

## TOPIC TWO: Characteristics of Living Things

### A. Chemistry

1. The most common elements in living things are (in order) Carbon, Hydrogen, Oxygen and Nitrogen (CHON).

2. **Organic Compounds**

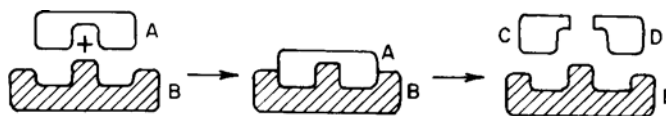
a. Have carbon AND hydrogen ( $C_6H_{12}O_6$  is organic,  $H_2O$  is not).

b. Organic molecules are larger than inorganic molecules.

3. **Carbohydrates** are sugars and starches.

a. All carbohydrates are made from simple sugars (like glucose) and they supply energy.

b. **Enzymes may break down starches and complex sugars into simple sugars.**



A starch (A) is broken down by an enzyme (B) into two simple sugars (C, D). This is also a good example of the **lock and key model**.

4. **Lipids** store energy and include fats, oils and waxes.

5. **Proteins** are made from **amino acids**.

a. **Proteins** make most of the chemicals used to build and run an organism's body, so *as far as your body is concerned, proteins are by far the most important of these three organic molecules.*

b. It is **the SHAPE of proteins** and how they fit together with other molecules that **determines what proteins can do.**

c. Four specific jobs of proteins:

1) **enzymes** (see next page for more on enzymes)

2) **receptor molecules** on the cell membrane. These are used to receive chemical messages (like hormones).

3) **antibodies** (proteins which fight infection)

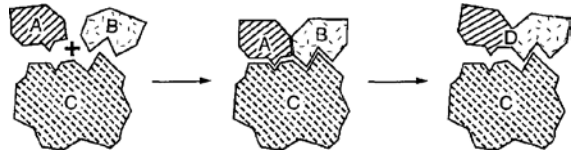
4) **hormones** (chemical messengers)

6. **Enzymes** are **catalysts** made from **protein**.

a. **Catalysts** affect the rates (speed) of chemical reactions.

b. **Lock and key model** – one type of enzyme fits one and only one type of molecule. Change its shape and the enzyme will no longer work (this is true for almost all proteins).

- c. **Very high temperatures** cause proteins and enzymes to lose their shape so that they no longer work properly. This is why high fevers are dangerous.



Another example of the **lock and key model**. In this case, the enzyme (C) is controlling a synthesis reaction.

7. **pH:** The pH scale measures the strengths of **acids** and **bases** on a scale of 0 to 14.
- A low pH (0-6) is an acid.
  - A high pH (8-14) is a base.
  - A pH of 7 is neutral (water).

## B. All living things must maintain homeostasis.

- Homeostasis** is a balanced state in an organism.
- Dynamic equilibrium** means that the body stays balanced by taking action whenever the balance is disturbed (like sweating when the body is too hot).
- To maintain homeostasis, organisms carry out the same basic life functions: **transport, nutrition, excretion, respiration, growth, synthesis, regulation and synthesis**. Know these terms!
- Metabolism** is the term used to describe all of these life processes.
- Failure to maintain homeostasis will result in disease or death.

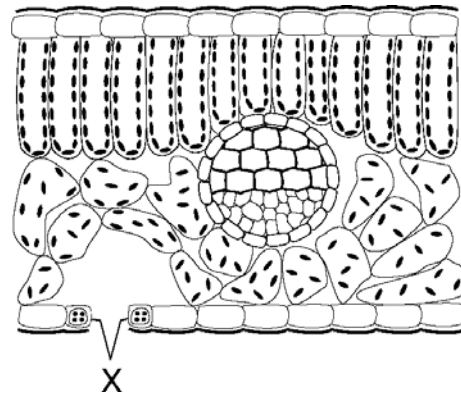
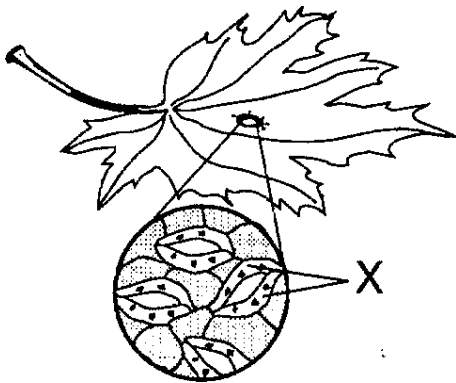
## C. Transport

- Diffusion:** movement of molecules from high concentrations to low concentrations. It requires no energy (passive transport).
- Active Transport** requires the use of energy, usually moving molecules from a low concentration to a high concentration (against the flow of diffusion).
- Osmosis** is the diffusion of water into or out of the cell. If water diffuses into the cell, the cell swells (get larger) and may burst. If it loses water (being put in salt water for example) it will shrivel up.

