

Unit 2: Cellular Chemistry, Structure, and Physiology

Module 4: Cellular Physiology

NC Essential Standard:

- 1.2.1 Explain how homeostasis is maintained in a cell and within an organism in various environments
- 4.2.1 Analyze photosynthesis and cell respiration in terms of how energy is stored, released, and transferred within and between these systems



Can you die from drinking too much water?

- YES. Sadly, a young woman died from participating in a radio contest called "Wee for a Wii".
- When you drink excessive amounts of water, the kidneys cannot process it quickly enough to keep the body's water/salt concentration balanced, so it moves from the bloodstream into cells by the process of OSMOSIS.
- Animal cells swell as water enters. Most cells have room for this, but not nerve cells that make up the brain. This swelling of brain tissue is what ultimately causes death.



I. Are my cells alive?

A. Cells are the basic unit of structure and function in living organisms.

1. All living things are made of cells

- a. Unicellular organisms are made of one cell. Ex. Bacteria
- b. Multicellular organisms are made of many, many, many cells. Ex. YOU!

2. All life processes occur at a cellular level.

- a. In a multicellular organism, many of the bodily functions (breathing and eating) are necessary to supply individual cells with things the cells need.
- b. The interactions of all the individual cells in a multicellular organism create a need for other bodily functions (excreting wastes).

- B. Cells must interact with their environment to maintain homeostasis.
1. In order for a cell to gain nutrients, the nutrients must be delivered to the cell (ex. by blood) or taken directly from the environment.
 2. In order for some cells to generate energy, they require oxygen. Therefore, this oxygen must be delivered to the cell (ex. by blood) or taken directly from the environment.
 3. Cells affect their environment by releasing wastes into their surroundings. Ex. Algae release oxygen into the lake.

II. How do things get into and out of the cell?



- A. All things entering or leaving the cell must pass through the cell membrane.

1. The cell membrane is **selectively permeable**.
2. Membranes contain structures that allow movement
 - a. The membrane contains **pores** (holes) that allow very small molecules to move in and out freely.
 - b. The membrane also contains **transport proteins** that are specifically shaped to allow essential molecules, such as water, into and out of the cell

- B. Some types of cell transport DO NOT require energy. This is called **passive transport**.

1. Molecules are constantly in motion. The movement of molecules is random.
2. **Diffusion** is the term used to describe the movement of molecules from areas of high concentration to areas of lower concentration due to random movement. Diffusion can occur in the air, in water or across a cell membrane.
Ex. A drop of red dye spreads throughout the water
Ex. The smell of burnt popcorn spreads through the house

Two ways that molecules move through the cell membrane:

- 1.
- 2.

Passive transport is movement of molecules from _____ to _____ concentration.

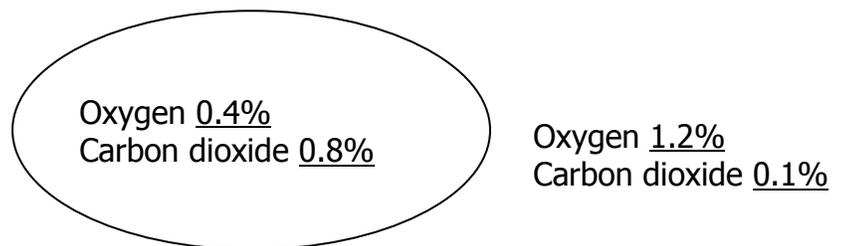
Differentiate between the terms "diffusion" and "osmosis":

Diffusion –

Osmosis –

Explain WHY the oxygen and carbon dioxide move as they do...

- a. **Concentration gradient** is the term used to describe the difference between higher and lower concentration.
 - b. **Osmosis** is the term used to specifically describe the movement of water across a membrane due to diffusion.
3. The principles of diffusion (and osmosis) can be used to predict the response of cells in different environments.
- a. An example of diffusion:
A cell has a concentration of 0.8% carbon dioxide gas and 0.4% oxygen gas. The blood surrounding the cell has an oxygen concentration of 1.2% and a carbon dioxide concentration of 0.1%. What will the cell lose? What will a cell gain?

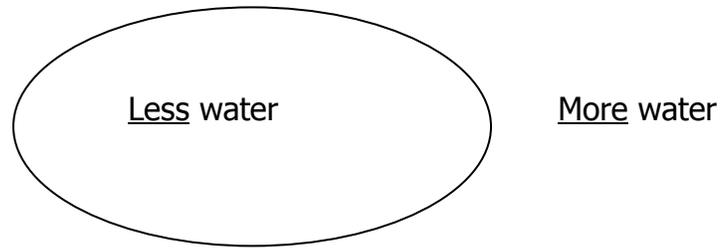


Answer:

Oxygen will diffuse into the cell and carbon dioxide will diffuse out of the cell. This is called gas exchange.

