Chapter 2 Chemistry

The chemical compositions of the body's structures determine their function.

I. **Basic Chemistry** – Chemistry is the scientific discipline concerned with the *atomic* composition and structure of substances and the reactions they undergo
   A. **Matter** – anything that occupies space and has *mass* – composition of all living and nonliving things – *atoms* (individual components) held together by energy
   B. **Mass** – the amount of *matter* in an object (the international unit for mass is the *kilogram* (kg) which is a 1000 grams)
   C. **Weight** – gravitational force acting on an object of a given *mass*

II. **Elements and Atoms**
   A. **Elements** – the simplest type of mater with ***unique*** chemical properties composed of only one *kind* of atom (112 known elements)
   B. **Atom** – the smallest particle of an element that has the *chemical characteristics* of that element

   * About 96% of the body's *weight* results from the elements *oxygen, carbon, hydrogen, and nitrogen*

III. **Atomic Structure** – characteristics of all matter results from the *structure, organization* and *behavior* of atoms – *atoms* are composed of 3 types of subatomic particles with electric charges
   A. **Neutrons** – have ***no*** electrical charge (neutral) – found in the atom's nucleus
   B. **Protons** – have a positive electrical charge (+) – found in the atom's nucleus
   C. **Electrons** – have a negative electrical charge (-) – have negligible as weight to the atom – are the building blocks of an atom – rotate/orbit around the nucleus in areas of limited space called *orbitals* (energy levels – 3 of them)
      1. **first orbital** – can hold 2 *electrons*
      2. **second orbital** - can hold 8 *electrons*
      3. **third orbital** – can hold 8 *electrons*
   D. **Terms**
      1. **Atomic Mass Unit** (AMU) – the weight of a proton or neutron
      2. **Atomic Mass** – protons + neutrons
      3. **Atomic Number** – the number of protons in an element – used to define an element
      4. **Valence Orbital** – outer most orbital of an atom
      5. **Electron Cloud** – a representation showing the possibility of where electrons are located in an atom

   * The number of protons and electrons in an atom are equal making the atom neutral in its electrical charge (neither positive nor negative). The protons and neutrons, which make up the nucleus, are responsible for the majority of the atom's mass/weight; however the volume of the atom is occupied by rapidly moving Electrons

IV. **Electrons & Chemical Bonding** – chemical behavior is largely determined by *outer most electrons* (electrons located in the *valence orbital*)

VIII. **Chemical Reactions & Classifications** – an *interaction* of or between atoms, ions, molecules, and/or compounds that form or break chemical bonds – 3 classifications

A. **Terms**
   1. **Reactants** – are substances entering into the chemical reaction
   2. **Products** – are substances that result from the chemical reaction

B. **Synthesis Reaction** – when two or more *reactants* combine to form a larger, more complex *product* – **A + B = AB** (ex: *ATP* (adenosine triphosphate) a high energy molecule consisting of an adenosine molecule and 3 phosphate groups is *synthesized* when ADP (adenosine diphosphate), which is adenosine with 2 phosphate groups, is joined with another phosphate group

C. **Decomposition Reaction** – *reactants* are broken down into smaller, less complex *products* – **AB** D **A & B** (ATP : $ ' 3 3

D. **Exchange Reactions** – is a combination of *decomposition* and *synthesis* – *products* are broken down (decomposed) and then recombined (synthesized) into other *products* – **AB + CD** D **AC & BD** (HCl (hydrochloric acid) + NaOH (sodium hydroxide) : 1 D & (table salt) and H_2O (water))

IX. **Reversible Reaction** – is a chemical reaction in which the reaction proceeds from the *reactants* to *products* and *products* to *reactants* – example

(runs in one place in the body) $\mathbf{CO_2 + H_2O}$ **H + HCO**$_3$ (runs in a different place in the body)

