CONCEPT: ENERGY SOURCES AND CONSUMPTION

Energy Sources

● To survive, cells need a constant source of _____

□ Second law of thermodynamics states that disorder in the universe only increases

- **Entropy** is the measure of a system's disorder

- Systems will spontaneously change towards more entropy

□ Living cells must generate _____ in a disordered environment

- **Energy** = the capacity to do work. It allows for chemical and physical changes that lead to order in the cell

- A **calorie**, which is the energy required to raise the temperature of 1g of H_2O by 1^oC, is the unit of energy

- 1 Joule (from chemistry) = 0.239 calories

EXAMPLE: Card tower demonstrating entropy and energy

● **Potential energy** (stored energy) and **Kinetic energy** (energy due to motion) are the two main energy classifications

□ In cells kinetic energy includes energy from heat (thermal), light (radiant), and electrons (electrical)

□ In cells, potential energy can be found in chemical bonds, and in *membrane concentration gradients*

□ Cells must do **work**, which is a measure of the _____ required to move or effect an object

- Synthetic work: changes in chemical bonds

- Mechanical work: changes in location or orientation of cell structure

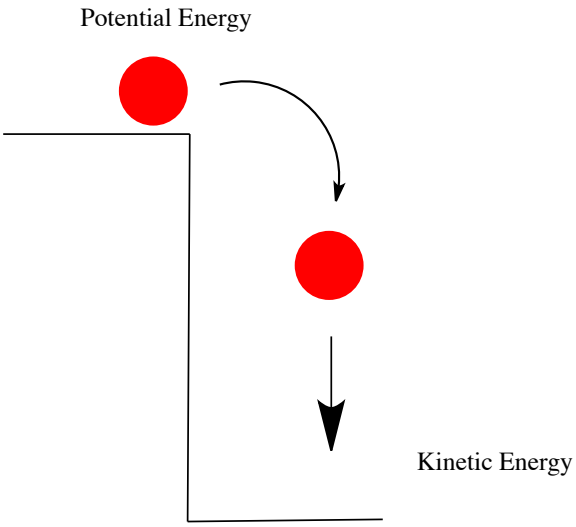
- Concentration work: Moving molecules across a membrane (*membrane concentration gradients)*

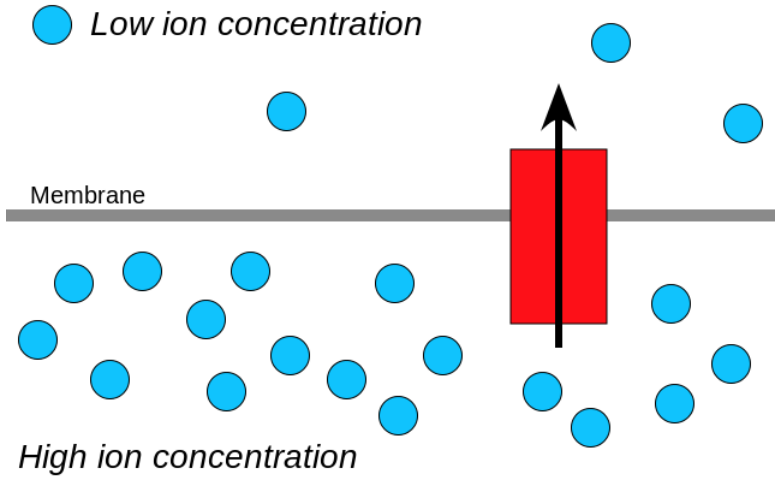
- *Electrical work: Moving ions across a membrane*

- *Heat:* Maintenance *of body temperature*

- *Bioluminescence: Production of light*

EXAMPLE: Potential energy to kinetic energy transformations





Energy Consumption

● Cells must be able to transfer energy from one form to another

□ First law of thermodynamics states that energy cannot be created nor destroyed – only _____

- **Phototrophs** use *photosynthesis to* change light energy into chemical energy (sugars)

