CHEMICAL BASIS OF LIFE

Objectives

1. Define atoms, molecules, elements, and compounds.
2. List the six macronutrients.
3. Define covalent and hydrogen bonding and state how each is formed.
4. Define and draw dehydration synthesis, hydrolysis and redox reactions.
5. Describe energy changes and factors that affect reaction rates.
6. List several properties of water that are important to living systems.

Outline

A. Atoms in Organisms
B. Bonding
    1. Compounds and Molecules
C. Chemical Reactions
    1. Special Biological Reactions
    2. Energy Changes
    3. Factors Affecting Reactions
D. Water

A. Atoms in Organisms

- Organisms composed of ~ 25 elements
    - Macronutrients
        - Six elements make up 98% of cell
            - Carbon (C)
            - Hydrogen (H)
            - Nitrogen (N)
            - Oxygen (O)
            - Phosphorus (P)
            - Sulfur (S)
    - Micronutrients
        - Elements required by cells
            - Needed in far smaller quantities

NATURALLY OCCURRING ELEMENTS IN THE HUMAN BODY

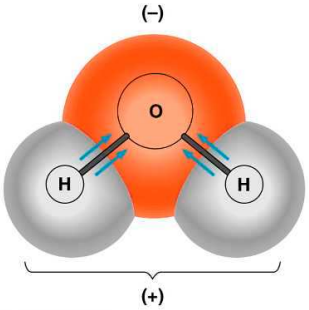
Symbol	Element	Wet Weight Percentage*	
O	Oxygen	65.0	96.3
C	Carbon	18.5	
H	Hydrogen	9.5	
N	Nitrogen	3.3	
Ca	Calcium	1.5	
P	Phosphorus	1.0	
K	Potassium	0.4	
S	Sulfur	0.3	
Na	Sodium	0.2	
Cl	Chlorine	0.2	
Mg	Magnesium	0.1	

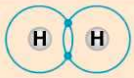
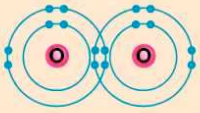
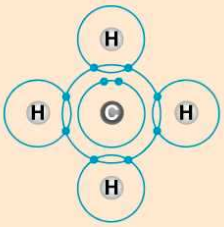
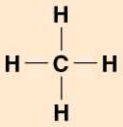
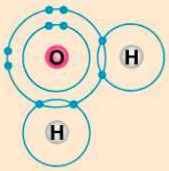
Trace elements (less than 0.01%): boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).

*Includes water.

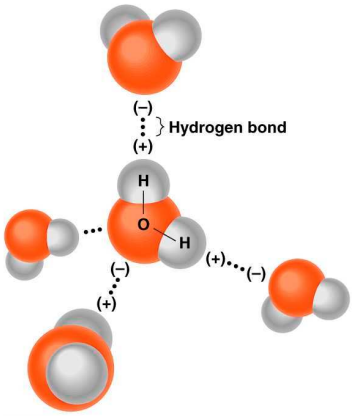
B. Bonding

- Covalent
  - Intramolecular connection
  - Pair of electrons shared by two atoms
    - Nonpolar bond
      - e.g., C–C
    - Polar bond
      - e.g., O–H
      - Gives a slight electrical charge

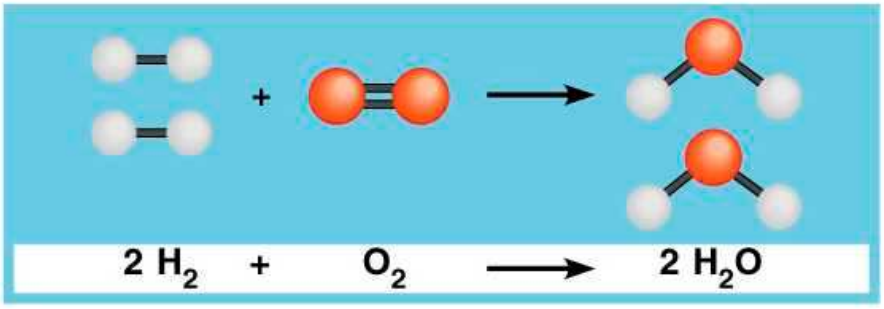


Molecular Formula	Electron Configuration	Structural Formula
H_2		H—H Single bond
O_2		O=O Double bond
CH_4 Methane		
H_2O Water		

- Hydrogen
  - Intermolecular attraction
  - Weak electromagnetic attraction
  - Due to polar bonding
    - H has partial positive charge
    - O or N has a partial negative charge
      - Opposite charges attract



