SBI4U-C

A Closer Look at the Cell

Introduction

Cells are the fundamental units of all life. In terms of the biological hierarchy, you have already learned about atoms, molecules, and some chemical reactions. Now, you will look at groups of molecules called organelles, which function to perform tasks within the more complex unit called the cell. In later units in the course, you will see how knowledge of the cell helps you to understand the working of the more complex levels in the hierarchy, including the organ and organ system of the organism.

This lesson begins with a review of the function of various organelles of the cells. The cell membrane will be discussed in detail, and the movement of material across a cell membrane will be explored. You will also conduct an investigation on the process of osmosis.

Planning Your Study

You may find this time grid helpful in planning when and how you will work through this lesson.

Suggested Timing for This Lesson (Hours)	
Cell Theory	½
Cell Structure	¾
The Cell Membrane	½
Membrane Transport	1
Activity: Osmosis Experiment	1
Cell Research in Medicine	¼
Key Questions	1

What You Will Learn

After completing this lesson, you will be able to

- explain the roles of various organelles in cellular processes
- describe the structure of cell membranes according to the fluid-mosaic model
- explain the dynamics of passive transport, facilitated diffusion, and the movement of large particles across the cell membrane through the processes of endocytosis and exocytosis
- plan and conduct an investigation to demonstrate the movement of substances across a membrane

Cell Theory

Robert Hooke was a famous architect, inventor, and scientist who lived in London, England, about 400 years ago. In 1665, he was looking at a sample of cork tissue under a then-recent invention, the microscope. The tiny structures he saw in the cork reminded him of the small rooms, called "cells," in which monks (holy men) in monasteries slept. Hooke decided to call the small structures in the cork tissue "cells."

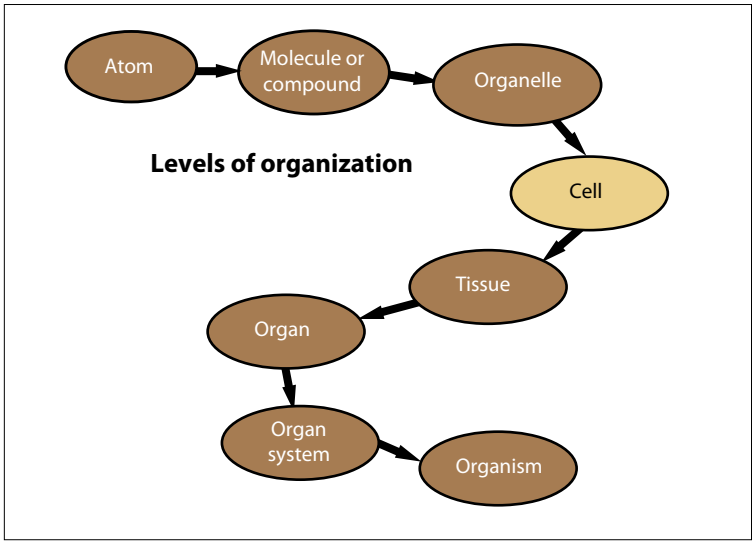


Figure 4.1: Levels of organization

Hooke's discovery of the cell led to a flurry of research and curiosity about cells. Cells are now understood to be the basic units of life. The importance of cells to biology is shown in the development of cell theory. "Theory" is a word that scientists use to describe a well-proven collection of facts and explanations. It does not mean a guess or a hunch. Cell theory is one of the foundations of biology.

Cell Theory

Cell theory is based on three fundamental statements:

1. **All living things are made up of cells.**

   This means that you, a bear, a flower, a giraffe, and every other living thing, are all made up of cells.

2. **The cell is the structural and functional unit of all living things.**

   All of your structures are made up of living cells, or, in some cases, the remains of dead cells. For example, your heart is made up of cells, as are your skin and your hair.

3. **All cells come from pre-existing cells by division.**

   Cells do not spontaneously come into being; they must come from other cells. You began as a joining of two cells—a single sperm and an egg. This combination of cells made your first cell, called a zygote. You have literally divided that first cell trillions of times to form the complex multicellular human you now are.

Cell Organization

If you had to define the word "organize," your first definition might be "to arrange" or "to tidy up and sort out." "Organize" can also mean "to work together to do a job or perform a function." Cells are organized systems of chemicals working together.

Figure 4.1 shows the hierarchy of organization in biological systems. This hierarchy starts with the atom, and increases in complexity at each higher level. The relatively simple organized structures inside cells are called organelles. Groups of cells are organized into more complex structures called tissue, such as muscle tissue. Different tissues can be organized to work together to form a complex organ, such as your heart or tongue.

Support Question

Be sure to try the Support Questions on your own before looking at the suggested answers provided.

28. What are the three fundamental statements of cell theory? Suggested answer

Cell Structure

All living things are composed of one or more cells. The cell must be able to perform tasks, in order to stay alive. Cells have structures that enable them to ingest food, excrete waste, and, in some cases, move around. Specialized structures, known as organelles, work together to make a cell function effectively. Although individual cells may be modified to perform specific functions, most animal and plant cells share many of the same basic organelles. Most of your study in this course deals with plants and animals. The cells of plants and animals have membranes surrounding their organelles. Figure 4.2 is a diagram of a typical plant cell and animal cell.

