

Cells

Teacher Materials



Teacher Preparation

Before you begin this unit, photocopy and distribute the following to students:

- Student Introduction (page 15)
- Unit Vocabulary (page 16)
- Student Briefs (pages 17–22)
- Appropriate Assessments (pages 23–34)



Key Unit Concepts

- *Cells* are the smallest units of life.
- Cells were discovered by the use of a microscope in the 17th century.
- *Cell theory* explains the function of cells and how they reproduce.
- *Multi-cellular* means having many cells.
- *Organelles* are different cell parts that carry out specific jobs that allow the cell to perform its life functions.
- *Diffusion* and *osmosis* are ways in which water, oxygen, and other materials are moved in and out of cells.
- New cells are produced by the division of already existing cells.
- *Mitosis* is when the cell nucleus divides.
- *DNA* is a chemical molecule inside of cells.
- *Chromosomes* are made from DNA.
- *Chromosomes* contain genetic information that determines how cells grow and develop.
- When a cell divides, each new cell gets a copy of all of the pairs of chromosomes.



Discussion Topics

- Have students provide some examples of discoveries that were only possible because of some breakthrough in technology.
- Cells form a system unto themselves. Have students brainstorm other biological systems.

See “Generic Strategies and Activities” on pages 8 and 9 for additional strategies useful to presenting this unit.

Cells

Activities



Brief #1: Cell Theory

- **Make an Illustrated Timeline:** Have students research important events and discoveries regarding cells. Using a large piece of butcher paper, ask them to make an illustrated timeline that depicts these events.
- **Write a Biography:** Ask students to select one person who made an important contribution to our understanding of cells. Ask them to write a short biography about that person and include a portrait.
- **Use a Microscope:** Have students look at a variety of slides under a microscope and describe what they see. If a microscope and slides are not available, have students look at magnified images of various living and nonliving things.

Key Words: *cells, microscopes, Robert Hooke, Anton van Leeuwenhoek, Robert Brown, Matthias Schleiden, Theodore Schwann, Rudolf Virchow, Albrecht van Kolliker, Julius van Sachs, Ernst Ruska, Max Knoll, George E. Palade*



Brief #2: Organelles

- **Make an Informational Poster:** Using large posterboard and a variety of colored markers, paint, etc., have students make a poster that features an animal cell. Make sure that the relevant cell parts are drawn and labeled.
- **Write a Poem, Song, or Rap:** Have students write a poem, song, or rap that tells the names and job of various animal organelles.
- **Make a Working Model:** Have each student make a working model of the cell membrane and the diffusion process.

Supplies: small plastic cup, small sandwich bag, cornstarch, iodine, eyedropper, twist tie, water, spoon

Procedure: Fill the cup halfway with water. Using the eyedropper, add about 10 drops of iodine. Put three spoonfuls of cornstarch into the plastic bag and close the bag with the twist tie. Put the cornstarch bag into the iodine bath. Have students observe the model every five minutes. Eventually, the iodine water will move through the bag and color the cornstarch. Have students use this model and demonstration to explain the process of cell diffusion.

Key Words: *animal cell, organelles, cell diffusion*



Brief #3: Cell Division and Reproduction

- **Perform a Skit:** Have students perform a skit that depicts the various phases of mitosis. The skit should include a narrator who talks about each phase as it is being performed.



