Be sure students understand what it means to say that cells are in an isotonic, a hypotonic, or a hypertonic solution. Point out that distilled water is used in the activity because carrot cells are probably isotonic to tap water.

**Answers to Student Worksheet**

**Table 1**

<table>
<thead>
<tr>
<th>Condition of Carrot Stick</th>
<th>Type of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose thread</td>
<td>salt water</td>
</tr>
<tr>
<td>Cells gained water</td>
<td>distilled water</td>
</tr>
<tr>
<td>Soft texture</td>
<td>salt water</td>
</tr>
<tr>
<td>Tight thread</td>
<td>distilled water</td>
</tr>
<tr>
<td>Firm texture</td>
<td>distilled water</td>
</tr>
<tr>
<td>Cells lost water</td>
<td>salt water</td>
</tr>
</tbody>
</table>

**Analyze and Conclude**

1. The diameter of the carrot stick indicates whether the carrot cells lost or gained water.
2. Student drawings and explanations should indicate that carrot cells will lose water and shrink when placed in salt water because salt water is hypertonic, that is, there is a greater concentration of solute molecules outside the carrot cells than within. Therefore, water diffuses out of the cells. When carrot cells are placed in the hypotonic distilled water, they will gain water because the concentration of solute molecules is lower outside the cells than within.
3. Covering fruits and vegetables with plastic wrap ensures that a relatively isotonic environment surrounds the fruit or vegetable. Therefore, water tends not to be gained or lost by cells.
4. Spraying vegetables with water keeps them fresh and crisp because the cells will not lose water when coated with an isotonic solution, such as water.

**Reinforcement and Study Guide**

**Page 85 • Section 8.1**

1. hypotonic solution
2. isotonic solution
3. hypotonic solution, hypertonic solution
4. hypertonic solution
5. h
6. a
7. c
8. d
9. f
10. b
11. e
12. g

**Page 86 • Section 8.2**

1. true
2. slow
3. true
4. faster
5. eight, eight
6. cell division
7. identical
8. nucleus
9. vanish
10. chromosomes
11. genetic material
12. chromatin
13. packed
14. interphase
15. mitosis
16. mitosis
17. interphase
18. interphase
19. interphase
20. mitosis
21. interphase
22. prophase
23. metaphase
24. anaphase
25. telophase
26. centrioles
27. sister chromatids
28. centromere
29. spindle fibres
30. In multicellular organisms, mitosis produces groups of cells that work together to perform a function. These groups are tissues. The tissues are organized in different combinations to form organs that have different functions.

**Page 88 • Section 8.3**

1. Enzymes are needed to begin and drive the cell cycle. They also direct the phases of the cell cycle.
2. Genes, segments of DNA located on the chromosomes, direct the production of these enzymes.
3. Lack of the enzymes needed to control the cell cycle, overproduction of those enzymes, or production of other enzymes at the wrong time all can cause the cell cycle to become uncontrolled.
4. Uncontrolled cell division and possibly cancer can result.
5. Certain environmental factors, such as cigarette smoke, pollution, and UV rays, can damage the genes that control the production of enzymes involved in the cell cycle. Uncontrolled cell division that leads to cancer may result.
6. A tumor is a mass of tissue that deprives normal cells of nutrients. In the final stages of cancer, cancer cells metastasize to other parts of the body, forming new tumors that disrupt organ functions.
7. Lung, colon, breast, and prostate cancers are the most prevalent.

Refuerzo y Guía de estudio
Página 89 • Sección 8.1
1. solución hipotónica
2. solución isotónica
3. solución hipotónica; solución hipertónica
4. solución hipertónica
5. h
6. a
7. c
8. d
9. f
10. b
11. e
12. g

Página 90 • Sección 8.2
1. verdadero
2. lentamente
3. verdadero
4. rápido
5. ocho, ocho
6. división celular
7. idénticas
8. núcleo
9. desvanecerse
10. cromosomas
11. material genético
12. cromatina
13. condensa
14. interfase
15. mitosis
16. mitosis
17. interfase
18. interfase
19. interfase
20. mitosis
21. interfase
22. profase
23. metafase
24. anafase
25. telofase
26. centriolos
27. cromátides hermanas
28. centrómero
29. fibras del huso
30. En los organismos multicelulares se producen mediante mitosis grupos de células que colaboran para realizar una función. Estos grupos de células forman tejidos. Los tejidos están organizados de diferentes maneras para formar órganos que llevan a cabo diferentes funciones.

