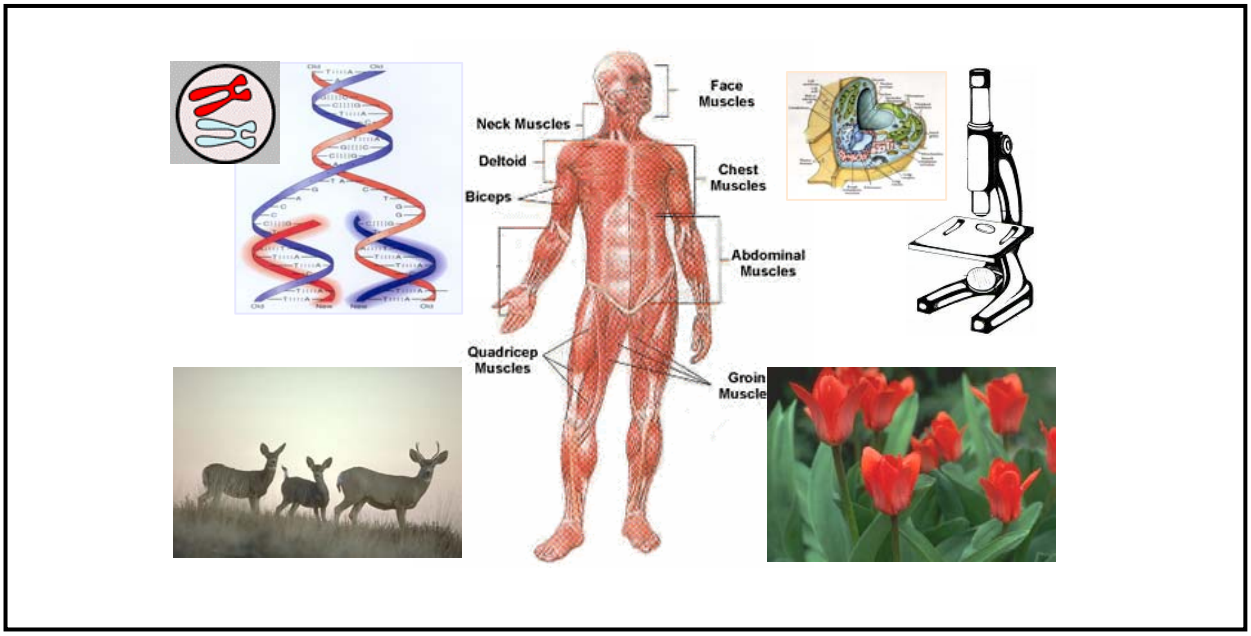
Project EASE

(Effective Alternative Secondary Education)

BIOLOGY



MODULE 3

Movement of Materials Through the Cell Membrane

BUREAU OF SECONDARY EDUCATION
Department of Education
DepED Complex, Meralco Avenue
Pasig City

Module 3
Movement of Materials Through the Cell Membrane

What this module is about

Have you tried washing the dishes or staying in a pool so long that your fingers became wrinkled? What caused your fingers to wrinkle? How long did it take your fingers to return to normal? Why does this happen?

In this lesson, you will learn how materials move into and out of the cells. You will also learn how materials are constantly being exchanged between a living cell and the non-living world. You will also learn how discoveries on cellular structures and functions have led to useful technologies.

This module has the following lessons:

- **Lesson 1 – Substance Transport Across the Membrane**
- **Lesson 2 – Passive Transport versus Active transport**
- **Lesson 3 – Useful Technologies on Cellular Structures and Functions**

What you are expected to learn

After going through this module, you are expected to:

1. discuss cellular exchange of materials with the environment;
2. explain osmosis as a type of diffusion;
3. distinguish between active and passive transport;
4. appreciate how discoveries on cellular structures and functions have led to useful technologies; and
5. explain how the activities of certain cell organelles are used to promote food production and health.

How to learn from this module

I know you are excited to start the adventure just as I am but remember to do the following tips to successfully achieve the objectives of this self-learning kit.

1. Read the instructions carefully.
2. Follow the instructions carefully.
3. Answer the pretest before you start the lesson.
4. Take note and record points for clarifications.
5. Try to achieve at least a 75% level of proficiency in the tests.
6. Work diligently and honestly.
7. Answer the posttest.

What to do before (Pretest)

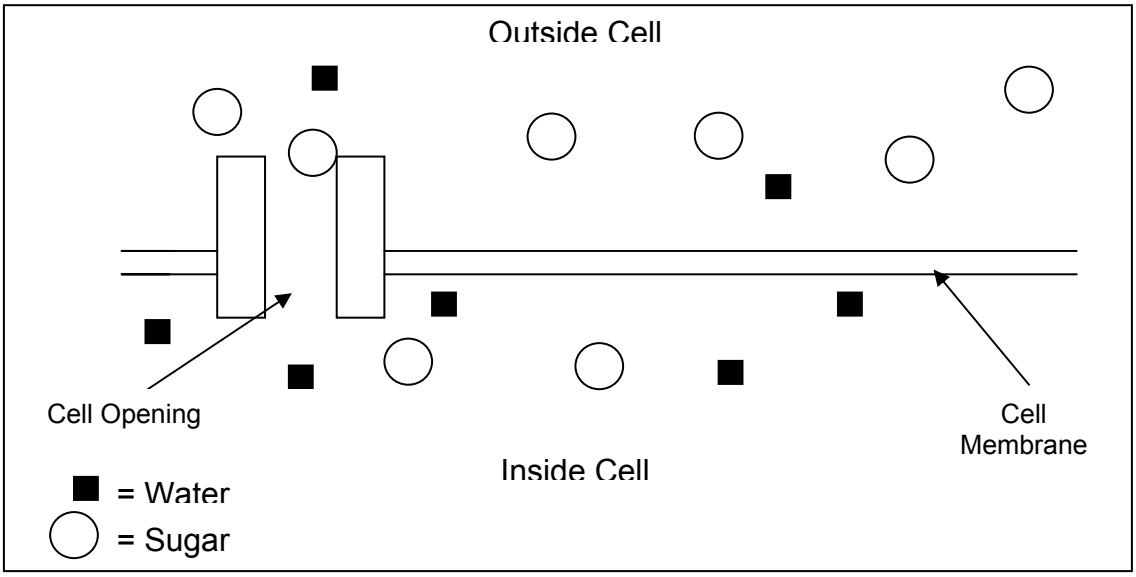
Answer the pre-test to measure how much you know about the topic. You can start now.

- There are 20 questions. Each question has ONLY ONE CORRECT ANSWER. Choose the one you believe to be best.
- Each question is worth 2 points.
- Read each question. Take your time.
- GOOD LUCK!

1. Which of the following molecules **can penetrate rapidly** across the cell membrane?
   a. H_2O
   b. Na^+
   c. sugar
   d. protein

2. Proteins enter and exit the cell by
   c. diffusion
   d. osmosis
   c. phagocytosis
   d. facilitated diffusion

Use the diagram to answer questions 3 and 4.



3. What happens with the water molecules?
   a. The water molecules will enter the cell.
   b. The water molecules will move out of the cell.
   c. The water molecules will remain where they are.