Internet Resources

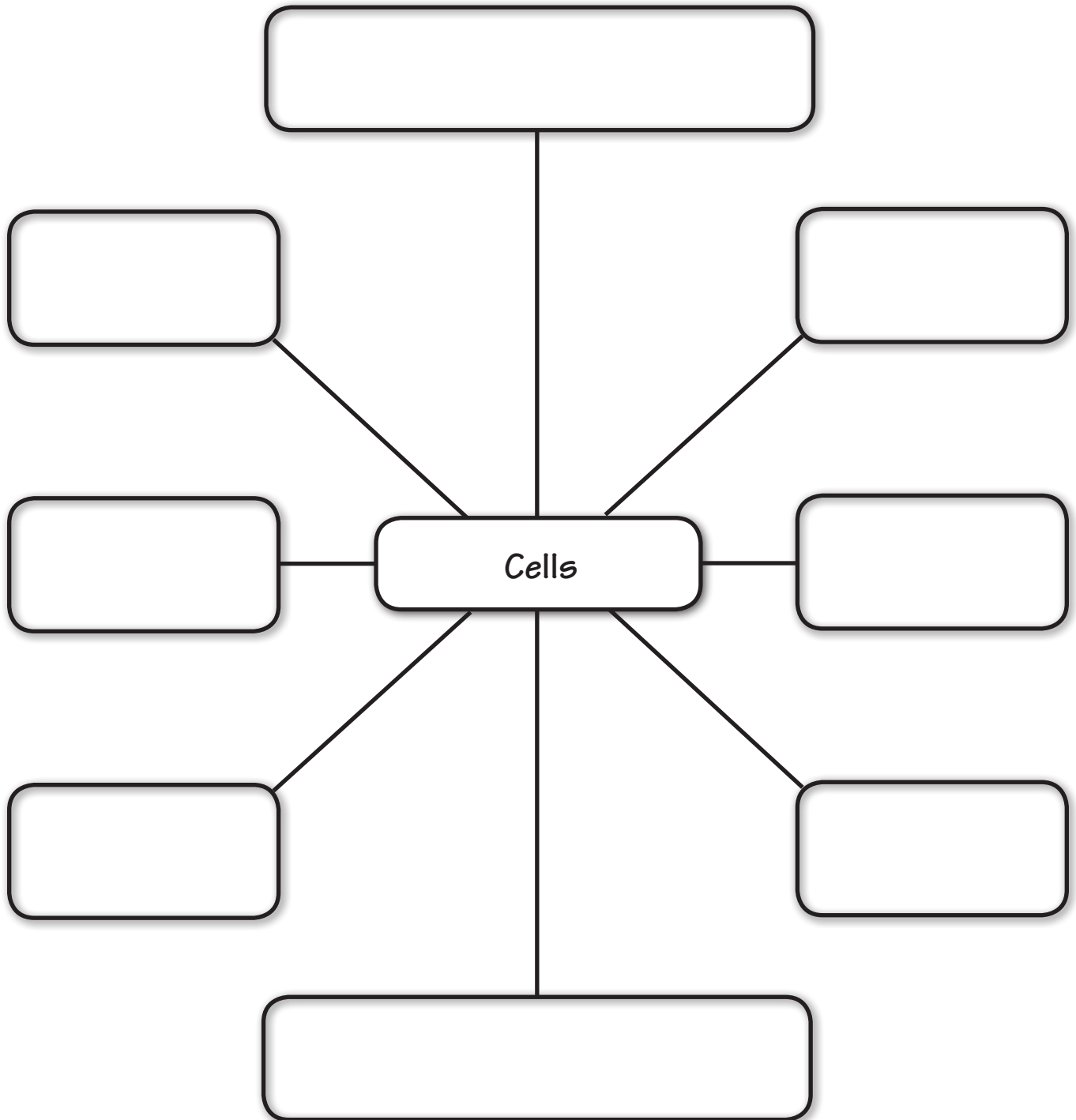
- <http://www.biology4kids.com/> — Biology4Kids website; contains specific information and graphics about cell structure and function
- <http://learn.genetics.utah.edu/content/begin/cells/> — link for “The Science Spot at Kid Zone”; has lots of good information and visuals about cells and other biology topics

Cells

Student Introduction: Cells Word Web

Name: _____ Date: _____

Directions: Use this word web to help you brainstorm the characteristics of cells. What do cells do? What are the different parts of a cell?



Cells

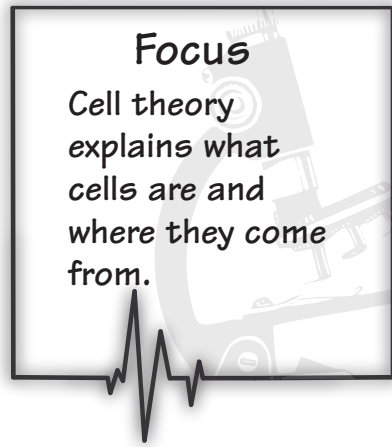
Vocabulary

1. **cell theory**—a group of observations about the function, behavior, and reproduction of cells
2. **cell membrane**—an organelle that acts as a kind of skin for the other organelles
3. **chromosomes**—tubular structures formed from DNA that are copied during mitosis
4. **cytoplasm**—organelle of liquid in which all of the other organelles are located
5. **diffusion**—the movement of substances from an area of high concentration to an area of low concentration
6. **DNA**—chemical molecule in which cell instructions are stored
7. **endoplasmic reticulum**—organelle that transports proteins
8. **lysosome**—an organelle that has chemicals that help to digest worn-out organelles and other viruses and bacteria that might harm the cell
9. **mitochondria**—organelles that generate chemical energy that the cell uses to power other organelles
10. **mitosis**—division of the cell nucleus
11. **multi-cellular**—having many cells
12. **nucleus**—the control center of the cell
13. **organelles**—parts of cells that help them to carry out their life functions
14. **osmosis**—the movement of water through the cell's membrane
15. **ribosome**—an organelle that begins to turn materials in the cell into protein
16. **vacuole**—an organelle that stores and moves water around the cell, and helps the cell to digest food and eliminate waste materials



Cells

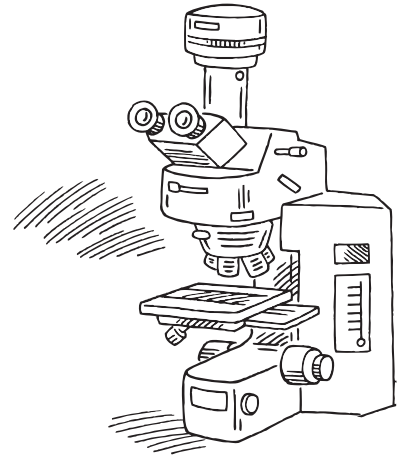
Brief #1: Cell Theory



Cells are the smallest units of life. All living things are made up of cells. But this was not always known to us. Sometimes the discovery of something can only come about because a piece of technology has been invented that allows us to study it. This is what happened with the discovery of cells.

Cells are very small. In fact, they are microscopic.

In 1635, a scientist named Robert Hooke made a microscope and looked at a piece of cork through it. Hooke saw that the microscopic piece of cork looked like a honeycomb. It was made of lots of tiny little areas that he called cells.



The cells that Hooke observed were not alive. The first person to observe a live cell under a microscope was Anton van Leeuwenhoek. In 1674, he saw a type of algae called spirogyra. He called the tiny moving cells “animalcules.”