## D. Nutrition

1. **Autotrophs** make their own food, while **heterotrophs** eat other organisms.
2. **Photosynthesis** is carried out by plants, alga, and blue-green bacteria (autotrophs). It **takes the radiant energy of the sun and puts it in the bonds of sugar molecules**.  
Photosynthesis occurs mostly in the chloroplast of plant cells.
  - a. Plants have **stomates** (holes) in their leaves that let them exchange the gasses used in photosynthesis. **Guard cells** open and close the stomates to keep the plant from dehydrating.
  - b. **Xylem and phloem** carry food and water through a plant.
  - c. **Common mistakes**
    - 1) *Photosynthesis gives us energy.* Photosynthesis only *stores* energy in food (glucose). We need **respiration** to get the energy out of the food.
    - 2) *Guard cells protect plants from diseases.* Guard cells only protect plants from water loss.

Two different views of the **stomates** and their **guard cells** (X).



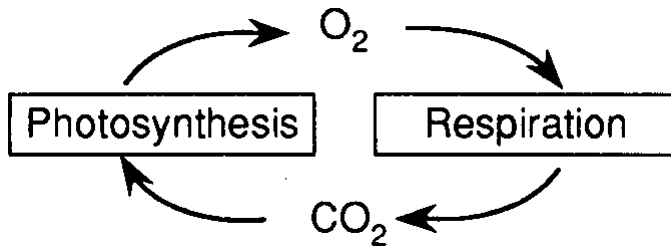
**E. Respiration** – The process that **takes energy from sugar molecules and places it in molecules of ATP**. ATP is the energy source of all living things.

1. **Aerobic respiration** requires oxygen and yields more ATP (energy) for a molecule of sugar than **anaerobic** (no oxygen) respiration.
2. When humans are forced to get energy from anaerobic respiration, we produce lactic acid that damages muscles (the *burn* you feel during exercise).

3. **Photosynthesis and Aerobic Respiration are opposite reactions!** They are also important in cycling oxygen, carbon, hydrogen and water through the environment.

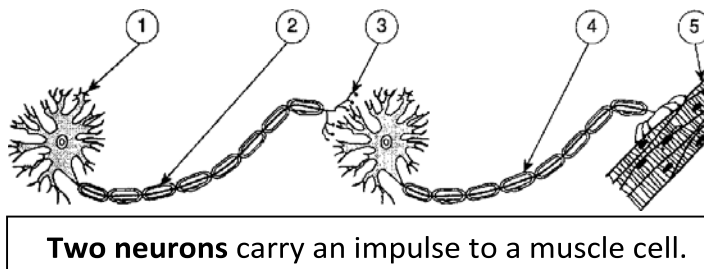
4. **Common mistakes**

- a. *Plant use is not respiration.* All organisms, including plants, use respiration to get their energy.
- b. *Respiration is breathing.* Breathing is **not** respiration. Breathing exchanges the gases needed for respiration. The simple process of inhaling and exhaling does not give you ATP.
- c. *Oxygen is used to breathe.* This is backwards. Breathing is used to get oxygen. Oxygen is then used to obtain energy from chemical respiration. Without oxygen, you have no ATP, and no energy.
- d. *All living things need oxygen/need to breathe.* Anaerobic organisms do not need oxygen, and do not have to breathe.



