Name ______________________________ Date ______________ Class ______________

TAKS OBJECTIVE

2 ORGANIZATION OF LIVING SYSTEMS

Cells

Look closely at the skin on your thumb. You can't see them, but your skin is made of thousands of cells. In fact, all living organisms are made of cells. Your body has about 100 trillion cells. Other organisms are made of more or fewer cells. Some living things, called **unicellular** organisms, are made of only one cell. Living things made of more than one cell are called **multicellular** organisms. Regardless of whether they are found in multicellular or unicellular organisms, cells are small.

The cell is a place of constant activity. Chemical reactions are taking place, and materials are moving in and out of the cell. Even the smallest of cells has the characteristics of living things:

- Cells take in energy.
- Cells obtain and use energy to run the processes of life.
- Cells reproduce.
- Cells maintain stable internal conditions.
- Cells pass on their characteristics to their offspring through genes.

In the human body most cells range from 5 μm to 20 μm in size. (One μm equals one-millionth of a meter.) You might wonder why cells are so small. In general, small cells work more efficiently than larger cells. All materials that enter and exit a cell must cross the cell's surface. In a small cell, all parts of the cell are near the cell's surface, and materials entering the cell can easily reach the parts. In a large cell, reaching all parts of the cell takes longer.

Scientists didn't always know about cells. Before the invention of the microscope, scientists couldn't see cells. In 1665, English scientist Robert Hooke used a crude microscope to observe a thin slice of cork. What he saw were the cell walls of dead plant cells. Ten years later, the Dutch scientist Anton van Leeuwenhoek used a microscope to view some pond water. In it he discovered many living creatures. Today we know that what Leeuwenhoek saw were unicellular organisms.

Still, it wasn't until 150 years later that scientists formed the **cell theory**, which has three parts:

1. All living things are made of one or more cells.
2. Cells are the basic units of structure and function in organisms.
3. All cells arise from existing cells.

Name ______________________ Date ____________ Class ____________

HOMEOSTASIS

If you look at a sleeping cat, you may think the animal's whole body is at rest. But the cat's body is busy making sure it maintains a stable internal environment—the correct body temperature, the right amount of water and oxygen, and the proper amount of many other materials in the body.

Conditions within all organisms are constantly changing. An animal may need a lot of energy at one moment and little the next. A plant may take in water now and give off water later. Within this constant change, all organisms, no matter how big or small, must keep the conditions within their bodies balanced. Balance within an organism is important so that its body can function properly.

Conditions outside an organism are also constantly changing. An organism must respond to these changes in the external environment, adjusting its internal environment accordingly. The temperature, amount of water and carbon dioxide, the amount of light, and other conditions around an organism may change. Although all organisms can exist in a range of conditions, they can only adjust within certain limits. The maintenance of stable internal conditions in spite of changes in external conditions is called **homeostasis**. If an organism cannot maintain homeostasis, the organism may become sick or die.

Homeostasis occurs at many levels within an organism—from individual cells to the entire organism. For example, think about your own body. Your cells help maintain constant internal conditions within the cell by controlling what materials enter and leave the cell. Cells reproduce to repair damaged or worn-out cells. Your whole body also works to maintain stability. When the temperature outside your body changes, your body tries to maintain its normal body temperature—98.6°F. If it's cold, your body may shiver to keep itself warm. If the temperature is hot, you sweat to stay cool.

Name ______________________ Date ____________ Class ____________

THE PERMEABLE CELL MEMBRANE

All cells have a cell membrane, a thin, flexible layer that surrounds the cell and separates the cell interior from its surroundings. Everything a cell needs—food, oxygen, water, and other materials—must enter through the cell membrane. Wastes must leave the cell through the cell membrane too.

You might compare the cell membrane to the covering of your body—your skin. Just as your skin protects the body, the cell membrane protects the cell. It also gives the cell its shape. Another function of the cell membrane is to control the movement of water and other materials into and out of the cell. The cell membrane keeps out some materials and allows others to enter the cell. This enables the cell to control which substances enter and leave it.