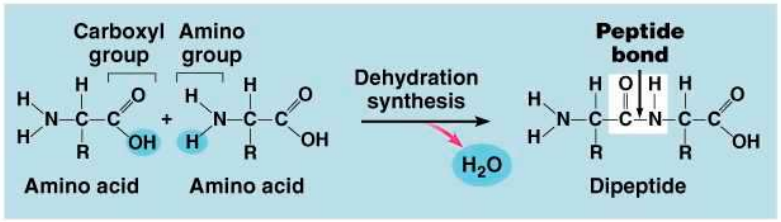
C. Chemical Reactions



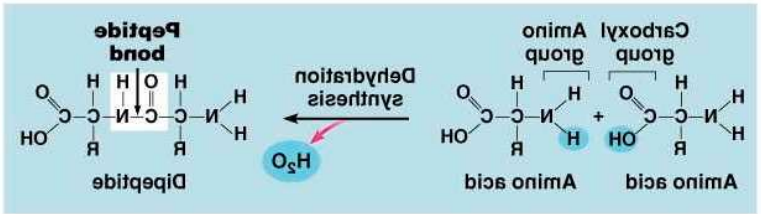
1. Special Biological Reactions

- Synthesis and Decomposition

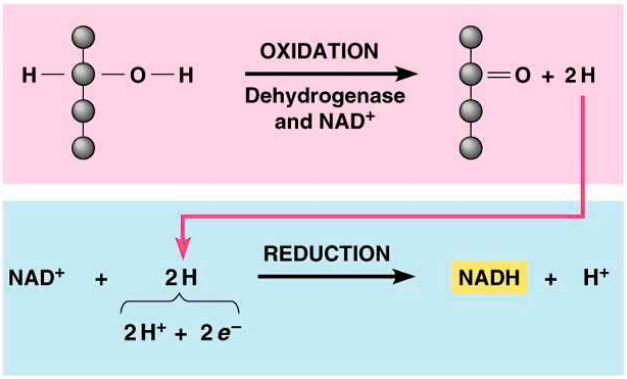
  - Dehydration synthesis



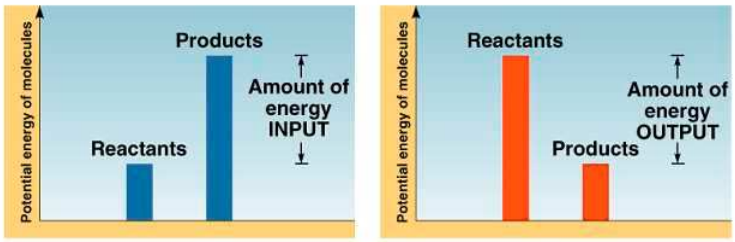
  - Hydrolysis



- Oxidation and Reduction (Redox)
    - Oxidation
    - Reduction



2. Energy Changes



- Endergonic Reactions

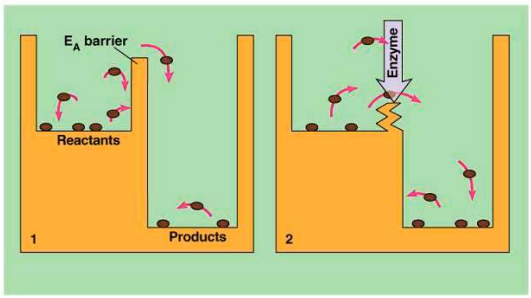
- Exergonic Reactions

3. Factors Affecting Reactions

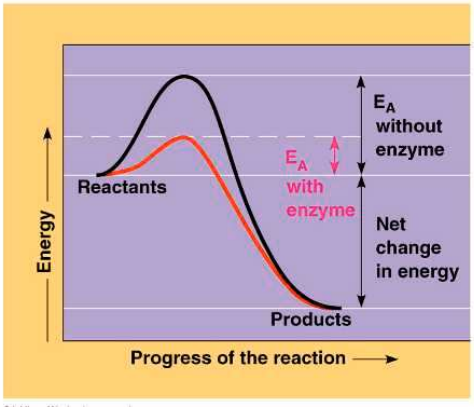
- concentration of reactants

- temperature

- catalysts
    - activation energy

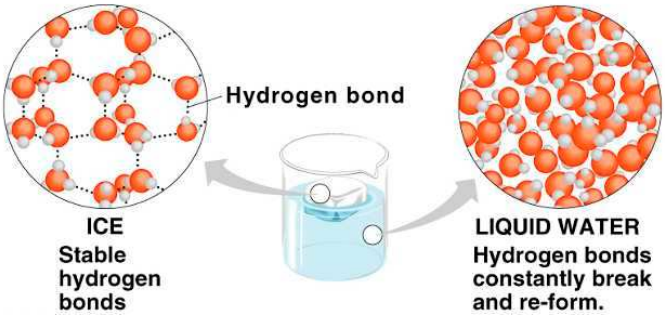


    - reduce amount of activation energy
        - not consumed by reaction
        - enzyme



D. Water

- H_2O
- H–O–H
- 65-75% of cell
- Important properties
  - O–H bond maintains a slight polarity
  - Molecules interact by hydrogen bonds
    - Cohesive and adhesive
    - Excellent temperature buffer
    - Solid less dense than liquid



  - Medium for many chemical reactions
  - Reactant or Product in many reactions
    - Product from dehydration synthesis
    - Reactant in a hydrolysis
  - Can dissociate into H^+ and OH^- ions
    - Basis of acids and bases