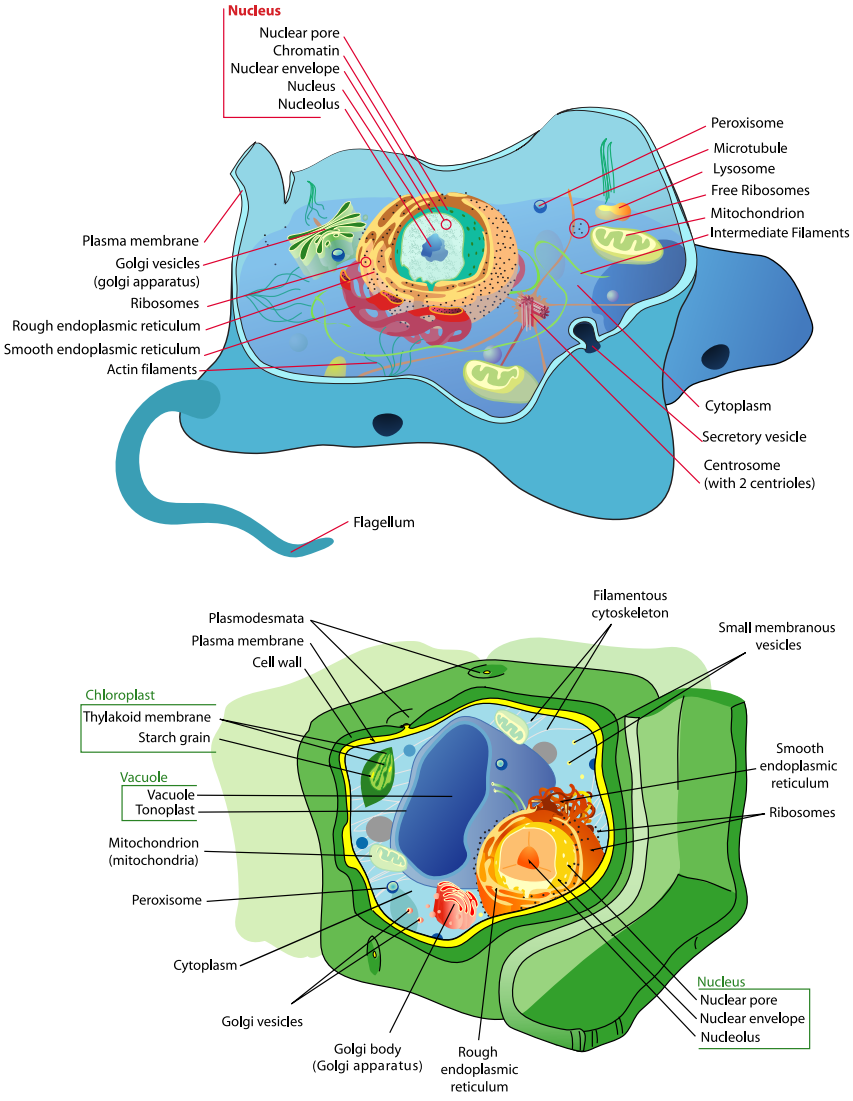


Figure 4.2: Structure of generalized plant and animal cells.

Organelles in Animal Cells

Small units that perform specialized functions within a cell are known as organelles. Plant and animal cells share some basic organelles.

Protoplasm: Protoplasm is the fluid substance in a cell that supports the organelles. The protoplasm found in the nucleus is called nucleoplasm. The protoplasm found outside the nucleus is called cytoplasm.

Cell membrane: The cell membrane separates the cell's contents from its surrounding environment. It controls the movement of materials in and out of the cell, and allows the exchange of food and gases. The cell membrane (also called the plasma membrane) is one of the most important organelles. Because of its importance, the structure and function of cell membranes will be discussed in greater detail later on in this lesson.

Nucleus: The nucleus is the control centre of the cell. It contains the cell's genetic material (DNA) and is surrounded by a porous membrane called the nuclear membrane. The nucleus is involved in cell division and is the storage area for all information and instructions for the organelles.

Nucleolus: The nucleolus located within the nucleus manufactures ribosome parts.

Ribosomes: Ribosomes manufacture proteins in the cell. They are attached to the endoplasmic reticulum or float freely in the cytoplasm.

Endoplasmic reticulum: The endoplasmic reticulum is a folded membrane that forms a series of canals within the cytoplasm. It acts as a passageway for materials moving to and from different parts of the cell and connects the nuclear membrane to the cell membrane. When a portion of the endoplasmic reticulum (ER) is covered with ribosomes, it is called rough endoplasmic reticulum (Rough ER). Portions that are free of ribosomes are called smooth endoplasmic reticulum (Smooth ER).

Golgi bodies: Golgi bodies package protein and secrete it outside the cell.

Mitochondria: The mitochondrion (plural, mitochondria) is the powerhouse of the cell. It produces energy, known as adenosine triphosphate (ATP), for cell functions.

Vacuoles: Vacuoles provide storage areas for food, minerals, and water.

Lysosomes: Lysosomes contain digestive enzymes that help to break down food molecules. Waste molecules and other toxins are broken down by lysosomes and transported out of the cell by vacuoles.

Microfilaments: Microfilaments are pipe-like structures that provide shape and support for cell movement. They function as a cell's skeleton.

Microtubules: Microtubules are protein-rich rods that provide pathways for organelle movement.

Centrioles: Centrioles are paired structures involved in animal cell division.

