapy techniques to treat cancer. Wright’s work in the 1950s and 1960s involved testing various anti-cancer drugs on people with different kinds of cancer. In the 1970s, Wright found that examinations of cancer cells grown in tissue culture could help predict which drugs would be most effective against that type of cancer. Since that time, Wright has been an active publisher of work in the field, and in 1975 she was honored by the American Association for Cancer Research for her contributions.

### Portfolio

#### Gifted

**Intrapersonal** Have the students hypothesize as to what might be happening to the nuclear envelope during mitosis. Have the students design an experiment that could test their hypotheses.

#### Meeting Individual Needs

**Intrapersonal** Have the students research the newest findings on what triggers the onset of mitosis and how microtubules are assembled and disassembled during spindle formation. Have students identify the cell cycle stages where the new finding is most likely to occur. Have students research the formation of cell walls after cell division in multicellular organisms. Have students research the newest findings on the role of microtubules in the coordination of cytokinesis in single-celled organisms.
The process of mitosis begins in interphase. The cell copies its chromosomes and the cell enters a new phase of mitosis as it divides. This phase is divided into three parts: prophase, metaphase, and telophase. During prophase, the chromosomes become visible and the nuclear envelope breaks down. In metaphase, the chromosomes line up at the center of the cell. Anaphase is the separation of the sister chromatids, which move to opposite ends of the cell. Finally, telophase is the formation of two new nuclei and the reappearance of the nuclear envelope.

H. The Imitation Game: A Busy Time

Interphase is the longest phase of the cell cycle and is divided into three parts: G1, S, and G2. During G1, the cell grows and checks if it is ready to divide. In S phase, the DNA is replicated. During G2, the cell prepares for cell division and checks if it is ready to divide.

I. The Phases of Mitosis

The process of mitosis is divided into four stages: prophase, metaphase, anaphase, and telophase. Each stage is characterized by specific events that occur in the cell. Prophase is the longest stage and is characterized by the condensation of chromosomes. In metaphase, the chromosomes are aligned at the cell center. Anaphase is characterized by the separation of sister chromatids, and in telophase, a new nuclear envelope forms around each set of chromosomes.

J. The Phases of the Cell Cycle

Cell division is a complex process that involves various phases. The cell cycle is divided into four stages: G1, S, G2, and M. G1 is the growth phase, S is the synthesis phase, G2 is the second growth phase, and M is the mitotic phase. Each phase is characterized by specific events that occur in the cell. The duration of each phase varies depending on the cell type and the organism.
Students often think that mitosis occurs in all cells of an organism throughout its life. Explain that in some tissues, once the cells are formed, no mitosis occurs. For example, once formed, nerve cells function throughout the life of the organism and do not undergo mitosis again. In plants, mitosis occurs only in the meristems and not throughout the entire plant.

**Enrichment**

Have students research recent discoveries on the structure of spindle fibers and on how movement occurs along these fibers. Have students report on their findings.

**Visual Learning**

Visual-Spatial: Encourage students to make models of the cell cycle. Have groups of students create a flow chart of the series of events that occur during the cell cycle. Have the students include their diagrams in their portfolios.

**Reinforcement**

Kinesthetic: Have groups of students make models of cells at various stages of cell division. Pipe cleaners or yarn pieces can represent chromosomes.

---

As prophase continues, the nucleus begins to disappear as the nuclear envelope and the nucleolus disintegrate. By late prophase, these structures are completely absent. In animal cells, two important pairs of structures, the centrioles, begin to migrate to opposite ends of the cell. Centrioles are small, dark, cylindrical structures that are made of microtubules and are located just outside the nucleus. Figure 8.13. Centrioles play a role in chromatic separation. As the pairs of centrioles move to opposite ends of the cell, another important structure, called the spindle, begins to form between them. The spindle is a football-shaped, cage-like structure consisting of thin fibers made of microtubules. In plant cells, the spindle is formed without centrioles. The spindle fibers play a vital role in the separation of sister chromatids during mitosis.