Cell Theory

The observations of Hooke, van Leeuwenhoek, and others led to the development of a theory about cells. **Cell theory states the following:**

- ✓ All living things are made of cells.
- ✓ Cells are the basic units of living things.
- ✓ All cells come from existing cells.

Vocabulary

1. cell theory
2. multi-cellular



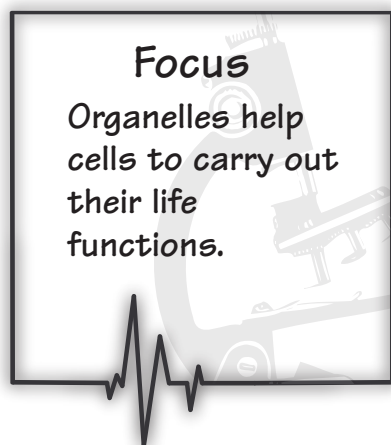
What Cells Do

While cells may be microscopic, they perform important and complex functions in living organisms. Cells must get food and nutrients, remove waste from their systems, and grow and reproduce. When cells can't carry out the life functions, they can die.

There are some organisms that are made of one or a few cells. But there are much larger organisms, like humans, who are made up of trillions of cells. **An organism that is made up of many cells is called multi-cellular.** The prefix *multi* means “many.”

Cells

Brief #2: Organelles



Cells are made up of different parts that help them to carry out their life functions. A cell's life functions include the following:

- ✓ eating
- ✓ growing
- ✓ reproducing

The different parts of a cell that help it to carry out these functions are called organelles. You may already know about the organelle called the nucleus. **The nucleus is like the control center of the cell.** But there are many other organelles and each different organelle performs a specific job.



Types of Organelles

Here is a list of other organelles that carry out important functions within the cell. Look at the diagram on page 19 to see how all of these parts fit together.

- ✓ **The endoplasmic reticulum is an organelle that helps to make and transport proteins and sugars around the cell.**
- ✓ **A vacuole is an organelle that stores and moves water around the cell and helps the cell to digest food and eliminate waste materials.**
- ✓ **The ribosome is an organelle that begins to turn materials in the cell into proteins.**
- ✓ **The lysosome is an organelle that has chemicals that help to digest worn-out organelles and other viruses and bacteria that might harm the cell.**
- ✓ **The organelle known as cytoplasm is a kind of liquid in which all of the other organelles are located.**
- ✓ **The cell membrane is an organelle that acts as a kind of skin for the other organelles. It is a barrier that keeps harmful things out of the cell, but it also lets helpful things into the cell.**
- ✓ **The mitochondria is an organelle that generates chemical energy that the cell uses to power other organelles.**

Vocabulary

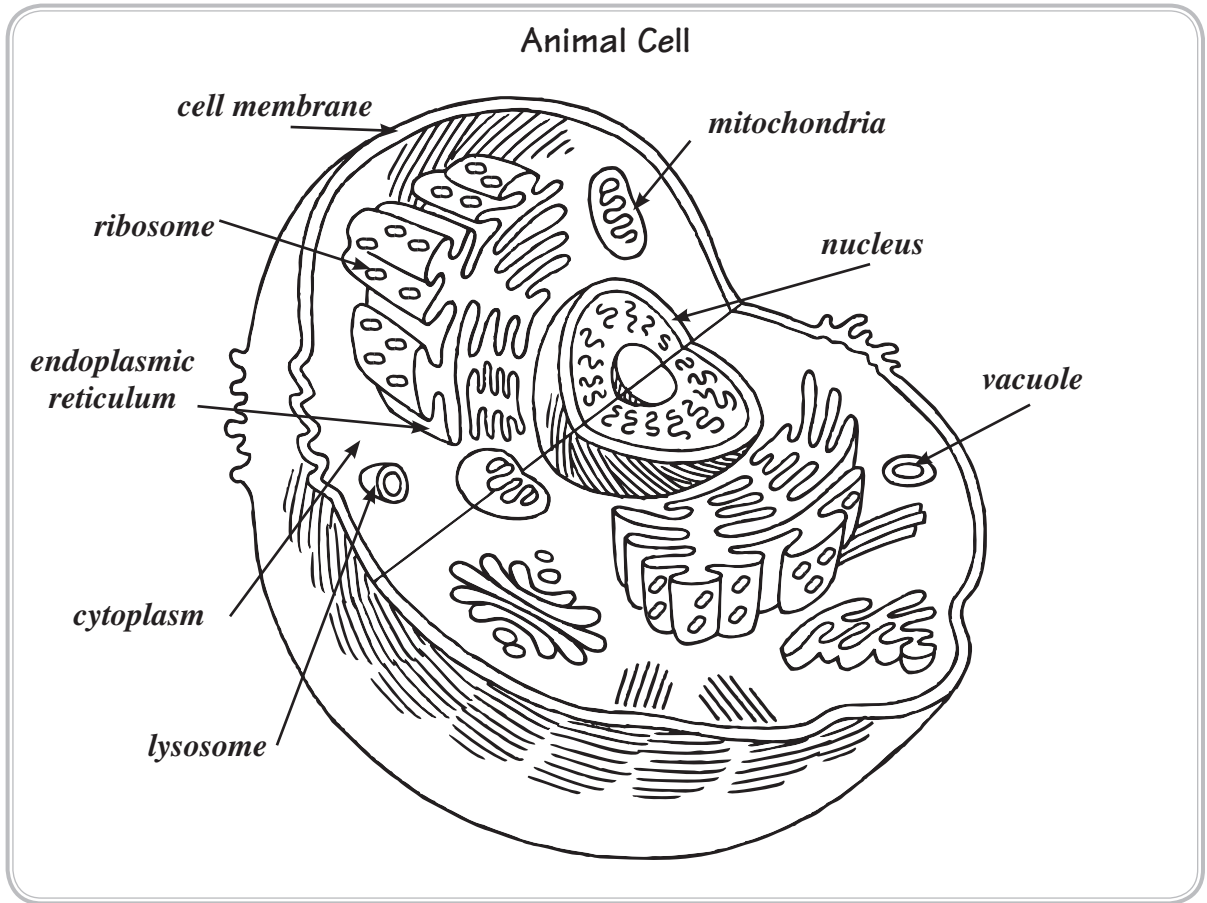
1. organelles
2. nucleus
3. endoplasmic reticulum
4. vacuole
5. ribosome
6. lysosome
7. cytoplasm
8. cell membrane
9. mitochondria
10. diffusion
11. osmosis