Cilia and flagella: If present, a flagellum is used to help the cell move (swim) around. For example, sperm cells have a flagellum so that they can spin like a propeller to travel towards the egg. Cilia are like very fine hairs on the cell's surface. They can be moved in coordinated waves to enable the cell to travel around, or to sweep particles away. For example, the cells that line your lungs have cilia that constantly move in order to remove debris, such as dust, that has landed in the mucous of your respiratory tract. The reason why not all animal cells have these cilia or a flagellum (plural, flagella) is because not all of them need to swim or move small particles aside.

Support Questions

29. Show the relationship between the terms "organelle" and "cell." Suggested answer

30. State the primary function for each of the following cell parts:

a) Cell or plasma membrane

b) Ribosomes

c) Lysosomes

d) Microtubules

e) Nucleus

f) Golgi bodies Suggested answer

31. Why would the cells of a mammal require more mitochondria than the cells of a lizard? (Hint: Lizards are cold-blooded animals.)

Suggested answer

The Cell Membrane

The cell membrane separates the cytoplasm from the external environment. It acts like the cell's "security guard," controlling which chemicals can get in or out of the cell. The cell membrane allows essential molecules into the cell and allows metabolic waste to leave. This means that the inside of a cell can be kept chemically different from its external environment.

The cell membrane is composed mainly of phospholipids. A phospholipid consists of a "head," containing a phosphate group, and a long "tail," made up of two fatty-acid chains. The phosphate "head" region is hydrophilic (meaning "water-loving") because it is water-soluble. The reason why the head end is hydrophilic is because it contains a polar phosphate (PO_4) group. Recall that the water molecule is also polar because it has a region of positive charge and a region of negative charge. Because polar molecules are attracted to other polar molecules, the head end is attracted to water molecules.

The "tail" portions are hydrophobic (meaning "water-fearing") and non-polar, because they are *not* water-soluble. This means that the tail end wants to point away from water. The hydrophobic tail contains one glycerol molecule attached to two fatty-acid chains, which means that each part of the tail is attracted to fats or oils because it is made up of fatty acids. Figure 4.3 shows the structure of a typical phospholipid.

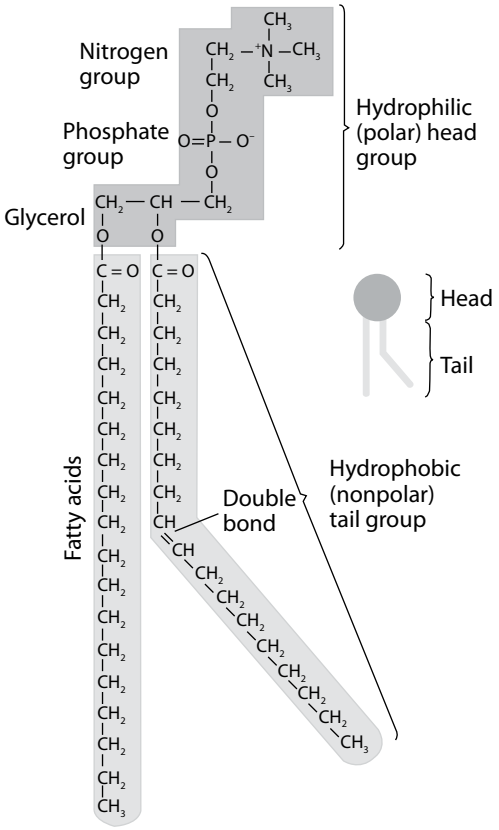


Figure 4.3: A phospholipid contains a hydrophilic head and a hydrophobic tail (made up of two fatty-acid chains and one glycerol molecule).

Having a water-seeking head and a fat-seeking tail means that two of these molecules will join tail-to-tail, when placed in water. This makes it the perfect molecule for constructing cell membranes in a watery environment. Also, you will note that in Figure 4.3, one of the fatty acids is unsaturated, meaning that it contains a double bond. This causes the molecules to slightly bend or kink. In the next section, you will see how this bending helps create passageways in the membrane.

The Fluid-Mosaic Model of the Cell Membrane

The cell membrane is made up of a double layer of phospholipids called the phospholipid bilayer. The outside layer is made up of the hydrophilic heads. They face outward toward the watery environment. The inside layer of the membrane is made up of the hydrophobic fatty-acid tails, which face inward.

Inserted into the membrane are proteins and cholesterol. They can fit in because of the bends caused by the one unsaturated lipid layer. The cholesterol molecules are free to drift around within the lipid bilayer to fix any breaks in the membrane. Cholesterol also helps to maintain the fluid condition of the bilayer. At low temperatures, cholesterol keeps the phospholipids apart, and at higher temperatures, it attracts the phospholipids and stabilizes the membrane. The proteins are called integral proteins, because they are embedded in the membrane and function as channels through which ions and other molecules can travel in and out of the cell.

The combination of the lipid bilayer, the proteins, and the cholesterol produces the fluid-mosaic model of the cell membrane. It is called "fluid" because the membrane is not completely solid, giving it the capability of allowing material to pass through it. It also means that the membrane can constantly adjust itself to maintain a seal around the cytoplasm. It is called "mosaic" because the membrane contains several kinds of molecules embedded in it.

One important type of protein embedded in the membrane is the glycoproteins, which are proteins with an attached carbohydrate. They act as receptor sites for hormones and aid in the cell's adhesion to other cells. Figure 4.4, which follows, shows the parts of a typical cell membrane.