**Metaphase: the second stage of mitosis**

During metaphase, the short second phase of mitosis, the doubled chromosomes become attached to the spindle fibers by their centromeres. The chromosomes are pulled by the spindle fibers and begin to line up on the midline, or equator, of the spindle. Each sister chromatid is attached to its own spindle fiber. One sister chromatid’s spindle fiber extends to one pole, and the other extends to the opposite pole. This arrangement is important because it ensures that each new cell receives an identical and complete set of chromosomes.

**Anaphase: the third phase of mitosis**

The separation of sister chromatids marks the beginning of anaphase, the third phase of mitosis. During anaphase, the centromeres split apart and chromatid pairs from each chromosome separate from each other. The chromatids are pulled apart by the shortening of the microtubules in the spindle fibers.

**Telophase: the fourth phase of mitosis**

The final phase of mitosis is telophase. Telophase begins as the chromatids reach the opposite poles of the cell. During telophase, many of the changes that occurred during prophase are reversed as the new cells prepare for their own independent existence. The chromosomes, which had been tightly coiled since the end of prophase, now unwind so they can begin to direct the metabolic activities of the new cells. The nuclear envelope forms around each set of chromosomes. Finally, a new cytoplasmic membrane begins to form between the two new nuclei.

**Division of the cytoplasm**

Following telophase, the cell’s cytoplasm divides into a process called cytokinesis. Cytokinesis differs between plants and animals. Toward the end of telophase in animal cells, the plasma membrane pinches in along the equator, as shown in Figure 8.14. As the cell cycle proceeds, the two new nuclei are separated. Find out more about mitosis in animal cells in the MiniLab.

Plant cells have a rigid cell wall, so the plasma membrane does not pinch in. Rather, a structure known as the cell plate is laid down across the cell equator. A cell membrane forms around each cell, and new cell walls form on each side of the cell plate until separation is complete.

---

**Reinforcement**

Students often think that mitosis occurs in all cells of an organism throughout its life. Explain that in some tissues, once the cells are formed, no mitosis occurs. For example, once formed, nerve cells function throughout the life of the organism and do not undergo mitosis again. In plants, mitosis occurs only in the meristems and not throughout the entire plant.

**Enrichment**

Have students research recent discoveries on the structure of spindle fibers and on how movement occurs along these fibers. Have students report on their findings.

**Visual Learning**

Visual-Spatial: Encourage students to make models of the cell cycle. Have groups of students create a flow chart of the series of events that occur during the cell cycle. Have the students include their diagrams in their portfolios.

---

**Reinforcement**

Kinesthetic: Have groups of students make models of cells at various stages of cell division. Pipe cleaners or yarn pieces can represent chromosomes.

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3 Assess
Check for Understanding
-'Test the students’ ability to recognize the various phases of mitosis. Place photomicrographs on an overhead projector and ask the class to identify each stage. L6

Retake Visual-Spatial
Review the phases of mitosis, emphasizing that the process is continuous and that one phase blends into the next. Use photomicrographs and diagrams to help students identify the phases and learn the terms associated with the structures in mitosis. L6 L7

Extension
Encourage students to research the stages of the cell cycle. They may find information on how long each stage lasts for various species and what events occur at each stage. L6

Assessment
Performance Call out various stages of mitosis and have students find and show that stage to their lab partners using onion root tips under the microscope. Walk around the room to check their results. L6

4 Close
Activity
Visual-Spatial Prepare a worksheet with drawings of various stages of mitosis. Ask students to draw the next stage for each. L6 L7 L8

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Section 8.3
Control of the Cell Cycle

A ccurate cell division and regulation of the cell cycle is critical to the health of an organism. Some cells, such as the cells lining the intestine, complete the cell cycle in 24 to 48 hours. Other cells, such as the cells in a frog embryo, complete the cell cycle in less than an hour. Some cells, such as nerve cells, never divide once they mature. Despite this diversity, the factors that control the cell cycle are generally similar. A mistake in the cell cycle can lead to cancer.

