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# 7.1 Life Is Cellular

## Lesson Objectives

- State the cell theory.
- Describe how the different types of microscopes work.
- Distinguish between prokaryotes and eukaryotes.

## Lesson Summary

**The Discovery of the Cell** The invention of the microscope in the 1600s enabled researchers to see cells for the first time.

- Robert Hooke named the empty chambers he observed in cork "cells."
- Anton van Leeuwenhoek was the first to observe living microorganisms.
- **Cells** are the basic units of life.
- Discoveries by German scientists Schleiden, Schwann, and Virchow led to the development of the **cell theory,** which states:
  - All living things are made of cells.
  - Cells are the basic units of structure and function in living things.
  - New cells are produced from existing cells.

**Exploring the Cell** Scientists use light microscopes and electron microscopes to explore the structure of cells.

- Compound light microscopes have lenses that focus light. They magnify objects by up to 1000 times. Chemical stains and fluorescent dyes make cell structures easier to see.
- Electron microscopes use beams of electrons focused by magnetic fields. They offer much higher resolution than light microscopes. There are two main types of electron microscopes—transmission and scanning. Scientists use computers to add color to electron micrographs, which are photos of objects seen through a microscope.

**Prokaryotes and Eukaryotes** Cells come in an amazing variety of shapes and sizes, but all cells contain DNA. Also, all cells are surrounded by a thin flexible barrier called a **cell membrane.** There are two basic categories of cells based on whether they contain a nucleus. The **nucleus** (plural: nuclei) is a large membrane-enclosed structure that contains DNA.

- **Eukaryotes** are cells that enclose their DNA in nuclei.
- **Prokaryotes** are cells that do not enclose their DNA in nuclei.

## The Discovery of the Cell

*For Questions 1–6, complete each statement by writing the correct word or words.*

**1.** The invention of the _____ made the discovery of cells possible.

**2.** Robert Hooke used the name _____ to refer to the tiny empty chambers he saw when he observed magnified cork.

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**3.** German botanist Matthias Schleiden concluded that _____ are made of cells.

**4.** German biologist Theodor Schwann concluded that _____ are made of cells.

**5.** Rudolph Virchow concluded that new cells are produced from _____.

**6.** The _____ combines the conclusions made by Schleiden, Schwann, and Virchow.

## Exploring the Cell

*For Questions 7–9, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.*

_____ **7.** The size of the image formed by a light microscope is unlimited because light that passes through matter is diffracted.

_____ **8.** Fluorescent dyes help scientists see the movement of compounds and structures in living cells.

_____ **9.** Transmission electron microscopes form a 3-D image of the surface of a specimen.

**10.** **THINK VISUALLY** In the second row of the table, draw diagrams to show how a sample of three yeast cells would look in the types of micrographs indicated in the top row of the table. Then, in the third row, describe how each image would be formed.

| A Comparison of Detail in Basic Types of Micrographs | | |
|---|---|---|
| **Light Micrograph** (LM 500x) | **Transmission Electron Micrograph** (TEM 4375x) | **Scanning Electron Micrograph** (SEM 3750x) |
| | | |
| A light microscope image is formed by _____ _____ _____. | A transmission electron micro-scope image is formed by _____ _____ _____. | A scanning electron micro-scope image is formed by a _____ _____ _____. |

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**11.** To study cells with a light microscope, different types of stains are usually available. Why is it generally more useful to stain eukaryotic cells than prokaryotic cells?

## Prokaryotes and Eukaryotes

**12.** Complete the table about the two categories of cells.

| Two Categories of Cells | | | |
|---|---|---|---|
| **Category** | **Definition** | **Size range** | **Examples** |
| Prokaryotic cells | | | |
| Eukaryotic cells | | | |

**13.** Which category of cells—prokaryotic or eukaryotic—is your body composed of?

### Apply the Big idea

**14.** Recall that in science, a theory is a well-tested explanation that unifies a broad range of observations and hypotheses and enables scientists to make accurate predictions about new situations. How does the cell theory demonstrate this definition of theory?