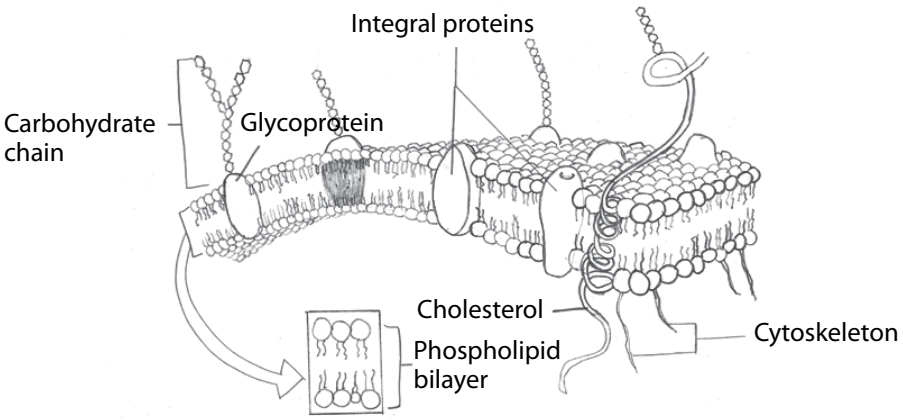


Figure 4.4: The fluid-mosaic model for the cell membrane. The membrane consists of a phospholipid bilayer with proteins embedded in it. Carbohydrates and cholesterol molecules are also present.

Selective Permeability

The cell membrane plays an essential role in regulating what enters and leaves the cell. Because most living membranes are able to control what passes through them, they are described as being selectively permeable.

Support Question

32. Why is it important that the cell membrane be fluid or capable of changing itself?

Suggested answer

Membrane Transport

The cell membrane provides a controlled gateway for molecules moving in and out of the cell. There are three processes by which molecules move in and out of the cell:

1. Passive transport
2. Active transport
3. The use of vesicles to move very large molecules around

Passive Transport

The movement of materials across a cell membrane without using any of the cell's energy is called passive transport. There are three types of passive transport: diffusion, osmosis, and facilitated diffusion.

Diffusion

Diffusion is the movement of molecules from an area of higher concentration to an area of lower concentration. Many molecules—especially small, uncharged ones, such as oxygen and carbon dioxide—can move easily through the cell membrane as a result of diffusion. Movement from an area of higher concentration to one of lower concentration is known as moving along the concentration gradient. This is illustrated in Figure 4.5 below.

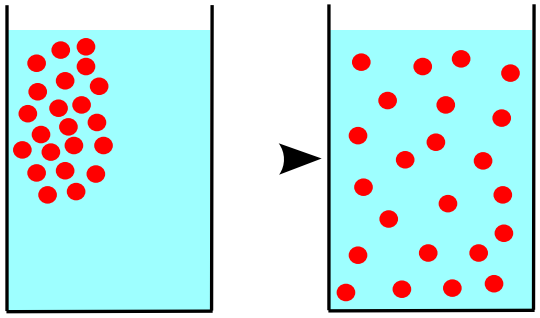


Figure 4.5: In diffusion, molecules move from an area of higher concentration to one of lower concentration.

When there is an equal concentration of particles throughout the solution, it is said to be in equilibrium.

There are three factors that affect how fast diffusion occurs:

State of matter: Diffusion occurs more rapidly in a gas than in a liquid.

Temperature: Diffusion occurs more rapidly at higher temperatures.

Size of the molecule: Large molecules cannot diffuse across cell membranes.

Osmosis

Osmosis is the diffusion of water across a selectively permeable membrane. Water molecules move from a region of higher water (lower solute) concentration to a region of lower water (higher solute) concentration. This movement will continue until equilibrium is reached. You will conduct an experiment on osmosis later on in the lesson.

Solutions are often categorized by their potential for osmosis across membranes. There are three categories: isotonic, hypertonic, and hypotonic.

Isotonic solution: The concentration of solutes in the fluid surrounding the cell is the same as it is in the cell cytoplasm. Therefore, the solute concentrations are at equilibrium and no net movement of water occurs.

Hypertonic solution: The fluid surrounding the cell has a higher solute concentration than the cytoplasm of the cell. As a result, water diffuses out of the cell by osmosis.

Hypotonic solution: The solute concentration of the fluid surrounding the cell is less than that of the cell's cytoplasm. As a result, water diffuses into the cell by osmosis.

Figure 4.6 provides an illustration of each of the categories described above.

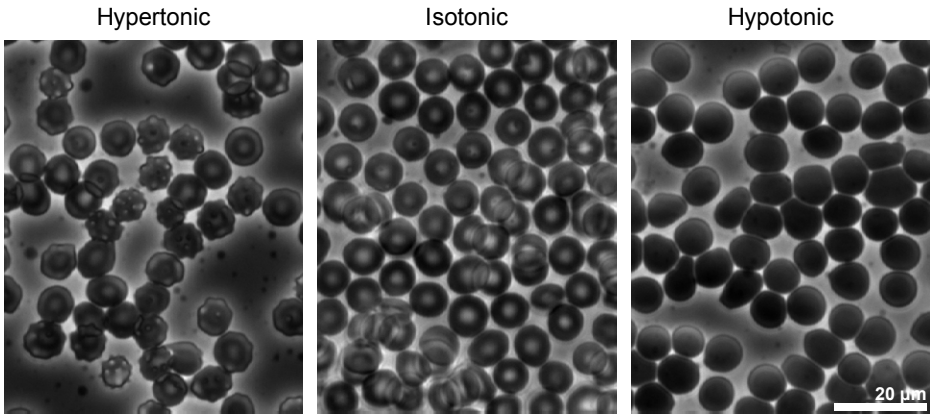


Figure 4.6: Hypertonic solution makes cells shrivel due to water loss, isotonic solution has no effect due to no water movement, and hypotonic solution makes cells gain water.