Normal Control of the Cell Cycle
For more than a quarter of a century, scientists have worked long and hard to discover the factors that initiate and control cell division. A clear understanding of these control factors can, among others, benefit medical research. Today, the full story is still not known; however, scientists do have some knowledge of enzymes that control the cell cycle.

Enzymes control the cell cycle
Most biologists agree that a series of enzymes monitors a cell’s progress from phase to phase during the cell cycle. Certain enzymes are necessary to begin and drive the cell cycle, whereas other enzymes control the cycle through its phases. Occasionally, cells lose control of the cell cycle. This uncontrolled division of cells can result from the failure to produce certain enzymes, the overproduction of other enzymes, or the production of other enzymes at the wrong time. Cancer is one result of uncontrolled cell division. This loss of control may be caused by environmental factors or by changes in enzyme production.

Enzyme production is directed by genes located on the chromosomes. A gene is a segment of DNA that controls the production of a protein.

Section Focus Transparency 20 and Master L6 L7

1 Focus
Bellringer
Before presenting the lesson, display Section Focus Transparency 20 on the overhead projector and have students answer the accompanying questions. L6 L7 L8

Resource Manager
Determine the students’ awareness of the causes of cancer and discuss with the class what each student can do to lead a healthy lifestyle.
Thinking Critically

1. basal cell and squamous, skin melanoma
2. lung, basal cell and squamous
3. Student answers may vary: use of sunscreen parlors and overexposure to sun are common answers.
4. Calculation: deaths – new cases = survivors. So (140 000 - 180 000) / 100 = 78%.
5. How can disruption of the cell cycle result in cancer?
6. Observing and Inferring. Although breast cancer is more prevalent than lung cancer, more deaths are caused by lung cancer than breast cancer. Using your knowledge of how cancer spreads and factors that influence cancer, provide an explanation for this difference. For more help, refer to Thinking Critically in the Skill Handbook.

3. Assess

Check for Understanding

Have students compare a normal and a cancer cell cycle.

Reteach

Write the following cell reproduction times (in minutes) on the board. Normal chicken stomach cells: interphase 120, prophase 60, metaphase 10, anaphase 3, telophase 12. Cancerous chicken stomach cells: interphase 16, prophase 15, metaphase 2, anaphase 1, telophase 1. Ask students to suggest possible reasons why they are different.

Assessment

Skill Ask students to sequence the events that regulate the cell cycle and describe how these events change in the growth of cancer cells.

4. Close

Activity

Intrapersonal Ask students to find out what types of cancer can affect a particular organ and what treatments are available.

Resources

Reinforcement and Study Guides, p. 36
Critical Thinking/Problem Solving, p. 8

Portfolio

Have students gather information on a specific type of cancer and prepare a brief oral report. Students should be encouraged to find information on the Internet. Use the Performance Task Assessment List for Oral Presentation in PASC, p. 71.
Where is mitosis most common? 

Mitosis and the resulting multiplication of cells are responsible for the growth of an organism. Does mitosis occur in all areas of an organism at the same rate, or are there certain areas within an organism where mitosis occurs more often? You will answer this question in this BioLab. Your organism will be an onion, and the areas you are going to investigate will be different locations in its root.

Data and Observations
Student data will vary but the following sample data can be used as a guide: Mitosis should be observed in cells in area X but not in area Y.

### Data Table

<table>
<thead>
<tr>
<th>Phase</th>
<th>Area X</th>
<th>Area Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interphase</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Prophase</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Metaphase</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Anaphase</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Telophase</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: It will be easier to count and keep track of cells by following rows. See Diagram A as a guide to counting.

1. Observing Which area of the onion root tip (X or Y) had the greatest number of cells undergoing mitosis? The fewest? Use specific totals from your data table to support your answer.