4. What happens with the sugar molecules?
   a. The sugar molecules will enter the cell.
   b. The sugar molecules will move out of the cell.
   c. The sugar molecules will remain where they are.

5. Through which process do sugar molecules enter or exit a cell?
   a. diffusion
   b. osmosis
   c. facilitated diffusion
   d. none of the above

6. Which process **ALWAYS** involves movement of materials from inside the cell to outside the cell?
   a. osmosis
   b. diffusion
   c. exocytosis
   d. endocytosis

7. A substance that moves across a cell membrane without using the cell's energy tends to move
   a. toward the area where it is more concentrated.
   b. away from the area where it is less concentrated.
   c. away from the area where it is more concentrated.

8. If a solution outside a cell is more concentrated so that the cell loses water to its environment, which of the following describes the external solution?
   a. isotonic
   b. hypotonic
   c. hypertonic
   d. in equilibrium

9. Which mechanism requires energy?
    a. osmosis
    b. diffusion
    c. active transport
    d. facilitated diffusion

10. Certain types of lymphocytes (white blood cells) in the lymph nodes ingest bacteria and debris. This function most likely occurs by
    a. exocytosis
    b. pinocytosis
    c. phagocytosis
    d. passive transport
    e. facilitated transport

11. Which of the following is characteristic of cell membrane?
    a. permeable
    b. impermeable
    c. semi permeable
    d. none of these

12. Which refers to a solution containing a greater concentration of solvent than the solution it is being compared with?
    a. isotonic
    b. hypotonic
    c. hypertonic
    d. equilibrium

13. Which solution contains a higher concentration of solute than the solution it is being compared with?
    a. isotonic
    b. hypotonic
    c. hypertonic
    d. equilibrium

14. What part of the cell maintains homeostasis in the cell?
    a. cell membrane
    b. mitochondria
    c. Golgi bodies
    d. ribosomes

15. What are the current benefits of having foods made from genetically modified crops?
    a. They improve farm profitability and make some farmers' jobs easier.
    b. They allow farmers to greatly increase the amount of crops produced.
    c. They improve convenience for consumers, e.g. by creating foods with longer shelf lives
    d. They improve the nutritional quality of foods.
    e. They cause less damage to the environment than conventional chemical intensive agriculture.

16. What effect does eating genetically modified foods have on your genes?
    a. It has no effect on your genes.
    b. It could cause your own genes to mutate.
    c. The effects on human genetics are not known.
    d. It could cause your own genes to absorb the excess genes.

17. Which best describes a transgenic crop?
    a. A crop which is a mutant.
    b. A crop which is an animal.
    c. A crop that has been bred to exhibit new characteristics.
    d. A crop that has had a gene from another species inserted.

18. Are foods made from genetically modified crops required to pass human testing?
    a. Yes, because it ensures safety of humans.
    b. No, because they are safe to be used by humans.

19. Are foods derived from genetically modified crops required to be tested for possible allergic reactions in people?
    a. Yes, because health/safety of humans is important.
    b. No, because they cause no allergic reactions in people.

20. Which of the following was the first mammal to be cloned?
    a. Dolly the sheep
    b. Piggy the piglet
    c. Rhesus monkey
    d. Donkey the horse

Got a perfect score? Check it out!

Key to answers on page 24.

Lesson 1. Substance Transport Across the Membrane

Look around you. The things you see, and even some things you cannot see, are made of **matter** (anything that has mass and takes up space). Living cells that make up your body are made of matter.

Matter is made of small non-living particles called **atoms** (hydrogen, oxygen, carbon, nitrogen). Atoms are seldom found alone in nature. Usually, they join together to form larger particles called **molecules** (combination of two or more atoms). Molecules are assembled to form cells.

Each individual cell exists in a liquid environment. The cells of our bodies are bathed in a liquid that was once part of blood. The presence of liquid makes it easier for materials like food, oxygen and water to move into and out of the cell.

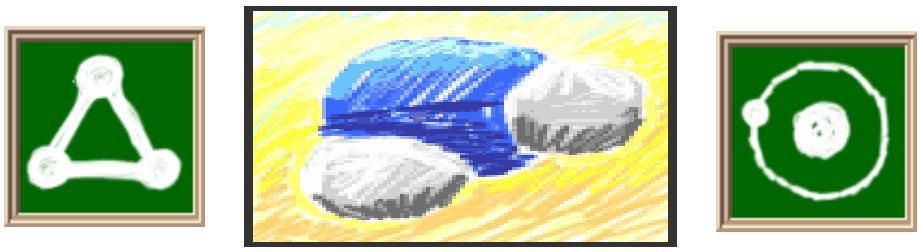


Figure 1.1 Atoms/molecules
Source: http://www.chem4kids.com/files/atom_intro.html

Have You Heard?

Water molecules are very, very small. To get an idea of just how small they are, try to imagine this. If a single drop of water were enlarged until it was the size of the earth, each water molecule in that earth-sized drop of water would be no larger than a golf ball!

Just as whole organisms take in food, cells also obtain food, oxygen, and other substances from their environment. They also release waste materials.

How do these things move into and out of the cell? What controls the movement of materials into and out of the cell?

You are right if you say that it is the job of the cell membrane.

Have you ever seen marbles in a mesh bag? A mesh bag has holes in it. But the marbles stay inside because they are larger than the holes.

What if you replaced marbles with sand? Gotcha! The sand will fall right through the holes because the sand grains are smaller than the holes.

The mesh bag is selectively permeable (passable) because it allows some things to pass through it but not others. The marbles and sand are models for molecules. For this reason, biologists describe a cell membrane as **selectively permeable**.

Water and other small molecules can easily pass through a cell membrane. Proteins and other large molecules must be broken down into smaller parts to enter the cell. Once inside a cell, the larger molecules can be rebuilt.

There are several ways in which materials enter and leave the cell. If materials move through a cell membrane without the help of energy, **passive transport** takes place. If materials require energy to move through a cell membrane, **active transport** takes place.

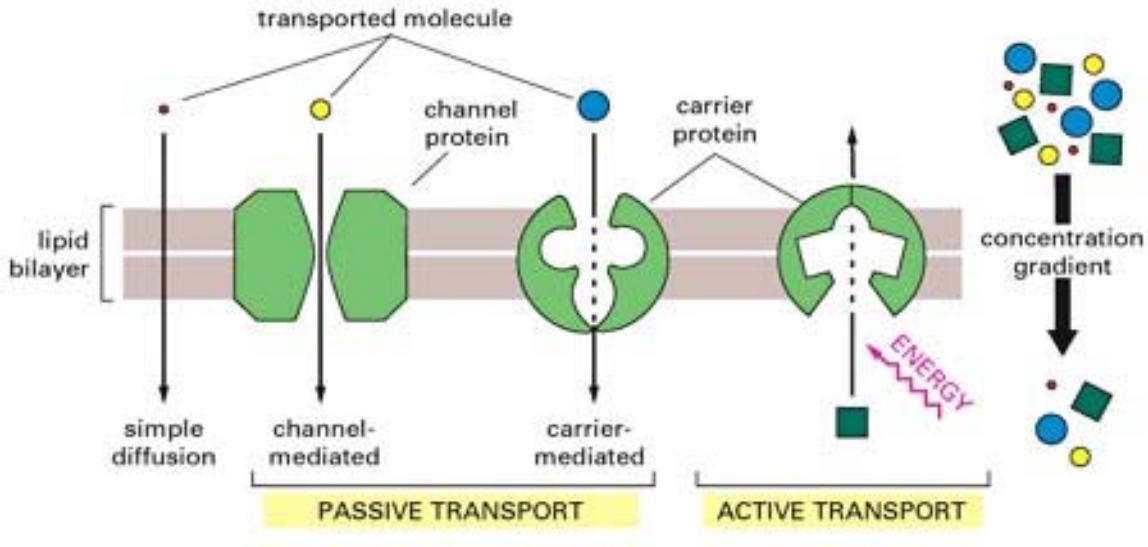


Figure 1.2 Passive transport and active transport
Source: http://www.accessexcelence.org/RC/VL/GG/index.html

