CH 460 - Acid/ Base Chemistry

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Key Notes

- Gibbs free energy
  - When going through protein structure, enzymatic activities, or processes like glycolysis, thinking about what contributes to a favorable delta G will help.
  - $\Delta G = \Delta H - T\Delta S$
  - Electrostatic forces contribute to a negative enthalpy
  - Increasing order contributes to a positive delta S
- Le Chatlier's principle
  - When learning about biological reactions, it's important to think how you can regulate them.
  - Increasing the reactants will shift the equilibrium to the right creating more products.
  - Increasing the product concentration will shift the equilibrium to the left creating more reactants.
- Acids and bases and the pH scale
  - When learning about active sites of enzymes and amino acids it's important to remember acids and bases.
  - A strong acid wants to give away hydrogens or accept electrons and can behave as a weak base.
  - A strong base wants to accept hydrogens or donate electrons and can behave as a weak acid.

Non-covalent Interactions (Strongest to weakest)

- Ionic
  - Salt bridges; forms between a cation and an anion
  - Some amino acids are positively or negatively charged and can form ionic bonds.
  - Coulomb's law
- Hydrogen
  - Between an electronegative atom such as oxygen and nitrogen and a hydrogen bond.
  - Stabilizes structural elements
  - Water can form up to 4 hydrogen bond
- Dipole-dipole
  - Between 2 dipole molecules
- Induced dipole
  - One dipole molecule can induce dipole in another molecule
- Van der waals
  - Dispersion forces
  - Also found in nonpolar molecules and nonpolar amino acids
  - One example is the pi pi stacking in DNA
  - Several ribose sugars are stacked
  - Double bonds in the sugar can influence the stacking

Hydrophobic Effect and Solvation

- Proteins
  - Amphiphilic/amphipathic meaning they have both hydrophobic and hydrophilic sides.
  - The hydrophobic core (inner part of a protein) comes together by forming van der waals interactions between nonpolar amino acids
  - The surface of a protein contains polar side chains that will form hydrogen bonds and salt bridges with the aqueous environment.
- Clathrate Structures
  - So the hydrophobic effect says that Hydrophobic molecules form clathrate structures in water.
  - Inserting hydrophobic molecules in water disrupts the hydrogen bonds formed by the aqueous environment. So the water molecules pushes the hydrophobic molecules together forming clathrate structures. By doing this, water can form more hydrogen bonds.
  - Hydrogen bonds cause hydrophobic molecules to form clathrate structures! not hydrophobic bonds!
  - Example: oil in water; When you add a few drops of oil in water you will see the droplets come together forming a huge blob. The hydrogen bonds in water causes the oil to come together
  - Example: the phospholipid bilayer
- Delta G
  - When the clathrate structures come together releasing more water molecules, this increases the entropy of the surroundings which compensates for the decrease of entropy in the system
  - Hydrogen bonds are reformed decreasing enthalpy which leads to a negative delta G which is favorable!

pH and Titration

- pH is a measure of the proton concentration
- pKa is the half dissociable of the acid.
- If the pH Is lower than the pka, the acid concentration is higher; if the pH is greater than the pka, the base concentration is higher
- If the pH equals the pka the concentrations of base and acid is equal = neutral. When the solution is neutral, it Is at its isoelectric point.
- When the pH is about plus or minus 1 unit of the pKa, it is considered a buffer
- Henderson-hasselbalch equation (look at quick review questions for an example)

Source: https://www.studocu.com/en-us/document/university-of-alabama-at-birmingham/biochemistry/other/worksheet-1/1831593/view

Quick Review Questions

1) Describe the different types of non-covalent interactions and list them from strongest to weakest.

1) Describe the hydrophobic effect and solvation.

1) Given the Henderson-hasselbalch equation, calculate the ratio of the conjugate base to acid.
   pH = 7.4, pka = 3.4, pH = pka + log (conjugate base/acid)

1) Explain the Laws of Thermodynamics and Gibbs free energy

1) Describe the relationship between the equilibrium constant (k) and the mass action expression (Q).

Source: https://www.studocu.com/en-us/document/university-of-alabama-at-birmingham/fundamentals-of-biochemistry/assignments/si-worksheet-1-key-si-questions-and-answers/1762305/view