The selective permeability of the cell membrane is due mainly to the **phospholipids** that make up the cell membrane. Figure 4-1 shows that each phospholipid has a polar head and two nonpolar tails. The polar head is attracted to water; the nonpolar tails repel water. You can also see that the cell membrane is made of two layers of phospholipids, called the **lipid bilayer**. The nonpolar tails of the phospholipid layers face each other in the interior of the lipid bilayer. The polar heads of the phospholipids point outward from the cell membrane toward the water that is inside and outside the cell.

The arrangement of phospholipids in the lipid bilayer allows water molecules to easily pass through the cell membrane. But most polar molecules, such as sugars and some proteins, cannot cross the cell membrane. Many of the substances the cell needs are polar molecules. To provide a way for these molecules to enter the cell, protein channels are embedded in the cell membrane. Each channel allows only a specific substance to pass through the cell membrane. Some channels are always open, and in other channels gates regulate the openings. The gates may open or close in response to stimuli, including the stretching of the cell membrane, a change in electrical charge, or the binding of specific molecules to the channel.

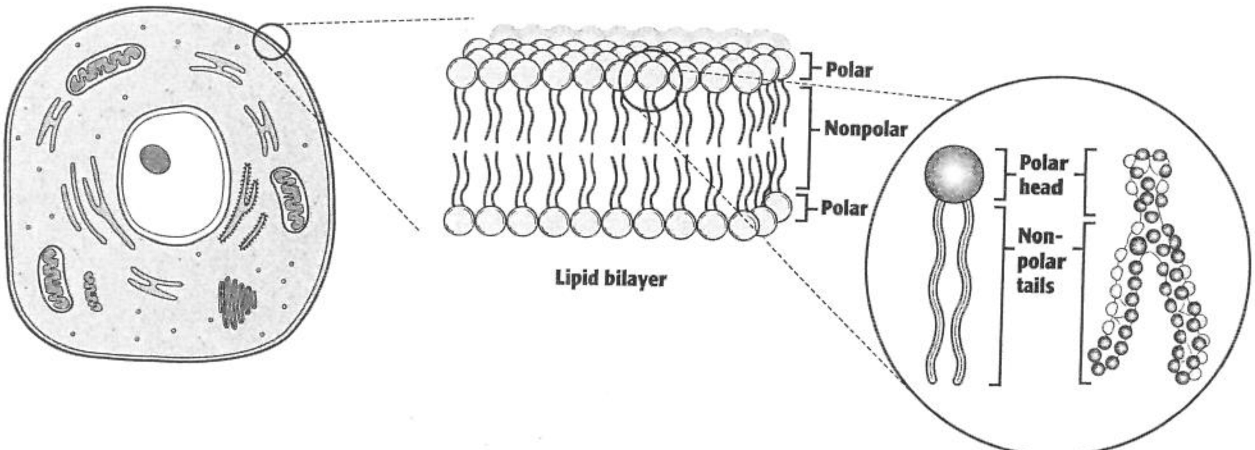


Figure 4-1

Name ______________________ Date ______________ Class ______________

Passive transport

If you place a drop of ink into a beaker of water, the ink will soon spread farther and farther from the drop until it is evenly distributed throughout the water. What causes the ink particles to spread out?

All substances are made of particles that are in constant motion. The particles move in straight lines until they hit something. Then they bounce off, again traveling in a straight line. This bouncing continues and repeats until eventually the particles are evenly spread out. Generally, particles tend to spread from a crowded, or more concentrated area to a less concentrated area. This process by which particles spread from an area of greater concentration to an area of less concentration is called **diffusion**.

Just as ink diffuses in water, many substances dissolved in the watery interior of the cell and in the fluid outside the cell enter or leave the cell by diffusing across the cell membrane. You can see in Figure 4-2 below that the particles move from an area outside the cell where their concentration is higher to an area inside the cell where their concentration is lower.

Not all molecules can pass through the cell membrane. The nonpolar interior of the cell membrane repels ions and most polar molecules, preventing these substances from diffusing across the cell membrane. Membranes that allow only some substances to pass through are called **semipermeable membranes**. The selectivity of the semipermeable cell membrane allows it to regulate what enters and leaves the cell.

You might think that only particles dissolved in water diffuse, but water molecules also diffuse. The diffusion of water through a cell membrane is called **osmosis**. Water molecules constantly move back and forth through the cell membrane. Inside the cell, water molecules are constantly interacting with other molecules, such as ions and polar molecules. Water molecules are attracted to many of these particles and are no longer free to move around. As a result, the concentration of "free" water molecules in the interior of the cell is less than the concentration of water molecules surrounding the cell. As a result, more water molecules move into the cell by osmosis than flow out of the cell.