Página 92 • Sección 8.3
1. Las enzimas inician y estimulan el ciclo celular, además de dirigir sus fases.
2. Los genes, segmentos de DNA localizados en los cromosomas, controlan la producción de estas enzimas.
3. La falta de las enzimas que se requieren para controlar el ciclo celular, la producción excesiva de estas enzimas o la producción de enzimas a destiempo pueden causar la pérdida de control del ciclo celular.
4. Puede ocasionar división celular descontrolada y quizás pueda producir un cáncer.
5. Ciertos factores ambientales como el humo del cigarrillo, la contaminación y los rayos UV pueden causar daños a los genes que dirigen la producción de las enzimas que controlan el ciclo celular. La división descontrolada de las células puede causar cáncer.
6. Un tumor es una masa de tejido que consume nutrientes destinados para las células sanas. En las etapas finales de un cáncer, ocurre la metástasis de las células cancerígenas y éstas se desplazan hacia otras partes del cuerpo, formando nuevos tumores que afectan las funciones de otros órganos.
7. Los tipos de cáncer de mayor incidencia son el cáncer del pulmón, del colon, de la mama y de la próstata.
• Then discuss the phases of mitosis. Point out that cytokinesis, not shown on the transparency, occurs after mitosis. Some cells, such as skeletal muscles, do not always go through cytokinesis. As a result, these cells have more than one nucleus.

• Tell students that the cell cycles can vary in length. For example, cells of the immune system divide rapidly when the body encounters a foreign substance and divide slowly during other periods.

Extension: Role Play

• Mitosis can be a difficult concept for students. This demonstration will enable them to “see” the process in concrete terms. Divide students into groups of about 8–10 students each. Then divide the students into pairs. Three of the pairs represent replicated chromosomes, so they are given stick-on labels on which are written 1-A, 1-B, 2-A, 2-B, 3-A, and 3-B. Draw a chalk circle on the floor. Have all the As move into the circle to represent the unreplicated chromosomes. The B’s enter the circle when DNA is synthesized. The “non-chromosome” students then direct the others in their actions (when to move as a pair, when to separate, where to go, etc.), as they move through the cell cycle. Repeat the process at least twice, changing roles so that all members play an active role.

Answers to Student Worksheet

1. Diffusion is a slow process. If a cell becomes too large, substances may take too long to reach the cell’s organelles, which may cause the cell to die.

2. If a cell becomes too large, it may not have enough DNA to produce all the proteins it needs.

3. As a cell’s size increases, its volume increases much faster than its surface area. As a result, the cell would need to take in nutrients and excrete wastes faster than the available surface area would allow. Eventually, the cell would starve and/or be poisoned.

4. Interphase: The cell grows; the chromosomes and centrioles duplicate; organelles are made in preparation for mitosis.

5. Prophase: The chromatin coils into visible chromosomes; nuclear envelope and nucleolus disappear; a spindle forms between the centrioles, which have moved to the opposite ends of the cell.

6. Metaphase: The chromosomes move to the equator of the spindle; each chromatid is attached to a separate spindle fiber by its centromere.

7. Anaphase: The centromeres split; sister chromatids are pulled apart to opposite poles of the cell.

8. Telophase: The nucleolus and nuclear envelope reappear; the chromosomes begin to uncoil; two new cells form.

Chapter Assessment

Page 111 • Reviewing Vocabulary

1. active transport
2. anaphase
3. hypotonic
4. cell cycle
5. interphase
6. gene
7. metaphase
8. sister chromatids
9. cancer
10. facilitated diffusion
11. mitosis
12. endocytosis
13. centromeres
14. During prophase, the spindle forms between the pairs of centrioles.
15. Organs are made of tissues organized in various combinations.