Measuring Osmosis

The osmotic potential of solutions can be measured with a device called an osmometer. This usually consists of a tube with a permeable membrane at one end (Figure 4.7).

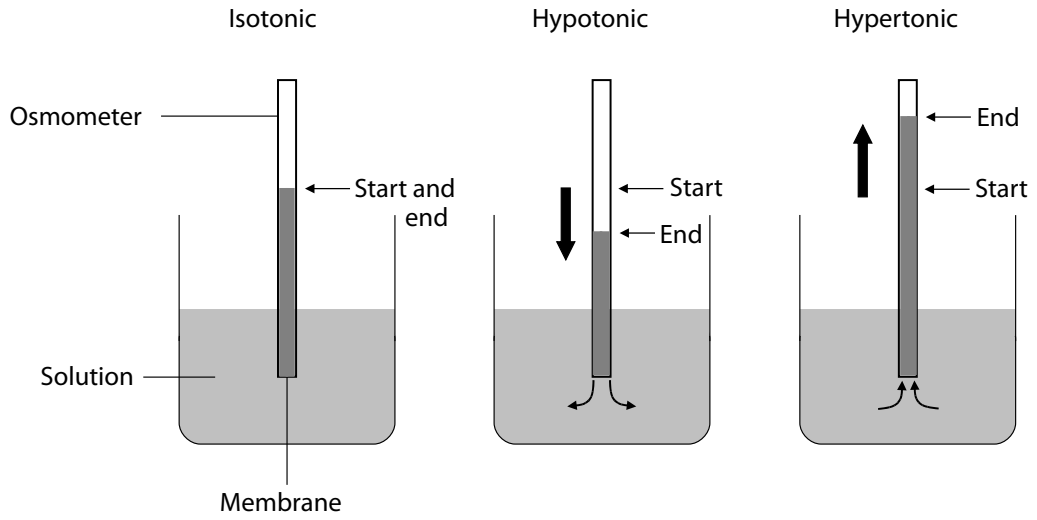


Figure 4.7: An osmometer measures the osmotic potential of solutions by changes in the height of fluid in the tube.

A solution of known solute concentration is placed inside the tube. The osmotic potential of the test solution is measured in relation to the concentration inside the tube. The change in height of the fluid in the tube before and after inserting the osmometer into the solution indicates the osmotic potential of the solution. If water leaves the osmometer to go into the solution, then the osmometer is hypotonic, in relation to the solution, and the fluid level drops. If water enters the osmometer from the solution, then the osmometer is hypertonic, in relation to the solution, and the fluid level rises.

Facilitated Diffusion

Some molecules may be too large or hydrophilic to travel through the lipid portion of the cell membrane. Facilitated diffusion occurs when molecules enter cells with the aid of "helper molecules" known as transport proteins. Transport proteins move materials into or out of cells along the concentration gradient (from high concentration to low concentration), so no energy is required. The structure of these proteins enables them to be highly selective. A particular transport protein will recognize and help move only one type of dissolved molecule or ion, based on the particle's shape, size, and electrical charge.

Now, take a look at a real-life example that occurs within your cells. The sugar molecule glucose is too large to travel through the cell membrane without the help of a transport protein (Figure 4.8). Since glucose is constantly being used inside cells for energy, the concentration of glucose inside the cell is lower than its concentration outside the cell. Therefore, glucose moves down the concentration gradient and into the cell by facilitated diffusion.

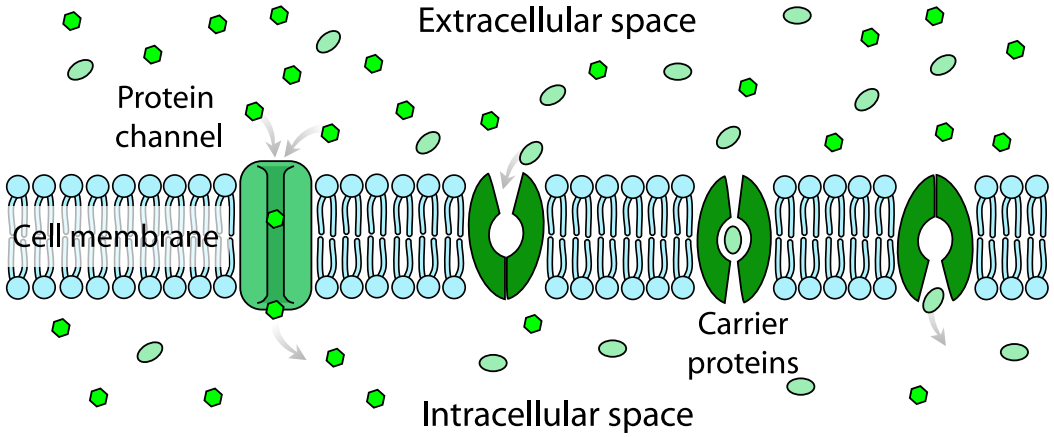


Figure 4.8: In facilitated diffusion, larger molecules, such as glucose, move along the concentration gradient from areas of higher concentration to areas of lower concentration. This is helped by proteins embedded within the cell membrane.

Active Transport

The movement of materials across a cell membrane using the cell's energy is called active transport. This is sometimes also called an active transport pump because the cell is literally using energy to "pump" the molecules through the membrane, against the concentration gradient. You might be asking yourself why this would be necessary. Sometimes a cell needs to create a large concentration gradient for a certain molecule between the inside and outside of the cell.