Particles that move into and out of cells by osmosis and diffusion do so by themselves. Cells do not use energy to move these particles. This kind of movement of substances without the use of cell energy is called **passive transport**.

Another type of passive transport, **facilitated diffusion**, occurs when transport proteins embedded in the cell membrane bind to a specific substance on one side of the cell membrane. The transport protein, called a **carrier protein**, then carries the substance across the membrane and releases it on the other side.

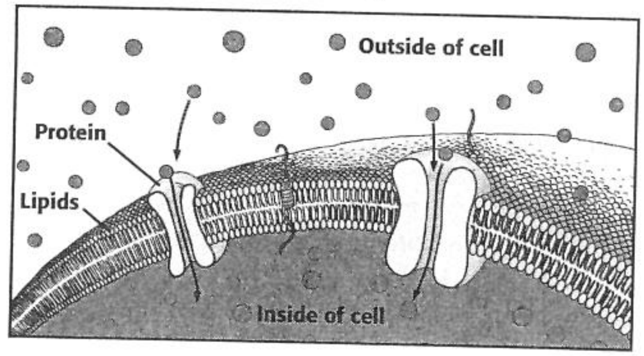


Figure 4-2

Name ______________________________ Date ____________ Class ____________

Active transport

Some substances a cell needs can't pass through the cell membrane by diffusion because the concentration of the substance is greater inside the cell than outside. To move these substances across the cell membrane, the cell must use energy. This type of movement, in which cells use energy to move materials across the cell membrane, is called **active transport**.

One type of active transport involves carrier proteins that are used as "pumps" to move substances. The carrier proteins bind to specific substances on one side of the cell membrane and release them on the other side where the concentration of the substance is greater. Notice in Figure 4-3 that the molecules are moving from an area where they are less concentrated to an area where they are more concentrated through carrier proteins. These carrier proteins often are called membrane pumps. One important membrane pump is the **sodium-potassium pump**, which transports sodium ions out of a cell and potassium ions into the cell.

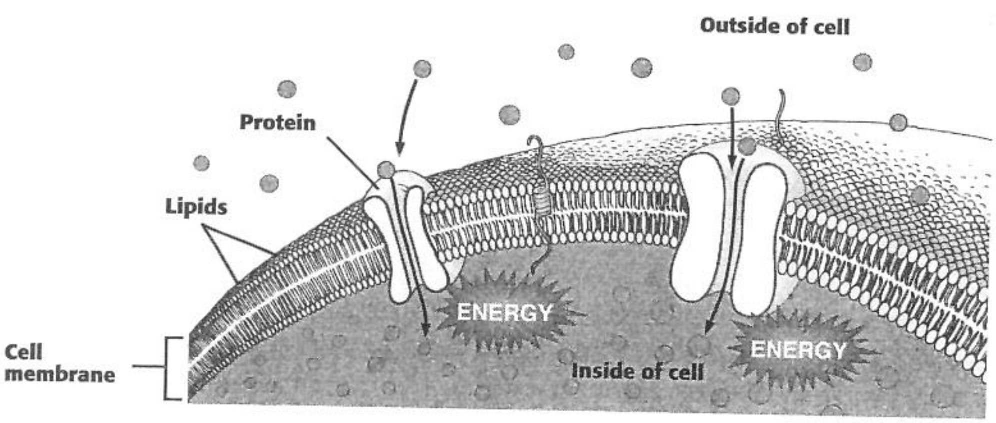


Figure 4-3

Sometimes the substances cells need, such as proteins and polysaccharides, are too large to pass through the cell membrane. How do these materials enter the cell? Figure 4-4 shows large particles moving into a cell through the process of **endocytosis**. You can see that the cell membrane can extend outward toward the particle and surround it. When the edges of the membrane meet, they fuse together to form a **vesicle**. The vesicle breaks loose from the rest of the cell membrane and moves toward the interior of the cell. Inside the cell, the vesicle opens and the material is released into the cell.

