MOLECULAR CELL PHYSIOLOGY Special Lecture - General, Inorganic, & Organic Chemistry

I. What makes chemistry important?
1. Metabolism
2. Growth and development
3. Environmental interactions

II. General & inorganic chemistry
- A. Units of measure
  1. Volume - liter
  2. Mass - gram
  3. Length - meter
- B. Chemical units of measure
  1. Molecular weight - mass of a substance that contains one mole (6.022×10^{23}) of atoms (or molecules)
  2. Mole - amount of a substance that contains 6.022×10^{23} atoms (or molecules)
  3. Molarity - number or moles in one liter of solution
- C. Metric system
  1. kilo - 10^{3}
  2. centi - 10^{-2}
  3. milli - 10^{-3}
  4. micro - 10^{-6}
- D. Composition of elements
  1. Atoms - smallest portion of an element
     - a) Protons
     - b) Electrons
     - c) Neutrons
- E. Function of atoms
  1. Electron excitation (energy)
  2. Chemical bonds
     - a) Covalent - share electrons
     - b) Ionic - charges attract
     - c) Hydrogen - weak attraction of H & O
- F. Important chemical phenomena
  1. Acid / base pH
     - a) Equilibrium
     - b) Availability & solubility of ions
     - c) Buffering capacity
  2. Oxidation / reduction
     - a) Donate / accept electrons
       The reaction, acetaldehyde + $2H^{+}$ + 2 electrons ====> ethanol, represents a reduction of acetaldehyde

III. Organic chemistry - carbon chemistry, chemistry of life
- A. Alkanes, alkenes, and alkynes
- B. Alcohols, ethers, and amines
- C. Aldehydes, ketones, and carboxylic acids
- D. Cyclic compounds and aromatics

IV. Henderson-Hasselbach equation

HA = H + A   Keq = [H][A]/[HA]   pH = -log[H]

[H] = Keq[HA]/[A]   -log[H] = -logKeq - log [HA]/[A]
pH = -logKeq + log[A]/[HA]   pH = pKeq + log[A]/[HA]
(assume for acid, Keq = Ka)   pH = pKa + log[A]/[HA]

MOLECULAR CELL PHYSIOLOGY - General, Inorganic, & Organic Chemistry (continued)

V. **Thermodynamics**
- A. **First Law: conservation of energy - energy cannot be created or destroyed (heat is work and work is heat)**
- B. **Second Law: Tendency towards entropy - energy tends to follow a path toward disorder (heat cannot on itself pass from a cooler body to a hotter body)**
- C. **Gibbs Free Energy (G)**
  - 1. **Free energy change ?G = ?G(prod) - ?G(react)**
    - a) **If ?G is negative, the reaction will occur spontaneously**
    - b) **If ?G is positive, the reverse reaction will tend to occur**
    - c) **If ?G is zero, the reaction is at equilibrium**
- D. **The change in Gibbs Free Energy can also be calculated as ?G = ?H - T?S where**
  - 1. **Enthalpy (H) is the bond energy of the system**
  - 2. **Temperature (T) is in degrees Kelvin**
  - 3. **Entropy (S) is a measure of randomness**

?G	?H	T?S
(-)	?H < 0 (exothermic)	T(?S > 0)
?	?H > 0 (endothermic)	T(?S > 0)
? (many biological systems)	?H < 0 (exothermic)	T(?S < 0)
(+)	?H > 0 (endothermic)	T(?S < 0)

Note that ?G = ?G° + RTlnQ where ?G° is the value of the change in free energy under conditions of 298 K, 1 atm pressure, pH of 7, and initial concentrations of 1 M for all reactants and products; R is the gas constant of 1.987 cal/(degree)(mol); T is the temperature in Kelvin; and Q is the initial ratio of products to reactants. ?G° can also be calculated as ?G° = -2.3RT logKeq

ATP ✍ ADP + Pi ?G = -7.3 kcal/mol
ADP ✍ AMP + Pi ?G = -7.3 kcal/mol

ATP energy is used to produce heat, electrolytic potential, transportation, cell movement, synthesis of phospholipids, DNA and RNA synthesis, etc.