Since molecules, atoms, and ions naturally move with a concentration gradient (from a higher to a lower concentration), this process requires the cell to expend energy (in the form of ATP). This is why it is called active transport (Figure 4.9). Like facilitated diffusion, active transport relies on transport proteins to allow substances to pass through the membrane. Active transport, however, requires energy to move substances against the concentration gradient.

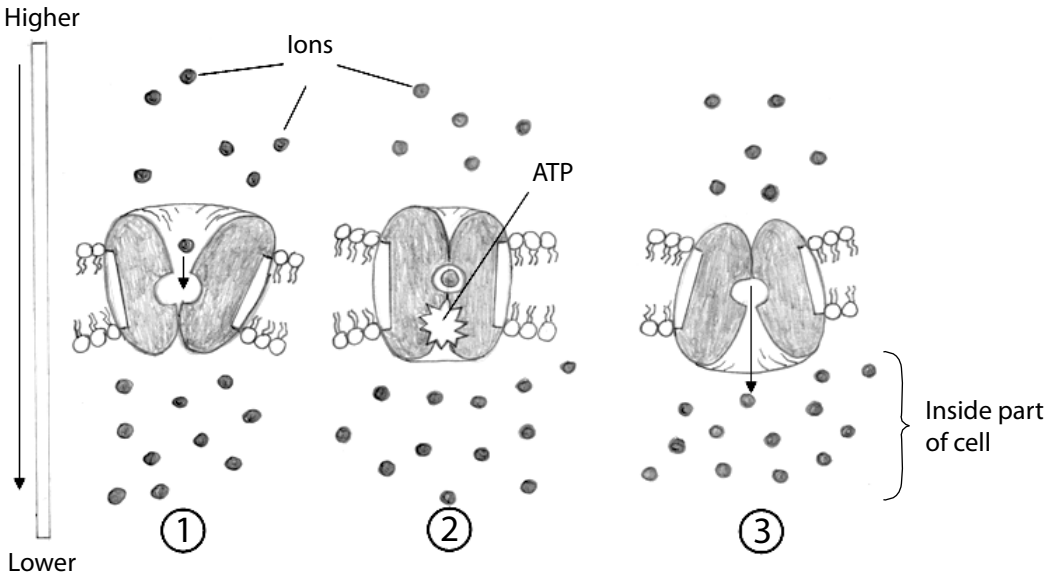


Figure 4.9: The process of active transport requires an input of cellular energy (ATP). (1) An ion is drawn onto the transport protein. (2) ATP is used to move the ion through the membrane. (3) The ion is released inside, on the other side of the membrane, where its concentration is higher.

A cell uses active transport to maintain an intracellular environment that is different from that outside the cell. For example, it allows a cell to bring in and store nutrients that are already in high concentration inside the cell. It also allows a cell to completely remove harmful waste products from the intracellular environment. Active transport is necessary for homeostasis—a process by which a constant internal environment is maintained, despite changes in the external environment. You will learn about homeostasis in a later unit.

Table 4.1 below summarizes the membrane transport methods described above.

Table 4.1: Summary of membrane transport methods

	Passive transport		Active transport
	Simple diffusion/osmosis	**Facilitated diffusion**	
Direction of movement	*High* to *low* concentration	*High* to *low* concentration	*Low* to *high* concentration
Uses a membrane protein	No	Yes	Yes
Uses energy	No	No	Yes (ATP)
Typical molecules using pathway	*Non-polar:* O_2, CO_2, H_2O	*Polar:* Glucose	*Ions:* Na^+, K^+, H^+

Vesicles

Some molecules are too large to be transported through the cell membrane. The cell uses a special method to move these molecules so that they do not have to pass through the phospholipid bilayer. The cell membrane can fold in on itself to wrap around and seal large objects in a sac called a vesicle. Like active transport, the cell must expend energy to use vesicles, in order to transport larger molecules (such as proteins and polysaccharides) across the cell membrane.

There are two ways in which vesicles are used to move materials across cell membranes: one to bring material in, called endocytosis, and one to take material out, called exocytosis.

Endocytosis

Endocytosis is the process by which cells ingest (take in) large materials. A portion of the cell (plasma) membrane surrounds the material to be transported into the cell. The "pinched-in" portion eventually breaks free from the cell membrane and forms a vesicle in the cytoplasm. This allows the material within the vesicle to travel to its final destination within the cell. There are three main types of endocytosis: phagocytosis, pinocytosis, and receptor-mediated endocytosis. All three are illustrated in Figure 4.10, which follows.

