I. Basic Chemistry

A. Definition of concepts

1. Matter: anything that occupies space and has mass
   a. Mass: the amount of material in an object
   b. Weight: varies with gravity

2. Energy is the capacity to do work (put matter into motion)
   a. Kinetic energy versus potential energy
      1) Potential energy: stored energy
      2) Kinetic energy: energy in action
   b. Forms of energy
      1) Chemical: potential is stored in form of bonds between atoms and molecules
      2) Electrical: movement of charged particles
      3) Mechanical: energy that directly moves matter
      4) Radiant (electromagnetic): energy that travels in waves

B. Composition of matter: atoms and elements

1. Elements: unique substances
   a. Atoms: the building blocks of elements

2. Atomic structure: atoms are composed of even smaller particles
   a. Nucleus: located at the center of an atom
      1) Protons: positively charged particles
      2) Neutrons: no charge (neutral)
   b. Electrons: negatively charged particles
3. Identifying elements:

II. Molecules and Mixtures

A. Definitions

1. Molecule - Combination of 2 or more atoms held together by chemical bond

2. Compound - Combination of 2 or more different atoms held by chemical bond

B. Mixtures: 2 or more components physically mixed together

1. Types of mixtures
   a. Solutions: homogeneous mixture of 2 or more components

      1) Solvent: substance in greatest quantity
      2) Solute: substance present in lesser amount

   b. Colloids: heterogeneous mixtures that appear milky

   c. Suspensions: heterogeneous mixture with particles large enough to settle out if given time

2. Distinguishing mixtures from compounds

   a. Mixture: no chemical bonding between components

   b. Compound: chemical bonding occurs
### III. Chemical bonds

**A. Role of electrons in chemical bonding**

1. **Electron shells:** *the space that electrons occupy*
   
   a. **Valence shell:** *outermost shell*
   
   b. **Octet rule:** *atoms (except hydrogen) want 8 electrons in valence shell*
B. Three types of chemical bonds

1. Ionic bonds occur by the transferring of electrons
   a. Anion: gains the electron
   b. Cation: loses the electron

2. Covalent bonds: occur by the sharing of electron pairs
   a. Single covalent bond
   b. Double covalent bond
   c. Triple covalent bond
d. Polar and nonpolar molecules
1) Nonpolar compounds: *are electrically balanced*

2) Polar compounds: *due to unequal electron sharing*

3. Hydrogen bond

**IV. Chemical reactions**

A. **Chemical equations**: *occur when forming or breaking chemical bonds*
   1. **Reactants**: *substances entering reactions*
   2. **Products**: *substance(s) formed by a chemical reaction*
   3. **Chemical equations describe these reactions**
B. Patterns of chemical reactions
   1. Synthesis reaction
      \[ A + B \rightarrow AB \]
   2. Decomposition reaction
      \[ AB \rightarrow A + B \]
   3. Exchange reaction
      \[ AB + CD \rightarrow AD + BC \]
   4. Oxidation-Reduction (redox)
      a. Electron **donor** is oxidized
         \[ \text{Na}^+ \text{ loses an electron to } \text{Cl}^- \]
      b. Electron **acceptor** is reduced
         \[ \text{Cl}^- \text{ receives an electron from } \text{Na}^+ \]

C. Energy flow in chemical reactions
   1. Endergonic reactions: *absorb energy*
   2. Exergonic reactions: *release energy*

D. Factors influencing chemical reaction rates
   1. Temperature
   2. Concentration
   3. Particle size
   4. Catalysts: *increase rate of reactions*

V. Biochemistry
A. Inorganic compounds: *lack carbon*
   1. Water
      a. High heat capacity
      b. High heat of vaporization
      c. Polar/solvent properties
      d. Reactivity
e. Cushioning

2. Salts

3. Acids and bases
   a. Acid: *is a proton donor*
   b. Base: *is a proton acceptor*
   c. pH *is a measure of the proton (hydrogen ion) concentration in solution*

d. Neutralization
\[
\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{HOH}
\]