Cells

Brief #2: Organelles (cont.)



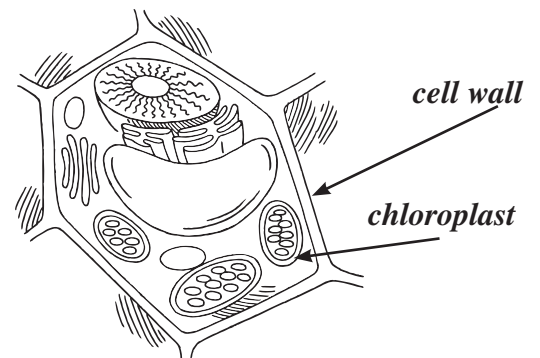
Types of Organelles (cont.)



Differences Between Cells

Not all cells are exactly the same. The job of the particular cells determines what kinds of organelles it will have. For example, muscle cells have a lot of mitochondrion because they need lots of energy to move. But neurons (nerve cells) have lots of dendrites. Dendrites are like the branches of a tree. They are responsible for sending and receiving chemical signals in the central nervous system.

Plant cells are also different from the cells of animals. A plant cell (pictured to the right) has a cell wall that helps the plant to keep its shape. It also has chloroplasts. These organelles contain the chlorophyll that the plant needs to make its own food.



Cells

Brief #2: Organelles (cont.)



Diffusion and Osmosis

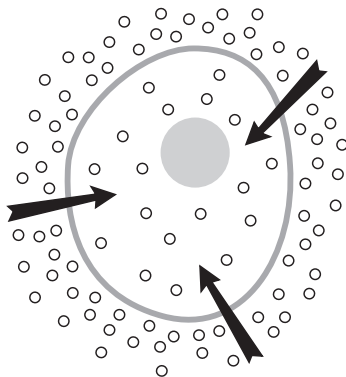
You have learned that the cell membrane is like a barrier, but it also acts like a door. The membrane keeps harmful molecules out of the cell, while allowing helpful molecules, like water and oxygen, into the cell. Cells use two different processes to move molecules in and out of the cell through the membrane.

Generally, substances move from an area of high concentration to an area of low concentration. This process is called diffusion, and it is what happens inside of cells.

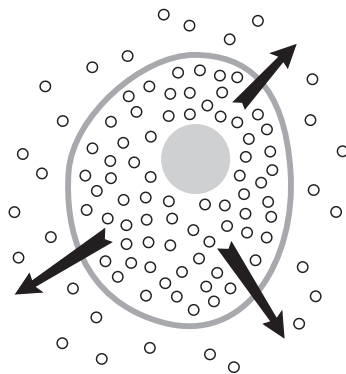
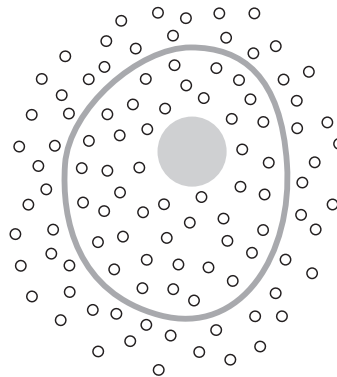
When there is the same amount of molecules on the inside as on the outside of a cell, the cell is in a state of equilibrium. Diffusion can take place with any kind of helpful molecules that pass through the cell membrane. **The process of osmosis works in the same way as diffusion, but osmosis only refers to the movement of water.**

This state of equilibrium is important to the health of the cell. Imagine that the cell is a balloon that is being filled with water or air. If you overfill the balloon with either the gas or the liquid, it will burst. The same thing can happen in cells. The process of diffusion keeps this from happening.