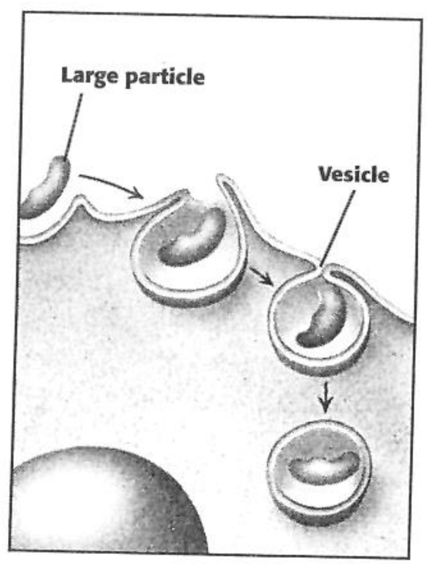


Figure 4-4

Name ______________________ Date ____________ Class ____________

Active transport and waste disposal

As cells carry on life processes such as cellular respiration, wastes are produced. Some wastes are very toxic, and if they are not removed from the cell, the cell will die. Many wastes are too large to pass through the cell membrane. How do cells get rid of these wastes?

Cells can send materials out of the cell in a process similar to endocytosis. Notice in Figure 4-5 that inside the cell, a vesicle forms around the large waste particles. The vesicle moves toward the cell membrane where it fuses with the membrane, forcing the materials in the vesicle out of the cell. This process of moving large particles out of the cell is called **exocytosis**.

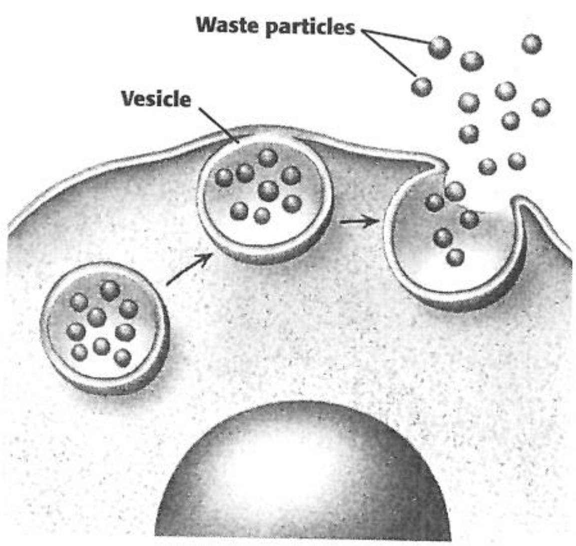


Figure 4-5

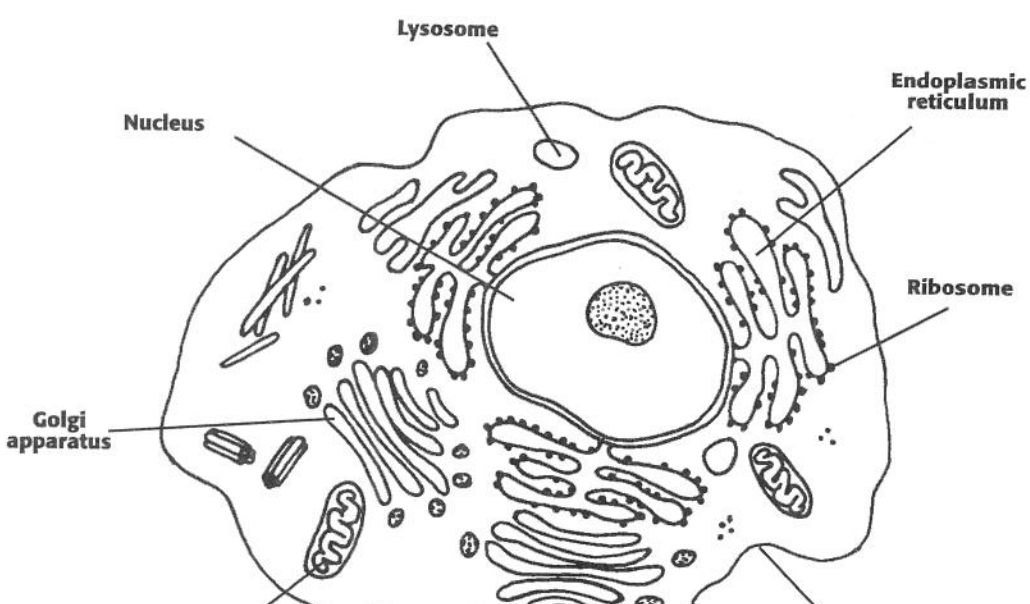
Name ______________________ Date ______________ Class ______________