What you will do

Activity 1.1

Can You Do This?

Do this simple activity to find out why your fingers wrinkle.

Pour 250 ml of water into each of two small bowls. Stir a pinch of salt. Label it salt water. Place slices of raw potato in each bowl. Predict how the potato slices will be affected. After 20 minutes, pick up the slices and examine them. Describe the slices. How do they compare with wrinkled fingers?

Key to answers on page 24.

What you will do

Self-Test 1.1

Answer the question briefly.

If the cell membrane were not semi-permeable, a cell might die. Why?

_____
_____
_____
_____

Key to answers on page 24.

Lesson 2. Passive Transport versus Active Transport

How do molecules move into and out of the cell?

Molecules move like a crowd of bump cars in an amusement park. They move from crowded areas into places where there are fewer of them.

Passive transport involves carriers, channels, or direct diffusion through a membrane. This type of transport always operates from regions of greater concentration to regions of lesser concentration. No external source of energy is required.

The force behind the movement of many substances across the cell membrane is called **diffusion**. There are three main types of diffusion: **simple, channel**, and **facilitated** diffusion.

Simple diffusion is when a small molecule passes through a lipidbilayer. It is classified as a means of passive transport. Simple diffusion does not involve a protein. An example of simple diffusion is osmosis

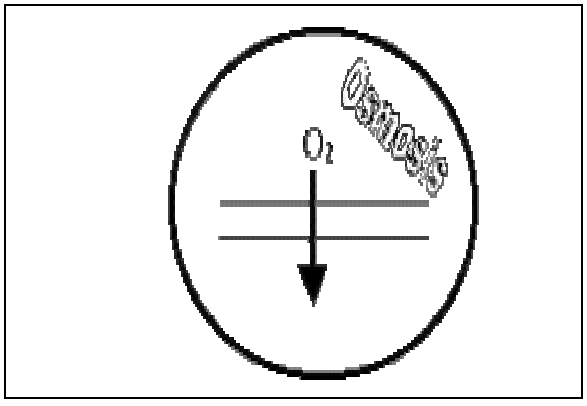


Figure 2.1 Example of simple diffusion
Source: http://biology.Kenyon.edu/HHMI/Biol113/diffusion.htm

Channel diffusion is another type of passive transport. Channel diffusion involves channel proteins where material moves through an open, aqueous pore. Channel diffusion can be regulated. Ions and charged particles can pass through the open pore.

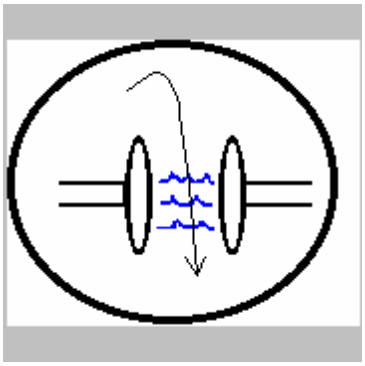


Figure 2.2 Example of channel diffusion
Source: hhtp://biology.Kenyon.edu/HHMI/Biol113/diffusion.htm

Facilitated diffusion is a type of passive transport that is dependent on single transport carriers. These protein carriers operate on a bind, flip, release mechanism. Facilitated diffusion is non-diffusional because the molecule moves along with the carrier.

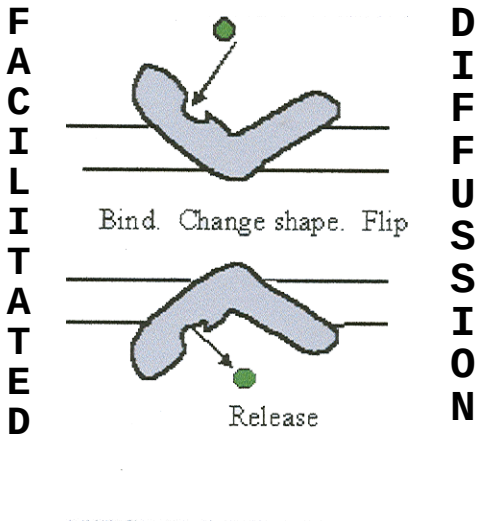


Figure 2.3 Example of facilitated diffusion
Source: hhtp://biology.Kenyon.edu/HHMI/Biol113/diffusion.htm

Do You Know?

You are on a large 10 ft x 10 ft x10 ft elevator. An obnoxious individual with a lit cigar gets in on the third floor with the cigar still burning. You are also unfortunate enough to be in a very tall building and the person says "Hey we're both going to the 62nd floor!" Disliking smoke you move to the farthest corner you can. Eventually you are unable to escape the smoke! This is an example of diffusion in action. Nearer the source the concentration of a given substance increases.

You experience diffusion when someone opens a bottle of perfume in a closed room, or when someone arrives freshly doused in perfume or cologne. Also, when drops of blue ink are added to a glass of water, diffusion takes place.

What you will do

Activity 2.1

MINI-Lab

How does temperature affect the rate of diffusion of molecules?

Prepare jars/bottles with equal amounts of cold water and hot tap water. Add one antacid tablet to each AT THE SAME TIME. Predict which will dissolve faster. Observe and record how long it takes for the tablet to dissolve in each beaker. Explain any differences you observe.

You can do this activity at home.

Key to answers on page 25.

If you will recall, water makes up a large part of living matter. The movement of water into and out of a cell is known as **osmosis**. The process can cause a cell to swell or get smaller depending on the amount of water around the cell. Water molecules move from where they are in large numbers to where they are in small numbers. When the number of water molecules inside and outside the cell is the same, **equilibrium** (balance) is reached.

