Chapter 8 Organizer

Cellular Transport and the Cell Cycle

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

Section	Objectives	Activities/Features
Section 8.1 **Cellular Transport** National Science Education Standards UCP.1-3, UCP.5; A.1, A.2; B.6; C.1, C.5 (2 session, 1 block)	1. **Explain** how the processes of diffusion, passive transport, and active transport occur and why they are important to cells. 2. **Predict** the effect of a hypotonic, hypertonic, or isotonic solution on a cell.	**MiniLab 8-1:** Cell Membrane Simulation, p. 204
Section 8.2 **Cell Growth and Reproduction** National Science Education Standards UCP.1-3, UCP.5; A.1, A.2; C.1, C.5; G.1-3 (2 sessions, 2 blocks)	3. **Sequence** the events of the cell cycle. 4. **Relate** the function of a cell to its organization as a tissue, organ, and an organ system.	**Problem-Solving Lab 8-1,** p. 209 **Problem-Solving Lab 8-2,** p. 210 **Inside Story:** The Cell Cycle, p. 211 **MiniLab 8-2:** Seeing Asters, p. 215 **Investigate BioLab:** Where is mitosis most common? p. 220
Section 8.3 **Control of the Cell Cycle** National Science Education Standards UCP.1, UCP.2; A.1, A.2; C.1, C.6; E.1, E.2; F.1, F.4, F.5, F.6; G.1, G.2 (2 sessions, ½ block)	5. **Describe** the role of enzymes in the regulation of the cell cycle. 6. **Distinguish** between the events of a normal cell cycle and the abnormal events that result in cancer. 7. **Identify** ways to potentially reduce the risk of cancer	**Problem-Solving Lab 8-3,** p. 218 **Health Connection:** Skin Cancer, p. 222

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 8.1 **Cellular Transport**	Reinforcement and Study Guide, p. 33 L2 Concept Mapping, p. 8 L3 ELL BioLab and MiniLab Worksheets, p. 35 L2 Laboratory Manual, pp. 55-56 L2 Content Mastery, pp. 37-38, 40 L1	Section Focus Transparency 18 L1 ELL Basic Concepts Transparency 8 L2 ELL Basic Concepts Transparency 9 L2 ELL Reteaching Skills Transparency 11 L1 ELL Reteaching Skills Transparency 12 L1 ELL
Section 8.2 **Cell Growth and Reproduction**	Reinforcement and Study Guide, pp. 34-35 L2 BioLab and MiniLab Worksheets, p. 36 L2 Laboratory Manual, pp. 57-60 L2 Content Mastery, pp. 37, 39-40 L1	Section Focus Transparency 19 L1 ELL Basic Concepts Transparency 10 L2 ELL Reteaching Skills Transparency 13 L1 ELL
Section 8.3 **Control of the Cell Cycle**	Reinforcement and Study Guide, p. 36 L2 Critical Thinking/Problem Solving, p. 8 L3 BioLab and MiniLab Worksheets, pp. 37-38 L2 Content Mastery, pp. 37, 39-40 L1	Section Focus Transparency 20 L1 ELL

Assessment Resources

Chapter Assessment, pp. 43-48
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 8 quiz

Additional Resources

Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

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

MATERIALS LIST

BioLab
p. 220 microscope, prepared slide of onion root tip

MiniLabs
p. 204 small beaker, starch solution, iodine solution, small plastic bag, twist tie
p. 215 microscope, prepared slide of "fish mitosis"

Alternative Lab
p. 202 potato, 100-mL beakers (2), table salt, water, graduated cylinder, labels, pen, stirring rod, balance, plastic wrap or aluminum foil, knife

Quick Demos
p. 202 microprojector, microscope slide, coverslip, India ink, water
p. 208 lamp cord, string, rubber band

Key to Teaching Strategies

- L1 Level 1 activities should be appropriate for students with learning difficulties.
- L2 Level 2 activities should be within the ability range of all students.
- L3 Level 3 activities are designed for above-average students.
- ELL ELL activities should be within the ability range of English Language Learners.
- COOP LEARN Cooperative Learning activities are designed for small group work.
- P These strategies represent student products that can be placed into a best-work portfolio.
- These strategies are useful in a block scheduling format.

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe
To order the following products, call Glencoe at 1-800-334-7344:
CD-ROM
NGS PictureShow: The Cell
Curriculum Kit
GeoKit: Cells and Microorganisms
Transparency Set
NGS PicturePack: The Cell

Products Available From National Geographic Society
To order the following products, call National Geographic Society at 1-800-368-2728:
Video
Discovering the Cell

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life
CD-ROM ELL
Animation: *The Cell Cycle*
Exploration: *Phases of Mitosis*
Videodisc Program
Passive Transport
Active Transport
The Cell Cycle

The Infinite Voyage
The Living Clock

The Secret of Life Series
Osmosis Demonstration

Getting Started Demo

Kinesthetic Have students observe the effect of osmosis on a raisin by placing raisins in warm water for several minutes. After removing the raisins from the water, they should observe the raisins and explain how osmosis may have caused the changes in appearance. L1 ELL

Theme Development

A major theme of the chapter is **homeostasis** as it relates to the function of the plasma membrane in regulating cellular transport and as a critical factor in successful cellular reproduction.

Another theme of the chapter is **unity within diversity.** This theme is evident as the striking similarities of the process of mitosis in cells of both plants and animals are presented.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

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

Note the crispness of a fresh piece of lettuce. Now place the lettuce in a salty solution, then in distilled water. *How is the crispness of the lettuce different in each solution? What do you think happened?*

internet CONNECTION To find out more about cellular transport and the cell cycle, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Magnification: 14 000×

Magnification: 36 000×

Cells divide in plant root tips (above) in normal growth. Some cells are cancerous (inset) and divide indefinitely.

Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Enrichment, pp. 205, 212; Meeting Individual Needs, p. 208; Portfolio, p. 209; Reinforcement, p. 214; Going Further, p. 221

Visual-Spatial Meeting Individual Needs, p. 204; Biology Journal, p. 205; Visual Learning, p. 214; Reteach, pp. 206, 216; Activity, p. 216

Interpersonal Tech Prep, p. 213

Intrapersonal Portfolio, p. 211; Meeting Individual Needs, p. 211; Extension, p. 219; Activity, p. 219

Linguistic Tech Prep, p. 203; Biology Journal, pp. 207, 217; Discussion, p. 213

Logical-Mathematical Discussion, p. 206; Portfolio, p. 212

Section 8.1

Prepare

Key Concepts

Students will recognize how the structure of the plasma membrane permits diffusion, passive transport, and active transport. They will develop an understanding of the importance of these processes in maintaining homeostasis and proper cell function.

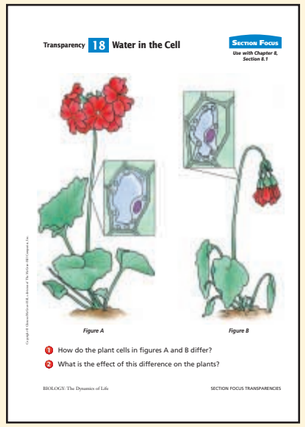
Planning

- Obtain India ink for the Quick Demo.
- Obtain celery sticks for the Reteach.
- Purchase raisins for the Getting Started Demo.
- Collect potato and measuring spoons for the Alternative Lab.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 18** on the overhead projector and have students answer the accompanying questions. L1 ELL



Section 8.1

Cellular Transport

SECTION PREVIEW

Objectives

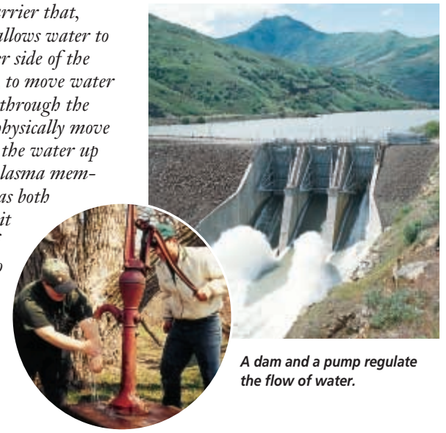
Explain how the processes of diffusion, passive transport, and active transport occur and why they are important to cells.

Predict the effect of a hypotonic, hypertonic, or isotonic solution on a cell.

Vocabulary

osmosis
isotonic solution
hypotonic solution
hypertonic solution
passive transport
facilitated diffusion
active transport
endocytosis
exocytosis

This dam is a barrier that, when opened, allows water to pass to the other side of the floodgates. In contrast, to move water from the well and out through the pump, someone must physically move the handle that draws the water up against gravity. The plasma membrane of a cell can act as both a dam and a pump as it regulates the traffic of ions and molecules into and out of the cell.



A dam and a pump regulate the flow of water.

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** (ahs 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

Word Origin

osmosis
From the Greek word *osmos*, meaning "pushing." Osmosis can push out a cell's plasma membrane.