2. Predicting If mitosis is associated with rapid growth, where do you believe is the location of most rapid root growth, area X or Y? Explain your answer.

3. Applying Where might you look for cells in the human body that are undergoing mitosis? List common examples.

4. Calculating According to your data, which phase of mitosis is most common? Least common?

5. Thinking Critically Assume that you were not able to observe cells in every phase of mitosis! Explain why this might be.

6. Using Diagram A as a guide:
   - Identify those cells that are in mitosis and in interphase.
   - Record in the data table the number of cells observed in each phase of mitosis and interphase for area X.

7. Switch to high power.

8. Switch to high power.

9. Using Diagram B as a guide:
   - Identify those cells that are in mitosis and in interphase.
   - Record in the data table the number of cells observed in each phase of mitosis and interphase for area Y.

### Preparation

- Obtain prepared slides of Allium (onion) root tip from a biological supply house.

### PROCEDURE

1. Copy the data table.
2. Using Diagram A as a guide, locate area X on a prepared slide of onion root tip.
3. Place the prepared slide under your microscope and use low power to locate area X. CAUTION: Use care when handling prepared slides.
4. Switch to high power.
5. Using Diagram B as a guide:
   - Identify those cells that are in mitosis and in interphase.
   - Record in the data table the number of cells observed in each phase of mitosis and interphase for area X.

### Analysis and Conclude

1. X; Y; student totals will vary to support the conclusions.
2. X; this was the area showing cells undergoing mitosis at the highest rate.
3. An area of rapid growth such as skin, hair follicles, intestine lining.
4. prophase (150), anaphase (2). The appearance of few cells in metaphase, anaphase and telophase may be the result of the speed at which these phases occur.
5. Answers may vary—the phase has already occurred, the phase has not yet occurred, area of view is not rapidly growing, incorrect observation or recording stage.

### Assessment

Knowledge Ask students to explain the steps that could be taken to make the gathering of data more accurate. Use the Performance Task Assessment List for Designing an Experiment in PASC, p. 23.

Kinesthetic Have students prepare their own slides of onion mitosis. Kits that provide the onion tips, stain, and directions are available through biological supply houses. (See Carolina Biological Supply catalog #08-11-113.)
Skin cancer accounts for one-third of all malignancies diagnosed in the United States, and the incidence of skin cancer is increasing. Most cases are caused by exposure to harmful ultraviolet rays emitted by the sun, so skin cancer must often develop on the exposed face or neck. The people most likely at risk are those whose fair skin contains smaller amounts of a protective pigment called melanin. 

Skin is composed of two layers of tissue, the epidermis and the dermis. The epidermis is the part that we see on the surface of our bodies and is composed of multiple layers of closely packed cells. As the cells reach the surface, they die and become flattened. Eventually they flake away. To replace the loss, cells on the innermost layer of the epidermis are constantly dividing. Your body has a natural protection system to shield cells from potentially harmful rays of the sun. A pigment called melanin is produced by cells called melanocytes and absorbs the UV rays before they reach basal cells.

Types of skin cancer
Uncontrolled division of epidermal cells leads to skin cancer. Squamous cell carcinoma is a common type of skin cancer that affects cells throughout the epidermis. Squamous cell cancer takes the form of red or pink tumors that can grow rapidly and spread. Precancerous growths produced by sun-damaged basal cells can become basal cell carcinoma, another common type of skin cancer. In basal cell carcinoma, the cancerous cells are from the layer of the epidermis that replenishes the shed epithelial cells. Both squamous cell carcinoma and basal cell carcinoma are usually detected when they are small and can be easily removed in a doctor’s office. Both types also respond to treatment such as surgery, chemotherapy, and radiation therapy.