- b. Examples of osmosis:
 - i. A blood cell has the same concentration of water and salt as saline solution. A doctor who failed high school biology and did not listen to the attending nurse used an injection full of distilled water (100% water). What will happen to the blood cells surrounded by the distilled water? (Hint: You will feel excruciating pain.) Explain.

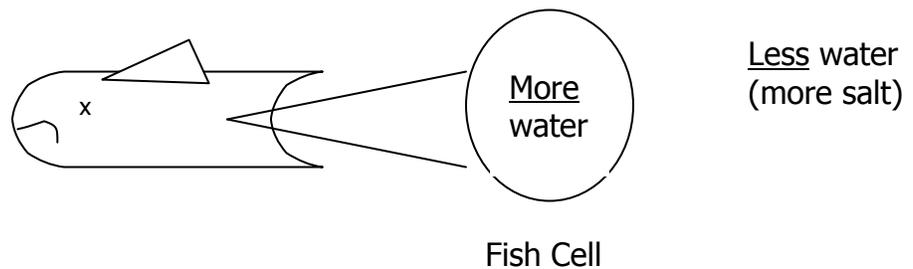
DRAW ARROWS on each of the cells shown in the notes to illustrate water moving across the cell membrane.



Answer:

Water will move into the cell through the process of osmosis, causing the cell to swell and possibly burst.

- ii. You go the pet store and purchase a fresh water fish. When you get home and place the fish in a salt water aquarium. The fish dies and you cry out "Why?" (No seriously, why?)



Answer:

Water in the fish's cells left the cell due to osmosis. The loss of water in the gill cells caused the death.

Equilibrium means....

4. The point at which the molecules are evenly dispersed is called **equilibrium**.
- a. Several factors affect the speed at which equilibrium is reached. These factors include temperature (higher temperature speeds the rate of diffusion) and concentration gradient (steeper gradients speed diffusion).

b. At equilibrium molecules continue to move but there is no net change in the concentration (distribution) of molecules.

C. Some types of transport DO require energy. This is called **active transport**.

Active transport is movement of molecules from _____ to _____ concentration

1. Active transport moves molecules against the concentration gradient (from low concentration to high concentration)
2. Active transport also moves large molecules into and out of the cell that could not normally cross the cell membrane.
3. The cell uses a special kind of energy for this transport. The chemical the cell uses is called ATP.

Check Yourself!

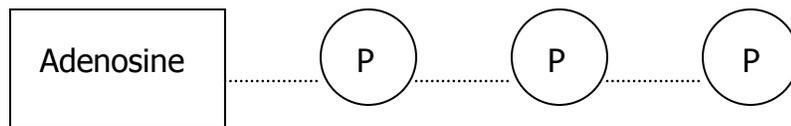
1. Why must some multicellular organisms breathe and eat?
2. Why do cells interact with their environment?
3. What structure do molecules pass through when entering or leaving the cell?
4. What type of transport requires no energy and includes diffusion and osmosis?
5. What is a concentration gradient?
6. What term is used to describe the diffusion of water across a membrane?
7. What type of transport moves molecules against the concentration gradient?
8. What term is used to describe an equal distribution of molecules between a cell and its environment?



- D. Photosynthesis provides no DIRECT source of energy for the cell. The cell must convert the sugar produced to another form of energy: ATP.

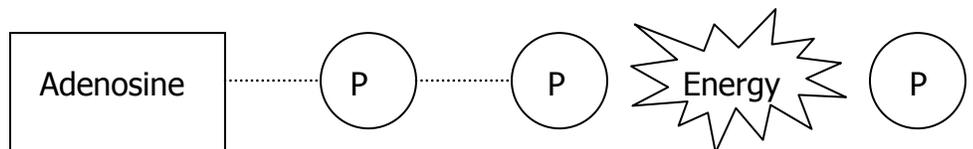
IV. What is this ATP, and why should I care?

- A. **ATP** stands for adenosine triphosphate. This basically means that it is a chemical with three phosphate groups attached.



ATP is used for....