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# 7.2 Cell Structure

## Lesson Objectives

- Describe the structure and function of the cell nucleus.
- Describe the role of vacuoles, lysosomes, and the cytoskeleton.
- Identify the role of ribosomes, endoplasmic reticulum, and Golgi apparatus in making proteins.
- Describe the function of the chloroplasts and mitochondria in the cell.
- Describe the function of the cell membrane.

## Lesson Summary

**Cell Organization** Eukaryotic cells contain a nucleus and many specialized structures.

- **Cytoplasm** is the fluid portion of a cell.
- **Organelles** are structures that have specialized functions in eukaryotic cells.
- The nucleus contains DNA and controls the activity of a cell.

**Organelles That Store, Clean Up, and Support** These structures include:

- **vacuoles:** membrane-enclosed saclike structures that store water, salts, and organic molecules
- **lysosomes:** small organelles filled with enzymes that break down large molecules and organelles that are no longer useful
- the **cytoskeleton:** a network of protein filaments; it helps the cell maintain its shape and is involved in movement
- **centrioles:** organelles made from tubulins; they help organize cell division in animal cells

**Organelles That Build Proteins** Three kinds of organelles work with the nucleus to make and distribute proteins:

- **ribosomes:** small particles of RNA and protein found throughout the cytoplasm in all cells; they produce proteins by following coded instructions from DNA
- the **endoplasmic reticulum (ER):** an internal membrane system where lipid components of the cell membrane are assembled, along with proteins and other materials
- the **Golgi apparatus:** an organelle that appears as a stack of flattened membranes; it modifies, sorts, and packages proteins and other materials from the ER for storage in the cell or release outside the cell

**Organelles That Capture and Release Energy** Two types of organelles act as power plants of the cells. Both types are surrounded by two membranes.

- **Chloroplasts** capture the energy from sunlight and convert it into food that contains chemical energy in a process called photosynthesis. Cells of plants and some other organisms contain chloroplasts, which contain chlorophyll.
- **Mitochondria** are found in nearly all eukaryotic cells; they convert the chemical energy stored in food to a usable form.

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**Cellular Boundaries** All cells are surrounded by a cell membrane. Many cells also have a cell wall. Both cell membranes and cell walls separate cells from the environment and provide support.

- **Cell walls** support, shape, and protect the cell. Most prokaryotes and many eukaryotes have them. Animals do not have cell walls. Cell walls lie outside the cell membrane. Most cell walls allow materials to pass through them.
- A cell membrane consists of a **lipid bilayer,** a strong but flexible barrier between the cell and its surroundings. The cell membrane regulates what enters and leaves the cell and also protects and supports the cell. Most biological membranes are **selectively permeable,** allowing some substances, but not others, to pass across them.

## Cell Organization

**1.** Describe the relationship between the cytoplasm and the nucleus of a cell.

_____

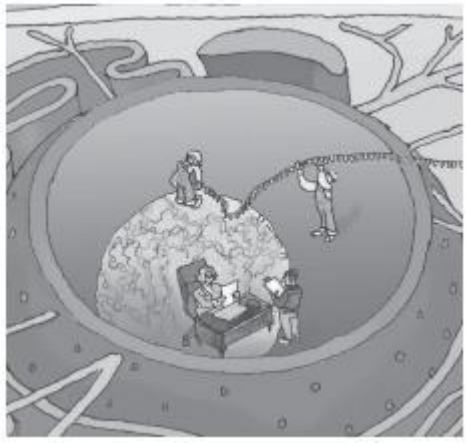
_____

_____

**2.** What does the term *organelle* mean literally?

_____

*For Questions 3–5, refer to the Visual Analogy comparing the cell with a factory.*



**3.** **VISUAL ANALOGY** In the visual analogy of a cell as a factory, what two functions of the nucleus are represented? How are these functions illustrated?