CELLULAR COMPONENTS

Although cells differ in size and shape, certain structures are common to all cells. All cells have a cell membrane, the thin membrane that surrounds the cell. Some cells, called **eukaryotes**, have a **nucleus**, which is surrounded by a nuclear membrane. The nucleus contains the cell's genetic material and controls the activities of the cell. The smallest and simplest cells, called **prokaryotes**, do not have a nucleus or other internal compartments. The genetic material of these one-celled organisms is not enclosed in a membrane-bound structure but instead is formed into a single circular molecule of DNA. Fossils of the first known cells on Earth reveal that these cells were prokaryotes.

The material inside cells that is not part of the nucleus is the **cytoplasm**. This jellylike material that fills the cell is made of water, salts, and other molecules. The cytoplasm includes many structures that often are suspended in a system of microscopic fibers called the **cytoskeleton**.

In eukaryotic cells, the cytoplasm includes many important structures called **organelles**. Each type of organelle has a different shape and performs a particular activity. Cytoplasm is in constant motion and the organelles within it move around. Locate each organelle in Figure 4-6 as you read about it.



Animal Cell
Figure 4-6

Name ______________________ Date ____________ Class ____________

CELLULAR COMPONENTS, CONTINUED

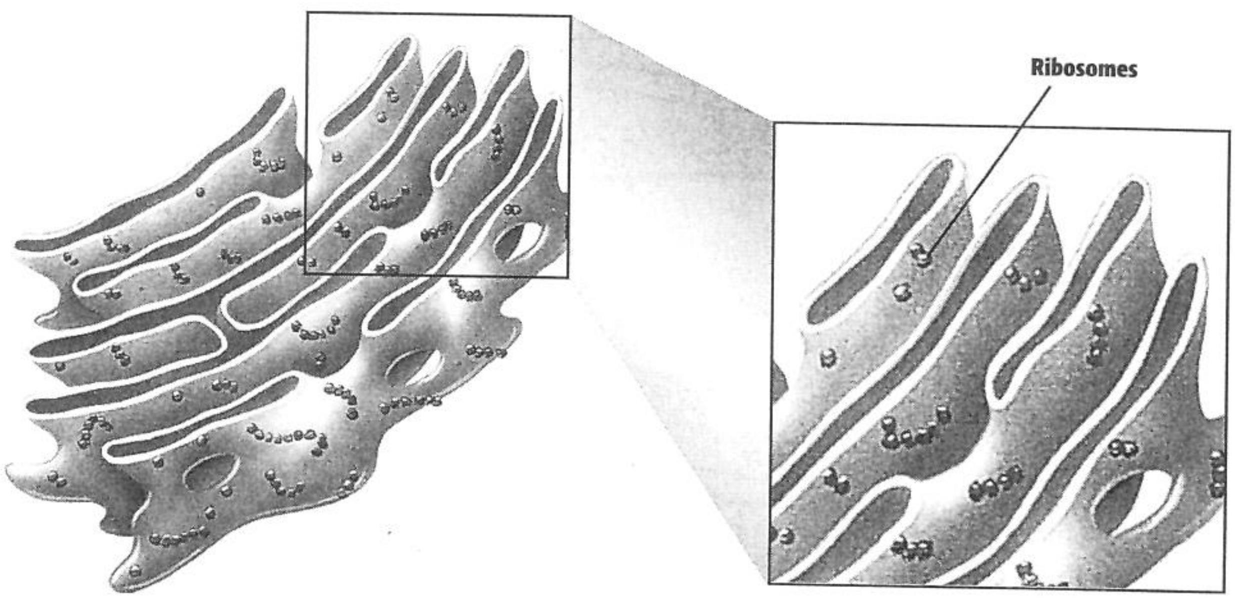
If you look at most cells, you will see more **ribosomes** than any other organelle. The ribosomes make proteins, using coded instructions that come from the nucleus. The way ribosomes are distributed in the cell depends on how the proteins they produce will be used.