** Equilibrium* - if *product formation* is equal to *reactant formation* - is unusual or unlikely

X. **Acids & Bases**

A. **Acid** – is a proton donor – hydrogen without it's electron is a proton (H)

B. **Base** (alkaline) – is a proton acceptor (ex: OH^- hydroxide ions)

C. **pH** – power of hydrogen – H (hydrogen ions)

XI. **pH Scale** – ranges from 0-14 and indicates the concentration of H (hydrogen ions) in a solution

A. **Neutral Solution** – has an equal number of H and OH æ and has a pH of 7.0 (distilled water) (H = OH æ)

B. **Acid Solution** – has a pH *less than* 7.0 with a greater concentration of H than OH æ (Acid = H > OH æ

C. **Basic/Alkaline Solution** – has a pH *greater than* 7.0 with a lesser concentration of H than OH æ % D V H < OH æ

D. **Acceptable Ranges**
   1. **Stomach** – pH between 2-4
   2. **Blood** – pH between 7.35-7.45 – has a pH [illegible]

XII. **Salts** – compound consisting of a positive ion (cation) other than H and a negative ion (anion) other than OH æ

XIII. **Buffers** – a chemical that resists changes in pH (either acid or alkaline) – helps stabilize the pH of solutions when an acid or alkaline (base) is added (ex; blood has many ***bicarbonate*** **(HCO_3** ææs a primary buffer)

XIV. **Inorganic Chemistry** – deals with those substances that ***do not*** contain *carbon* (C) – 2 exceptions

A. **Carbon dioxide (CO_2)**

B. **Carbon monoxide (CO)**

XV. **Organic Chemistry** – characterized by a series of carbon atoms bound together by *covalent* bonds creating the “back-bone” of many large molecules – 4 major

a. **Saturated** – contains only *single covalent bonds* between the carbon atoms
b. **Unsaturated** – contains one or more *double covalent bonds* between the carbon atoms
    - x **Monounsaturated** – contains 1 *double covalent bond* between carbon atoms
    - x **Polyunsaturated** – contains 2 or more *double covalent bonds* between carbon atoms

B. **Triglycerides (tricylglycerols)** – most common type of fat molecule – have three *fatty acids* bound to a *glycerol* chain – formed by dehydration *synthesis* (loses a water molecule each time) – source of energy storage and protection (by insulating and padding) for the body

C. **Phospholipids** – a diglyceride + phosphocolene molecule – similar to a *triglyceride* except that one of the *fatty acids*, bound to the *glycerol* is replaced by a molecule containing phosphorus (making the end with the phosphorus *polar* and the end with the fatty acid *nonpolar*) – used in cell membrane construction
1. **Hydrophilic** – *water loving* – the *polar* end of a phospholipid
2. **Hydrophobic** – *water fearing* – the *nonpolar* end of a phospholipid

D. **Steroids** – composed of carbon atoms bound together into four "ring-like" structures
1. **Cholesterol** – the most important *steroid* because other steroids are synthesized from it - also an important component of cell membranes
2. **Bile salts** – synthesized from cholesterol – important for fat absorption in the intestines
3. **Hormones** – chemical messengers in the body – synthesized from *cholesterol*
    a. **Estrogen** – important to the female reproductive system
    b. **Progesterone** – important to the female reproductive system
    c. **Testosterone** – important to the male reproductive system
    d. **Cortisol** – stress hormone
    e. **Aldosterone** – produced by the adrenal glands – important in regulating sodium (Na) and potassium (K) levels in the body
4. **Prostaglandin** – a modified *fatty acid* with a 5 carbon ring structure and a tail extending off of it (first found in prostate secretion) – made by ***all*** tissues (in response to damage) – ***inflammatory chemical*** (creates the *inflammatory response* (redness, heat, swelling, pain, and loss of function))

XVIII. **Proteins** – contain *carbon, hydrogen, oxygen, and nitrogen* (most have some *sulfur* as well) – consist of many *amino acids*

1. **Hydrogen bonds** – formed between different ***aa*** at different levels/areas on the chain cause the ***aa*** chain to fold and/or coil creating the unique three dimensional shape of the protein
2.

1. **Nitrogenous bases** – governed by the ***law of complimentary base pairing*** – 2 groups bound together by hydrogen bonds
    a. **Pyrimidines** – have a *single* carbon-nitrogen ring
        - **Cytosine** – binds only to ***guanine*** – found in DNA & RNA
        - **Thymine** – binds only to ***adenine*** – found in DNA
        - **Uracil** – binds only to ***adenine*** – found in RNA
    b. **Purines** – have *double* carbon-nitrogen rings
        - **Adenine**