- B. The cell uses ATP for energy. ATP is much smaller and faster to use than a larger molecule such as sugar. The energy in ATP is in the bonds connecting the four parts together.
- C. When the cell needs energy from ATP, it uses enzymes to break the third phosphate off of the molecule. The energy released is used for things in the cell such as active transport. Removing the third phosphate creates ADP and a loose phosphate.



- D. ATP can be recycled. When more energy is available, a third phosphate is added to ADP to make more ATP.

V. How do cells use the sugar to make ATP?

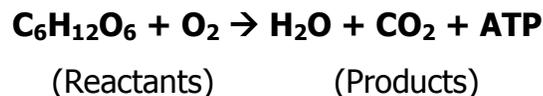
- A. All cells must use a process called **cellular respiration** to create ATP. Cellular respiration converts sugar (produced in photosynthesis) to create ATP.
- B. Cellular respiration takes place within the cell.

The goal of cellular respiration is ...

Types of organisms that use cellular respiration:

1. In eukaryotic cells, organelles called mitochondria are the sites of cellular respiration.
2. Mitochondria use many enzymes to break down sugar (glucose) and store the energy in the chemical bonds of ATP.
3. Prokaryotes also use cellular respiration, but they do NOT have mitochondria. Instead, prokaryotes use parts of their cell membrane.

C. Cellular respiration is also a metabolic pathway. The simplified equation for cellular respiration is:



Reactants of cellular respiration:

- 1.
- 2.

Products of cellular respiration:

- 1.
- 2.
- 3.

1. The reactants of respiration are glucose and oxygen. The sugar (glucose) is obtained from the vacuole (in plant cells) or from ingestion (eating) of food. If oxygen is used, it is obtained from the air.
2. The products of respiration are ATP, water and carbon dioxide. The water and carbon dioxide are released into the environment as waste products. ATP is kept in the cell for use as an energy molecule.

D. There are two types of cellular respiration: aerobic and anaerobic.

Differences in ATP production in aerobic vs. anaerobic respiration:

Aerobic –

Anaerobic -

1. **Aerobic respiration** requires the use of oxygen and makes A LOT of ATP.
2. **Anaerobic respiration** (also called **fermentation**) takes place when no oxygen is available to the cell and produces very little ATP. However, this process is much faster than aerobic respiration.

**Anaerobic respiration
is also called**

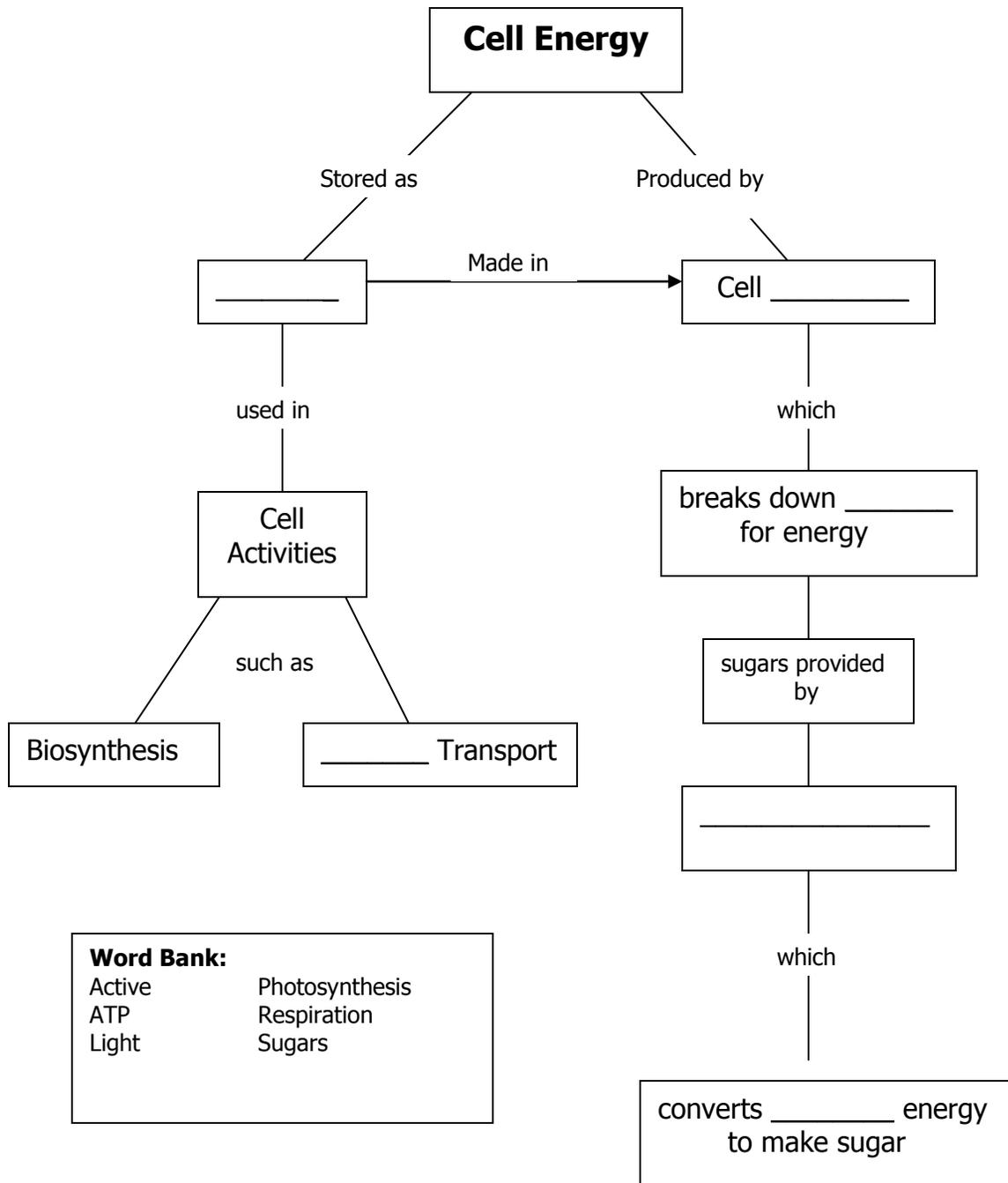
- a. In most microorganisms, fungi, and plant cells, anaerobic respiration produces alcohol as a waste product (**alcoholic fermentation**).
- b. In animal cells, anaerobic respiration produces lactic acid as a waste product (**lactic acid fermentation**).