The **endoplasmic reticulum**, or **ER**, is a system of membranes that moves substances, including proteins, to all parts of the cell. Look at Figure 4-7. You can see in the diagram that the membranes of the ER are folded many times. The part of the ER with attached ribsomes is called rough ER. In addition to rough ER, another type of ER, smooth ER, makes lipids and breaks down toxic substances.

The **Golgi apparatus** is a set of flattened, membrane-bound sacs that serves as the packaging and distribution center of the cell. Enzymes in the Golgi apparatus change the proteins that are received from the ER.

Almost all eukaryotic cells contain many **mitochondria**. These organelles release energy from stored food molecules in the cell. The cell uses the energy for growth, development, and movement.

Many animal and fungal cells contain **lysosomes**, small, spherical organelles that contain digestive enzymes. The enzymes digest food into particles that can be used by the rest of the cell. They also break down worn-out organelles. They are the "vacuum cleaners" of the cell.



Endoplasmic reticulum (ER)
Figure 4-7

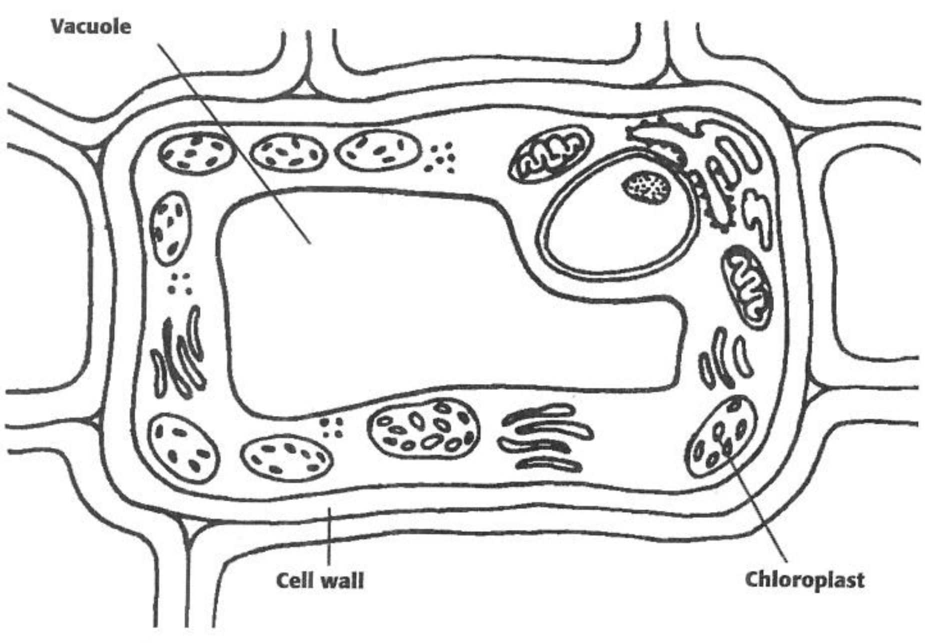
Name ______________________________ Date ______________ Class ______________

CELLULAR COMPONENTS, CONTINUED

Many cells contain one or more membrane-bound sacs that store materials such as water, salts, proteins, carbohydrates, and wastes. These structures are called **vacuoles**, and in most types of cells, the vacuoles are relatively small. Many plant cells, such as the one shown in Figure 4-8, have a large central vacuole that is filled with water and may contain many other substances, including ions, nutrients, and wastes. The pressure of water stored in these vacuoles enables the plant to stand upright.

Other cell structures common to plant cells are the cell wall and chloroplasts. The thick **cell wall** of a plant cell lies outside the cell membrane. It surrounds the cell membrane, gives the cell its shape, protects the cell from damage, and connects the cell to surrounding cells. The cell wall is made from proteins and carbohydrates, including cellulose, which gives it strength and rigidity. The cells of some algae, fungi, and bacteria also have cell walls.

Chloroplasts are green structures found in plant cells and some other organisms, such as eukaryotic algae. Animal cells do not contain chloroplasts. Chloroplasts use the energy from sunlight to make energy-rich carbohydrates in the process of photosynthesis. Chloroplasts contain their own DNA and are thought to be the descendents of ancient prokaryotic cells.