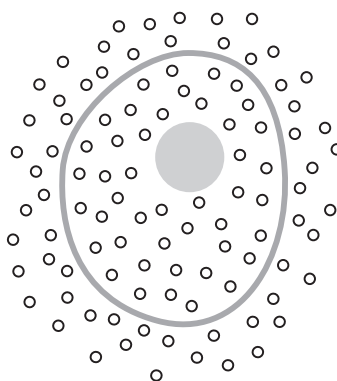
1. *If there are more particles outside the cell...*



2. *they diffuse into the cell until they're evenly distributed.*



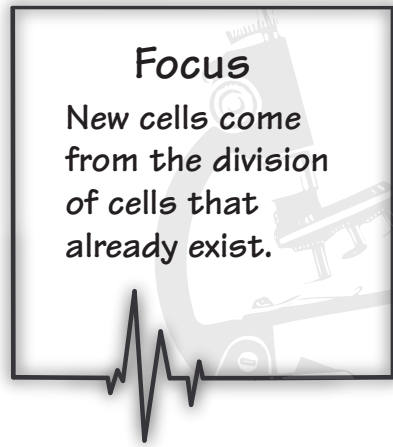
3. *If there are more particles inside the cell...*



4. *they move out of the cell until they're evenly distributed.*

Cells

Brief #3: Cell Division and Reproduction



It is possible that right at this moment you are over four feet tall. You will continue to grow taller and taller as you age until you stop growing at about the age of 21. But what makes you grow taller and taller with each passing year? The answer is the division of your cells.

Cells are very small—so small that they can't be seen without the aid of a microscope. But your cells have to do all of the same things that your body does to keep you healthy. Cells must take in oxygen and food, and they must remove waste products from their systems.

The tiny size of a cell actually makes it possible for the cell to perform all of these functions. Materials that the cell needs can move from organelle to organelle quickly because the distance between each organelle is so small. If cells continued to get bigger and bigger, it would make these processes more difficult.

Vocabulary

1. DNA
2. mitosis
3. chromosomes



The Division of Cells

If a single cell can only grow so big, then how is that multi-cellular organisms, like us, can grow bigger with age? The answer is that each cell in a multi-cellular organism divides. When a cell divides, it produces an exact duplicate of itself. New cells also replace old cells that are worn out.

Inside the nucleus of every cell is DNA. **DNA is a chemical molecule that stores all of the information and instruction about how the organism will grow and develop.** For instance, the DNA of an elephant is different from the DNA of a shark.

Cell division begins with a process called mitosis. **Mitosis means that the cell nucleus, which contains the DNA, divides. The DNA coils and forms tubular structures called chromosomes.**

Chromosomes come in pairs and each living organism has a different number of chromosomes. Human beings have 23 pairs of chromosomes; 46 chromosomes altogether. During mitosis, the nucleus of each new cell receives a full set of chromosomes. Mitosis is complete when the cytoplasm divides. So from one cell, two identical cells are produced. The flow chart on page 22 shows the different steps involved in the production of new cells.

Fast Fact

Average Height of
an American Male:
about 5'9"

Average Height of
an American Female:
about 5'4"

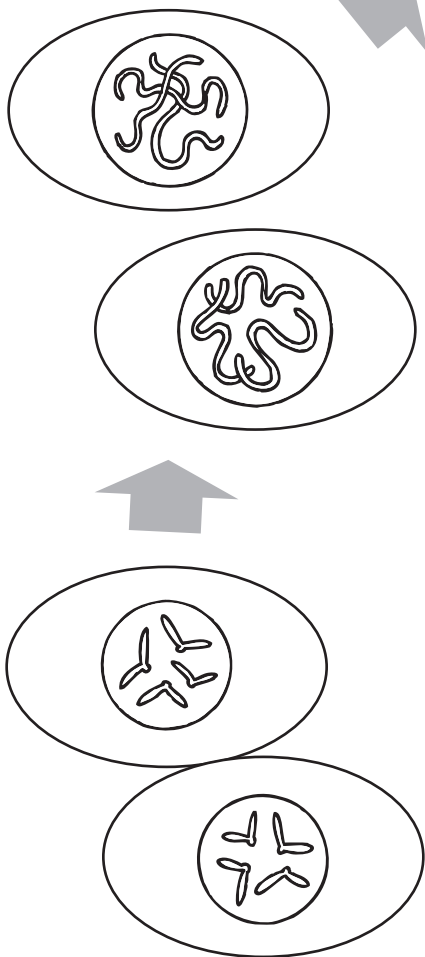
Cells

Brief #3: Cell Division and Reproduction (cont.)

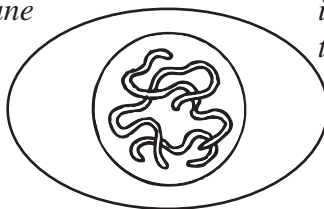


The Division of Cells (cont.)

3. The cytoplasm divided. In animal cells, the cell membrane pinches inward, forming two identical cells. In plant cell, a new cell wall divides one cell into two.

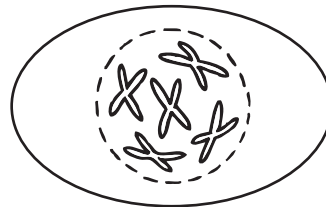


2d. Mitosis is completed as a new membrane forms around each nucleus.

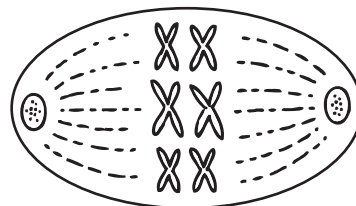


1. The cell makes a copy of its DNA and gets ready to divide.

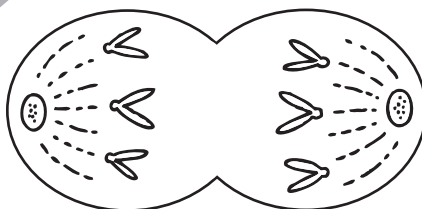
2a. Mitosis begins. Chromosomes become visible and the membrane around the nucleus dissolves.



