Lecture 1 Notes

* **Biochemistry**
  + Study of the dynamic steady state
* **Strong bonds**
  + Covalent (electrons are shared between atoms)
  + Ionic bonds (electrons are transferred between atoms resulting in a cation/anion)
* **Weak bonds**
  + More influential, in terms of life, than strong bonds
    - Broken easily and there’s a lot more of them
  + Hydrogen bonds (water, polypeptides, DNA)
  + Ionic interactions (salts, acids)
    - Ionized atoms interact with other ionized particles
  + Hydrophobic interactions (biological membranes, 3D protein structure)
  + Van der Waals interactions (overall stability)
* **Hydrogen bonds**
  + Electronegative atom (usually O or N) being attracted to H
  + Bonds can be inter or intramolecular (within molecules and between molecules)
  + Uses of H bonds
    - Important for forming polypeptide structure
    - Important in interactions of water giving rise to various properties
      * Buoyancy, viscosity, lattice structure while frozen, high boiling point
    - Dissolving polar solvents like alcohols
    - Binding complementary DNA strands
    - Important in terms of solubility
      * Due to its polarity, it readily dissolves other polar molecules
  + A stronger hydrogen bond is when the bond angle is 180 degrees (a little kink may weaken it a little)
* **Ionic interactions**
  + Ionic interactions form crystalline solids
  + Dissolve easily in water because it is super polar plus it is easier to go from a highly ordered state to a disordered state
  + Coulomb’s law
    - Smaller the distance between particles, the greater the force and vice versa
    - In water, the high polarity makes the ionic forces weaker
  + Important for energetic behaviors in a cell
    - When ATP breaks down to ADP, there is a huge release of energy because negative ions were held together and finally split apart
* **Hydrophobic (Nonpolar) interactions**
  + Lipids are almost exclusively nonpolar/hydrophobic
  + If you drop hydrophobic particles into polar solvent, the hydrophobic particles will aggregate due to repulsion from water and because it is energetically favorable
  + Polypeptide chains have polar and nonpolar components which will allow it to fold in aqueous solutions into most energetically favorable shape with nonpolar particles near middle and polar particles near outside
* **Van der Waals interactions (dipole-dipole)**
  + Any cluster of atoms will have “polar-like” characteristics when electrons shift about randomly among an atom
  + Spontaneous polarization
  + Super weak but summed over large areas can lead to an extreme force because each atom is capable of this force
  + Ex: how geckos climb up glass/sheer surfaces
* **Functional groups**
  + Polar groups: O, N, P
  + Nonpolar groups: C, H
  + Functional groups dictate molecular interactions
  + Generally attached to and removed from molecules through covalent bonds
  + Functional groups interact with other functional groups through weak interactions
* **Biologically relevant macromolecules**
  + Nitrogenous bases of RNA and DNA
    - Large capability for hydrogen bonding
    - Ring structure allows it to stack into double helix
  + Amino acids
    - Amino group on one end and carboxyl group on another end (allows for H bonding) with variable side chain
  + Lipids
    - Mostly nonpolar hydrophobic interactions
  + Sugars
    - Composed mostly of carbons and hydroxyl groups (allows for H bonds)
    - Can stack and form chains
      * When broken, they release a lot of energy
* **Water: solvent and reactant**
  + Hydrogen bonds with itself and others
  + Weakens ionic interactions
  + Sequesters hydrophobic moieties
  + Participates in many important interactions
    - Cleavage of ATP (without water, we cannot derive energy from ATP)
    - Oxidation reactions in the electron transport chain during photosynthesis
  + Water ionizes easily
    - H2O 🡪 H+ + OH-