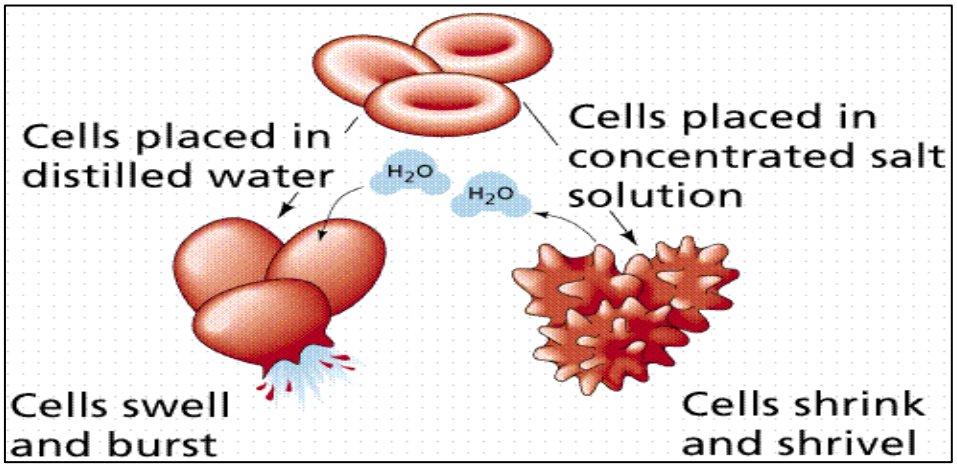


Figure 2.4 Water relations and cell shape in blood cells.
Source: www.sinauer.com & www.whfreeman.com

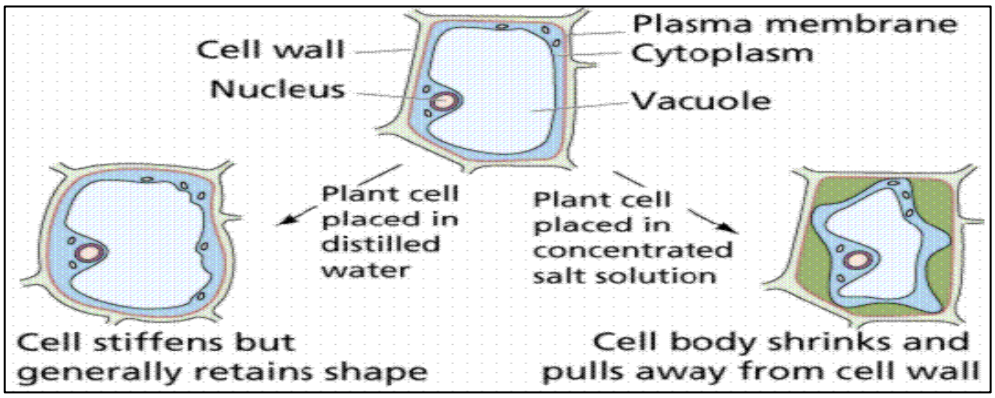


Figure 2.5 Water relations in a plant cell.
Source: www.sinauer.com & www.whfreeman.com

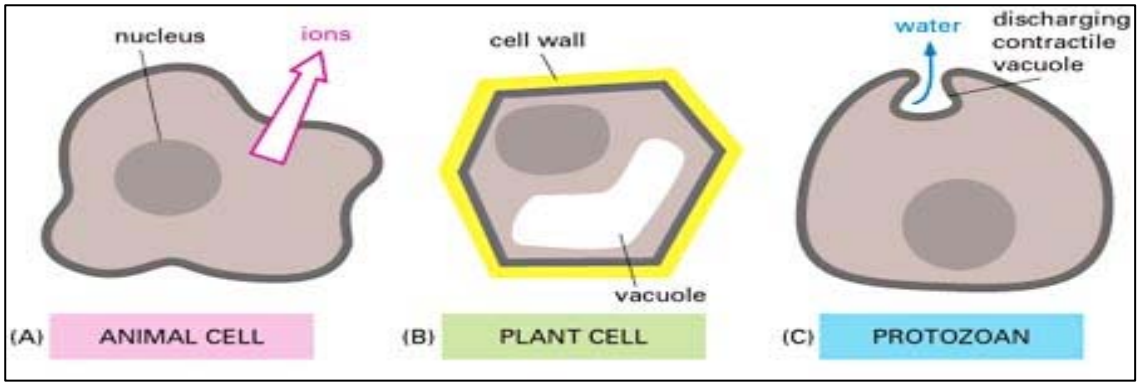


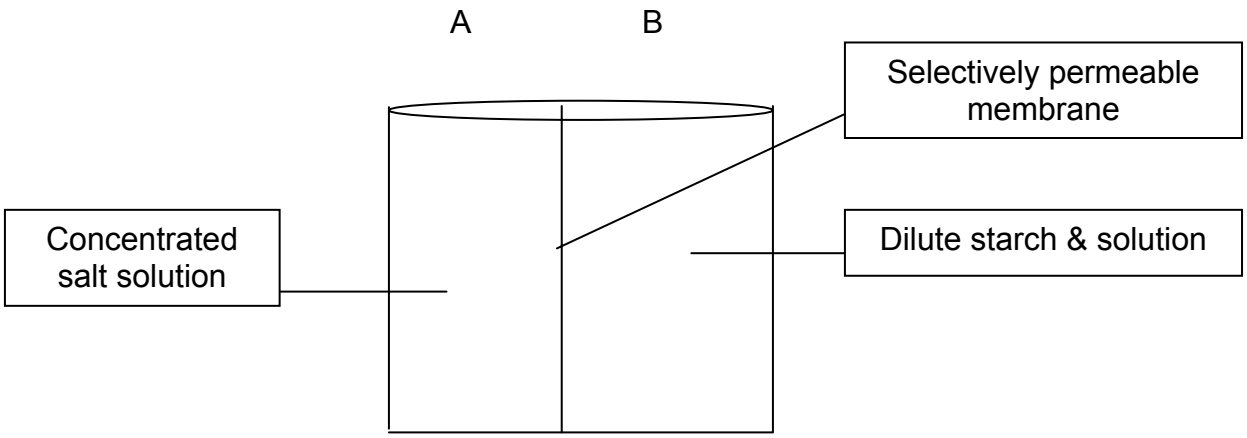
Figure 2.6
Source: http://www.accessexcelence.org/RC/VL/GG/index.html

Three ways in which cells avoid osmotic swelling. The animal cell keeps the intracellular solute concentration low by pumping out ions (A). The plant cell is saved from swelling and bursting by its tough wall (B). The protozoan avoids swelling by periodically ejecting the water that moves into the cell (C).

What you will do

Activity 2.2 Applying a Concept

- The beaker in the diagram has a selectively permeable membrane separating two solutions. Suppose that the salt molecules are small enough to pass through the membrane but the starch molecules are too large to pass through. Will the water level on either side of the membrane change? Explain your answer.



- If a cell membrane were not selectively permeable, a cell might die. Explain why.

_____
_____
_____
_____

Key to answers on page 25.

Think about this

If you become thirsty, you feel dried up. If cells don't have the water that they need, they lose water. If you forget to water a plant, it will become dry. Ah! Water is really important to life.

PROBLEM SOLVING

What happened to the salad?

Edith made a salad of lettuce, tomatoes, carrots, and cucumbers. She seasoned the salad with herbs, salt and pepper, then she placed it in the refrigerator for a couple of hours.

When Edith returned, she took the salad from the refrigerator. The lettuce had wilted, and the other vegetables were limp. She noticed that there was liquid in the bottle in the bowl. Where did the liquid come from?