- **Chemotrophs** change organic nutrients into freely usable energy (CO_2, H_2O)

- Energy and heat continually cycle between organisms and the universe in the form of C, O, N, and H_20

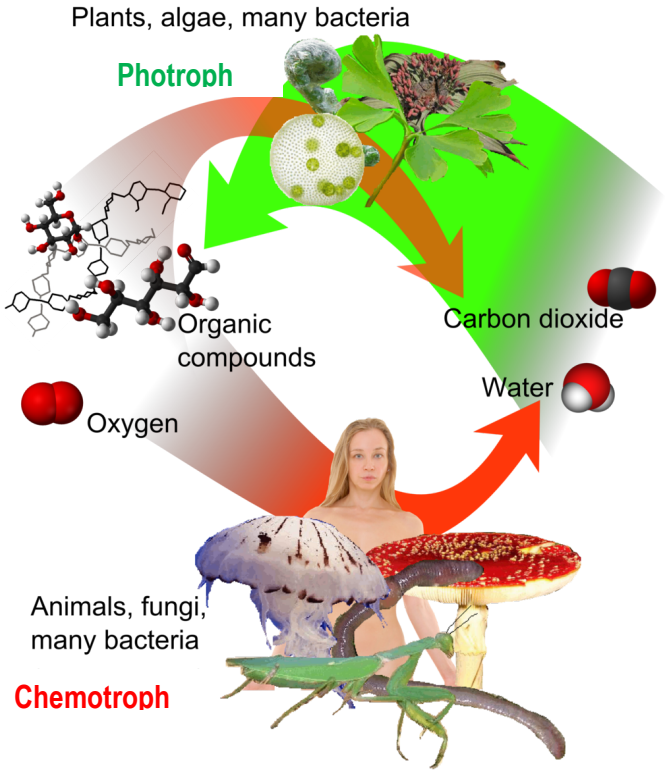
□ **Metabolism** is the _____ of chemical reactions in the cell is made up of two components:

- **Catabolism** is the breakdown of food into smaller molecules

- **Anabolic** is the synthesis of molecules

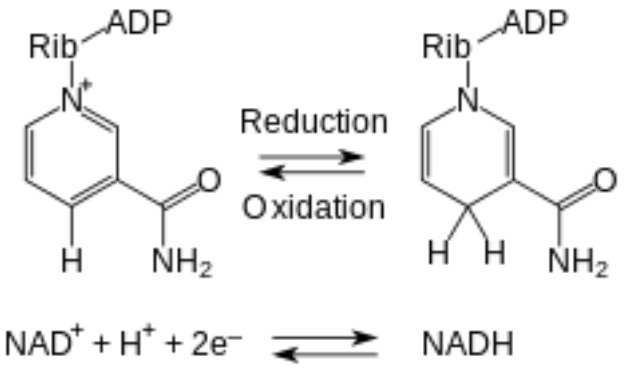
- **Enzymes** are proteins that assist with cellular chemical reactions

EXAMPLE: Cyclic energy transfer between phototrophs and chemotrophs



- The movement of _____ control energy transfer in cells
  - □ **Oxidation** is the removal of electrons from an atom or molecule; It releases energy
    - Cellular **respiration** depends on the oxidation of organic molecules to consume and use energy from food
  - □ **Reduction** is the addition of electrons to an atom or molecule; It requires an energy input

EXAMPLE: Oxidation and reduction reactions between NAD^+ and NADH



PRACTICE:

1. Which of the following is a measure of the energy needed to move a sodium ion from a high concentration to a low concentration?
    a. Kinetic Energy
    b. Entropy
    c. Potential Energy
    d. Work

2. True or False: Reduction is the process of adding electrons to an atom or molecule?
    a. True
    b. False

3. Metabolism, which is the sum of chemical reactions, consists of all but which of the following components?
    a. Catabolism
    b. Melabolism
    c. Anabolism