The most lethal skin cancer is malignant melanoma. Melanomas are cancerous growths of the melanocytes that normally protect other cells in the epithelium from the harmful rays of the sun. An important indication of a melanoma can be a change in color of an area of skin to a variety of colors including black, brown, red, dark blue, or gray. A single melanoma can have several colors within the tumor. Melanomas can also form at the site of moles. Melanomas can be dangerous because cancerous cells from the tumor can travel to other areas of the body before the melanoma is detected. Early detection is essential, and melanomas can be surgically removed.

**Connection to Biology**

Scientists know that the UV rays of sunlight can contribute to skin cancer. How can you minimize the risk?

To find out more about skin cancer, visit the Glencoe Science Web Site. www.glencoe.com/sec/science

Chapter 8 Assessment

**Section 8.1**

**Main Ideas**
- Osmosis is the diffusion of water through a selectively permeable membrane.
- Passive transport moves a substance with the concentration gradient and requires no energy from the cell.
- Active transport moves materials against the concentration gradient and requires energy to overcome the osmotic flow of materials with the concentration gradient.
- Large particles may enter a cell by endocytosis and leave by exocytosis.

**Vocabulary**
- active transport (p. 220)
- endocytosis (p. 206)
- facilitated diffusion (p. 220)
- exocytosis (p. 206)
- hypotonic solution (p. 202)
- hypertonic solution (p. 202)
- osmosis (p. 201)
- passive transport (p. 224)

**Section 8.2**

**Main Ideas**
- Cell size is limited largely by the diffusion rate of materials into and out of the cell, the amount of DNA available to program the cell’s metabolism, and the cell’s surface area-to-volume ratio.
- The life cycle of a cell is divided into two general periods: a period of active growth and metabolism known as interphase, and a period of cell division known as mitosis.
- Mitosis is divided into four phases: prophase, metaphase, anaphase, and telophase.
- The cells of most multicellular organisms are organized into tissues, organs, and organ systems.

**Vocabulary**
- anaphase (p. 210)
- cell cycle (p. 210)
- centromere (p. 212)
- chromatid (p. 210)
- chromosome (p. 208)
- cytokinesis (p. 210)
- interphase (p. 210)
- metaphase (p. 214)
- mitosis (p. 216)
- organelle (p. 215)
- organelle system (p. 216)
- prophase (p. 210)
- telophase (p. 216)

**Section 8.3**

**Main Ideas**
- The cell cycle is controlled by key enzymes that are produced at specific points in the cell cycle.
- Cancer is caused by genetic and environmental factors that change the genes that control the cell cycle.
- For some types of cancer, research has shown that lifestyle choices like eating a healthy diet and exercising regularly can reduce the incidence of cancer.

**Vocabulary**
- cancer (p. 217)
- gene (p. 217)

**Internet Address Book**

Note Internet addresses that you find useful in the space below for quick reference.