Think critically: Why had the lettuce wilted (dried up)?

Key to answers on page 25.

In red blood cells, for example, a carrier protein in the cell membrane transports glucose (sugar) from one side of the membrane to the other. This process is controlled by **diffusion**.

Diffusion, osmosis, and facilitated diffusion are forms of passive transport.

Sometimes, a cell uses energy to pump molecules through the cell membrane. This process, **active transport**, can move molecules from less crowded areas to more crowded areas. In other words, active transport can move molecules away from the direction in which they diffuse (move).

This process is the opposite of diffusion and it requires energy. An example of this type of active transport can be seen when:

- plant root cells take in minerals from the soil. The cells use energy to move additional minerals into the root cells.
- in the body, wastes are moved by active transport out of some kidney cells.

Where does energy come from for active transport to take place?

If your answer is mitochondria, I salute you, you are really learning fast.

How are large amounts of material transported through the cell membrane?

Some white blood cells in your blood are capable of swallowing whole bacteria. Other cells, such as the single-celled ameoba, are capable of "eating" clumps of sugar, and even tiny pieces of bread! Many cells will seem to "eat" small particles of food, foreign material, or even other cells. This process is called **endocytosis**. **Phagocytosis** is the type of endocytosis where an entire cell is engulfed. **Pinocytosis** is when the external fluid is engulfed. Endocytosis occurs when the material to be transported binds to certain specific molecules in the membrane. Examples include the transport of insulin and cholesterol into animal cells.

As you might expect, cells are also capable of sending material out of the cell. When other large molecules are removed from the cell, the process is generally known as **exocytosis**.

Endocytosis and exocytosis are forms of active transport. Refer to the diagram below.

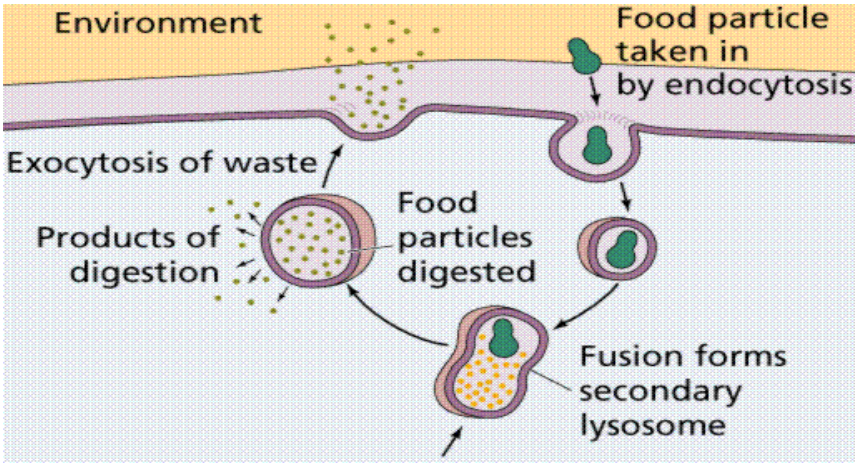


Figure 2.7 Exocytosis and endocytosis
Source: http://www.accessexcelence.org/RC/VL/GG/index.html

Remember

Cells have to stay in balance with their environment. Cells keep this balance, called **homeostasis**, by controlling what enters and leaves the cells through passive and active transport. You can see that the selectively permeable cell membrane and its transport systems are important in keeping cells and organisms alive and healthy.

Now that you have finished the second lesson, let's find out how much you learned from it.

What you will do

Self-Test 2.2

Analyze This

1. If you could place a single red blood cell in a glass of distilled water, what do you think would happen to the cell? Explain.

   _____
   _____
   _____
   _____

2. Predict what would happen if you put a cell into very sugary water.

   _____
   _____
   _____
   _____

Key to answers on page 25.

Lesson 3. Biotechnology

Biotechnology can be broadly defined as "using living organisms or their products for commercial purposes." As such, biotechnology has been practiced by human society since the beginning of recorded history in such activities as baking bread, brewing alcoholic beverages, or breeding food crops or domestic animals.

A narrower and more specific definition of biotechnology is "the commercial application of living organisms or their products, which involves the deliberate manipulation of their DNA molecules". This definition implies a set of laboratory techniques developed within the last 20 years that have been responsible for the tremendous scientific and commercial interest in biotechnology, the founding of many new companies, and the redirection of research efforts and financial resources among established companies and

universities. These laboratory techniques provide scientists with a spectacular vision of the design and function of living organisms, and provide technologists in many fields with the tools to implement exciting commercial applications.

Biotechnology has helped meet the food needs of today's society - where would the world have been without this technology? Learn more about it…

Areas of applied biotechnology

In 1885, a scientist named Roux demonstrated that embryonic chick cells could be kept alive outside an animal's body. For the next hundred years, advances in **cell tissue culture** have provided fascinating glimpses into many different areas such as biological clocks and cancer therapy.

Monoclonal antibodies are new tools to detect and localize specific biological molecules. In principle, monoclonal antibodies can be made against any macromolecule and used to locate, purify or even potentially destroy a molecule. An example of monoclonal antibodies can be found in anticancer drugs.

