Chapter 4-2: Functional Groups

Functional groups contribute to the molecular diversity of life

- ***Functional groups***: Components of organic molecules that are most commonly involved in chemical reactions
  - Attachments that replace one or more hydrogen atoms to the carbon skeleton of the hydrocarbon.
  - Behave the same from one organic molecule to another.
  - Number and arrangement help give each molecule its unique properties.
- There are ***six*** functional groups that are most important to the chemistry of life:

hydroxyl
carbonyl
carboxyl
amino
sulfhydryl
phosphate

  - All are hydrophilic and increase solubility of organic compounds in water.

- The basic structure of testosterone (male hormone) and estradiol (female hormone) is identical.
  - Both are steroids with four fused carbon rings, but they differ in the functional groups attached to the rings.
  - These then interact with different targets in the body.

- In a **hydroxyl group** (-OH), a hydrogen atom forms a polar covalent bond with an oxygen which forms a polar covalent bond to the carbon skeleton.
  - Because of these polar covalent bonds hydroxyl groups improve the solubility of organic molecules (water molecules are attracted to the hydroxyl group).
  - Organic compounds with hydroxyl groups are **alcohols** and their names typically end in *-ol*.

- A **carbonyl group** (=CO) consists of an oxygen atom joined to the carbon skeleton by a double bond.
  - If the carbonyl group is on the ***end*** of the skeleton, the compound is an **aldelhyde**.
  - If not, then the compound is a **ketone**.
  - Isomers with aldehydes versus ketones have different properties.

- A **carboxyl group** (-COOH) consists of a carbon atom double bonded to an oxygen atom and single bonded to a hydroxyl group.
  - Compounds with carboxyl groups are **carboxylic acids**.
  - A carboxyl group acts as an acid because the combined electronegativities of the two adjacent oxygen atoms increase the dissociation of hydrogen as an ion (H^+)—*releases hydrogen ions!*

- An **amino group** (-NH_2) consists of a nitrogen atom attached to two hydrogen atoms and the carbon skeleton.
  - Organic compounds with amino groups are **amines**.
  - The amino group acts as a base because ammonia can pick up a hydrogen ion (H^+) from the solution.
  - Amino acids, the building blocks of proteins, have amino and carboxyl groups (We'll learn more about these later ☺).

- A **sulfhydryl group** (-SH) consists of a sulfur atom bonded to a hydrogen atom and to the backbone.
  - This group resembles a hydroxyl group in shape.
  - Organic molecules with sulfhydryl groups are **thiols**.
  - Sulfhydryl groups help stabilize the structure of proteins by forming bonds with them.

- A **phosphate group** (-OPO_3^{2-}) consists of phosphorus bound to four oxygen atoms (three with single bonds and one with a double bond).
  - A phosphate group connects to the carbon backbone via one of its oxygen atoms.
  - Phosphate groups are ***anions*** with two negative charges as two protons have dissociated from the oxygen atoms.
  - One function of phosphate groups is to transfer energy between organic molecules.