Page 112 • Understanding Main Ideas (Part A)

1. c 6. d
2. a 7. c
3. b 8. c
4. b 9. b
5. d 10. d

Page 113 • Understanding Main Ideas (Part B)

1. C
2. prophase
3. centriole
4. spindle
5. D
6. A separate nuclear envelope is forming around each set of chromosomes. The spindle is breaking down.
7. D, A, F, C, E, B or A, F, C, E, B, D
8. During cytokinesis in animal cells, the plasma membrane pinches in along the equator to form two new cells. In plant cells, a cell plate forms across the equator; then a plasma membrane forms around each new cell and a new cell wall is secreted on each side of the cell plate.
**Page 114 • Thinking Critically**

1. higher
2. Na⁺
3. Ca²⁺
4. 30 mM
5. yes; Na⁺ ions
6. To maintain different concentrations of ions on either side of the plasma membrane, the cell must move the ions against a concentration gradient. To do so, the cell uses active transport, in which carrier proteins bind with the ions and move them across the membrane. This process requires energy.

**Page 115 • Applying Scientific Methods**

1. Colchicine causes cells to produce multiple sets of chromosomes in their nuclei.
2. The untreated root tips were the control group; the root tips treated with colchicine were the experimental group.
3. treatment of the onion roots with colchicine
4. the cell cycle of the onion root cells
5. Answers may vary. The slides of untreated root tips will show cells in interphase and in various stages of mitosis. The slides of treated root tips will show cells only in interphase and in prophase. The cells in prophase will have no spindle fibers, and they may show some cells with multiple sets of chromosomes.
6. The colchicine stopped mitosis after prophase.
7. If the cells of the colchicine-treated onion root and the cells of the untreated onion root appeared in the same stages of mitosis under the microscope, the researcher could conclude that the colchicine had no effect.
8. It states the problem; a conclusion is never stated as a question.
9. The researcher might first investigate the structure of spindle fibers and the chemical constituents of colchicine and then design an experiment that specifically tests how colchicine blocks the formation of spindle fibers.
10. When a plant has extra sets of chromosomes, it has extra copies of genes, which produce more of the proteins that the genes code for. Proteins are used in cellular reactions and in cellular structures. Having the additional proteins causes the fruits and flowers to be larger.
Extension: Research
• Have students research the sodium-potassium pump, which is an active transport system that allows nerve cells to send impulses. Students can draw a diagram similar to the one shown in the transparency to explain how the sodium-potassium pump works.

Answers to Student Worksheet
1. carrier protein
2. The ions are more concentrated on one side of the plasma membrane than on the other side.
3. Cells must use energy in order to counteract the tendency of particles to diffuse from a region of higher concentration to a region of lower concentration.
4. A carrier protein binds with an ion or other particle to be transported against the concentration gradient. Using chemical energy from the cell, the protein then changes shape in order to carry the particle through the plasma membrane to the other side. When the particle is released, the protein reverts to its original shape.
5. The energy is produced by chemical reactions in the mitochondria of the cell.
6. In endocytosis, a particle is not taken through the plasma membrane. Rather, the plasma membrane engulfs the particle and makes a sac or vacuole around it. That portion of the membrane then breaks away, bringing the vacuole and its contents into the cell.
7. Endocytosis is classified as active transport because it requires energy.
8. Exocytosis; in exocytosis, materials are expelled from a vacuole.

Basic Concepts Transparency 10
Page 103 • Mitosis

Purpose
• To review the phases and importance of mitosis

Teaching Suggestions
• Project the transparency. Discuss the processes and structures involved in each phase of mitosis.
• Point out that although four phases of mitosis are illustrated separately, the process is continuous, with each phase gradually developing into the next.

Extension: Photography
• Interested students might wish to take microphotographs of cells in various phases of mitosis. If your school does not have the necessary equipment, try enlisting the help of a local college or university.