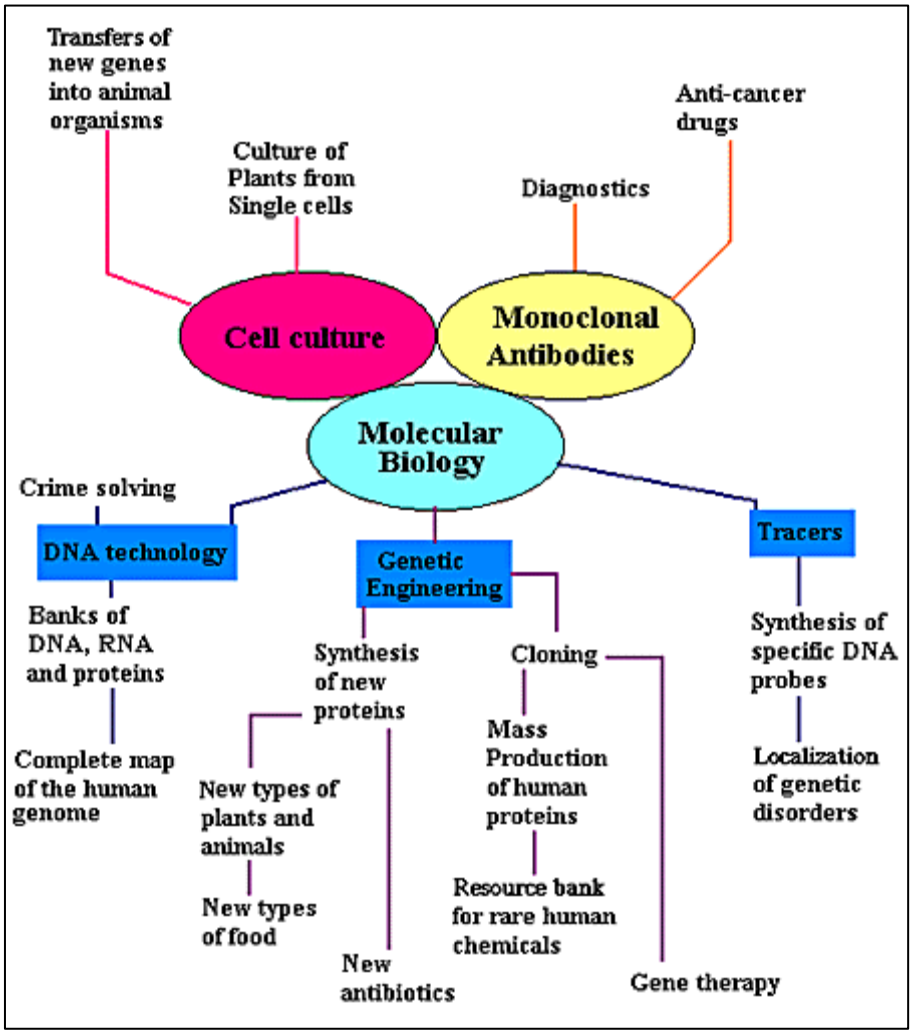


Figure 3.1 Biotechnology: Present and Future
Source: http://www.accessexcellence.org/RC/VL/GG/biotechnology.html

Molecular biology is useful in many fields. **DNA technology** is utilized in solving crimes. It also allows searchers to produce banks of DNA, RNA and proteins, while mapping the human genome. **Tracers** are used to synthesize specific DNA or RNA probes, essential to localizing sequences involved in genetic disorders.

With **genetic engineering**, new proteins are synthesized. These can be introduced into plants or animal genomes, producing a new type of disease resistant plants, capable of living in inhospitable environments (i.e. temperature and water extremes). When introduced

into bacteria, these proteins can also produce new antibiotics and useful drugs.

Techniques of cloning generate large quantities of pure human proteins, which are used to treat diseases like diabetes. In the future, a resource bank for rare human proteins or other molecules is a possibility. For instance, DNA sequences which are modified to correct a mutation, to increase the production of a specific protein or to produce a new type of protein can be stored . This technique will probably play a key role in gene therapy.

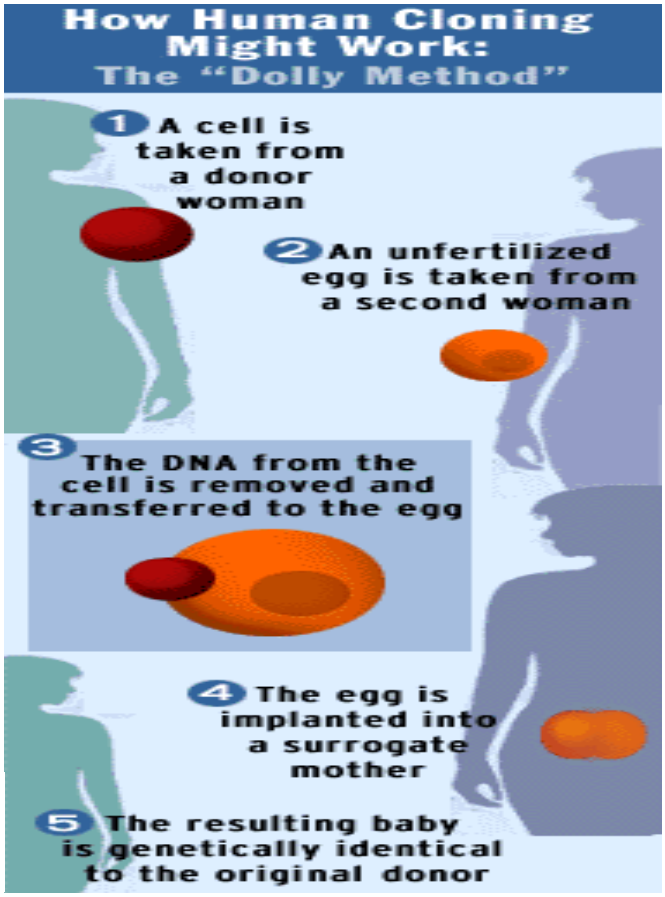


Figure 3.2 How human cloning works
Source: http://www.ornl.gov/sci/techresources/Human_Genome/elsi/cloning.shtml

Celebrity Sheep Died at Age 6

Image credit: Roslin Institute Image Library, http://www.roslin.ac.uk/imagelibrary/

Dolly, the first mammal to be cloned from adult DNA, was put down by lethal injection Feb. 14, 2003. Prior to her death, Dolly had been suffering from lung cancer and crippling arthritis. Although most Finn Dorset sheep live to be 11 to 12 years of age, postmortem examination of Dolly seemed to indicate that, other than her cancer and arthritis, she appeared to be quite normal. The unnamed sheep from which Dolly was cloned had died several years prior to her creation. Dolly was a mother to six lambs, bred the old-fashioned way.

Using Biotechnology to Modify Plants and Animals

Combining DNA from different existing organisms (plants, animals, insects, bacteria, etc.) results in modified organisms with a combination of traits from the parents. The sharing of DNA information takes place naturally through sexual reproduction and has been exploited in plant and animal breeding programs for many years.

However, sexual reproduction can occur only between individuals of the same species. A Holstein cow can be mated with a Hereford bull because the two animals are different breeds of the same species, cattle. But trying to mate a cow with a horse, a different species of animal, would not be successful.

What is new since 1972 is that scientists have been able to identify the specific DNA genes for many desirable traits and transfer only those genes, usually carried on a plasmid or virus, into another organism. This process is called genetic engineering and the transfer of DNA is accomplished using either direct injection or the Agrobacterium, electroporation, or particle gun transformation techniques. It provides a method to transfer DNA between any living cells (plant, animal, insect, bacterial, etc.). Virtually any desirable trait found in nature can, in principle, be transferred into any chosen organism. An organism modified by genetic engineering is called **transgenic**. See diagram at the right.