Assessment Planner

Portfolio Assessment
- **Alternative Lab, TWE,** p. 203
- **Assessment, TWE,** p. 208
- **MiniLab, TWE,** p. 215
- **Problem-Solving Lab, TWE,** p. 218

Performance Assessment
- **Alternative Lab, TWE,** p. 203
- **MiniLab, SE,** pp. 204, 215
- **Problem-Solving Lab, TWE,** pp. 209, 210
- **Assessment, TWE,** p. 216
- **BioLab, SE,** p. 221

Knowledge Assessment
- **Assessment,** pp. 202, 206, 217
- **BioLab, TWE,** p. 221
- **Section Assessment, SE,** pp. 206, 216, 219
- **Chapter Assessment, SE,** pp. 223-225

Skill Assessment
- **MiniLab, TWE,** p. 204
- **Assessment, TWE,** p. 219

2 Teach

Assessment

Knowledge The kinetic theory of matter explains the transport of molecules from one place to another. Elicit what the major differences, at the molecular level, are among a solid, a liquid, and a gas. Students should recognize that the freedom of random particle movement is the only difference. L2

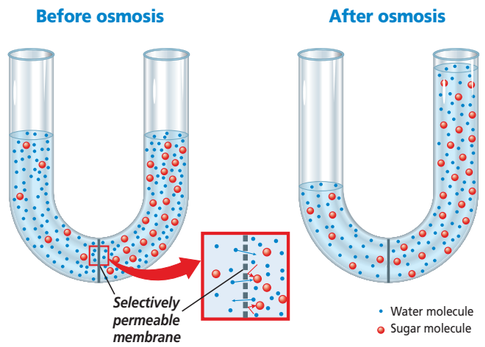
Quick Demo

Demonstrate Brownian movement using a microprojector and a very dilute solution of India ink. The effects of collisions of water and ink molecules (jiggling) can be seen when you place a wet mount over a light bulb and quickly refocus the slide. Students should be able to see increased kinetic energy with increased temperature.

Resource Manager

Section Focus Transparency 18 and Master L1 ELL
Tech Prep Applications, pp. 13-14 L2
Basic Concepts Transparency 8 and Master L2 ELL
Laboratory Manual, pp. 55-56 L2

Figure 8.1
During osmosis, water diffuses across a selectively permeable membrane. Notice that the number of sugar molecules did not change on each side of the membrane, but the number of water molecules did change.



it, as shown in ***Figure 8.1,*** water flows to the side of the membrane where the water concentration is lower. The water continues to diffuse until it is in equal concentration on both sides of the membrane. Therefore, we know that unequal distribution of particles, called a concentration gradient, is one factor that controls osmosis.

With your knowledge of osmosis, it is important to understand how osmosis affects cells.

Cells in an isotonic solution

Most cells, whether in multicellular or unicellular organisms, are subject to osmosis because they are surrounded by water solutions. In an **isotonic solution,** the concentration of dissolved substances in the solution is the same as the concentration of dissolved substances inside the cell. Likewise, the concentration of water in the solution is the same as the concentration of water inside the cell.

Cells in an isotonic solution do not experience osmosis and they retain their normal shape, as shown in ***Figure 8.2.*** Most solutions, including the immunizations your doctor gives, are isotonic so that cells are not damaged by the loss or gain of water.

Cells in a hypotonic solution

In a **hypotonic solution,** the concentration of dissolved substances is lower in the solution outside the cell than the concentration inside the cell. Therefore, there is more water outside the cell than inside. Cells in a hypotonic solution experience osmosis that causes water to move through the plasma membrane into the cell. With osmosis, the cell swells and its internal pressure increases.

As the pressure increases inside animal cells, the plasma membrane swells, like the red blood cells shown in ***Figure 8.3.*** If the solution is extremely hypotonic, such as distilled water, the plasma membrane may be unable to withstand this pressure and may burst.

Because plant cells contain a rigid cell wall that supports the cell, they do not burst when in a hypotonic solution. As the pressure increases inside the cell, the plasma membrane is pressed against the cell wall. Instead of bursting, the plant cell becomes more firm. Grocers use this reaction to keep produce looking fresh by misting the fruits and vegetables with water.

Figure 8.2
In an isotonic solution, water molecules move into and out of the cell at the same rate, and cells retain their normal shape (a). Notice the concave disc shape of a red blood cell (b). A plant cell has its normal shape and pressure in an isotonic solution (c).

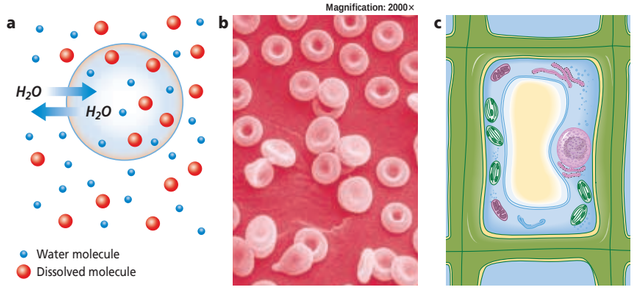
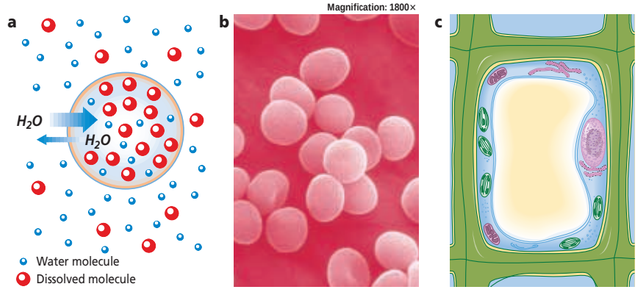


Figure 8.3
In a hypotonic solution, water enters a cell by osmosis, causing the cell to swell (a). Animal cells, like these red blood cells, may continue to swell until they burst (b). Plant cells swell beyond their normal size as pressure increases (c).



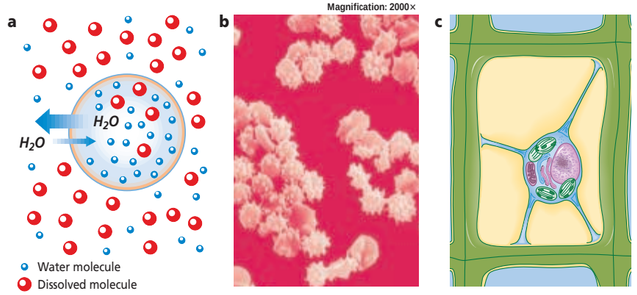
Cells in a hypertonic solution

In a **hypertonic solution,** the concentration of dissolved substances outside the cell is higher than the concentration inside the cell. Cells in a hypertonic solution experience osmosis that causes water to flow out.

Animal cells in a hypertonic solution shrivel because of decreased pressure in the cells, as indicated in ***Figure 8.4.*** This explains why you should not salt meat before cooking. The salt forms a hypertonic solution on the meat's surface. Water inside the meat cells diffuses out, leaving the cooked meat dry and tough.

Plant cells in a hypertonic environment lose water, mainly from the central vacuole. The plasma membrane and cytoplasm shrink away from the cell wall, as shown in ***Figure 8.4.*** Loss of water in a plant cell results in a drop in pressure and explains why plants wilt.

Figure 8.4
In a hypertonic solution, water leaves a cell by osmosis, causing the cell to shrink (a). Animal cells like these red blood cells shrivel up as they lose water (b). Plant cells lose pressure as the plasma membrane shrinks away from the cell wall (c).



WORD Origin
iso-, hypo-, hyper-
From the Greek words *isos,* meaning "equal," *hypo,* meaning "under," and *hyper,* meaning "over," respectively.

TechPrep

Food Preservation

Linguistic People in early agricultural societies observed that dried or salted meats resisted spoilage. Adding sufficient amounts of sugar inhibits growth in foods such as sugar-cured hams, jams, and jellies. This is because drying food or adding salt or sugar lowers the available moisture, preventing spoilage caused by bacterial growth. Have students research some food preparation processes and write a "recipe" for preserving and storing one food item, then compile a class cookbook of all the recipes. L3

Concept Development

Explain to students that *net movement* is the overall movement of a material and not the specific movement of each particle.

GLENCOE TECHNOLOGY

VIDEODISC
The Secret of Life
Osmosis Demonstration

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. Record the texture of the potato cubes before soaking (hard or soft).
5. Cover the beakers with plastic wrap or aluminum foil and allow them to sit undisturbed for two days.
6. 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 left the potato by osmosis because of the high salt content of the water outside the potato.*

Assessment

Portfolio Have students prepare a written laboratory report containing a data table and the answers to the analysis questions. Use the Performance Task Assessment List for Lab Report in **PASC,** p. 47. L2 P

MiniLab 8-1

Purpose
Students will determine if a plastic membrane is selectively permeable.

Process Skills
formulate models, draw conclusions, observe and infer, recognize cause and effect

Safety Precautions
Have students wear gloves, aprons, and goggles. Remind students to rinse immediately if iodine gets on skin or clothing. If iodine gets in eyes, rinse thoroughly at the eyewash station.

Teaching Strategies
- Allow students to work in teams of two or three.
- See p. 40T of the Teacher Guide for preparation of starch and iodine solutions. Lightweight, inexpensive bags work best for this lab.

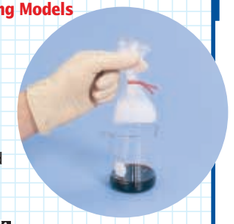
Expected Results
The inside of the bag will be purple indicating passage of iodine into the bag. The outside of the bag will be rust color, indicating starch did not pass out of the bag.

Analysis
1. Start—starch was clear, iodine was rust; end—starch was purple, iodine was rust.
2. **a.** Iodine moved into the bag as shown by the purple color. **b.** Starch did not move out of bag as shown by no color change outside of the bag.
3. The plastic membrane let iodine pass into the bag but blocked starch from passing out.

Assessment
Skill Ask students to make a diagram depicting pore size of the plastic membrane in relation to molecule size of iodine and starch. Use the Performance Task Assessment List for Scientific Drawing in **PASC,** p. 55. L2

MiniLab 8-1 Formulating Models

Cell Membrane Simulation If membranes show selective permeability, what might happen if a plastic bag (representing a cell's membrane) were filled with starch molecules on the inside and surrounded by iodine molecules on the outside?



Selective permeability

Procedure
1. Fill a plastic bag with 50 mL of starch. Seal the bag with a twist tie.
2. Fill a beaker with 50 mL of iodine solution. **CAUTION:** ***Rinse with water if iodine gets on skin. Iodine is toxic.***
3. Note and record the color of the starch and iodine.
4. Place the bag into the beaker. **CAUTION:** ***Wash your hands after handling lab materials.***
5. Note and record the color of the starch and iodine 24 hours later.