Check Yourself!

1. What pigment AND reactants are required for photosynthesis to occur?
2. What does photosynthesis produce?
3. Where does photosynthesis occur in eukaryotic cells?
4. Where is the energy in ATP stored?
5. Why does the cell use ATP instead of sugar for energy?
6. What reactants are required for cellular respiration to occur?
7. What does cellular respiration produce?
8. Where does cellular respiration occur in eukaryotic cells?
9. How is fermentation alike and different from aerobic respiration?



Concept Map: Cell Energy



Word Bank:
Active Photosynthesis
ATP Respiration
Light Sugars

Unit 2 / Module 4

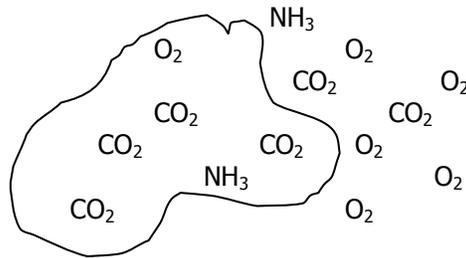
Problem-Solving Set

1. Oxygen and carbon dioxide molecules are able to diffuse through the cell membrane. Inside a cell, the concentration of oxygen molecules is 0.5% and the concentration of carbon dioxide molecules is 0.8%. In the blood surrounding the cell, the concentration of oxygen is 1.2%, and the concentration of carbon dioxide is 0.2%. Which way will the oxygen and carbon dioxide molecules move?

Draw a picture of the situation:

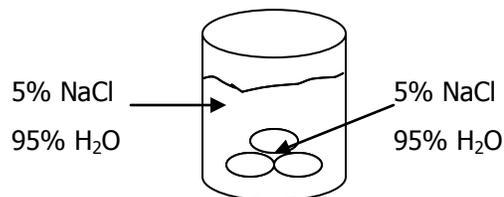
The oxygen will move _____ of blood and _____ cells.
The carbon dioxide will move _____ of cells and _____ blood.

2. Observe the following cell. What will happen to the molecules after a period of time?

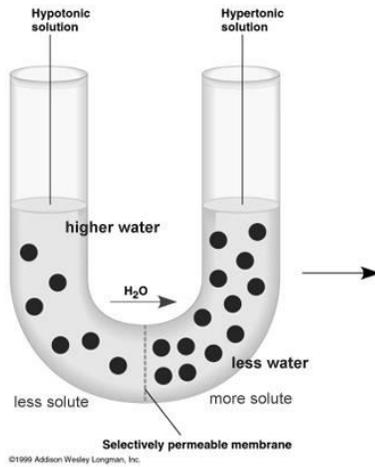


The _____ molecules will move into the cell and the _____ molecules will move out of the cell.

