Name Period Date

SECTION 3.1

CELL THEORY

Reinforcement

KEY CONCEPT Cells are the basic unit of life.

The invention of the microscope in the late 1500s revealed to early scientists a whole new world of tiny cells. Most cells are so small that they cannot be seen without a microscope. The discoveries of scientists from the 1600s through the 1800s led to the cell theory, which is a unifying concept of biology. The **cell theory** has three major principles:

- All organisms are made of cells.
- All existing cells are produced by other living cells.
- The cell is the most basic unit of life.

All cells can be divided into two major groups: **prokaryotic cells** or **eukaryotic cells.** The main differences between the two kinds of cells are in their structure:

- Eukaryotic cells have a nucleus defined by a membrane, while prokaryotic cells have no nucleus.
- In eukaryotic cells, the DNA, or genetic information, is found in the nucleus. In prokaryotic cells, the DNA is found in the **cytoplasm,** the jellylike substance that fills both types of cells.
- Eukaryotic cells have **organelles,** structures that perform jobs for a cell. Most organelles are surrounded by membranes. Prokaryotic cells do not have organelles surrounded by membranes.

Prokaryotic cells make up organisms called prokaryotes. All prokaryotes are tiny and consist of single cells. Bacteria are prokaryotic cells. Eukaryotic cells make up eukaryotes. You are a eukaryote, as are plants and some types of single-celled organisms. All multicellular organisms, or organisms that have many cells, are eukaryotes.

1. What is the smallest, most basic unit of life?

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2. Where is the DNA in a prokaryote? in a eukaryote?

_____

3. Why would you need a microscope to see a prokaryotic organism?

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4. A friend tells you he read somewhere that rotting garbage can turn into maggots, which are fly larvae, and the maggots then can grow into adult flies. What part of the cell theory could you use to refute his claim?

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SECTION 3.2

CELL ORGANELLES

Reinforcement

KEY CONCEPT Eukaryotic cells share many similarities.

Plants, animals, and some single-celled organisms are eukaryotes. Eukaryotic cells have an organized internal structure and organelles that are surrounded by membranes. Organelles look different from each other and have different functions. Several have a specific job in making and processing proteins so that a cell can live, function, and reproduce. Plant and animal cells have a lot of the same parts, but a few of their parts are different. The list below tells you what each cell part does.

Part	Job and Description
nucleus	double membrane layer that stores and protects DNA; includes the nucleolus, a dense region where ribosomes are assembled.
endoplasmic reticulum (ER)	network of thin folded membranes that help produce proteins and lipids; two kinds of ER: smooth and rough
ribosomes	tiny round organelles that link amino acids together to form proteins; may be in the cytoplasm or on the ER, which makes it look rough
Golgi apparatus	stacked layers of membranes that sort, package, and deliver proteins
vesicles	little sacs that carry different molecules where they're needed; made and broken down as needed by the cell
mitochondria	bean-shaped organelles that release energy from sugars for the cell
centrioles	found in animal cells; organize microtubules to form cilia and flagella
vacuoles	sacs that store materials for the cell; the materials might be water, food molecules, ions, and enzymes
cell walls	strong layer that protects, supports, and gives shape to plant cells; not found in animal cells
chloroplasts	change energy from the sun into chemical energy for the plant; not found in animal cells
cytoplasm	jellylike substance that fills a cell
cell membrane	double-layer of phospholipids that forms a boundary between a cell and its surrounding environment
lysosomes	membrane-bound organelles that contain enzymes

1. What are two characteristics of eukaryotic cells?

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2. What is the function of mitochondria?

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3. What two organelles are found in plant cells but not in animal cells?

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SECTION 3.3

CELL MEMBRANE

Reinforcement

KEY CONCEPT The cell membrane is a barrier that separates a cell from the external environment.

The **cell membrane** forms a boundary that separates the inside of a cell from the outside environment. It plays an active role by controlling the passage of materials into and out of a cell and by responding to signals. The membrane is made of molecules called **phospholipids,** which consist of three parts: (1) a charged phosphate group; (2) glycerol; (3) two fatty acid chains.

The structure of phospholipids gives them distinct chemical properties. The phosphate group and glycerol form a polar "head." The fatty acid chains form a nonpolar "tail." Cells are both surrounded by water and contain water. In the cell membrane, phospholipids form a double layer, or bilayer. In this way, the polar heads interact with the polar water molecules outside and inside a cell. The nonpolar tails are sandwiched together inside the bilayer, away from the water.

The cell membrane also includes a variety of molecules that give the membrane properties it would not otherwise have.

- Cholesterol molecules make the membrane stronger.
- Proteins help molecules and ions cross the membrane and can act as **receptors,** proteins that detect a signal and respond by performing an action.
- Carbohydrates help cells distinguish one cell type from another.

The **fluid mosaic model** describes the characteristics and makeup of the cell membrane. The phospholipids can slip past each other like a fluid. The membrane is made up of many different molecules, like a mosaic.