Analysis
1. Describe and compare the color of the iodine and starch at the start and at the conclusion of the experiment.
2. Fact: 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 can still occur by other mechanisms as long as the substance is moving with the concentration gradient.

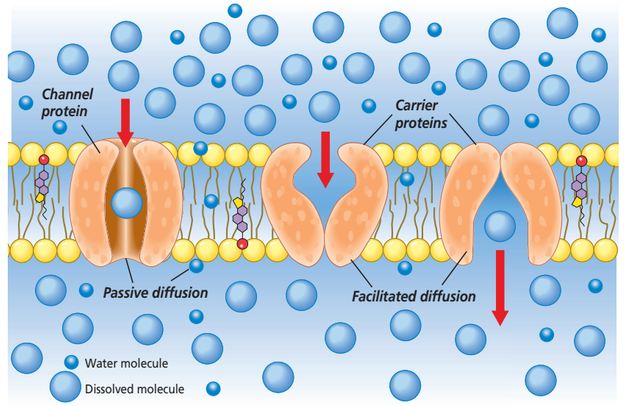
You can investigate passive transport by performing the *MiniLab* shown here.

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.

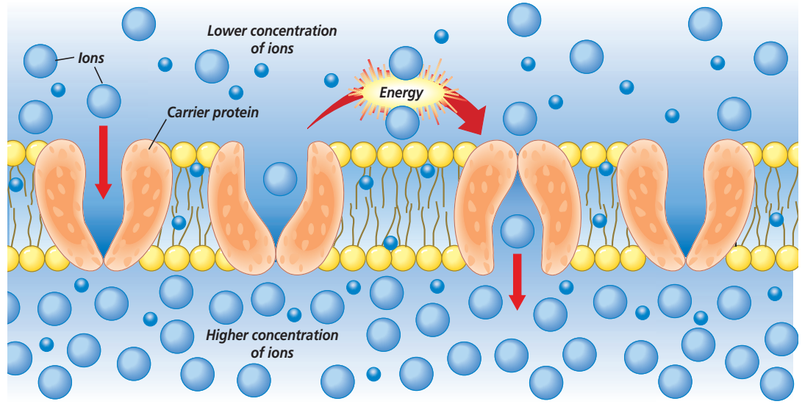
The passive transport of materials across the plasma membrane with the aid of transport proteins is called **facilitated diffusion.** As illustrated in ***Figure 8.5,*** the transport proteins provide convenient openings for particles to pass through. Facilitated diffusion is a common method of moving of 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.

Figure 8.5
Channel proteins provide the openings through which small, dissolved particles, especially ions, diffuse by passive transport.



CD-ROM
View an animation of passive transport in the Presentation Builder of the Interactive CD-ROM.

Figure 8.6
Carrier proteins are used in active transport to pick up ions or molecules from near the cell membrane, carry them across the membrane, and release them on the other side. Active transport requires energy.



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

CD-ROM
View an animation of active transport in the Presentation Builder of the Interactive CD-ROM.

Enrichment

Kinesthetic Channel proteins are often called ion channels. Ion channels have "gates" that open briefly in response to certain conditions such as mechanical stimulation. Using this information, help students create a model describing the gate analogy and demonstrate the transport of channel proteins. L3

3 Assess

Check for Understanding

Evaluate students' understanding of the following terms: passive transport, active transport, diffusion, facilitated diffusion, isotonic, hypotonic, and hypertonic. Have students predict the direction of movement between cells and solutions. L2

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Passive Transport (Ch. 24)
Disc 1, Side 1, 28 sec.
Active Transport (Ch. 25)
Disc 1, Side 1, 15 sec.

Resource Manager
BioLab and MiniLab Worksheets, p. 35 L2
Concept Mapping, p. 8 L3 ELL
Basic Concepts Transparency 9 and Master L2 ELL

Meeting Individual Needs

Learning Disabled

Visual-Spatial Using colored chalk, draw a U-tube on the chalkboard similar to the "before osmosis" diagram in Figure 8.1. Draw molecules in at least two colors, showing one that cannot cross the selectively permeable membrane. Have students make a similar diagram using colored pencils. Challenge students to diagram the "after osmosis" stage. Walk around the room, checking to see if students understand the concept of osmosis as they draw. Help students as needed. L1 ELL

Biology Journal

Comparing Modes of Transport

Visual-Spatial Have students create a table that lists and compares the modes of passive transport with those of active transport. Students should identify the kinds of materials transported by each mode. *For passive transport, tables should include diffusion through a bilayer (osmosis and diffusion of small molecules) and facilitated diffusion (channel transport proteins and carrier proteins). Active transport modes should include transport proteins, endocytosis, and exocytosis.* L2

Reteach

Visual-Spatial Place several celery sticks in salt water and several in tap water. Ask students to describe any changes they observe in the celery. L1 ELL

Assessment

Knowledge Place a recipe for making pickles on an overhead. Ask students to explain in their journals the role of osmosis in making pickles. L2

4 Close

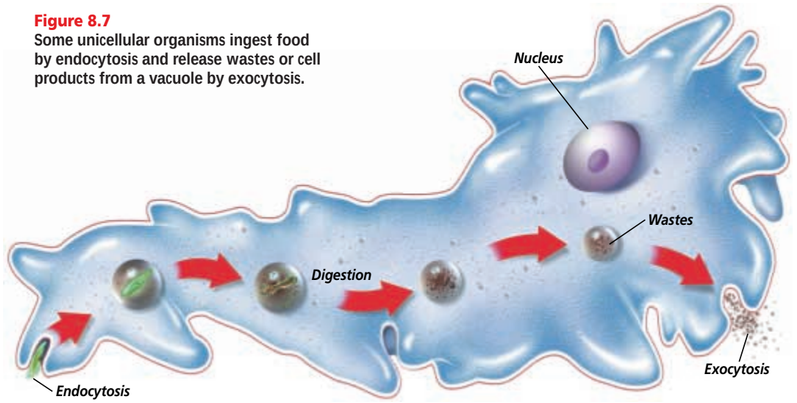
Discussion

Logical-Mathematical Explain to students that when cut carrot sticks begin to wilt they can be made firm again by placing them in water. Ask students to explain why. L2

Resource Manager

Reinforcement and Study Guide, p. 33 L2
Content Mastery, p. 38 L1
Reteaching Skills Transparency 11 and Master L1 ELL

Figure 8.7
Some unicellular organisms ingest food by endocytosis and release wastes or cell products from a vacuole by exocytosis.



WORD Origin
endo-, exo-
From the Greek words *endon*, meaning "within," and *exo*, meaning "out." Endocytosis moves materials into the cell; exocytosis moves materials out of the cell.

whole cells. **Endocytosis** is a process by which a cell surrounds and takes in material from its environment. This material 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 8.7 shows the reverse process of endocytosis, called exocytosis. **Exocytosis** is the expulsion or secretion of materials from a 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, they 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.

Section Assessment

Understanding Main Ideas
1. What factors affect the diffusion of water through a membrane by osmosis?
2. How do animal cells and plant cells react differently to osmosis in a hypotonic solution?
3. Compare and contrast active transport and facilitated diffusion.
4. How do carrier proteins facilitate passive transport of molecules across a membrane?

Thinking Critically
5. A paramecium expels water when the organism is surrounded by freshwater. What can you deduce about the concentration gradient in the organism's environment?

SKILL REVIEW
6. **Observing and Inferring** Osmosis is a form of diffusion. What effect do you think an increase in temperature has on osmosis? For more help, refer to *Thinking Critically* in the **Skill Handbook.**

Section

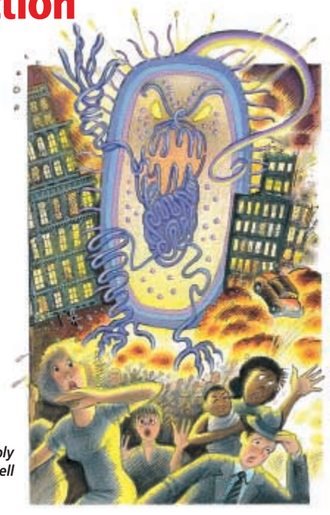
8.2 Cell Growth and Reproduction

SECTION PREVIEW

Objectives
Sequence the events of the cell cycle.
Relate the function of a cell to its organization as a tissue, organ, and an organ system.

Vocabulary
chromosome
chromatin
cell cycle
interphase
mitosis
prophase
sister chromatid
centromere
centriole
spindle
metaphase
anaphase
telophase
cytokinesis
tissue
organ
organ system

Picture this unlikely scene. As the movie begins, people run screaming madly in the streets. In the background, a huge cell towers above the skyscrapers, its cilia-covered surface slowly waving to propel it through the city. Flagella flail along its side, smashing the buildings. Proteins on the plasma membrane form a crude face with a sneer. Although this scene is ridiculous, how do you know that giant cells are not possible? What limits the size of a cell?



An impossibly large cell

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

Prepare

Key Concepts

Students will learn that there are limits to cell size. Limiting factors include, among others, diffusion, DNA content, and surface area-to-volume ratio. Students learn that cells react by dividing when they reach maximum size. The events of the cell cycle are considered, including the stages of mitosis.