Plant Cell
Figure 4-8

PROTEIN SYNTHESIS

The cell is a flurry of activity. Part of that activity is the constant stream of information-carrying molecules that come from the nucleus to all parts of the cell. Some information-carrying molecules contain instructions for building proteins, important building blocks of many cell structures. This information is sent to the ribosomes, where protein synthesis begins.

Proteins that will be used within the cell are produced by ribosomes that float freely in the cytoplasm. Proteins that will be exported for use outside the cell are produced by ribosomes attached to the endoplasmic reticulum, or ER.

As each protein is made in a ribosome, it crosses the rough ER membrane and enters the ER. A portion of the ER then pinches off to form a vesicle. This vesicle keeps the protein separate from proteins produced by free ribosomes in the cytoplasm.

From the ER, vesicles that contain newly made proteins are transported to the Golgi apparatus. In the Golgi apparatus, carbohydrates and lipids are attached to the proteins. The modified proteins are put into membrane-wrapped packages that form from the surface of the Golgi apparatus. The materials packaged this way can be sent to particular parts of the cell, or the membranes of the package can fuse with the cell membrane to release the materials outside the cell.

Name ______________________ Date ____________ Class ____________

TAKS OBJECTIVE

2 TAKS PRACTICE QUESTIONS

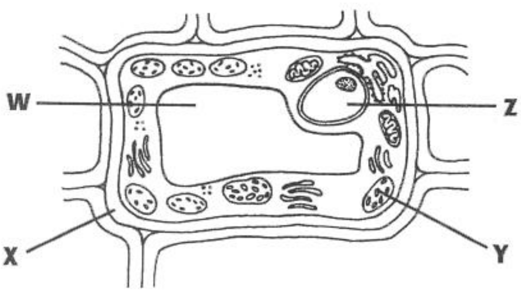
1 Which is a difference between prokaryotes and eukaryotes?

A Eukaryotes have a nuclear membrane.

B Organelles are found only in prokaryotes.

C The cells of prokaryotes contain cytoplasm.

D Prokaryotes contain an endoplasmic reticulum.



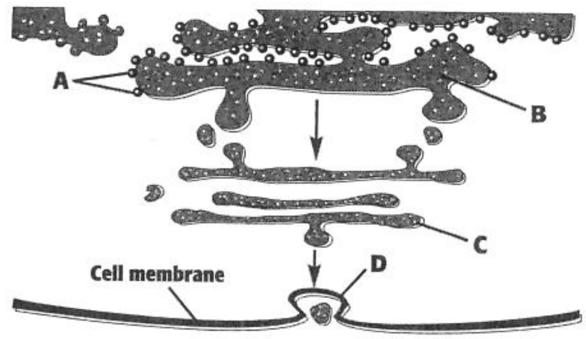
2 In which cell part does photosynthesis take place?

F Part W

G Part X

H Part Y

J Part Z



3 The diagram shows the organelles involved in the packaging of proteins inside the cell. What is the function of organelle C?

A Proteins are synthesized.

B Vesicles move proteins outside the cell.

C Carbohydrates and lipids are attached to the proteins and the modified proteins are put into membrane-wrapped packages.

D A vesicle forms around the protein.

Name ______________________ Date ____________ Class ____________

TAKS PRACTICE QUESTIONS, CONTINUED

4 Which of the following is an example of osmosis?

F The movement of ions from an area of high concentration to an area of lower concentration

G The movement of ions from an area of low concentration to an area of higher concentration

H The movement of water from an area of high concentration to an area of lower concentration

J The movement of water from an area of low concentration to an area of higher concentration

5 What happens to a cell when particles move out of the cell through facilitated diffusion?

A The cell gains energy.

B The cell uses energy.

C No energy change takes place.

D The cell produces energy.

$$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$$

6 Which process does the equation summarize?

F Glycolysis

G Calvin cycle

H Photosynthesis

J Cellular respiration

Question 8

What is one reason that dehydrated patients are given intravenous (IV) solutions of pure water with a small amount of dissolved salt rather than just pure water?

A To help prevent cells from shriveling because of the pressure caused by osmosis

B So that the pressure caused by osmosis will cause a net movement of salt into cells

C So that dissolved substances will be transported across cell membranes and out of cells

D To help keep the concentrations of dissolved substances inside and outside the cells equal

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