2b. Pairs of chromosome copies line up at the center of the cell.



2c. Each pair of chromosomes separates, and the two halves move to opposite ends of the cell.



Cells

Multiple-Choice Assessment

Name: _____ Date: _____

Directions: Read each question carefully. Fill in the correct answer circle.

1. Why didn't people know about cells until the 17th century?

- Ⓐ They couldn't see them.
 - Ⓑ Cells didn't exist then.
 - Ⓒ Eye glasses had not been invented.
 - Ⓓ none of these
-

2. What instrument must you use in order to see a cell?

- Ⓐ telescope
 - Ⓑ thermometer
 - Ⓒ barometer
 - Ⓓ microscope
-

3. What did Robert Hooke observe that led him to his theories about cells?

- Ⓐ a human fingernail
 - Ⓑ a human eyelash
 - Ⓒ a piece of cork
 - Ⓓ a spirogyra
-

4. What did van Leeuwenhoek call "animalcules"?

- Ⓐ cork
 - Ⓑ spirogyra
 - Ⓒ flat worms
 - Ⓓ dead cells
-

5. Which of the following is not a part of cell theory?

- Ⓐ All living things are made of cells.
- Ⓑ Cells are the basic units of life.
- Ⓒ Cells are created by osmosis.
- Ⓓ All cells come from existing cells.



Cells

Multiple-Choice Assessment *(cont.)*

6. *Multi-cellular* means

- Ⓐ “having many cells.”
 - Ⓑ “being single-celled.”
 - Ⓒ “plant cells.”
 - Ⓓ “animal cells.”
-

7. What are organelles?

- Ⓐ the cell nucleus
 - Ⓑ different parts of a cell
 - Ⓒ where the DNA is located
 - Ⓓ where the chromosomes are located
-

8. Which of the following is not an organelle?

- Ⓐ DNA molecules
 - Ⓑ ribosome
 - Ⓒ cell membrane
 - Ⓓ vacuole
-

9. What is one of the functions of the cell membrane?

- Ⓐ It produces food.
 - Ⓑ It converts light into energy.
 - Ⓒ It produces waste products.
 - Ⓓ It keeps harmful materials out of the cell.
-

10. Which organelle is responsible for making chemical energy?

- Ⓐ the mitochondria
- Ⓑ the endoplasmic reticulum
- Ⓒ the ribosome
- Ⓓ the cytoplasm



Cells

Multiple-Choice Assessment *(cont.)*

11. What does a plant cell have that an animal cell does not have?

- Ⓐ organelles
 - Ⓑ cytoplasm
 - Ⓒ nucleus
 - Ⓓ chloroplasts
-

12. Diffusion is the movement of substances

- Ⓐ from an area of low concentration to an area of high concentration.
 - Ⓑ from a cool area to a warm area.
 - Ⓒ from an area of high concentration to an area of low concentration.
 - Ⓓ none of these
-

13. *Osmosis* refers to

- Ⓐ the movement of carbon through a cell.
 - Ⓑ the movement of water through a cell.
 - Ⓒ the movement of oxygen through a cell.
 - Ⓓ the division of the cell nucleus.
-

14. How are new cells produced?

- Ⓐ by osmosis
 - Ⓑ by cell division
 - Ⓒ by diffusion
 - Ⓓ by recombining DNA
-

15. What is DNA?

- Ⓐ a type of cell
- Ⓑ a type of nucleus
- Ⓒ a type of chromosome
- Ⓓ a type of chemical molecule



Cells

Multiple-Choice Assessment *(cont.)*

16. The division of the cell nucleus is called

- Ⓐ osmosis.
 - Ⓑ mitosis.
 - Ⓒ diffusion.
 - Ⓓ collision.
-

17. DNA is formed into

- Ⓐ molecules.
 - Ⓑ cells.
 - Ⓒ chromosomes.
 - Ⓓ none of these.
-

18. When a cell divides, each new cell receives

- Ⓐ one chromosome each.
 - Ⓑ improved chromosomes.
 - Ⓒ a shared nucleus.
 - Ⓓ a full set of chromosomes.
-

19. What signals the completion of mitosis?

- Ⓐ the cytoplasm divides
 - Ⓑ the chromosomes are formed
 - Ⓒ old cells die
 - Ⓓ DNA is expanded
-

20. How many pairs of chromosomes do people have?

- Ⓐ 10
- Ⓑ 15
- Ⓒ 46
- Ⓓ 23



Cells

Sentence-Completion Assessment

Name: _____ Date: _____

Directions: Read each statement. Fill in the word or words that best complete the sentence.

1. People first saw cells in the _____ century.
2. In order to see a cell you need to use a _____ .
3. Robert Hooke observed a piece of _____ under a microscope.
4. Anton van Leeuwenhoek called the spirogyra he observed _____ .
5. Scientists developed a _____ about the function of cells and how they reproduce.
6. _____ means an organism that has many cells.
7. An _____ is a part of the cell with a specific job to perform.
8. A _____ stores and moves water around the cell.
9. The _____ is kind of like the skin of the cell.
10. The _____ is responsible for making chemical energy.
11. Chloroplasts can be found only in _____ cells.