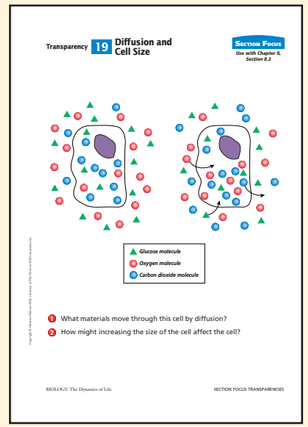
Planning

- Obtain a telephone cord for Meeting Individual Needs.
- Purchase pipe cleaners or yarn for the Reinforcement.
- Collect old insulated electrical cords for the Quick Demo.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 19** on the overhead projector and have students answer the accompanying questions. L1 ELL



Section Assessment

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 plasma membrane pushes against the cell wall, providing added support.
3. Facilitated diffusion and active transport use carrier proteins. Facilitated diffusion does not require energy; active transport does.
4. Carrier proteins move substances that cannot diffuse through the plasma membrane from an area of higher to lower concentration.
5. The organism is in a hypotonic environment and the concentration gradient is from outside to inside.
6. Increasing temperature will increase the rate of osmosis, but it will not change the final outcome because it cannot change the membrane permeability to other solutes.

BIOLOGY JOURNAL

Limits to Cell Size

Linguistic Using what they know about the relationship of surface area to the volume of an object, ask students to write a paragraph explaining why the existence of a single-celled giant creature such as the one in the movie *The Blob* would be impossible. L2

Resource Manager

Section Focus Transparency 19 and Master L1 ELL

2 Teach

Assessment

Portfolio Have students draw interphase and the four stages of mitosis. Make sure they include the chromosomes with sister chromatids, mitotic spindle fibers, and centrioles. L2 ELL

Quick Demo

Show how chromatids separate during anaphase. Slightly separate the middle portion between the two covered wires of an old piece of insulated electrical cord. Tie a piece of string to each piece of the separated cord. Slip a rubber band around the cord and through the strings. Pull the strings slowly apart until the wire splits in two, similar to the way chromatids are pulled along the spindle in a dividing cell.

Magnification: 100×

Figure 8.8
This giant amoeba, *Pelomyxa,* is several millimeters in diameter. It can have up to 1000 nuclei.

diffusion, organisms can't be just one giant-sized cell. They would die long before nutrients could reach the organelles that needed them.

DNA limits cell size

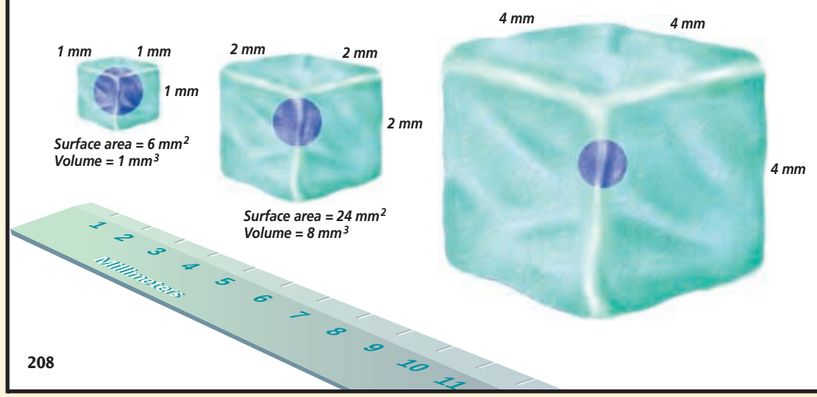
You have learned that the nucleus contains blueprints for the cell's proteins. Proteins are used throughout the cell by almost all organelles to perform critical cell functions. But there is a limit as to how quickly the blueprints for these proteins can be copied in the nucleus and made into proteins in the cytoplasm. The cell cannot survive unless there is enough DNA to support the protein needs of the cell.

What happens in larger cells where an increased amount of cytoplasm requires increased supplies of enzymes? In many large cells, such as the giant amoeba *Pelomyxa* shown in ***Figure 8.8,*** more than one nucleus has evolved. Large amounts of DNA in many nuclei ensure that cell activities are carried out quickly and efficiently.

Surface area-to-volume ratio

Another size-limiting factor is the cell's surface area-to-volume ratio. As a cell's size increases, its volume increases much faster than its surface area. Picture a cube-shaped cell like those shown in ***Figure 8.9.*** The smallest cell has 1 mm sides, a surface area of 6 mm^2, and a volume of 1 mm^3. If the side of the cell is doubled to 2 mm, the surface area will increase fourfold to $6 \times 2 \times 2 = 24$ mm^2. Observe what happens to the volume; it increases eightfold to 8 mm^3.

Figure 8.9
Surface area-to-volume ratio is one of the factors that limits cell size. Note how the surface area and the 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.



Meeting Individual Needs

Visually Impaired

Kinesthetic To demonstrate chromosome coiling and thickening to students who are visually impaired, remove a short, coiled telephone cord from a telephone. Have students stretch out the cord. Explain that the stretched cord represents an interphase chromosome. Have students allow the cord to return to its normal shape. Explain that this coiling is what happens to chromosomes during prophase, when the chromatin condenses. L1 ELL

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 through which oxygen, nutrients, and wastes could diffuse. The cell would either starve to death or be poisoned from the buildup of waste products. You can investigate surface area-to-volume ratios yourself in the *Problem-Solving Lab* shown here.

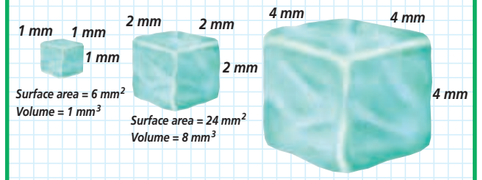
Because cell size can have dramatic and negative effects on a cell, cells must have some method of maintaining optimum size. In fact, cells divide before they become too large to function properly. Cell division accomplishes other purposes, too, as you will read next.

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.

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. Right now, as you are reading this page, many of the cells in your body are growing, dividing, and dying. Old cells on the soles of your feet and on the palms of your hands are being shed and replaced, cuts and bruises are healing, and your intestines are producing millions of new cells each second. New cells are produced as tadpoles become frogs, and as an ivy 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.

The discovery of chromosomes

Most interesting to the early biologists was their observation that just before cell division, several short, stringy 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 sohmz).

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.

Word Origin

chromosome
From the Greek words *chroma,* meaning "colored," and *soma,* meaning "body." Chromosomes are dark-staining structures that contain genetic material.

Portfolio

Surface Area Demonstration

Kinesthetic Using a few small boxes and one large box that is approximately the same size as the small boxes combined and wrapping paper, ask the students to figure out which set will need more paper, the large box or the small boxes each wrapped separately.

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. L3 P

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 cells, whether from an elephant or an earthworm, are microscopic in size.

Thinking Critically

1. 8
2. As the cell surface area grows, its volume increases dramatically. More resources are needed by organelles and more waste is produced.
3. 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.

Assessment

Performance 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. L2

Problem-Solving Lab 8-2

Purpose

Students will compare cell cycles of two different types of cells.

Background

Mitosis requires the same relative amount of time no matter what type of cell is dividing. The amount of time spent in interphase determines the length of the cell cycle.

Process Skills

compare and contrast, interpret data, analyze

Teaching Strategies

- Relate this lab to the uncontrolled growth of cancer cells, which spend a very short time in interphase.

Thinking Critically

1. The first part of interphase, in which the cell is growing, is the most variable in length.
2. The cell with the longer period of growth would carry on more metabolic activities than the more rapidly dividing cell.
3. Students should justify their answers with statements such as that certain types of cells are always being damaged and need to be replaced.

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. L2

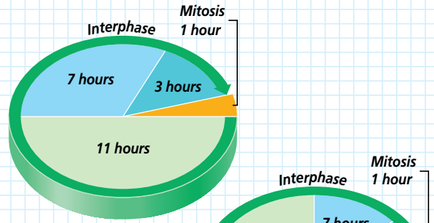
Problem-Solving Lab 8-2

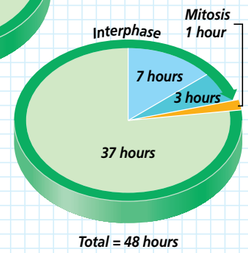
Observing and Inferring

How does the length of the cell cycle vary? The cell cycle varies greatly in length from one kind of cell to another. Some kinds of cells divide rapidly, while others divide more slowly.

Analysis

Examine the cell cycle diagrams of two different types of cells. Observe the total length of each cell cycle and the length of time each cell spends in each phase of the cell cycle.





Thinking Critically

1. Which part of the cell cycle is most variable in length?
2. What can you infer about the functions of these two types of cells?
3. Why do you think the cycle of some types of cells is faster than in others? Explain your answer.

Accurate transmission of chromosomes during cell division is critical.

The structure of eukaryotic chromosomes

For most of a cell's lifetime, chromosomes exist as **chromatin,** long strands of DNA wrapped around proteins. Under an electron microscope, chromatin looks somewhat chaotic, resembling a plate of tangled-up spaghetti. This loose, seemingly unorganized arrangement is necessary for the protein blueprints to be copied. However, before a cell can divide, the long strands of chromatin must be reorganized, just as you would coil a long strand of rope before storing it. As the nucleus begins to divide, chromosomes take on a different structure in which the chromatin becomes tightly packed.

The Cell Cycle

Fall follows summer, night follows day, and low tide follows high tide. Many events in nature follow a recurring, cyclical pattern. Living organisms are no exception. One cycle common to most living things is the cycle of the cell. The **cell cycle** is the sequence of growth and division of a cell.

As a cell proceeds through its cycle, it goes through two general periods: a period of growth and a period of division. The majority of a cell's life is spent in the growth period known as **interphase.** During interphase, a cell grows in size and carries on metabolism. Also during this period, chromosomes are duplicated in preparation for the period of division.

Following interphase, a cell enters its period of nuclear division called **mitosis** (mi TOH sus). Mitosis is the process by which two daughter cells are formed, each containing a complete set of chromosomes. Interphase and mitosis make up the bulk of the cell cycle. One final process, division of the cytoplasm, takes place after mitosis. Look at the *Inside Story* to find out how many stages of growth are involved in interphase. You can use the *Problem-Solving Lab* on this page and the *BioLab* at the end of this chapter to investigate the rate of mitosis.