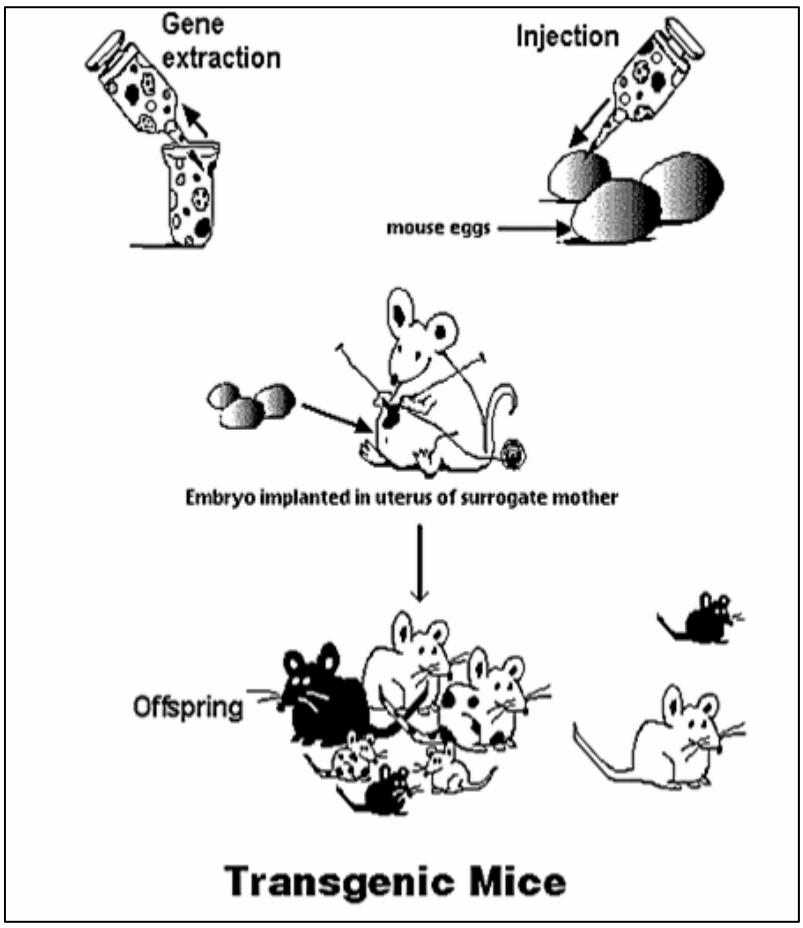


Figure 3.3 Transgenic mice
Source: http://www.accessexcelence.org/RC/VL/GG/biotechnology.html

Products of Genetic Engineering

Specific applications of genetic engineering are abundant and increasing rapidly in number. **Genetic engineering is being used in the production of pharmaceuticals, gene therapy, and the development of transgenic plants and animals.**

1. **Pharmaceuticals** human drugs such as insulin for diabetics, growth hormone for individuals with pituitary dwarfism, and tissue plasminogen activator for heart attack victims, as well as animal drugs like the growth hormones, bovine or porcine somatotropin, are being produced by the fermentation of transgenic bacteria that have received the appropriate human, cow, or pig gene.

2. **Gene Therapy**, the first clinical gene therapy is underway to correct an enzyme deficiency called ADA (Adenosine deaminase) in children. Bone marrow cells are removed, defective DNA in bone marrow cells is supplemented with a copy of normal DNA, and the repaired cells are then returned to the patient's body.

3. **Transgenic Plants**. Transgenic plants that are more tolerant of herbicides, resistant to insect or viral pests, or express modified versions of fruit or flowers have been grown and tested in outdoor test plots since 1987. The genes for these traits have been delivered to the plants from other unrelated plants, bacteria, or viruses by genetic engineering techniques.

4. **Transgenic Animals**. Presently, most transgenic animals are designed to assist researchers in the diagnosis and treatment of human diseases. Several companies have designed and are testing transgenic mammals that produce important pharmaceuticals in the animal's milk. Products such as insulin, growth hormone, and tissue plasminogen activator that are currently produced by fermentation of transgenic bacteria may soon be obtained by milking transgenic cows, sheep, or goats.

Figure 3.4
Tissue culture of transgenic plants in a controlled environmental chamber
Source: USDA

Using Biotechnology in Diagnostic Applications

Since each living creature is unique, each has a unique DNA recipe. Individuals within any given species, breed, or hybrid line can usually be identified by minor differences in their DNA sequences - as few as one difference in a million letters can be detected! Using the techniques of DNA fingerprinting and PCR (polymerase chain reaction) scientists can diagnose viral, bacterial, or fungal infections, distinguish between closely related individuals, or map the locations of specific genes along the vast length of the DNA molecules in the cells.

What you will do

Activity 3.1

You decide!

Although the human genome initiative could mean good things for people with genetic disorders, the use of such technology may cause problems. Some genetic traits may hinder an individual's ability to perform a job safely. Do you feel that an employer should be given the right to use genetic information to judge an individual's ability to perform a job?

What you will do

Self-Test 3.1

1. Are foods derived from genetically modified crops nutritionally superior?

    a. Yes, they offer substantial health advantages over foods produced from conventional crops.
    b. Yes, they offer some health advantages over foods produced from conventional crops.
    c. No, they are neither better nor worse than foods from conventional crops.
    d. No, they are slightly less healthful than foods from conventional crops.
    e. No, foods produced from genetically modified crops are a known health risk.

2. Which of the following best describes a transgenic organism?

    a. a cloned organism
    b. a mutated organism
    c. an organism produced by sexual reproduction.
    d. an organism that contain genetic information from another species.

Key to answers on page 25.

Let's Summarize

1. Cell membranes act as barriers to most, but not all, molecules. The development of a cell membrane that could allow some materials to pass while constraining the movement of other molecules was a major step in the evolution of the cell. Cell

membranes are differentially (or semi-) permeable barriers separating the inner cellular environment from the outer cellular (or external) environment.

2. **Passive transport** requires no energy from the cell. Examples include the diffusion of oxygen and carbon dioxide, osmosis of water, and facilitated diffusion.
3. **Diffusion** is the net movement of a substance (liquid or gas) from an area of higher concentration to one of lower concentration.
4. **Osmosis** is the diffusion of water across a semi-permeable (or differentially permeable or selectively permeable) membrane.
5. **Hypertonic** solutions are those in which more solute (and hence lower water potential) is present. **Hypotonic** solutions are those with less solute (again read as higher water potential). **Isotonic** solutions have equal (iso-) concentrations of substances. Water potentials are thus equal. Although there will still be equal amounts of water movement in and out of the cell, the net flow is zero.
6. **Active transport** requires the cell to spend energy, usually in the form of ATP. Examples include transport of large molecules (non-lipid soluble).
7. **Endocytosis** is the case when a molecule causes the cell membrane to bulge inward, forming a vesicle. **Phagocytosis** is the type of endocytosis where an entire cell is engulfed. **Pinocytosis** is when the external fluid is engulfed. Receptor-mediated endocytosis occurs when the material to be transported binds to certain specific molecules in the membrane. Examples include the transport of insulin and cholesterol into animal cells.
8. **Biotechnology** can be broadly defined as "using living organisms or their products for commercial purposes." As such, biotechnology has been practiced by human society since the beginning of recorded history in such activities as baking bread, brewing alcoholic beverages, or breeding food crops or domestic animals.

Whew, at last! You have finished studying the module. But, before you completely exit from this module, let us find out how much you learned.

Posttest

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What effect does eating genetically modified foods have on your genes?
    a. It has no effect on your genes.
    b. It could cause your own genes to mutate.
    c. The effects on human genetics are not known.
    d. It could cause your own genes to absorb the excess genes.

2. What are the current benefits of having foods made from genetically modified crops?
    a. They improve farm profitability and make some farmers' jobs easier.

b. They allow farmers to greatly increase the amount of crops produced.
c. They improve convenience for consumers, e.g. by creating foods with longer shelf lives.
d. They improve the nutritional quality of foods.
e. They cause less damage to the environment than conventional chemical intensive agriculture.