_____

_____

_____

_____

_____

_____

_____

**4.** Which feature of the nucleus is *not* clearly shown by the visual analogy?

_____

**5.** What is another possible analogy that could be compared with the structure and function of a cell? _____

_____

_____

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# Organelles That Store, Clean Up, and Support

**6.** What are vacuoles?

_____

_____

**7.** What are the two roles of the central vacuole in plant cells?

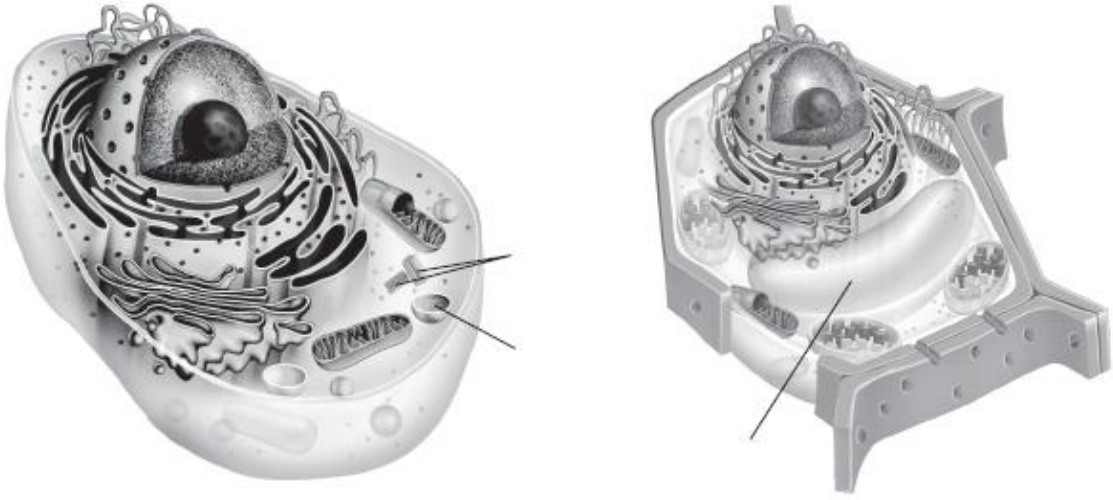
_____

**8.** How are contractile vacuoles different from other types of vacuoles?

_____

_____

**9.** In the diagrams of the animal cell and the plant cell, label the structures indicated by the lines.



**10.** What is the role of lysosomes in the cell? Why is this a vital role?

_____

_____

_____

**11.** Which structures of the cytoskeleton are found in animal cells but not in plant cells?

_____

**12.** What other structures of the cytoskeleton would show the same pattern of microtubules as a flagellum?

_____

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## Organelles That Build Proteins

**13.** What are ribosomes? What do they do?

**14.** In which organelle are the lipid components of the cell membrane assembled?

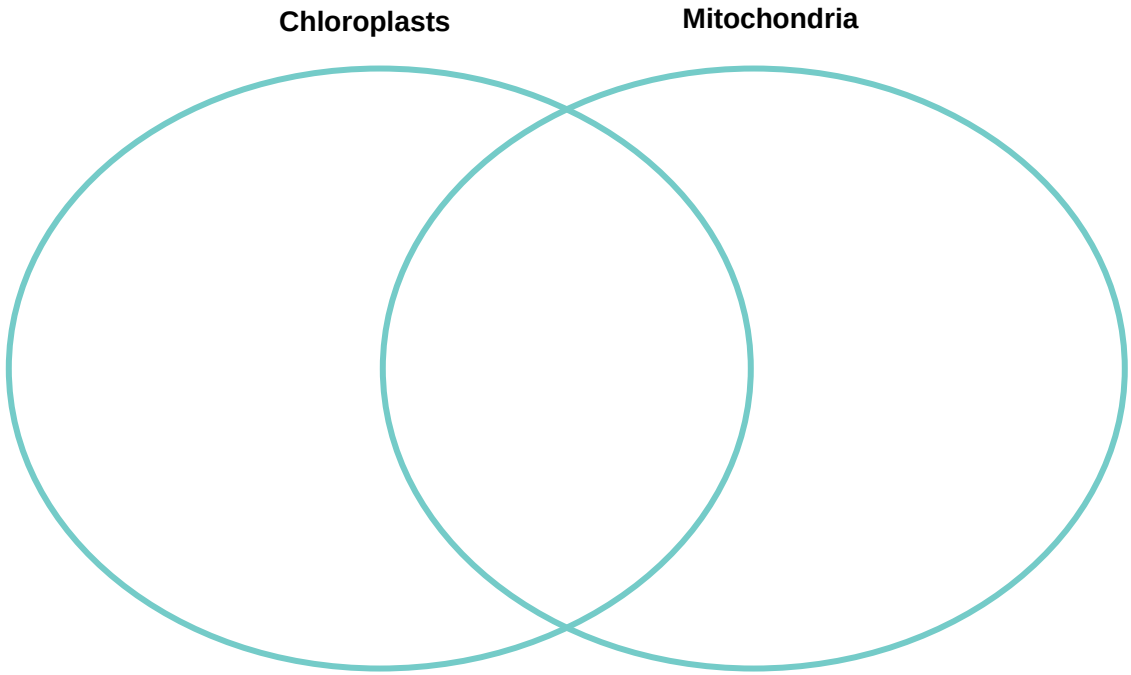
**15.** What is the difference between rough ER and smooth ER?

