Chapter 2; Lectures 1, 2, 3 [part 1]

Special thanks to Alexis Gianelia, who contributed the most to this lecture.

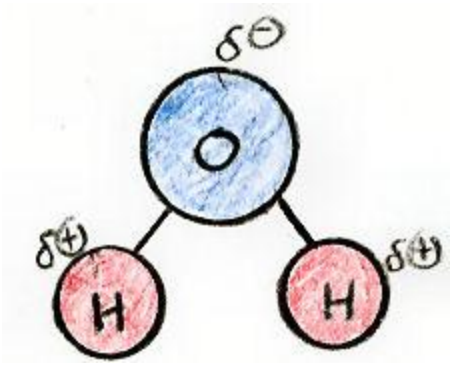
The Periodic Table

- **Atomic Number:** number of protons in an atom, has a lot of weight on the properties of an atom
- **Atomic Mass/Weight**: often called the Dalton; the mass of an atom in atomic mass units (amu). Also has a lot of weight on the properties of an atom.
- **Isotope**: an element with a different number of neutrons than protons. Amu is a weighted average of all isotopes and 'normal' elements (+neutron means +weight). These have more or less exactly the same chemical properties as their normal counterparts, but some are radioactive.
  - Iodine is used as a chemical tracer in medicine
  - C14 is used in carbon dating
- Most important for Biology: H, C, N, O, P, S
- Na, K important as ions
- Mn, Fe, Co important for proteins

Chemical Bonds

Determined by valence electrons (outermost orbital)

1. **Covalent Bond**: sharing of electrons; atoms form bonds until valence shell filled
   a. strongest bond
   b. predictable length and angle
   c. double and triple covalent bonds are possible
   d. if atoms are close to each other in electronegativity, will share bonds equally: **non-polar covalent**
   e. usually a covalent bond will be a **polar covalent**, in which electrons are drawn more closely to one nucleus than another
      i. this is an arbitrary distinction, excepting same-element bonds, the electron will technically always be more attracted to one atom; .4 to 1.7 difference in electronegativity is polar covalent (shouldn't need to know this)



   f. **water is polar covalent** and it has a dipole moment (more on dipole to be vaguely familiar with)
2. **Hydrogen Bond**: specific bonds created between strongly electronegative atom and a hydrogen atom that is covalently bonded to a different electronegative atom
   a. weaker than most ionic bonds
   b. formed due to partial charges
   c. bonding within one molecule or between two molecules
3. **Ionic Bond**: electron 'given up' by one atom to another, more electronegative atom and thus more energetically favorable arrangement with valencies filled (or closer to being filled)
   a. Positively charged ion- **cation**
   b. Negatively charged ion- **anion**
4. **Hydrophobic Interaction**: water forces non-polar molecules together because doing so minimizes their disruptive effects on hydrogen-bonded water network (remember that water wants to decrease its own surface area as much as possible)

a. Polar molecules are generally hydrophilic (ionic or polar substances tend to dissolve due to H bonds)
b. Non polar molecules are hydrophobic, tend to aggregate with other nonpolar molecules (this is more because of the water molecules trying to 'push' other molecules away to decrease surface area)

5. **Van Der Waals Interaction**: the more confusing one, non-polar molecules are also attracted to each other via weak attractions.
    a. Brief interactions that result from constantly shifting electron distribution
    b. Sum of many interactions over entire span of large non-polar molecule can result in substantial attraction; non-polar molecules may stick together in polar environments because of this

Bond Energy

- Bond energy is the amount of energy needed to separate two bonded or interacting atoms under *physiological conditions*
- Physiologic conditions- term in biochem referring to environment within an organism rather than in a lab
- Make sure you know there is a difference

Chemical Reactions

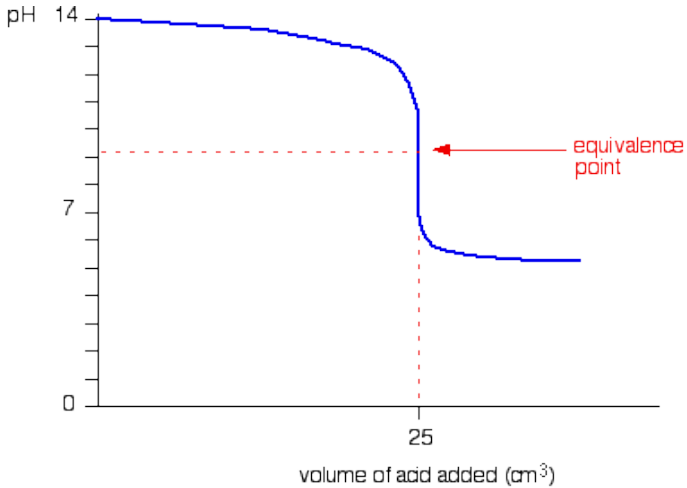
- Chemical reactions occur when atoms combine or change partners
- Reactants converted into products…. Reactions -> Products
- Chemical reaction can be written as an equation, which must balance (conservation of mass)

Molarity

- A mole is the amount of substance in grams whose weight is equal to its molecular weight
- A 1 molar solution (1M) is a mole of a compound dissolved in water to make 1 liter (combined mass, so the solution + the solvent = 1 liter)

Acids and Bases

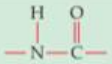
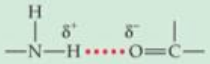
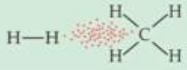
- Acids- release H+
- Bases- accept H+
- Acids- donate hydrogen ions in solution
    - If reaction (dissociation) is complete, the acid is considered 'strong'
    - The carboxyl group (-COOH) is common in biological compounds because it is a weak acid (dissociates partially and fairly easily reversible)
        - -COOH -> -COO- + H+
- Bases accept hydrogen ions and release hydroxide ions
    - NaOH ionizes completely to Na+ and OH-, OH- absorbs H+ to form water; strong base
    - Amino group (-NH2) is an important part of many biological compounds, functions as a weak base by partially and reversibly accepting H+
        - --NH2 + H+ -> -(NH3)+
- pH is measure of H+ concentration in solution
- It is the negative log of the hydrogen ion concentration in moles per liter (pH 7 = 1 * 10-7 moles per liter of water)



Buffers

- Make a solution more resistant to pH change by reacting with both bases and acids (note that this does not necessarily mean keeping a solution neutral, some buffers keep a solution basic or acidic)
- A solution of a weak base and its conjugate acid makes up a buffer (or weak acid and conjugate base, means the same thing)
- Buffers illustrate the **law of mass action**- addition of reactants accelerates reaction, addition of products slows it down; removal of reactants slows reaction, removal of products can speed it up (product side can depend on the reaction)
- These form a **titration curve** (above) this may help with titration curves
    - Give you reactivity at a given pH
    - The protonation state at a given pH
- Protonation: addition of a proton (H+) to an atom, molecule or ion
- If pH changes overmuch, proteins will denature, which would be absurdly destructive… as in death

This picture is golden:

NAME	BASIS OF INTERACTION	STRUCTURE	BOND ENERGY[a] (KCAL/MOL)
Covalent bond	Sharing of electron pairs		50–110
Hydrogen bond	Attraction of opposite charges		3–7
Ionic bond	Attraction of opposite charges		3–7
Hydrophobic interaction	Exclusion of nonpolar molecules from water		1–2
van der Waals interaction	Interaction due to fluctuating electrical charges		1