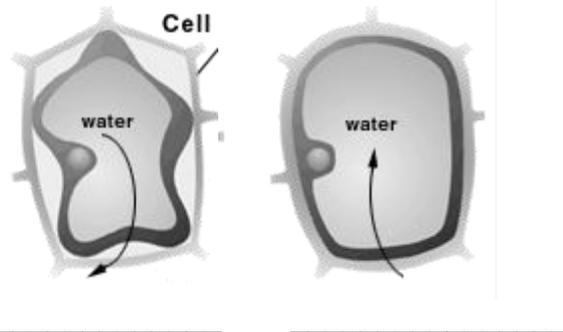
3. The following picture shows blood cells in a saline (salt) solution. Draw arrows on the picture to show which way the water will move.



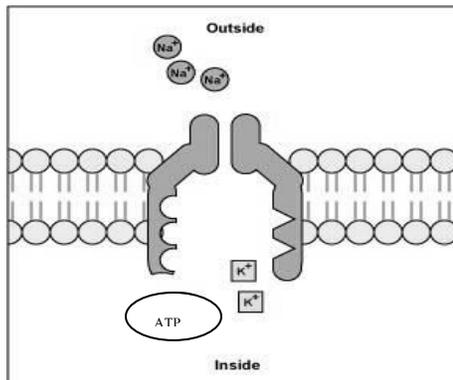
4. Observe the following picture. Draw another picture in the space provided to show how water levels would change after osmosis.



5. Below are pictures of plant cells surrounded by watery solutions. Below each picture, write if the plant cell is in a solution of "more water" or "less water".



6. In the picture below sodium (Na) will move **out** of the cell and potassium (K) will move **into** the cell. Will this be active or passive transport? Why?



The diagram shows _____ transport.

Explanation:

7. Identify the pictures below. What process occurs in each of these structures?

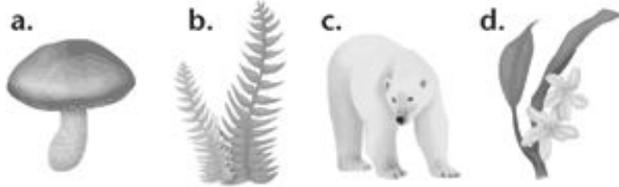


Name: _____
Process: _____

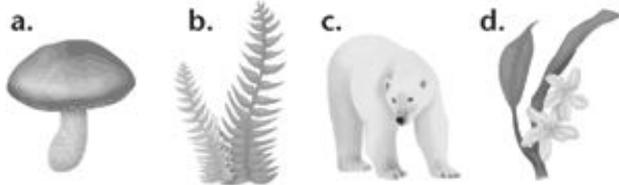


Name: _____
Process: _____

8. Which organisms perform photosynthesis?



Which organisms perform cellular respiration?



9. In making bread dough, microorganisms called yeast are used. The yeast undergo anaerobic respiration (also called fermentation), and in the process, the bread dough rises. What gas are the yeast releasing that causes the bread dough to rise?

10. Write out the chemical equation for photosynthesis:

Write out the chemical equation for cellular respiration:

11. Complete the following table:

	Photosynthesis	Cellular Respiration
Organelle		
Types of organisms		
Reactants (what is used)		
Products (what is made)		

12. Defend the following statement:

Photosynthesis and cellular respiration are the opposite of each other.

13. Complete the flow chart below:

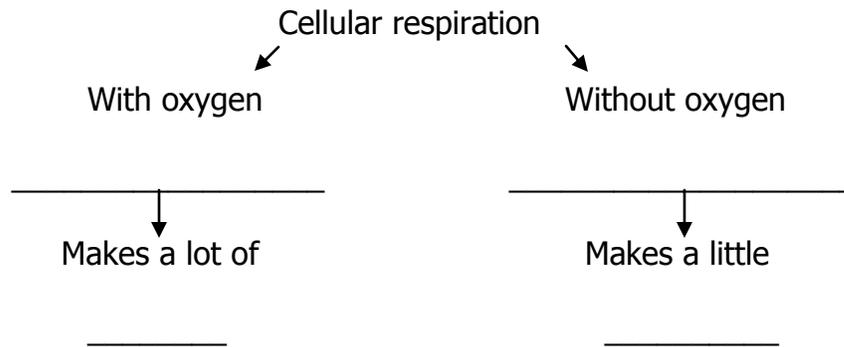


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