**16.** Using the cell as a factory analogy, describe the role of the Golgi apparatus in cells.

**17.** Suppose a cell's Golgi apparatus does not function properly. How might this problem affect other cells?

## Organelles That Capture and Release Energy

**18.** Complete the Venn diagram to compare and contrast chloroplasts and mitochondria.



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*For Questions 19–22, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.*

_____ **19.** Chloroplasts are <u>never</u> found in animal cells.

_____ **20.** <u>Unlike</u> chloroplasts, mitochondria are surrounded by a double membrane.

_____ **21.** Nearly all of the <u>mitochondria</u> in your cells were inherited from your mother.

_____ **22.** Both chloroplasts and mitochondria <u>lack</u> genetic information in the form of DNA.

## Cellular Boundaries

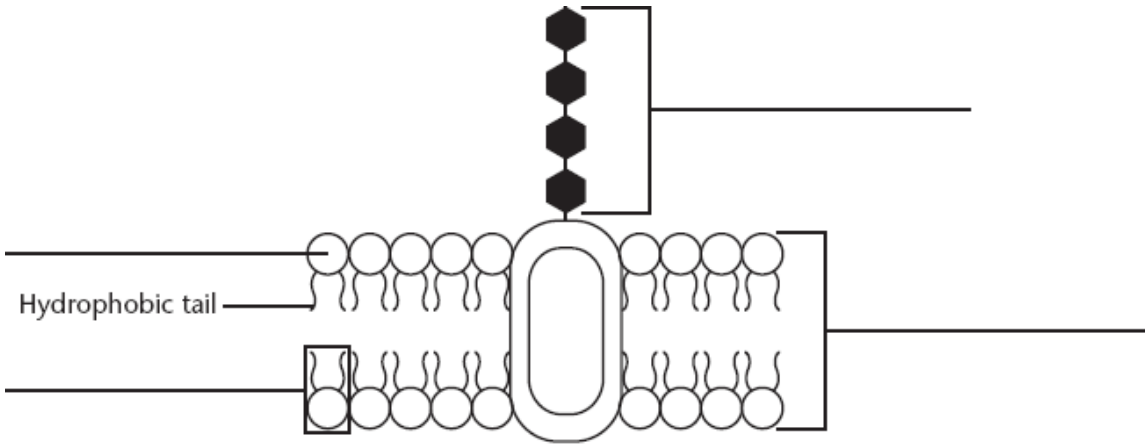
*For Questions 23–25, complete each statement by writing the correct word or words.*

**23.** Most cell _____ are porous to water and other materials but strong enough to support and protect cells.

**24.** Nearly all of the plant tissue called _____ is made up of cell walls.

**25.** Besides supporting and protecting a cell, the cell membrane _____ what enters and leaves the cell.

**26.** Complete the diagram of a section of a cell membrane. Then, on the line below the diagram, write the name of the model that describes the cell membrane's structure.




### Apply the Big idea

**27.** What is the function of vesicles in the synthesis of proteins and the release of those proteins outside the cell?

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# 7.3 Cell Transport

## Lesson Objectives

- Describe passive transport.
- Describe active transport.

## Lesson Summary

**Passive Transport** The movement of materials across the cell membrane without using cellular energy is called passive transport.