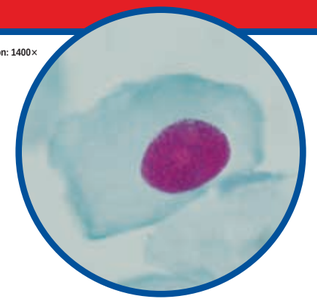
Inside Story

The Cell Cycle

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 cytoplasm, called cytokinesis, follows mitosis.

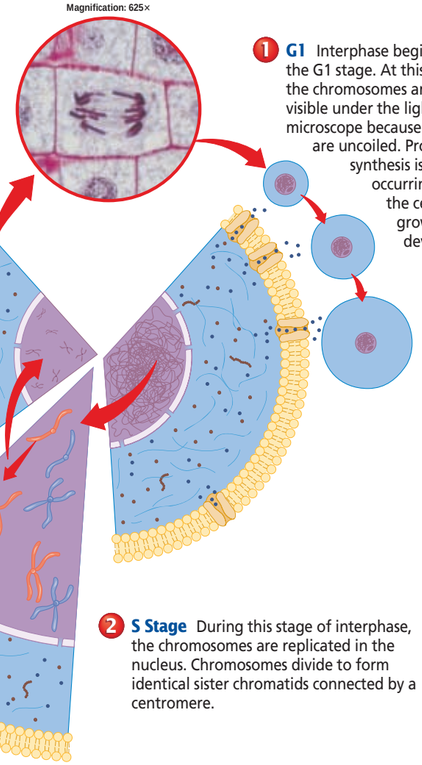
Critical Thinking ***During which stage of the interphase does a cell spend most of its time? Why?***

Magnification: 1400×



Interphase

Magnification: 625×



4 Mitosis When interphase is complete, the cell undergoes mitosis. Mitosis consists of four stages (***Figure 8.12***) 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.

1 G1 Interphase 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 as the cell grows and develops.

3 G2 The chromosomes begin to shorten and coil, and protein synthesis is in high gear. In this stage of interphase, most of the proteins being synthesized are needed for mitosis and the cell organizes and prepares for mitosis. In animals, the centriole pair replicates and prepares to form the mitotic spindle.

2 S Stage During this stage of interphase, the chromosomes are replicated in the nucleus. Chromosomes divide to form identical sister chromatids connected by a centromere.

Inside Story

Purpose

Students will see the relationship between interphase and mitosis and learn the stages of interphase.

Background

Most of a cell's life is spent in interphase. Interphase can be divided into discrete phases, and each phase carries out specific cellular activities.

Teaching Strategy

- Ask students to identify and describe the stages of the cell cycle. L1

Visual Learning

- Have students draw a cell in each of the G1, S, and G2 stages of interphase. Students should include the structure of chromosomes and indicate whether they are coiled or uncoiled and where they are replicated. L2 ELL
- Have students create a table with columns labeled for the three stages of interphase, the four stages of mitosis, and cytokinesis. Have them fill the columns with descriptions of the activities occurring during that stage. L2

Critical Thinking

A cell spends more time in the G1 stage than in S1 or G2. It is in G1 where intense cellular activity, including rapid cell growth and protein synthesis, takes place prior to the onset of mitosis.

Cultural Diversity

Jane Cooke Wright

Discuss with students the role of African-American scientist 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

Nuclear Envelope During Mitosis

Intrapersonal Have the students hypothesize as to what might be happening to the nuclear envelope during mitosis. Have students design an experiment that could test their hypotheses. L2

Meeting Individual Needs

Gifted

Intrapersonal Have students research the newest findings on what triggers the onset of mitosis and how microtubules are assembled and disassembled during spindle formation. Students could also research the formation of cell walls after cell division in plants. L3

Enrichment

Kinesthetic Have students work in groups to design models of the four stages of mitosis. Students might use colored macaroni or licorice for chromosomes. Have students include their completed models in their portfolios. L1 ELL COOP LEARN

INVESTIGATE BioLab

The BioLab at the end of the chapter can be used at this point in the lesson.

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Animation: *The Cell Cycle* Disc 1
Exploration: *Phases of Mitosis* Disc 1

VIDEODISC
Biology: The Dynamics of Life
The Cell Cycle (Ch.28)
Disc 1, Side 1
1 min. 48 sec.

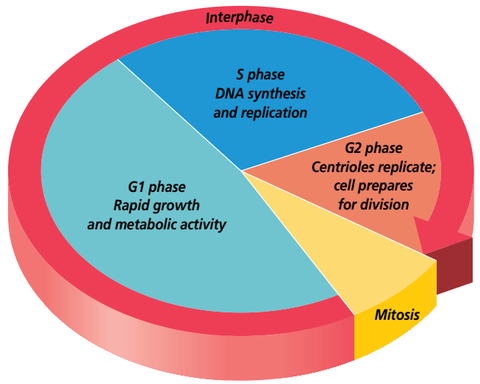
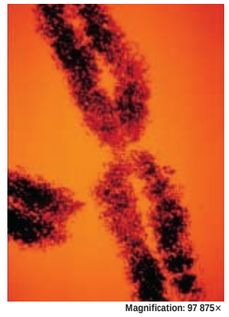


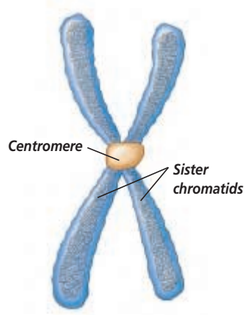
Figure 8.10
In preparation for mitosis, most of the time spent in the cell cycle is in interphase. The process of mitosis, represented here by the yellow wedge, is shown in detail in *Figure 8.12*

Interphase: A Busy Time

Interphase, the busiest phase of the cell cycle, is divided into three parts as shown in ***Figure 8.10.*** During the first part, the cell grows and protein production is high. In the next part of interphase, the cell copies its chromosomes. DNA synthesis does not occur all through interphase but is confined to this specific time. After the chromosomes have been duplicated, the cell enters another shorter growth period in which mitochondria and other organelles are manufactured and cell parts needed for cell division are assembled. Following this activity, interphase ends and mitosis begins.

Figure 8.11
This photomicrograph shows a fully coiled chromosome. The two sister chromatids are held together by a centromere.


Magnification: 97 875×



The Phases of Mitosis

Cells undergo mitosis as they approach the maximum cell size at which the nucleus can provide blueprints for proteins and the plasma membrane can efficiently transport nutrients and wastes into and out of the cell.

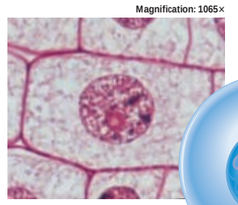
Although cell division is a continuous process, biologists recognize four distinct phases of mitosis—each phase merging into the next. The four phases of mitosis are prophase, metaphase, anaphase, and telophase. Refer to ***Figure 8.12*** to help you understand the process as you read about mitosis.

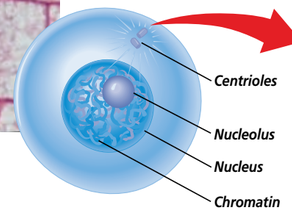
Prophase: the first phase of mitosis

During **prophase,** the first and longest phase of mitosis, the long, stringy chromatin coils up into visible chromosomes. At this point the chromosomes look hairy. As you can see in ***Figure 8.11,*** each duplicated chromosome is made up of two halves. The two halves of the doubled structure are called **sister chromatids.** Sister chromatids and the DNA they contain are exact copies of each other and are formed when DNA is copied during interphase. Sister chromatids are held together by a structure called a **centromere,** which plays a role in chromosome movement during mitosis. By their characteristic location, centromeres also help scientists identify and study chromosomes.

Figure 8.12
Mitosis begins after interphase. Follow the stages of mitosis as you read the text. The diagrams describe mitosis in animal cells and the photos show mitosis in plant cells.

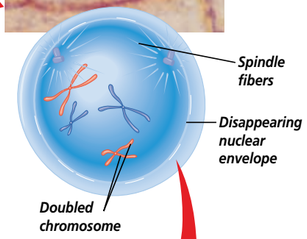
A Interphase precedes mitosis. Refer to the *Inside Story.*

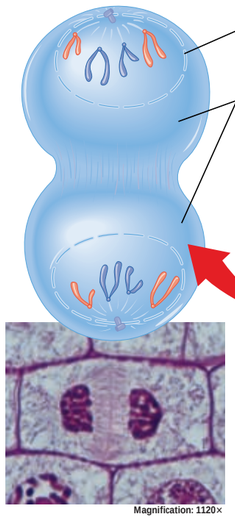

Magnification: 1065×



B Prophase The chromatin coils to form visible chromosomes.

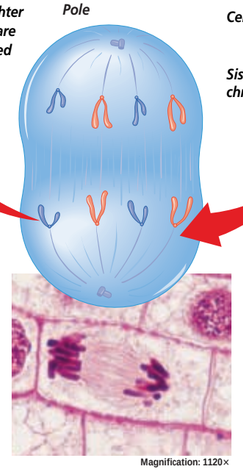

Magnification: 1065×





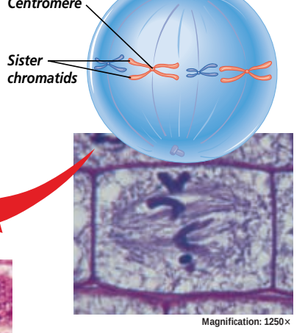
Magnification: 1120×

E Telophase Two distinct daughter cells are formed. The cells separate as the cell cycle proceeds into the next interphase.



Magnification: 1120×

D Anaphase The centromeres split and the sister chromatids are pulled apart to opposite poles of the cell.