www.glencoe.com/sec/science
1. What kind of environment is described when the concentration of dissolved substances is greater outside the cell than inside? 
   a. hypotonic 
   b. hypertonic 
   c. isotonic 
   d. saline
2. Osmosis is defined as: 
   a. as an active process 
   b. as a diffusion of water through a selectively permeable membrane 
   c. as an example of facilitated diffusion 
   d. as requiring a transport protein 
3. An amoeba ingests large food particles by: 
   a. endocytosis 
   b. exocytosis 
   c. exonucleolysis 
   d. endosome
4. Considering the area-to-volume ratio, what structure does surface area represent? 
   a. cytoplasm 
   b. cytoplasmic RNA 
   c. centrioles 
   d. DNA
5. Chromosomes are made of: 
   a. cytoplasm 
   b. centriole 
   c. DNA 
   d. RNA
6. Which of the following does NOT occur during interphase? 
   a. excretion of wastes 
   b. protein synthesis 
   c. cell repair 
   d. nuclear division
7. If a cell that has eight chromosomes goes through mitosis, how many chromosomes will the daughter cells have? 
   a. 8 
   b. 16 
   c. 15 and 13 
   d. 32
8. During metaphase, the chromosomes move to the equator of what structure (shown here)? 
   a. poles 
   b. cell plate 
   c. centriole 
   d. spindle
9. All but which of the following factors limit cell size? 
   a. time required for diffusion 
   b. elasticity of the plasma membrane 
   c. presence of only one nucleus 
   d. surface area-to-volume ratio
10. Which of the following is NOT a known cause of cancer? 
    a. environmental influences 
    b. certain viruses 
    c. cigarette smoke 
    d. bacterial infections
11. Transcription requires energy. 
   a. ATP transport requires energy. 
   b. ATP is present only in the cytoplasm 
   c. ATP is present only in the mitochondria 
   d. ATP is present only in the plasma membrane
12. A red blood cell placed in a 3% salt solution will: 
   a. shrink 
   b. remain the same size 
   c. swell 
   d. burst
13. Sprinkling sugar on a bowl of strawberries creates a _______ solution surrounding the strawberries. 
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   d. isotonic
14. Grocers spray water on produce to increase the _______ inside the cells. 
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20. Which of the following is a segment of DNA that controls the production of a protein? 
   a. centriole 
   b. gene 
   c. chromosome 
   d. centriole
21. How would you expect the number of mitochondria in a cell to be related to the amount of active transport it carries out? 
22. Explain why drinking quantities of ocean water is dangerous to humans. (Hint: The body excretes salt as a water solution.) 
23. Suppose that all of the enzymes that control the normal cell cycle were identified. Suggest some ways that this information might be used to fight cancer.

Chapter 8 Assessment
ASSURING MAIN IDEAS
UNDERSTANDING MAIN IDEAS
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   c. presence of only one nucleus 
   d. surface area-to-volume ratio
20. Which of the following is a segment of DNA that controls the production of a protein? 
   a. centriole 
   b. gene 
   c. chromosome 
   d. centriole

Chapter 8 Assessment
APPLYING MAIN IDEAS
21. Cells that carry on a great deal of active transport would have more mitochondria to supply the necessary amounts of energy. 
22. In order to excrete the excess salt, the body excretes more water than it takes in. 
23. By being able to control the enzymes, scientists may be able to modify the rapid cell division in cancer cells.

Chapter 8 Assessment
THINKING CRITICALLY
24. The amoeba, being in a hyper-tonic solution, would probably die because water diffuses out. 
25. Cells divide to maintain optimum size and surface-area-to-volume ratios so that the cell can receive all of the nutrients it needs and excrete wastes sufficiently.

Chapter 8 Assessment
ASSESSING KNOWLEDGE & SKILLS
1. c 
2. b 
3. d 
4. There is no relationship between the number of chromosomes in body cells and the complexity of an organism.

Chapter 8 Assessment
Table 8.1 Chromosome comparison of four organisms
<table>
<thead>
<tr>
<th>Organism</th>
<th>Human</th>
<th>Rye</th>
<th>Potato</th>
<th>Pig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of chromosomes in body cells</td>
<td>46</td>
<td>14</td>
<td>48</td>
<td>64</td>
</tr>
<tr>
<td>Number of chromosomes in daughter cells</td>
<td>46</td>
<td>14</td>
<td>48</td>
<td>64</td>
</tr>
</tbody>
</table>

Chapter 8 Assessment
Interpreting Data
Examine the table then answer the following questions.
1. During late interphase, the chromosomes double to form chromatids that are attached to each other. During which phase do the chromatids separate? 
   a. prophase 
   b. anaphase 
   c. metaphase 
   d. telophase
2. What number belongs in the space labeled A under Rye in the table? 
   a. 14 
   b. 28 
   c. 7 
   d. 21
3. If one pair of chromatids failed to separate during mitosis in eye cells, how many chromosomes would end up in the daughter cells? 
   a. 28 and 28 
   b. 14 and 14 
   c. 7 and 8 
   d. 15 and 13
4. Thinking Critically
   Using the information presented in the table, explain how the number of chromosomes in body cells is related to the complexity of an organism.