3. What part of the cell maintains homeostasis in the cell?
   a. ribosomes
   b. mitochondria
   c. golgi bodies
   d. cell membrane

4. Which solution contains a higher concentration of solute than the solution it is being compared with?
   a. isotonic
   b. hypotonic
   c. hypertonic
   d. equilibrium

5. Which refers to a solution containing a greater concentration of solvent than the solution it is being compared with?
   a. isotonic
   b. hypotonic
   c. hypertonic
   d. equilibrium

6. Which of the following best describes a cell membrane?
   a. permeable
   b. impermeable
   c. semi permeable
   d. none of these

7. Certain types of lymphocytes (white blood cells) in the lymph nodes ingest bacteria and debris. This function most likely occurs by
   a. exocytosis
   b. pinocytosis
   c. phagocytosis
   d. passive transport
   e. facilitated transport

8. Which mechanism requires energy?
   a. osmosis
   b. diffusion
   c. active transport
   d. facilitated diffusion

9. If a solution outside a cell is more concentrated so that the cell loses water to its environment, which of the following describes the external solution?
   a. isotonic
   b. hypotonic
   c. hypertonic
   d. In equilibrium

10. Are foods derived from genetically modified crops required to be tested for possible allergic reactions in people?
    a. Yes, because health/safety of humans is important.
    b. No, because they cause no allergic reactions in people.

11. Are foods made from genetically modified crops required to pass human testing?
    a. Yes, because it ensures safety of humans.

b. No, because they are safe to be used by humans.

12. Which of the following was the first mammal to be cloned?
    a. Dolly the sheep
    b. Piggy the piglet
    c. Rhesus monkey
    d. Donkey the horse

13. A transgenic crop is:
    a. a crop which is a mutant.
    b. a crop which is an animal.
    c. a crop that has been bred to exhibit new characteristic.
    d. a crop that has had a gene from another species inserted.

14. Proteins enter and exit the cell by
    a. diffusion
    b. osmosis
    c. phagocytosis
    d. facilitated diffusion

15. Which of the following molecules **can penetrate rapidly** across the cell membrane?
    a. H_2O
    b. Na^+
    c. sugar
    d. protein

16. A substance that moves across a cell membrane without using the cell's energy tends to move
    a. toward the area where it is more concentrated.
    b. away from the area where it is less concentrated.
    c. away from the area where it is more concentrated.

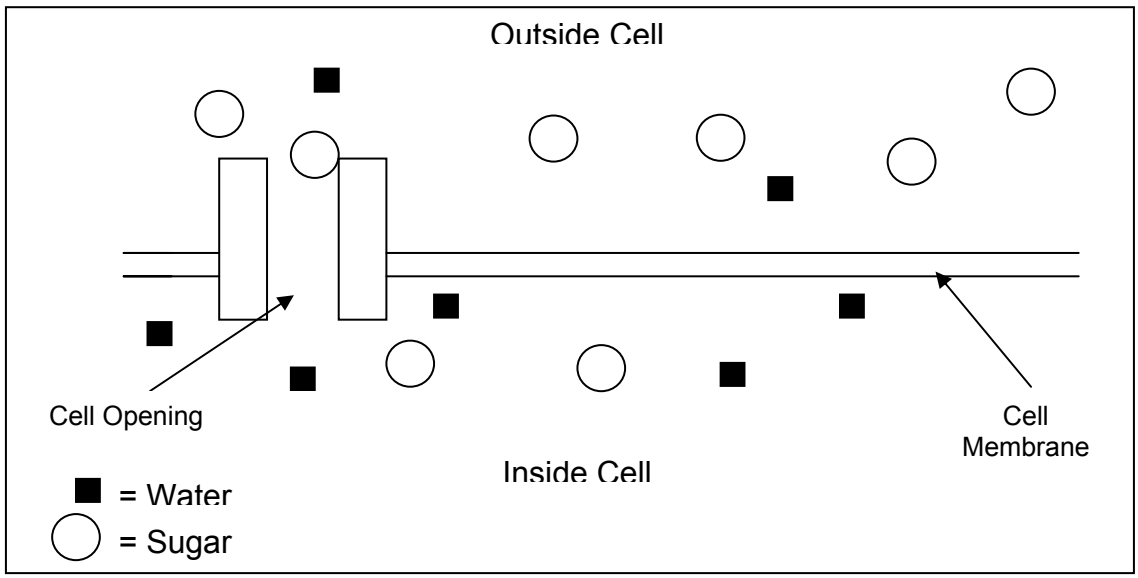
17. Which process ALWAYS involves movement of materials from inside the cell to outside the cell?
    a. osmosis
    b. diffusion
    c. exocytosis
    d. endocytosis

18. In what way do sugar molecules enter or exit a cell?
    a. diffusion
    b. osmosis
    c. facilitated diffusion
    d. none of the above

Use the diagram on the next page to answer questions 19 and 20.

19. What happens with the water molecules?
    a. The water molecules will enter the cell.
    b. The water molecules will move out of the cell.
    c. The water molecules will remain where they are.

20. What happens with the sugar molecules?
    a. The sugar molecules will enter the cell.
    b. The sugar molecules will move out of the cell.
    c. The sugar molecules will remain where they are.



Got a perfect score? Check it out!

Key to answers on page 26.

Key to Answers

Pretest

1. a	6. c	11. a	16. b
2. d	7. c	12. b	17. d
3. b	8. c	13. c	18. a
4. a	9. c	14. d	19. a
5. c	10. a	15. a	20. a

Lesson 1

Activity 1.1

What you've just seen is the effect of water moving into and out of the potato cells.

Self-Test 1.1

If the cell is not semi-permeable then the cell either bursts or shrinks because of uncontrolled movement of molecules.

Lesson 2

Activity 2.1

Substances or materials dissolve faster at high temperature. At high temperature, the rate of diffusion is faster than at low temperature. Cells must maintain the temperature within the normal range to facilitate the movement of materials into and out of the cell.

Activity 2.2
Applying a Concept

Yes. The water level in A will rise because of the diffusion of water molecules from an area where they are higher to an area where they are lower. This talks about the principle of osmosis.

If the cell membrane is permeable (passable) to all substances, then, the cell might expand and eventually burst because of too much pressure. If all the materials will move out of the cell, it might shrink or get smaller. It might also be deprived of materials that the cell needs to survive.

Self-Test 2.1

The liquid came from the vegetables. The lettuce had wilted because the water from the lettuce moved out. This shows the process of osmosis.

Self-Test 2.2
Analyze This

Q1 The cell expanded and burst because the distilled water moved into the cell. (osmosis)
Q2 The cell would shrink or get smaller because the water from the cell would move out.

Lesson 3

Self-Test 3.1

1. Answer: c. No. They are neither better nor worse than foods from conventional crops. "Most of the genetically modified crops currently available are designed to reduce farmers' production costs. Under some circumstances there may be less pesticides used, and there is some indication that genetically modified corn is less likely to be infected with fungal toxins that are natural carcinogens, but the overall health effect of these benefits is minor," Goldsbrough says. "In the future these technologies hold the promise of delivering foods that are nutritionally enhanced. For example, foods might provide essential vitamins or contain natural compounds that can help improve your health."
2. d.

Posttest

1. b	6. a	11. a	16. c
2. a	7. a	12. a	17. c
3. d	8. c	13. d	18. c
4. c	9. c	14. d	19. b
5. b	10. a	15. a	20. a

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