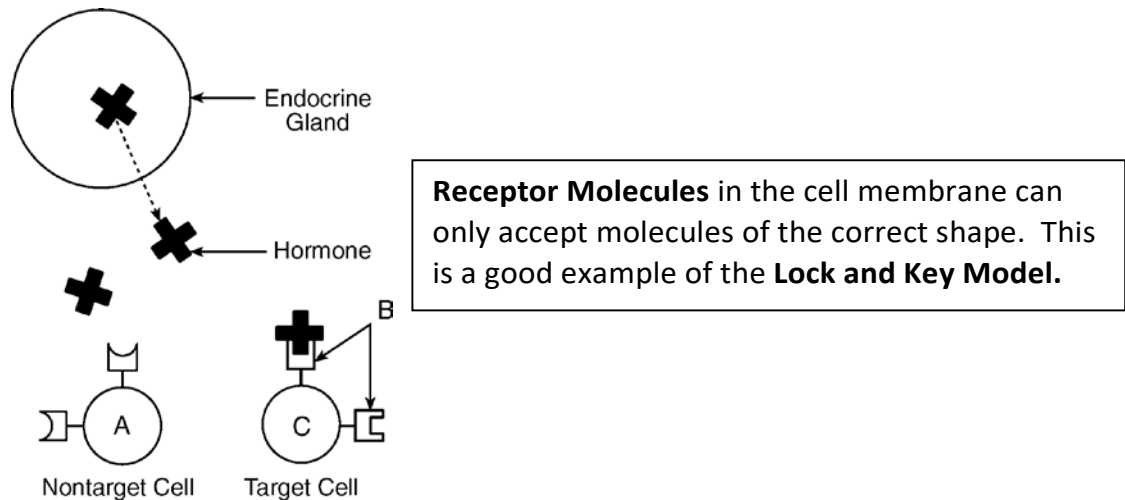
**F. Regulation** – The coordination and control of other life functions.

1. A **stimulus** is a change in the environment that you **respond** to.
2. A **neuron** is a nerve cell.
3. An **impulse** is the electrical signal carried by the nerves. Neurotransmitters are chemicals that help carry the impulse.
4. A **hormone** is a chemical signal secreted by different glands in the body. Examples of hormones include **insulin, adrenaline, testosterone** and **estrogen**



5. **Receptor molecules** are **proteins** on the surface of the cell membrane that receive signals from the nervous and endocrine system. These are needed for your cells to communicate and work together.

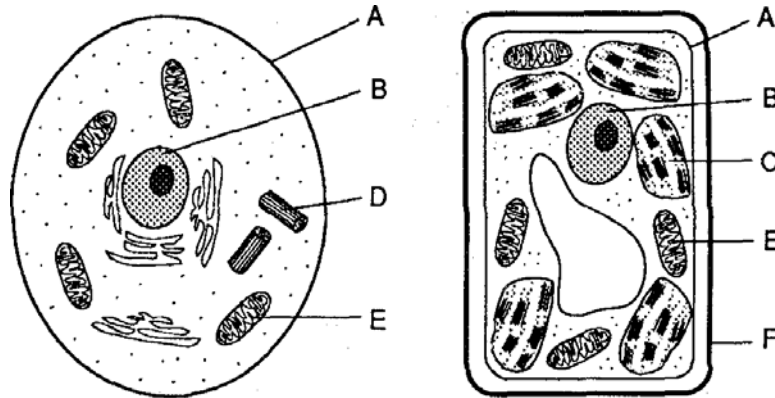
As with all proteins, it is the shape of the receptor molecule that determines its functions (in this case, which signals it receives).



**G. Cells** – Cells are the basic unit of life. All living things (except viruses) are made of cells.

1. You must know the cell theory:
  - a. All living things are made of 1 or more cells.
  - b. Cells carry out all an organism's life functions.
  - c. All cells come from other cells.
2. You must know the following organelles and their functions: cell membrane, cell wall, nucleus, chloroplast, cytoplasm, ribosome, vacuole, mitochondria
3. Know the differences between plant and animal cells.
  - a. Plant cells have cell walls; animal cells do not.
  - b. Plant cells have chloroplasts; animal cells do not.
  - c. Animal cells have centrioles; plant cells do not.
  - d. Animal cells usually have many small vacuoles, plant cells usually have fewer, larger vacuoles.
  - e. **Common mistake:** *Animal cells have a cell membrane; plant cells have a cell wall.* ALL cells have a cell membrane, including those with cell walls (plants, fungi, some bacteria and protists). The cell wall is mostly for protection; the cell membrane is needed to control movement into and out of the cell.

4. **The cell membrane** is made of lipids and proteins. It shows selective permeability – only some molecules can pass through it. (See pg. 2 for Transport.)
- a. Small molecules (like  $O_2$ ,  $H_2O$ ,  $CO_2$ , and sugars) can pass freely through the cell membrane through **diffusion**.
  - b. Large molecules (like proteins and starches) cannot pass through the cell membrane without the help of **transport proteins**.
  - c. If the cell must use energy (ATP) to move a molecule, it is called **active transport**.
  - d. The basic types of proteins in the cell membrane are:
    - 1) Receptor proteins
    - 2) Transport proteins
    - 3) Antigens



Adapted from *What You Absolutely Must Know to Pass the NYS Living Environment/Biology Regents*  
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