B. Organic compounds: *all contain carbon*

1. Carbohydrates: *sugars and starches*
   a. Monosaccharides: *simple sugars*
   \[
   \begin{array}{c}
   \text{Glucose} \\
   \text{Fructose} \\
   \text{Galactose} \\
   \text{Deoxyribose} \\
   \text{Ribose}
   \end{array}
   \]
   b. Disaccharides: *double sugar*
   \[
   \begin{array}{c}
   \text{Sucrose} \\
   \text{Maltose} \\
   \text{Lactose}
   \end{array}
   \]
   c. Polysaccharides: *long chains of simple sugars*
   \[
   \begin{array}{c}
   \text{Glycogen}
   \end{array}
   \]
2. Lipids: *organics that do not dissolve in water*

a. **Neutral fats:** *triglycerides*

1) **Saturated fat:** *no double bonds between carbons*

![Triglyceride formation diagram]

Three fatty acid chains are bound to glycerol by dehydration synthesis.

Glycerol \[\text{H} - \text{C} - \text{O} - \text{H}\] \hfill \text{3 fatty acid chains}\hfill \text{Triglyceride, or neutral fat}\hfill \text{3 water molecules}

2) **Unsaturated fat:** *double bonds between carbons*

b. **Phospholipids:** *2 fatty acids plus a phosphate*

![“Typical” structure of a phospholipid molecule]

Two fatty acid chains and a phosphorus-containing group are attached to the glycerol backbone.

Example:
Phosphatidylcholine

Phosphorus-containing group (polar “head”) \[\text{CH}_3 \text{N} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{O} - \text{P} - \text{O}^-\] \hfill \text{Glycerol backbone} \hfill \text{2 fatty acid chains (nonpolar “tail”)}

Polar “head” \hfill \text{Nonpolar “tail”} (schematic phospholipid)

2. **Steroids:** *based on (built from) cholesterol*

![Cholesterol diagram]

Cholesterol (cholesterol is the basis for all steroids formed in the body)
3. Proteins: organics that contain C,H,O, plus Nitrogen
   a. Amino acids and the peptide bond
      1) Amino acids: building blocks for proteins
         a) 20 common types form all proteins
         2) Protein: a long chain of amino acids connected by covalent bond called a peptide bond

b. Levels of structure (see figure below)
   1) Primary: the linear sequence of amino acids
2) Secondary: primary twists on itself (due to H-bonds)
   a) Alpha helix: like a slinky toy

   b) Beta pleated sheet: like pleated ribbon

3) Tertiary: secondary folds on itself (H-bonds)

4) Quaternary: two or more polypeptides
5) Put it all together:

c. Fibrous proteins *(structural proteins)*
   1) Collagen
   2) Elastin

d. Globular proteins *(functional proteins)*
   1) Antibodies
   2) Hormones
   3) Enzymes

e. Protein denaturation: *Acid or heat (usually) will break hydrogen bonds causing structure to fall apart*

   1) Hydrogen bonds easily break
f. Enzymes and enzyme activity: biological catalysts

1) Very specific
2) Enzymes are not consumed
3) Enzymes are always a protein
4) Enzyme names usually end in the suffix: “ase”
5) Enzyme functions

4. Nucleic acids (DNA and RNA)
   a. Nucleotides: are building blocks of the nucleic acids

b. Two classes of nucleic acids: DNA and RNA
   1) DNA: is the genetic material (genes) of cell (A,T,G,C)
a) Blueprint for the body
b) Must not be damaged
c) Location: found in nucleus of the cell
d) DNA structure: double strand of nucleotides

2) RNA: contains A, U, G, C
   a) “photocopy” of the genes in DNA
   b) Location: synthesized in the nucleus, then transported to the cytoplasm
   c) Structure: single strand of nucleotides

5. Adenosine triphosphate (ATP)