Answers to Student Worksheet
1. The spindle forms during prophase. As the two centriole pairs move to opposite ends of the cell, the spindle forms between them.
2. metaphase
3. prophase
4. Cytokinesis follows mitosis.
5. The cells are those of animals since they contain centrioles, which are not present in plant cells.
6. Cytokinesis is the division of the cytoplasm of daughter cells, which occurs after mitosis. During cytokinesis in animal cells, the plasma membrane pinches in along the equator until two separate cells are formed. In plant cells, the cytoplasm is divided by the formation of a cell plate across the equator. A new cell wall is then secreted on each side of the cell plate until the two new cells are separate.
7. It ensures genetic continuity and the continuation of cellular processes vital to the survival of the organism.

Reteaching Skills Transparency 11
Page 105 • Active Versus Passive Transport

Purpose
• To demonstrate the similarities and differences between active transport and passive transport
• Skill: Comparing and contrasting

Teaching Suggestions
• Present the transparency. Ask students to make a table that compares passive transport and active transport with respect to concentration gradient, use of transport proteins, and energy usage.

Extension: Collection
• For the next several days, have the class create a “rolling collection” of examples of ways that concentration gradients function in their lives—“rolling” because students add items over the coming days as they learn more about biology. Items can include essays, drawings, sculptures, and other displays. Examples may come only from biology or from biology and other aspects of students’ lives.

Answers to Student Worksheet
1. The statement is accurate because molecules move from areas of higher concentration to areas of lower concentration. It is not accurate because it implies that by the end of the process all the molecules have moved to a new place. In reality, the
**Concept Map**  
**Page 93 • Transport Through Membranes**

1. energy  
2. lower concentration  
3. higher concentration  
4. passive  
5. simple diffusion  
6. facilitated diffusion  
7. osmosis  
8. higher concentration  
9. lower concentration

**Critical Thinking**  
**Page 94 • Linking a Tumor Suppressor Gene to the Cell Cycle**

1. The study was done on only a few families, so conclusions about the gene’s connection to cancer in the general population could not be made. Also, since the research connected the gene defect with only a rare type of breast cancer, conclusions about its involvement in more common forms of breast cancer could not be made.
2. The gene could be a part of the process of correcting mutations or a mistake in DNA replication by giving the cell time to find and correct the problem before cell division takes place. Otherwise, damaged genetic material would be passed on to daughter cells, which might lead to development of cancer or other diseases.
3. It reveals how p53 acts to prevent cells from dividing. If a cell remains in interphase, it does not go through mitosis, which leads to cell division.
4. The researchers hypothesized that one or more genes in the older DNA coded for a substance that inhibits cell division and that this substance would slow or stop division of the young cells.
5. Control of cell division involves more than two genes. More research on the genetic control of the cell cycle will be needed before the issue is completely understood.

**Section Focus Transparency 18**  
**Page 95 • Water in the Cell**

**Purpose**  
- To introduce the concept of osmosis

**Teaching Suggestions**  
- Project the transparency, and have students note the difference between the two plants. Ask students to suggest why the plant in Figure B has wilted. Students most likely will suggest that the cause is a lack of water.

**Section Focus Transparency 19**  
**Page 96 • Diffusion and Cell Size**

**Purpose**  
- To introduce the concept that diffusion limits cell size

**Teaching Suggestions**  
- Before projecting the transparency, explain to students the roles of oxygen, glucose, and carbon dioxide in a cell. (Oxygen is used in the process that breaks down glucose and releases energy, which produces carbon dioxide as a waste product.)
- Project the transparency, and have students observe the differences in the concentration of each type of molecule inside and outside the cell in Figure A. Then ask students to explain the movements of the molecules in Figure B. (Glucose and oxygen are diffusing into the cell because their concentrations are higher outside the cell than inside the cell. Carbon dioxide is diffusing out of the cell because its concentration is higher inside the cell than outside the cell.)

**Answers to questions on the transparency include:**

1. Oxygen, glucose, and carbon dioxide diffuse through the cell.
2. If a cell becomes too large, materials might not be able to diffuse into and out of the cell fast enough for the cell to function properly.