Magnification: 1250×

C Metaphase The chromosomes move to the equator of the spindle.

Discussion

Linguistic Discuss the details of the timing mechanism of the cell cycle with the class.

The S phase of interphase and mitosis may be triggered by an enzyme called "cdc2 kinase." Another protein called "cyclin" is also involved in cell division control. In a new cell, cyclin is synthesized continuously and once it builds up to a critical level, it links up with cdc2 kinase protein to form a complex.

Several other biochemical steps then serve to activate the cdc2–cyclin complex, transforming it into maturation-promoting factor (MPF). Mitosis then takes place.

Now ask the students to write about another process (biological or otherwise) and the timing mechanism that governs the steps or phases of the process. Students should include a discussion of what happens if one portion of the process breaks down. L3

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell
How Cells Reproduce
Unit 3, 10 min. 13 sec.
How Cells Reproduce
(in its entirety)

Resource Manager
Basic Concepts Transparency 10 and Master L2 ELL
Laboratory Manual, pp. 57-60 L2

Internet Address Book

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

_____
_____
_____
_____

Portfolio

Cell Cycle

Logical-Mathematical The average human cell that is capable of dividing has a cell cycle of 20 hours. Have students calculate how many cells there would be in one week if they start with one cell at time zero. Students should show their work and place the pages in their portfolios. L2 P

TechPrep

Biology in Practice

Interpersonal Ask a cell biologist to talk to the class about how basic cell biology is critical to advanced research. Ask the speaker to describe how his or her investigations revolve intricately around what the class is learning in this unit. Have the class prepare some questions in advance to ask the guest. L2

Revealing Misconceptions

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. L3

Visual Learning

Visual-Spatial Encourage students to make a flow chart of the series of events that occur during the cell cycle. Have students include their diagrams in their portfolios. L2 P

Reinforcement

Kinesthetic Have groups of students make models of cells at various stages of cell division. Pipe cleaners or yarn pieces can represent chromosomes. L1 ELL COOP LEARN

Resource Manager

Reteaching Skills Transparency 12 and Master L1 ELL

CD-ROM

View an animation of the cell cycle in the Presentation Builder of the Interactive CD-ROM.

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 chromatid separation.

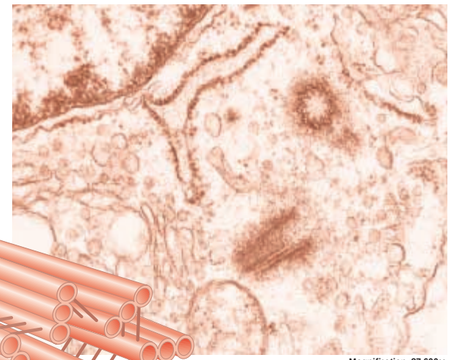
As the pairs of centrioles move to opposite ends of the cell, another important structure, called the spindle, begins to form between them. The **spindle** is a football-shaped, cagelike structure consisting of thin fibers made of microtubules. In plant cells, the spindle forms without centrioles. The 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.



Magnification: 87 600×

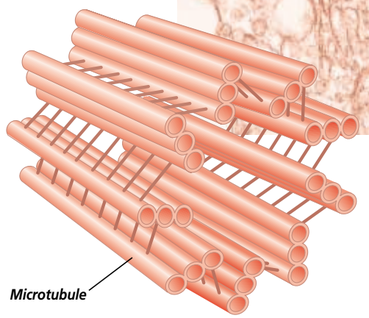


Figure 8.13
Centrioles duplicate during interphase. In the photomicrograph, one centriole is cut crosswise and the other longitudinally.

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 spindle begins to break down, the nucleolus reappears, and a new nuclear envelope forms around each set of chromosomes. Finally, a new double membrane begins to form between the two new nuclei.

Division of the cytoplasm

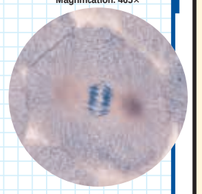
Following telophase, the cell's cytoplasm divides in a process called **cytokinesis** (site uh kih NEE sus). Cytokinesis differs between plants and animals. Toward the end of telophase in animal cells, the plasma membrane pinches in along the equator as shown in ***Figure 8.14.*** As the cell cycle proceeds, the two new cells 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's equator. A cell membrane forms around each cell, and new cell walls form on each side of the cell plate until separation is complete.

MiniLab 8-2 Comparing and Contrasting

Seeing Asters The result of the process of mitosis is similar in plant and animal cells. However, animal cells have asters whereas plant cells do not. Animal cells undergoing mitosis clearly show these structures.

Magnification: 465×



Asters

Procedure

1. Examine a slide marked "fish mitosis" under low- and high-power magnification. **CAUTION:** ***Use care when handling prepared slides.***
2. Find cells that are undergoing mitosis. You will be able to see dark-stained rodlike structures within certain cells. These structures are chromosomes.
3. Note the appearance and location of asters. They will appear as ray or starlike structures at opposite ends of cells that are in metaphase.
4. Asters may also be observed in cells that are in other phases of mitosis.

Analysis

1. Describe the appearance and location of asters in cells that are in prophase.
2. Explain how you know that asters are not critical to mitosis.
3. Design an experiment that tests the hypothesis that asters are not essential for mitosis in animal cells.

Magnification: 1100×

Figure 8.14
At the end of telophase in animal cells, such as this frog egg, proteins positioned just under the plasma membrane at the equator of the cell contract and slide past each other to cause a deep furrow. The furrow deepens until the cell is pinched in two.

MiniLab 8-2

Purpose
Students will observe animal cells that are undergoing mitosis and will note the location and appearance of the aster.

Process Skills
compare and contrast, observe and infer, critical thinking

Teaching Strategies

- Advise students that the slide material is taken from fish blastulas. Ask students why this material is ideal for the study of cells undergoing mitosis.
- To reduce cost of purchasing a class set of prepared slides, purchase one slide and use a microvideo camera or a microprojector if available. Alternatively, purchase 35 mm slides and project them onto the screen with a slide projector.
- If necessary, review the stages of mitosis with students.

Analysis

1. Asters are starlike projections of microtubules associated with centrioles. Asters are found at the cell poles in prophase.
2. Asters are not critical because plant cells undergo mitosis without the structures.
3. Laser microbeams can be aimed to destroy specific organelles. Destroy the asters in a dividing cell and note if the cell completes mitosis.

Assessment

Portfolio Have students research the role and function of the aster and summarize the scientific opinion in their portfolios. Use the Performance Task Assessment List for Writing in Science in **PASC,** p. 87. L3

MEETING INDIVIDUAL NEEDS

English Language Learners

Remind students of the derivation of the term chromosome. Elicit from them how the literal meaning, "colored body," applies to chromosomes. *Chromosomes are dark-staining structures that contain genetic material.* L1 ELL

Resource Manager

Reinforcement and Study Guide, pp. 34-35 L2
BioLab and MiniLab Worksheets, p. 36 L2

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. L2

Reteach

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 structures in mitosis. L2 ELL

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. L3

Assessment

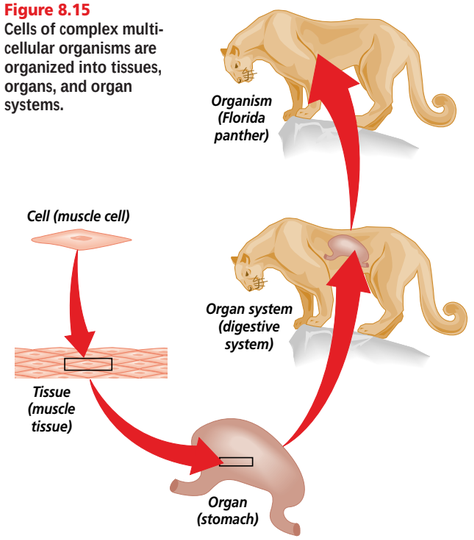
Performance Call out various stages of mitosis and have students find and show that stage to their lab partners using onion root slides under the microscope. Walk around the room to check their results. L1

4 Close

Activity

Visual-Spatial Prepare a worksheet with drawings of various stages of mitosis. Ask students to draw the next stage for each. L1 ELL

Figure 8.15
Cells of complex multicellular organisms are organized into tissues, organs, and organ systems.



those of the parent cell and will grow and divide just as the parent cell did.

When mitosis is complete, unicellular organisms remain as single cells—the organism simply multiplied. In multicellular organisms, cell growth and reproduction result in groups of cells that work together as **tissue** to perform a specific function. Tissues organize in various combinations to form **organs** that perform more complex roles within the organism. For example, cells make up muscle tissue, then muscle tissue works with other tissues in the organ called the stomach to mix up food. Multiple organs that work together form an **organ system.** The stomach is one organ in the digestive system, which functions to break up and digest food.

All organ systems work together for the survival of the organism, whether the organism is a fly or a human. ***Figure 8.15*** shows an example of cell specialization and organization for a complex organism. In addition to its digestive system, the panther has a number of other organ systems that have developed through cell specialization.It is important to remember that no matter how complex the organ system or organism becomes, the cell is still the most basic unit of that organization.

Results of mitosis

Mitosis is a process that guarantees genetic continuity, resulting in the production of two new cells with chromosome sets that are identical to those of the parent cell. These new daughter cells will carry out the same cellular processes and functions as

Section Assessment

Understanding Main Ideas

1. Describe how a cell's surface area-to-volume ratio limits its size.
2. Why is it necessary for a cell's chromosomes to be distributed to its daughter cells in such a precise manner?
3. How is the division of the cytoplasm different in plants and in animals?
4. In multicellular organisms, describe two cellular specializations that result from mitosis.

Thinking Critically

5. At one time, interphase was referred to as the resting phase of the cell cycle. Why do you think this description is no longer used?