- **Diffusion** is the process by which particles move from an area of high concentration to an area of lower concentration.
- **Facilitated diffusion** is the process by which molecules that cannot directly diffuse across the membrane pass through special protein channels.
- **Osmosis** is the facilitated diffusion of water through a selectively permeable membrane.
  - **Aquaporins** are water channel proteins that allow water to pass through cell membranes.
  - Two adjacent solutions are **isotonic** if they have the same concentrations of solute.
  - **Hypertonic** solutions have a higher concentration of solute compared to another solution.
  - **Hypotonic** solutions have a lower concentration of solute compared to another solution.
- **Osmotic pressure** is the force caused by the net movement of water by osmosis.

**Active Transport** The movement of materials against a concentration difference is called active transport. Active transport requires energy.

- Transport proteins that act like pumps use energy to move small molecules and ions across cell membranes.
- The bulk transport of large molecules and clumps of materials into and out of cells occurs by movements of the cell membrane, which require energy.

## Passive Transport

*For Questions 1–4, write the letter of the correct answer on the line at the left.*

_____ **1.** Which of the following must be true for diffusion to occur?

**A.** Molecules or particles must have different sizes.

**B.** Special protein channels must always be available.

**C.** There must be areas of different concentrations.

**D.** Energy must be available.

Name_____ Class_____ Date_____

_____ **2.** Which term refers to the condition that exists when *no* net change in concentration results from diffusion?

**A.** concentration **C.** osmosis

**B.** equilibrium **D.** randomness

_____ **3.** Air has a higher concentration of oxygen molecules than does the cytoplasm of your lung cells. Where in your lungs will there be a net increase of oxygen?

**A.** in the air breathed in **C.** outside of the lung cells

**B.** in the air breathed out **D.** inside of the lung cells

_____ **4.** Which of the following statements tells how facilitated diffusion differs from simple diffusion?

**A.** Particles move through cell membranes without the use of energy by cells.

**B.** Particles tend to move from high concentration to lower concentration.

**C.** Particles move within channel proteins that pass through cell membranes.

**D.** Particles tend to move more slowly than they would be expected to move.

*For Questions 5–7, match the situation with the result. Write the letter of the correct answer on the line at the left.*

| Situation | Result |
|---|---|
| _____ **5.** Cells are in an isotonic solution. | **A.** The cells lose water. |
| _____ **6.** Cells are in a hypertonic solution. | **B.** The cells gain water. |
| _____ **7.** Cells are in a hypotonic solution. | **C.** The cells stay the same. |

**8.** **THINK VISUALLY** In the table below, draw how each type of cell will look after being placed in a hypertonic solution.

| Appearance of Cells in a Hypertonic Solution | |
|---|---|
| **Animal Cells** | **Plant Cells** |
| | |

Name_____ Class_____ Date_____

## Active Transport

**9.** What is the function of active transport in moving small molecules and ions across cell membranes? Give an example.

**10.** How does ATP enable transport proteins to move ions across a cell membrane?

**11.** What are the proteins used in active transport called?_____

**12.** Complete the table to summarize the types of bulk transport.

| Types of Bulk Transport | |
|---|---|
| **Type** | **Description** |
| Endocytosis | |
| Phagocytosis | |
| Exocytosis | |

## Apply the Big idea

**13.** Most sports drinks are isotonic in relation to human body fluids. Explain why athletes should drink solutions that are isotonic to body fluids when they exercise rather than ones that are hypotonic to body fluids (contain a greater proportion of water in comparison to the fluids in and around human body cells).

Name_____ Class_____ Date_____

# 7.4 Homeostasis and Cells

## Lesson Objectives

- Explain how unicellular organisms maintain homeostasis.
- Explain how multicellular organisms maintain homeostasis.

## Lesson Summary

**The Cell as an Organism** Sometimes a single cell is an organism. Single-celled organisms must be able to carry out all the functions necessary for life.

- Unicellular organisms maintain **homeostasis,** relatively constant internal conditions, by growing, responding to the environment, transforming energy, and reproducing.
- Unicellular organisms include both prokaryotes and eukaryotes.
- Unicellular organisms play many important roles in their environments.