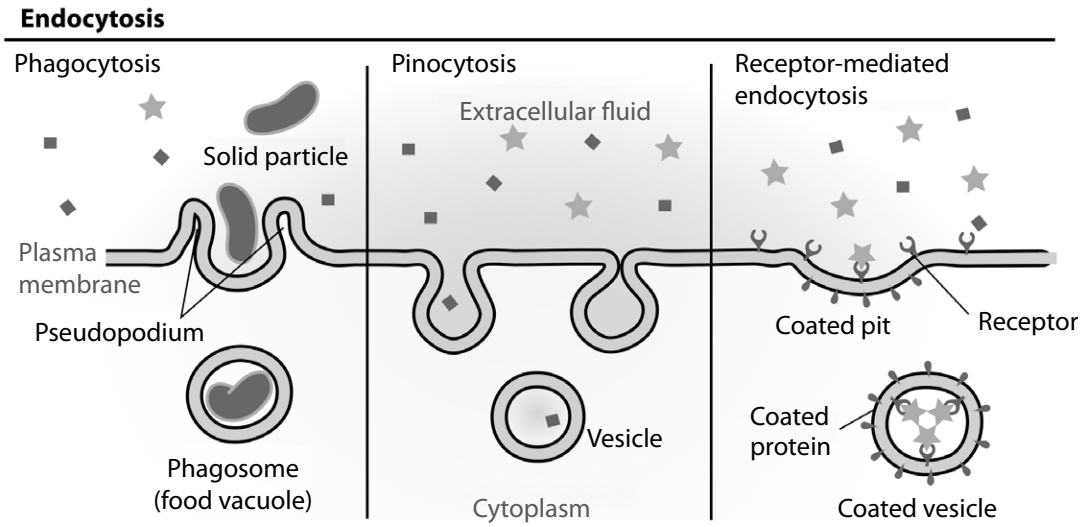


Figure 4.10: Three types of endocytosis. All result in material from outside the cell being brought inside the cell and surrounded by a membrane.

Phagocytosis ("cell-eating"): Phagocytosis is the process by which cells engulf large, solid particles. For example, this may occur when your immune cells (for example, white blood cells) engulf invading bacteria to destroy them. The trapped bacteria are digested after the vesicle fuses with a lysosome inside the cell.

Pinocytosis ("cell-drinking"): Pinocytosis is the process by which liquid droplets enter the cell, along with any small particles they may contain. This occurs in nearly all cell types, almost all of the time.

Receptor-mediated endocytosis: Receptor-mediated endocytosis (RME) enables the cell to acquire bulk quantities of specific substances. RME involves the use of receptors to recognize and bind molecules before they are engulfed. During RME, the molecule that is to enter the cell binds to special receptor proteins located on the outside of the cell membrane. Once enough molecules have gathered in an area, the cell membrane pinches in, forming the vesicle that will transport these molecules into the cell.

This process is how molecules such as cholesterol enter the cell. If a person consumes too much cholesterol in their diet, there won't be enough receptors to handle it all. Instead, the cholesterol builds up in the walls of the arteries and veins where it hardens, forming a sticky substance called plaque. This excess plaque can block blood vessels, leading to heart disease.

Exocytosis

Exocytosis is the opposite of endocytosis. Exocytosis uses vesicles to export large molecules out of the cell. This is useful for removing large waste particles. For example, lysosomes often break down wastes and other toxins inside the cell, and these wastes are then transported out of the cell in a vesicle. The vesicle is transported through the cytoplasm to fuse with the cell membrane. The cell membrane rearranges, opens, and releases the contents of the vesicle outside the cell.

Support Questions

33. How does passive transport differ from active transport? Suggested answer

34. Two identical osmometers (a device used to measure osmosis) are prepared. One is placed into distilled water, while the other is placed into a solution of 10% sugar. Assuming that the membrane is only permeable to water, what conclusions can be drawn if

a) the osmometer placed in distilled water rapidly fills up with water?

b) the osmometer placed in 10% sugar slowly loses water? Suggested answer

35. Using the terms "osmosis" and a selection of either "hypotonic," "isotonic," or "hypertonic," explain how you could revive a wilted flower. Suggested answer

36. In what kind of solution must blood be, if red blood cells are to remain healthy? Explain. Suggested answer

37. Describe two ways in which phagocytosis differs from pinocytosis. Suggested answer

Activity: Osmosis Experiment

Purpose

In this activity, you will investigate the movement of water in and out of a strip of potato in two solutions: tap water, and a salt solution.

Note: If you are unable to perform this experiment, sample observations are provided at the end of this activity. You can use these sample data to answer the Support Questions at the end of the activity.

Materials

- One peeled potato (any type will work)
- Tap water
- Two small glasses
- Table salt
- Tablespoon
- Small knife
- Ruler
- Measuring cup

Procedure

1. Use a knife to cut two identical potato strips. Each "strip" should be about 4 cm long and 1 cm wide. It is important that both of them are the same size. Use a ruler to confirm that they are of equal size. Record the length (L), width (W), and thickness (T) of each strip, and calculate the volume (V).
2. Fill each glass with 250 mL (1 cup) of water. Label the glasses "A" and "B."
3. Place one potato strip into glass A so that it is totally submerged.
4. Add three tablespoons of salt to glass B, and then add the other potato strip so that it is totally submerged.
5. Allow the potato strips to soak for 24 hours.
6. After 24 hours, measure the dimensions of your strips and calculate their volume in cm^3 (L × W × T).

7. Record your observations in a data table like the one below.

Treatment	Initial size of potato strip (cm)				Size of potato strip after 24 hours (cm)			
	L	W	T	V	L	W	T	V
Glass A—just water								
Glass B—water and salt								

Results and Analysis

Answer the four Support Questions that follow. Use the sample observations provided here (click the "Sample data" button), if you were unable to do this experiment.

Sample data

Support Questions

38. **a)** What was the change in the volume of the potato strip in glass A after 24 hours?

b) What was the change in the volume of the potato strip in glass B after 24 hours?

c) Which glass showed most change? Were their changes both in the same direction? Suggested answer

39. Discuss the movement of water into or out of each strip (assume that salt cannot move). Did water enter or exit the strip? Suggested answer

40. Use the terms "hypotonic" and "hypertonic" to classify each solution in relation to the potato strip and explain why the water moved as it did for each strip. Suggested answer

41. How would increasing the temperature of the hypertonic solution affect osmosis for the potato strip? Explain how this works. Suggested answer

Cell Research in Medicine

Scientists are continually using knowledge of cells and cell processes to invent or discover technological advancements that can benefit society. Most are designed to cure or prevent disease, or to improve and extend our lifespan. Three examples of medical use of cell research include cancer treatments, production of hybridomas, and tissue cultures.