The cell membrane has a property called **selective permeability,** which means that it allows some molecules to cross but blocks others. Selective permeability helps a cell maintain homeostasis.

Cells have receptors both in the cell membrane and inside the cell. Receptors help cells communicate with other cells and respond to the environment.

- Membrane receptors bind to signals that cannot cross the cell membrane. They cross the membrane and transmit a message inside the cell by changing shape.
- Intracellular receptors are located inside a cell and bind to molecules that can cross the cell membrane. They may interact with DNA to control certain genes.

1. Why do phospholipids form a bilayer in the cell membrane?

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2. How does a sieve (or colander) demonstrate the property of selective permeability?

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SECTION 3.4

DIFFUSION AND OSMOSIS

Reinforcement

KEY CONCEPT Materials move across membranes because of concentration differences.

Cells are continuously exchanging materials with their environment across the cell membrane. **Passive transport** is the movement of molecules across a cell membrane that does not require energy input by the cell. **Diffusion,** a type of passive transport, is the movement of molecules from an area of higher concentration to an area of lower concentration. This difference in concentration from one area to another is called a **concentration gradient.** When a molecule diffuses, it can be described as moving down its concentration gradient.

Not all molecules can cross the cell membrane. **Facilitated diffusion** is the diffusion of molecules across a membrane through transport proteins, proteins that form channels across the membrane.

Diffusion is a result of the natural energy of molecules. When molecules are in solution, they collide and scatter. Over time, these molecules will become evenly spread throughout the solution, which means that the molecules have reached dynamic equilibrium. The molecules continue to move, but their concentration remains equal.

Water also moves from a higher water concentration to a lower water concentration. The diffusion of water is called **osmosis.** The higher the concentration of dissolved particles that are in a solution, the lower the concentration of water molecules. The reverse is also true. That is, the lower the concentration of dissolved particles that are in a solution, the higher the concentration of water molecules.

Scientists have developed terms to compare the concentration of solutions with some reference point. Here, our reference point is the concentration of particles in a cell.

- An **isotonic** solution has the same concentration of dissolved particles as a cell. A cell in an isotonic solution will not change.
- A **hypertonic** solution has a higher concentration of dissolved particles than a cell. A cell in a hypertonic solution will shrivel.
- A **hypotonic** solution has a lower concentration of dissolved particles than a cell. A cell in a hypotonic solution will swell.

1. Organize the terms *isotonic, hypertonic,* and *hypotonic* in order from the solution with the lowest concentration of dissolved particles to the highest concentration.

_____

2. Suppose you have a container divided by a membrane that is permeable to water but not to sugar. Side A has a 10% sugar solution. Side B has a 40% sugar solution. Both start out at 10 cm in height. Over time, the height of one side drops to 7 cm, and the height of the other side increases to 13 cm. Which side of the container is now at 7 cm? Explain.

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SECTION 3.5

ACTIVE TRANSPORT, ENDOCYTOSIS, AND EXOCYTOSIS

Reinforcement

KEY CONCEPT Cells use energy to transport materials that cannot diffuse across the membrane.

Cells use active transport to obtain materials they need that they could not get by means of diffusion or facilitated diffusion. **Active transport** is the movement of a substance against its concentration gradient by the use of transport proteins embedded in the cell membrane and chemical energy. The transport proteins used in active transport are often called pumps. Most often, the chemical energy that is used comes from breakdown of a molecule called ATP. A cell may use this energy directly or indirectly.

- The sodium-potassium pump directly uses energy from the breakdown of ATP to pump two potassium ions into a cell for every three sodium ions it removes from the cell.
- The proton pump indirectly uses energy from the breakdown of ATP to remove hydrogen ions (protons) from a cell. This action creates a charge gradient, which is a form of stored energy. This charge gradient can then be used to drive other pumps to transport molecules such as sucrose.

Some molecules are too large to be transported through proteins. These molecules can be moved in vesicles, so they never actually have to cross the membrane. The movement of these vesicles also requires energy from a cell.

- **Endocytosis** is the process of taking liquids or large molecules into a cell by engulfing them in a vesicle. During endocytosis, the cell membrane makes a pocket around the material to be brought in. The pocket pinches together around the material and breaks off, forming a vesicle, inside the cell. This vesicle then joins with a lysosome, which breaks down the contents if needed and recycles the vesicle. **Phagocytosis** is a type of endocytosis and means "cell eating."
- **Exocytosis** is the process of releasing materials from a cell by fusion of a vesicle with the cell membrane. In this process, a vesicle forms around select materials. The vesicle is moved to the cell surface, and it fuses with the cell membrane, releasing the contents. Exocytosis plays an important role in releasing hormones and digestive enzymes and in transmitting nerve impulses.

1. In what ways are active transport, endocytosis, and exocytosis similar?

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2. In what ways does active transport differ from endocytosis and exocytosis?

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3. List one function that exocytosis carries out in the human body.

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