**Multicellular Life** Cells of multicellular organisms are interdependent and specialized.

- The cells of multicellular organisms become specialized for particular tasks and communicate with one another to maintain homeostasis.
- Specialized cells in multicellular organisms are organized into groups.
  - A **tissue** is a group of similar cells that performs a particular function.
  - An **organ** is a group of tissues working together to perform an essential task.
  - An **organ system** is a group of organs that work together to perform a specific function.
- The cells of multicellular organisms communicate with one another by means of chemical signals that are passed from one cell to another.
  - Certain cells form connections, or cellular junctions, to neighboring cells. Some of these junctions hold cells together firmly.
  - Other cells allow small molecules carrying chemical signals to pass directly from one cell to the next.
  - To respond to a chemical signal, a cell must have a **receptor** to which the signaling molecule can bind.

## The Cell as an Organism

*For Questions 1–5, complete each statement by writing the correct word or words.*

1. The term _____ refers to the relatively constant internal physical and chemical state of a living cell.
2. Unicellular prokaryotes, called _____, are adapted to living in a remarkable number of different places.
3. Some unicellular eukaryotes, called _____, contain chloroplasts.
4. Yeasts are unicellular _____, which are eukaryotes.
5. Other unicellular eukaryotes include _____ and algae.

Name_____ Class_____ Date_____

**6.** How do single-celled organisms maintain homeostasis?

**7.** Why is maintaining homeostasis particularly important to single-celled organisms?

## Multicellular Life

**8.** How are the cells of a multicellular organism like a baseball team?

**9.** How does a multicellular organism maintain homeostasis?

**10.** Complete the table by describing the functions of the specialized cells.

| Examples of Specialized Cells | | |
|---|---|---|
| **Type of Cell** | **Name of Specialized Cell Part** | **Function of Specialized Cell Part** |
| cells that line the upper air passages in humans | cilia | |
| pine pollen grains | wings | |

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**11.** The Venn diagram below consists of four concentric circles. Complete the diagram to show the relationships among four levels of organization of life. Use the terms *cells*, *organ*, *organ system*, and *tissue*.

**12.** Starting with the outermost circle of the diagram, explain how each level is related to the next level within each circle.

_____

_____

_____

**13.** What is the name of the areas that hold adjacent cells together and enable them to communicate?

_____

## Apply the Big idea

**14.** On the Venn diagram above, where would you add a circle that represents the organism level of life? Where would you add a circle that represents another organ of the same organ system?

_____

_____

_____

_____

_____

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# Chapter Vocabulary Review

*For Questions 1–4, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.*

_____ **1.** All cells are surrounded by a cell wall.

_____ **2.** The flexible nature of a cell membrane results from its channel proteins.

_____ **3.** Selectively permeable membranes allow only certain materials to pass through them.

_____ **4.** Centrioles are found in animal cells.

*For Questions 5–11, match the organelle with its description.*

**Organelle**

_____ **5.** Ribosomes

_____ **6.** Endoplasmic reticulum

_____ **7.** Golgi apparatus

_____ **8.** Lysosomes

_____ **9.** Vacuoles

_____ **10.** Chloroplasts

_____ **11.** Mitochondria

**Description**

**A.** Convert energy from sunlight into chemical energy that is stored in food

**B.** Stack of membranes that modifies, sorts, and packages proteins and other materials for storage or release

**C.** Convert chemical energy stored in food into a form that can be easily used by the cell

**D.** An internal membrane system where lipid components of cell membranes are made

**E.** Saclike structures that store materials

**F.** Small particles of RNA and protein on which proteins are assembled using instructions from DNA

**G.** Filled with enzymes used to break down carbohydrates into smaller molecules

*For Questions 12–15, complete each statement by writing the correct word or words.*

**12.** Osmosis occurs through water channel proteins called _____.

**13.** The force created by the net movement of water through a cell membrane is called _____ pressure.

**14.** Red blood cells are able to maintain homeostasis because they are bathed in blood, which is _____ to the fluid in the cells themselves.

**15.** To respond to a chemical signal, a cell must have a _____ to which the signaling molecule can bind.