Skill Review

6. **Making and Using Tables** Make a table showing the phases of the cell cycle. Mention one important event that occurs at each phase. For more help, refer to *Organizing Information* in the **Skill Handbook.**

Section Assessment

1. As volume increases, surface area does not increase sufficiently to support large cells.
2. Each daughter must get an identical copy of the set of chromosomes.
3. A cell plate forms when a plant cell divides; the plasma membrane of an animal cell pinches in to divide the cytoplasm.
4. Possible answers include tissues, organs, organ systems.
5. The cell is not resting, but growing, producing proteins, and replicating its chromosomes in preparation for division.
6. Interphase, chromosomes are copied; prophase, nuclear envelope disappears; metaphase, chromosomes line up; anaphase, chromatids separate; telophase, chromosomes move to the poles.

Section

8.3 Control of the Cell Cycle

SECTION PREVIEW

Objectives

Describe the role of enzymes in the regulation of the cell cycle.

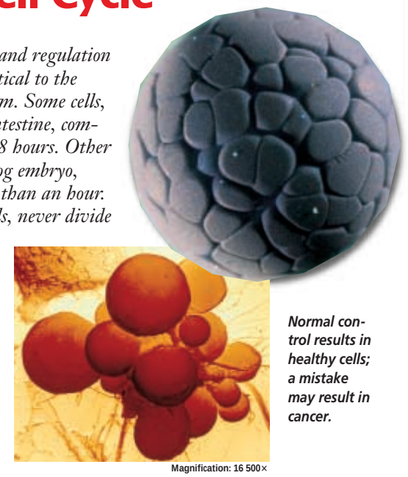
Distinguish between the events of a normal cell cycle and the abnormal events that result in cancer.

Identify ways to potentially reduce the risk of cancer.

Vocabulary

cancer
gene

Accurate 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 results in healthy cells; a mistake may result in cancer.

Magnification: 16 500×

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 clues.

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 dividing of cells can result from the failure to produce certain enzymes, the overproduction of 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.

Biology Journal

Cancer

Linguistic Have students research a specific type of cancer and write a summary in their journals. Have them include the role of genes in producing the cancer, if this is known. L2

Resource Manager

Section Focus Transparency 20 and Master L1 ELL

Prepare

Key Concepts

Students will learn about the events that regulate the cell cycle and compare these normal events with the abnormal events that result in cancer.

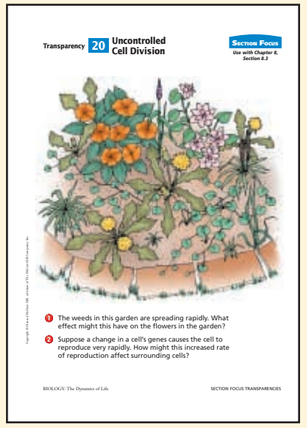
Planning

- Obtain blocks for Meeting Individual Needs.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 20** on the overhead projector and have students answer the accompanying questions. L1 ELL



2 Teach

Assessment

Knowledge Determine the students' awareness of the causes of cancer and discuss with the class what each student can do to lead a healthy lifestyle.

Problem-Solving Lab 8-3

Purpose

Students will analyze a graph showing incidence of certain body organ cancers.

Process Skills

interpret data, think critically, analyze information, sequence, make and use graphs

Teaching Strategies

- Allow students to work in small groups.
- Explain the difference between skin melanoma and basal cell or squamous skin cancers.
- Help student to determine % survival if they are having difficulty.

Thinking Critically

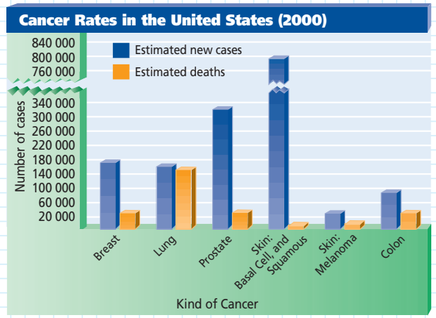
1. basal cell and squamous, skin melanoma
2. lung, basal cell and squamous
3. Student answers may vary: use of suntan parlors and overexposure to sun are common answers.
4. Calculation: deaths – new cases = survivors. So (survivors ÷ new cases) × 100 = % survival. 180 000 – 40 000 = 140 000. Then (140 000 ÷ 180 000) × 100 = 78%.

Assessment

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. L2

Problem-Solving Lab 8-3 Interpreting Data

How does the incidence of cancer vary? Cancer affects many different body organs. In addition, the same body organ, such as our skin, can be affected by several different types of cancer. Some types of cancer are more treatable than others. Use the following graph to analyze the incidence of cancer.



Thinking Critically

1. Which cancer type is most common? Least common?
2. Which cancer type seems to be least treatable? Most treatable?
3. Offer a possible explanation for why the incidence of basal and squamous skin cancer is so high.
4. Using breast cancer as an example, calculate the percent of survival for this cancer type.

Many studies point to the portion of interphase just before DNA replication as being a key control period in the cell cycle. Scientists have identified several enzymes that trigger DNA replication.

Cancer: A Mistake in the Cell Cycle

Currently, scientists consider cancer to be a result of changes in one or more of the genes that produce enzymes that are involved in controlling the cell cycle. These changes are expressed as cancer when something prompts the damaged genes into action. Cancerous cells form masses of tissue called tumors that deprive normal cells of nutrients. In later stages, cancer cells enter the circulatory system and spread throughout the body, a process called metastasis, forming new tumors that disrupt the function of organs, organ systems, and ultimately, the organism.

Cancer is the second leading cause of death in the United States, exceeded only by heart disease. Cancer can affect any tissue in the body. In the United States, lung, colon, breast, and prostate cancers are the most prevalent types. Use the *Problem-Solving Lab* on this page to estimate the number of people in the United States who will develop these kinds of cancers in this decade, and how many people are expected to die from cancers. The *Health Connection* feature at the end of this chapter further discusses skin cancer.

The causes of cancer

The causes of cancer are difficult to pinpoint because both genetic and environmental factors are involved. The environmental influences of cancer become obvious when you consider that people in different countries develop different types of cancers at different rates. For example, the rate of breast cancer is relatively high in the United States, but relatively low in Japan. Similarly, stomach cancer is common in China, but rare in the United States.

In addition, when people move from one country to another, cancer rates appear to follow the pattern of the country in which they are currently living, not their country of origin. Other environmental factors, such as cigarette smoke, air and water pollution, and exposure to ultraviolet radiation from the sun, are all known to damage the genes that control the cell cycle. Cancer may also be caused by viral infections that damage genes.

Cancer prevention

From recent and ongoing investigations, scientists have established a clear link between a healthy lifestyle and the incidence of cancer.

Physicians and dietary experts agree that diets low in fat and high in fiber content can reduce the risk of many kinds of cancer. For example, diets high in fat have been linked to increased risk for colon, breast, and prostate cancers, among others. People who consume only a minimal amount of fat reduce the potential risk for these and other cancers and may also maintain a healthy body weight more easily. In addition, recent studies suggest that diets high in fiber are associated with reduced risk for cancer, especially colon cancer. Fruits, vegetables, and grain products are excellent dietary options because of their fiber content and because they are naturally low in fat. The foods displayed in ***Figure 8.16*** illustrate some of the choices that are associated with cancer prevention.

Vitamins and minerals may also help prevent cancer. Key in this category are carotenoids, vitamins A, C, and E, and calcium. Carotenoids are found in foods such as yellow and orange vegetables and green leafy vegetables. Citrus fruits are a great source of vitamin C, and many dairy products are rich in calcium.

In addition to diet, other healthy choices such as daily exercise and not using tobacco also are known to reduce the risk of cancer.

Figure 8.16 A healthy diet may reduce your risk of cancer.

Section Assessment

Understanding Main Ideas

1. Do all cells complete the cell cycle in the same amount of time?
2. Describe how genes control the cell cycle.
3. How can disruption of the cell cycle result in cancer?
4. How does cancer affect normal cell functioning?

Thinking Critically

5. What evidence shows that the environment influences the occurrence of cancer?

Skill Review

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. L2

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 3. Ask students to suggest possible reasons why they are different.

Extension

Intrapersonal Ask students to find out how chemotherapy drugs work. Ask them to find out why hair follicles and the lining of the digestive system are affected by these drugs, resulting in hair loss and nausea. L3

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. L2

4 Close

Activity

Intrapersonal Ask students to find out what types of cancer can affect a particular organ and what treatments are available. L2

Resource Manager

Reinforcement and Study Guide, p. 36 L2
Content Mastery, pp. 37, 39-40 L1
Critical Thinking/Problem Solving, p. 8 L3

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage: *The Living Clock, Time Therapy: Curing Cancer Through Chronobiology* (Ch. 9)
7 min. 30 sec.

Portfolio

Interview

Have students interview the school nurse to find out the warning signs of cancer. Have the students compile the class results in their portfolios and then discuss how these signs relate to the rapid cell division that occurs in cancer. L2 P

Section Assessment

1. No, the rate of completion varies widely depending on the cell and its function.
2. Genes code for proteins and enzymes that monitor and control the cell cycle.
3. Uncontrolled cell division could cause tumor formation and cancer.
4. Cancer cells form masses of tissue that deprive normal cells of nutrients.
5. People in different countries get cancer at different rates. Immigrants are influenced by the cancer pattern of the new environment.
6. Lung tissue has a much larger blood supply than does breast tissue; therefore, lung cancer spreads more rapidly than breast cancer.