Cancer Treatments

Cancer cells reproduce in an abnormal manner. Cancer patients often undergo treatments such as chemotherapy to destroy the abnormal cancer cells. One major problem with chemotherapy drugs is that they are not able to target just the cancer cells; they kill healthy cells as well, making the patient very ill. New drug combinations are being developed that can kill cancer cells, while leaving healthy cells unharmed. These drugs work because they target the different ways that cancer cells and normal cells carry out their functions. This requires researchers to understand how normal cells are built and how their parts work together. One recent success has been the use of drug combinations to attack the energy-producing mitochondria of cancer cells, while leaving the healthy cells unaffected.

Hybridomas

Hybridomas are cells that have been engineered to produce a desired antibody in large amounts. Antibodies are special proteins that are able to fight and prevent viral diseases. A hybridoma is a hybrid cell produced by fusing (joining) cancer cells to normal white blood cells. These white blood cells are fused with tumour cells that can grow indefinitely in culture. This fusion is performed by making the cell membranes more permeable. The fused hybrid cells (called hybridomas), being cancer cells, will multiply rapidly and indefinitely, and will produce large amounts of the desired antibodies, which can then be isolated to prevent disease.

Tissue Cultures

Tissue cultures are groups of cells grown in a special dish called a petri dish. These tissues can then be implanted into an organism to assist in the organism's growth and repair. One potential application of tissue culture would be for people with Parkinson's disease. Parkinson's disease is a disease of the nervous system in which motor movements are impaired, due to the degeneration of a portion of brain tissue. Scientists have explored using embryonic tissue culture to repair this damage to nervous tissue. In other cases, tissue cultures are used for burn victims or for organ damage repair.

Key Questions

Now work on your Key Questions in the online submission tool. You may continue to work at this task over several sessions, but be sure to save your work each time. When you have answered all the unit's Key Questions, submit your work to the ILC.

Total: 18 marks

12. Why would muscle cells require more mitochondria than fat cells? **(3 marks)**

13. Distinguish between diffusion and active transport, in terms of

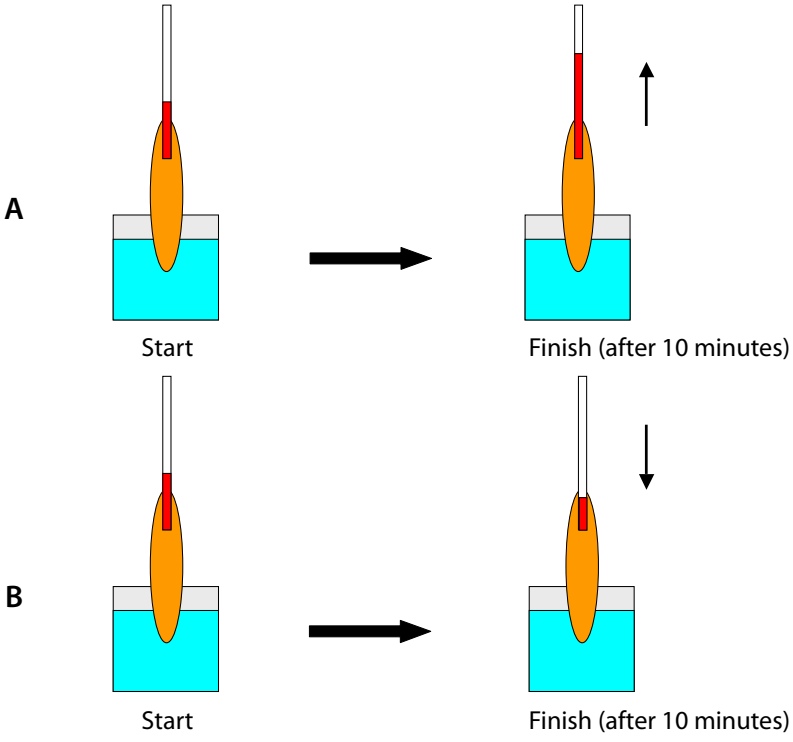
a) energy involvement. **(2 marks)**

b) direction of molecular flow. **(2 marks)**

14. Describe two ways that receptor-mediated endocytosis is different from phagocytosis. **(2 marks)**

15. Describe the function of integral proteins and cholesterol in the cell membrane. **(2 marks)**

16. The following diagram shows a carrot used as an osmometer. Scientists set up an experiment by placing carrots in two beakers, each one containing a different solution: either distilled water or a 10% salt solution. Unfortunately, the scientists forgot to label the contents of their beakers so they don't know which one contained the salt solution and which one contained the distilled water.



a) What problem was being investigated? **(1 mark)**

b) On the basis of the observations after 10 minutes, which beaker contained the distilled water? Explain. **(3 marks)**

17. Explain how rinsing your mouth with salt water may help to reduce swelling of the gums. Use appropriate terms including osmosis, hypotonic, hypertonic, and/or isotonic. **(3 marks)**

This is the last lesson in Unit 1. When you have completed all the Key Questions, submit your work to the ILC. A teacher will mark it and you will receive your results online.