Cells

Sentence-Completion Assessment *(cont.)*

12. The movement of substances from an area of high concentration to an area of low concentration is called _____ .
13. The movement of water through a cell is called _____ .
14. New cells are produced when existing cells _____ .
15. The chemical molecule that contains the cell's instructions is called _____ .
16. The division of the cell nucleus is called _____ .
17. _____ are formed from DNA.
18. Mitosis is complete when the _____ divides.
19. Humans have _____ pairs of chromosomes.
20. The _____ is an organelle that digests worn-out organelles.



Cells

True-False Assessment

Name: _____ Date: _____

Directions: Read each statement carefully. If the statement is true, put a **T** on the line provided. If the statement is false, put an **F** on the line provided.

- _____ 1. Cells can only be seen though a microscope.
- _____ 2. Robert Hooke observed the dead cells of cork in the 17th century.
- _____ 3. *Animalcules* is Latin for animal.
- _____ 4. Cells are the basic units of life.
- _____ 5. “Multi-cellular” means having two cells.
- _____ 6. Organelles are plant cells.
- _____ 7. A ribosome is a type of organelle.
- _____ 8. Animal cells have cell walls.
- _____ 9. The mitochondria is responsible for producing chemical energy in a cell.
- _____ 10. Plant cells have chloroplasts.



Cells

True-False Assessment *(cont.)*

- _____ 11. Diffusion is the movement of water through cells.
- _____ 12. Osmosis is when the nucleus of a cell divides.
- _____ 13. New cells are produced by the division of existing cells.
- _____ 14. DNA is a chemical molecule.
- _____ 15. Osmosis is the movement of water through the cell membrane.
- _____ 16. Chromosomes are formed from DNA.
- _____ 17. New cells receive a full set of chromosomes.
- _____ 18. Mitosis is complete when the cell membrane collapses.
- _____ 19. Humans have 23 pairs of chromosomes.
- _____ 20. The endoplasmic reticulum digests worn out organelles.



Cells

Matching Assessment

Name: _____ Date: _____

Directions: Read the items in both lists below and on page 32 carefully. Choose an item from List B that best matches an item from List A. Write the corresponding letter from List B on the line. You will have some left over.

List A	List B
_____ 1. size of cells	A. smallest unit of life
_____ 2. Hooke observation	B. chromosomes
_____ 3. animalcules	C. cell theory
_____ 4. ideas about cells	D. spirogyra
_____ 5. many-celled	E. DNA
_____ 6. organelles	F. endoplasmic reticulum
_____ 7. vacuole	G. completion of mitosis
_____ 8. cell membrane	H. energy generator
_____ 9. mitochondria	I. multi-cellular
_____ 10. plant cell part	J. division of nucleus
_____ 11. high to low concentration	K. Anton van Leeuwenhoek
_____ 12. osmosis	L. cell skin



Cells

Matching Assessment *(cont.)*

List A	List B
_____ 13. production of new cells	M. division
_____ 14. chemical molecule	N. chloroplast
_____ 15. mitosis	O. water movement
_____ 16. tubular DNA	P. diffusion
_____ 17. cytoplasm division cells	Q. digests worn cells
_____ 18. 23 in humans	R. pairs of chromosomes
_____ 19. lysosome job	S. cork cells
_____ 20. cell	T. water storage
	U. microscopic
	V. cell parts