INVESTIGATE BioLab

Time Allotment
One class period

Process Skills
collect data, compare and contrast, apply concepts, think critically, interpret data, observe and infer

Preparation

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

Procedure

Teaching Strategies

- Review the phases of mitosis with students.
- Allow students to look at the onion root tip slide macroscopically or through a dissecting microscope first to locate areas X and Y. Area X is a site of high mitotic activity. Area Y is a site of almost no mitotic activity.
- Remind students that when slides are placed on the microscope stage, everything is reversed. The tip end of root should be facing away from the student, and when moving from area X to Y, the slide must be moved away from the student.
- You may wish to verify that students are looking at the correct areas before they begin their counts.
- If materials are in short supply, consider doing the lab using a microprojector or with a video camera setup.
- Advise students that the cells on the prepared slide are not alive. The cells have been caught in the various stages of mitosis.

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

Phase	Area X	Area Y
Interphase	95	36
Prophase	15	0
Metaphase	5	0
Anaphase	2	0
Telophase	4	0

INVESTIGATE BioLab

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.*

Preparation

Problem
Does mitosis occur at the same rate in all parts of an onion root?

Objectives
In this BioLab, you will:
- **Observe** cells in two different root areas.
- **Identify** the stages of mitosis in each area.

Materials
prepared slide of onion root tip
microscope

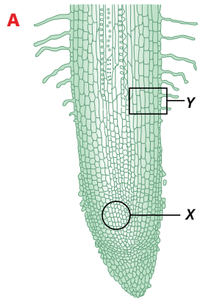
Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.

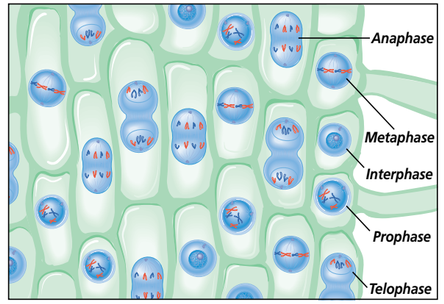
Procedure

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:
   a. Identify those cells that are in mitosis and in interphase.
   b. Record in the data table the number of cells observed in each phase of mitosis and interphase for area X.

Data Table

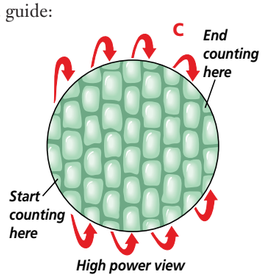
Phase	Area X	Area Y
Interphase		
Prophase		
Metaphase		
Anaphase		
Telophase		





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

6. Using Diagram **A** again, locate area Y on the same prepared slide.
7. Place the prepared slide under your microscope and use low power to locate area Y.
8. Switch to high power.
9. Using Diagram **B** as a guide:
   a. Identify those cells that are in mitosis and in interphase.
   b. Record in the data table the number of cells observed in each phase of mitosis and interphase for area Y.



Analyze and Conclude

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?
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.

Going Further

Application Prepare a circle graph that shows the total number of cells counted in area X and the percentage of cells in each phase of mitosis.

interNET CONNECTION To find out more about mitosis, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Resource Manager
BioLab and MiniLab Worksheets, p. 37 L2

INVESTIGATE BioLab

Analyze 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. L2

Going Further

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 #D8-17-1130.) L2

Health Connection

Purpose

Students will examine the types and causes of skin cancer.

Teaching Strategies

- Discuss skin safety in the sun. Have students who have been sunburned talk about their experience. Ask how often students wear sunscreen.

Connection to Biology

When people learn the facts about the role of the sun in causing skin cancer, their perceptions may change.

Health Connection

Skin Cancer

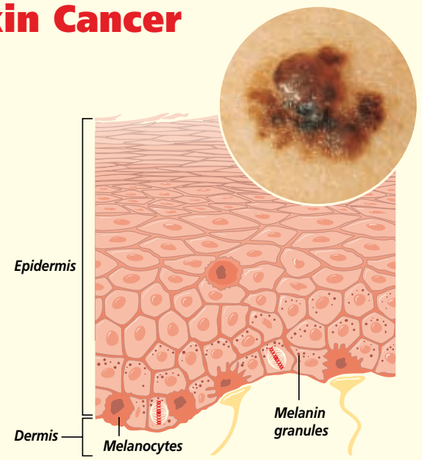
Skin cancer accounts for one-third of all malignancies diagnosed in the United States, and the incidence of skin cancer is increasing. Most cases are caused by exposure to harmful ultraviolet rays emitted by the sun, so skin cancer most often develops on the exposed face or neck. The people most likely 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 skin 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 cancers

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 discovered 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.



Structure of the skin

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?

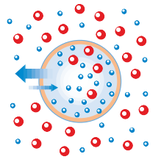
internet connection To find out more about skin cancer, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

Chapter 8 Assessment

Summary

Section 8.1

Cellular Transport



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 opposite flow of materials with the concentration gradient.
- Large particles may enter a cell by endocytosis and leave by exocytosis.

Vocabulary

active transport (p. 205)
endocytosis (p. 206)
exocytosis (p. 206)
facilitated diffusion (p. 204)
hypertonic solution (p. 203)
hypotonic solution (p. 202)
isotonic solution (p. 202)
osmosis (p. 201)
passive transport (p. 204)

Section 8.2

Cell Growth and Reproduction

Main Ideas

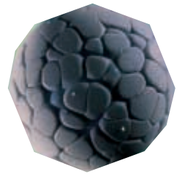
- Cell size is limited largely by the diffusion rate of materials into and out of the cell, the amount of DNA available to program the cell's metabolism, and the cell's surface area-to-volume ratio.
- The life cycle of a cell is divided into two general periods: a period of active growth and metabolism 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. 214)
cell cycle (p. 210)
centriole (p. 214)
centromere (p. 212)
chromatin (p. 210)
chromosome (p. 209)
cytokinesis (p. 215)
interphase (p. 210)
metaphase (p. 214)
mitosis (p. 210)
organ (p. 216)
organ system (p. 216)
prophase (p. 212)
sister chromatid (p. 212)
spindle (p. 214)
telophase (p. 215)
tissue (p. 216)

Section 8.3

Control of the Cell Cycle



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)

Chapter 8 Assessment

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW

All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.

Internet Address Book

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

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 8: *Cellular Transport and the Cell Cycle*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 43-48
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 8 quiz

Understanding Main Ideas

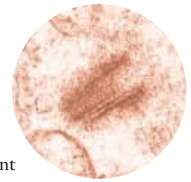
1. b
2. b
3. c
4. d
5. d
6. d
7. b
8. d
9. b
10. d
11. Active
12. shrink
13. hypertonic
14. pressure
15. interphase
16. chromosomes
17. interphase
18. centriole
19. tissues
20. gene

Chapter 8 Assessment

Understanding Main Ideas

1. What kind of environment is described when the concentration of dissolved substances is greater outside the cell than inside?
   a. hypotonic **c.** isotonic
   b. hypertonic **d.** saline
2. Osmosis is defined how?
   a. as an active process
   b. as 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 what process?
   a. osmosis **c.** endocytosis
   b. diffusion **d.** exocytosis
4. Considering the surface area-to-volume ratio, what structure does surface area represent?
   a. cytoplasm **c.** ER
   b. mitochondria **d.** plasma membrane
5. Chromosomes are made of what?
   a. cytoplasm **c.** RNA
   b. centrioles **d.** DNA
6. Which of the following does NOT occur during interphase?
   a. excretion of wastes **c.** protein synthesis
   b. 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. 4 **c.** 16
   b. 8 **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. _____ transport requires energy.
12. A red blood cell placed in a 3% salt solution will _____.
13. Sprinkling sugar on a bowl of strawberries creates a _____ solution surrounding the strawberries.
14. Grocers spray water on produce to increase the _____ inside the cells.
15. Chromosomes are replicated during the _____ stage of the cell cycle.
16. The _____ inside cells contain DNA and become darkly colored when stained.
17. Most of a cell's life is spent carrying on the activities of _____.
18. The _____ (shown here) is present only in an animal cell.



19. An organ consists of several kinds of _____.
20. A _____ is a segment of DNA that controls the production of a protein.

Test-Taking Tip

Become an Expert on What You Fear the Most

If you just can't remember all those different parts of those important processes, don't run away. Instead, consider it a challenge, meet the problem head on, and you'll probably be surprised at how easy it is to conquer the toughest concepts.

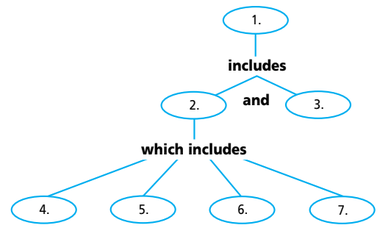
Chapter 8 Assessment

Applying Main Ideas

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.

Thinking Critically

24. **Making Predictions** What do you think will happen when a freshwater paramecium is placed in salt water?
25. **Observing and Inferring** How does cell division in adult animals help maintain homeostasis?
26. **Concept Mapping** Complete the concept map using the following vocabulary terms: mitosis, cell cycle, metaphase, prophase, telophase, interphase, anaphase.



CD-ROM

For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

Different species of organisms vary in the number of chromosomes found in body cells.

Table 8.1 Chromosome comparison of four organisms

Organism	Human	Rye	Potato	Guinea Pig
Number of chromosomes in body cells	46	14	48	64
Number of chromatids during metaphase of mitosis	92	A	96	128
Number of chromosomes in daughter cells	46	14	48	64

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 **c.** anaphase
   b. metaphase **d.** telophase
2. What number belongs in the space labeled A under Rye in the table?
   a. 14 **c.** 7
   b. 28 **d.** 21
3. If one pair of chromatids failed to separate during mitosis in rye cells, how many chromosomes would end up in the daughter cells?
   a. 28 and 28 **c.** 7 and 8
   b. 14 and 14 **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.

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.

Thinking Critically

24. The amoeba, being in a hypertonic 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.
26. 1. Cell cycle; 2. Mitosis; 3. Interphase; 4. Prophase; 5. Metaphase; 6. Anaphase; 7. Telophase

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.