Unit 2: Basic Chemistry

I. Matter and Energy
   A. Matter–anything that occupies space and has mass (weight)
   B. Energy–the ability to do work
      1. Chemical
      2. Electrical
      3. Mechanical
      4. Radiant
   C. Composition of Matter
      1. Elements–fundamental units of matter
         a. 96% of the body is made from four elements
            (1) Carbon (C)
            (2) Oxygen (O)
            (3) Hydrogen (H)
            (4) Nitrogen (N)
         b. Atoms–building blocks of elements
   D. Atomic Structure
      1. Nucleus
         a. Protons (p+)
         b. Neutrons (n0)
      2. Outside of nucleus
         a. Electrons (e-)
   E. Identifying Elements
      1. Atomic number–equal to the number of protons that the atom contains
      2. Atomic mass number–sum of the protons and neutrons
   F. Isotopes and Atomic Weight
      1. Isotopes
         a. Have the same number of protons
         b. Vary in number of neutrons
      2. Isotopes and Atomic Weight
         a. Atomic weight
            (1) Close to mass number of most abundant isotope
            (2) Atomic weight reflects natural isotope variation
      3. Radioactivity

a. Radioisotope
(1) Heavy isotope
(a) Tends to be unstable
(b) Decomposes to more stable isotope
(c) Radioactivity–process of spontaneous atomic decay

II. Molecules and Compounds
A. Molecule–two or more like atoms combined chemically
B. Compound–two or more different atoms combined chemically

III. Chemical Reactions
A. Atoms are united by chemical bonds
B. Atoms dissociate from other atoms when chemical bonds are broken
C. Electrons and Bonding
1. Electrons occupy energy levels called electron shells
2. Electrons closest to the nucleus are most strongly attracted
3. Each shell has distinct properties
4. The number of electrons has an upper limit
5. Shells closest to the nucleus fill first
6. Bonding involves interactions between electrons in the outer shell (valence shell)
7. Full valence shells do not form bonds

D. Inert Elements
1. Atoms are stable (inert) when the outermost shell is complete
2. How to fill the atom's shells
a. Shell 1 can hold a maximum of 2 electrons
b. Shell 2 can hold a maximum of 8 electrons
c. Shell 3 can hold a maximum of 18 electrons
3. Atoms will gain, lose, or share electrons to complete their outermost orbitals and reach a stable state
4. Rule of eights
a. Atoms are considered stable when their outermost orbital has 8 electrons
b. The exception to this rule of eights is Shell 1, which can only hold 2 electrons

E. Reactive Elements
    1. Valence shells are not full and are unstable
        a. Tend to gain, lose, or share electrons
            b. Allow for bond formation, which produces stable valence
F. Chemical Bonds
    1. Ionic bonds
        a. Form when electrons are completely transferred from one atom to another
            b. Ions
            (1) Charged particles
                (a) Anions are negative
                    (b) Cations are positive
        c. Either donate or accept electrons
    2. Covalent bonds
        a. Atoms become stable through shared electrons
            b. Single covalent bonds share one pair of electrons
            c. Double covalent bonds share two pairs of electrons
            d. Examples of Covalent Bonds
            (1) Polarity
                (a) Covalently bonded molecules
                    I. Some are non-polar
                        A. Electrically neutral as a molecule
                    II. Some are polar
                        A. Have a positive and negative side
    3. Hydrogen bonds
        a. Weak chemical bonds
            b. Hydrogen is attracted to the negative portion of polar molecule
            (1) Provides attraction between molecules
G. Patterns of Chemical Reactions
    1. Synthesis reaction (A + B⇒AB)
        a. Atoms or molecules combine
            b. Energy is absorbed for bond formation
    2. Decomposition reaction (AB ⇒ A + B)
        a. Molecule is broken down
            b. Chemical energy is released

H. Patterns of Chemical Reactions
1. Exchange reaction (AB + C ⇛ AC + B)
a. Involves both synthesis and decomposition reactions
b. Switch is made between molecule parts and different molecules are made

IV. Biochemistry: Essentials for Life
A. Organic compounds
1. Contain carbon
2. Most are covalently bonded
a. Example: $C_6H_{12}O_6$ (glucose)
B. Inorganic compounds
1. Lack carbon
2. Tend to be simpler compounds
3. Example: H_2O (water)
4. Important Inorganic Compounds
a. Water
(1) Most abundant inorganic compound
(2) Vital properties
(3) High heat capacity
(4) Polarity/solvent properties
(5) Chemical reactivity
(6) Cushioning
b. Salts
(1) Easily dissociate into ions in the presence of water
(2) Vital to many body functions
(3) Include electrolytes which conduct electrical currents
c. Acids
(1) Release hydrogen ions (H+)
(2) Are proton donors
d. Bases
(1) Release hydroxyl ions (OH−)
(2) Are proton acceptors
e. Neutralization reaction
(1) Acids and bases react to form water and a salt
(2) pH
(a) Measures relative concentration of hydrogen ions
I. pH 7 = neutral

II. pH below 7 = acidic
III. pH above 7 = basic
IV. Buffers—chemicals that can regulate pH change

C. Important Organic Compounds
1. Carbohydrates
a. Contain carbon, hydrogen, and oxygen
b. Include sugars and starches
c. Classified according to size
(1) Monosaccharides—simple sugars
(2) Disaccharides—two simple sugars joined by dehydration synthesis
(3) Polysaccharides—long-branching chains of linked simple sugars

2. Lipids
a. Contain carbon, hydrogen, and oxygen
b. Carbon and hydrogen outnumber oxygen
c. Insoluble in water
d. Common lipids in the human body
(1) Neutral fats (triglycerides)
(a) Found in fat deposits
(b) Composed of fatty acids and glycerol
(c) Source of stored energy
(2) Phospholipids
(a) Form cell membranes
(3) Steroids
(a) Include cholesterol, bile salts, vitamin D, and some hormones
I. Cholesterol
A. The basis for all steroids made in the body

3. Proteins
a. Made of amino acids
(1) Contain carbon, oxygen, hydrogen, nitrogen, and sometimes sulfur
b. Account for over half of the body's organic matter
c. Provide for construction materials for body tissues
d. Play a vital role in cell function
(1) Act as enzymes, hormones, and antibodies

e. Amino acid structure
(1) Contain an amine group (-NH_2)
(2) Contain an acid group (-COOH)
(3) Vary only by R groups
f. Fibrous proteins
(1) Also known as structural proteins
(2) Appear in body structures
(3) Examples include collagen and keratin
(4) Stable
g. Globular proteins
(1) Also known as functional proteins
(2) Function as antibodies or enzymes
(3) Can be denatured
(4) Enzymes
(a) Act as biological catalysts
(b) Increase the rate of chemical reactions

4. Nucleic Acids
a. Provide blueprint of life
b. Nucleotide bases
c. A = Adenine
d. G = Guanine
e. C = Cytosine
f. T = Thymine
g. U = Uracil
h. Make DNA and RNA
(1) Deoxyribonucleic acid (DNA)
(a) Organized by complimentary bases to form double helix
(b) Replicates before cell division
(c) Provides instructions for every protein in the body
(2) Adenosine triphosphate (ATP)
(a) Chemical energy used by all cells
(b) Energy is released by breaking high energy phosphate bond
(c) ATP is replenished by oxidation of food fuels