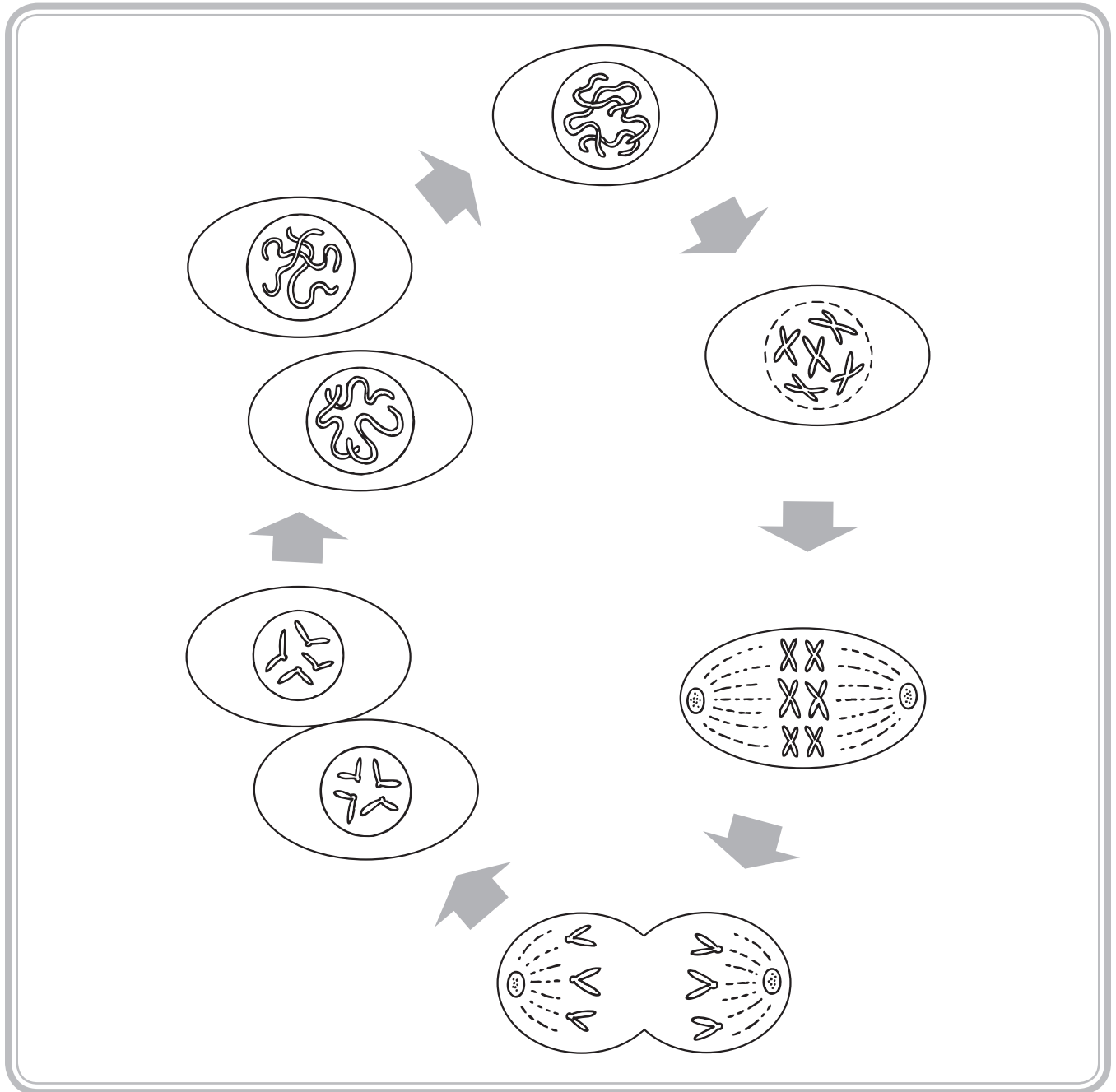


Cells

Graphic Assessment

Name: _____ Date: _____

Directions: Look carefully at the flow chart below. Describe what is happening in each illustration.



Cells

Short-Response Assessment

Name: _____ Date: _____

Directions: Read each question carefully. Write a short response of a few sentences to each question.

1. What is cell theory? Explain how it evolved over time.

2. Explain the relationship between technology and scientific discovery.

3. Describe diffusion and osmosis.

4. Describe the process of mitosis.



Short-Response Rubric

Criteria	Possible Points	Score
The response is 4 to 6 sentences long.	25	
The response conforms to the standard conventions of grammar and spelling.	25	
The response answers the questions posed.	25	
The response contains enough details and elaboration to fully answer the question.	25	

Answer Key

Unit #1

Multiple Choice (pages 23–26)

1. A
2. D
3. C
4. B
5. C
6. A
7. B
8. A
9. D
10. A
11. D
12. C
13. B
14. B
15. D
16. B
17. C

18. D

19. A

20. D

Sentence Completion (pages 27–28)

1. 17th
2. microscope
3. cork
4. animalcules
5. theory
6. Multi-cellular
7. organelle
8. vacuole
9. cell membrane
10. mitochondria
11. plant
12. diffusion
13. osmosis
14. divide

15. DNA

16. mitosis

17. Chromosomes

18. cytoplasm

19. 23

20. lysosome

True-False (pages 29–30)

- | | |
|-------|-------|
| 1. T | 11. F |
| 2. T | 12. F |
| 3. F | 13. T |
| 4. T | 14. T |
| 5. F | 15. T |
| 6. F | 16. T |
| 7. T | 17. T |
| 8. F | 18. F |
| 9. T | 19. T |
| 10. T | 20. F |

Answer Key (cont.)

Matching (pages 31–32)

1. U
2. S
3. D
4. C
5. I
6. V
7. T
8. L
9. H
10. N
11. P
12. O
13. M
14. E
15. J
16. B
17. G
18. R
19. Q
20. A

Graphic (page 33)

Compare answers to chart on page 22. Consult rubric on page 213.

Short Response (page 34)

1. Cell theory explains what cells are and where they come from. Cell theory states that all living things are made of cells, cells are the basic units of living things, and all cells come from existing cells. Cell theory has evolved over time. Because cells are too small to be seen by the naked eye, the inventions of better and more powerful microscopes have led to an increasing understanding of cells. This progress should only continue as

our scientific technology improves.

2. Give students credit for all well-supported answers.
3. Cells use two different processes to move molecules in and out of the cell through the membrane. In a cell, substances move from an area of high concentration to an area of low concentration by process called *diffusion*. When there is the same amount of molecules on the inside as on the outside of a cell, the cell is in a state of equilibrium. Diffusion can take place with any kind of molecules that pass through the cell membrane. Osmosis works the same way as diffusion, but osmosis only refers to the movement of water.
4. *Mitosis* means that the cell nucleus, which contains the DNA, divides. The DNA coils and forms tubular structures called chromosomes. During mitosis, the nucleus of each new cell receives a full set of chromosomes. Mitosis is complete when the cytoplasm divides, so from one cell two new identical cells are produced.

Unit #2

Multiple Choice (pages 49–53)

1. D
2. D
3. D
4. C
5. A

6. C
7. B
8. D
9. B
10. A
11. D
12. C
13. B
14. A
15. C
16. B
17. A
18. D
19. D
20. B
21. A
22. D
23. A
24. C
25. C

Sentence Completion (pages 54–55)

1. asexual
2. sexual
3. fission
4. budding
5. fragmentation
6. egg
7. sperm
8. chromosomes
9. meiosis
10. egg, sperm
11. zygote
12. pollen
13. stamen
14. pistil
15. DNA
16. double helix
17. genes
18. A, T, G, C