3.2

Functional Groups

The term functional group refers to the groupings of atoms within molecules. Functional groups determine the specific chemical properties of the molecules and as explained above, the rotation of light. The understanding of functional groups is pivotal to being able to understand the functions of the four major macromolecules: carbohydrates, lipids, proteins, and nucleic acids. Functional groups in macromolecules are usually attached to carbon backbones in different places, and each macromolecule group has unique sets of functional groups. Some of the most important functional groups are identified below in the table.

Functional Group Name	Structure	Polarity	Properties and Features	Compound names	Macromolecule example
Alkyl		Nonpolar	Hydrophobic, Vander Waals interactions	Hydrocarbons	Lipids
Hydroxyl		Polar	Soluble in water	Alcohols	Carbohydrates
Carbonyl		Polar	Soluble in water	Aldehydes or ketones	Nucleic acids, carbohydrates
Carboxyl		Ionic	Soluble in water, acidic	Carboxylic acids	Lipids, amino acids
Amino		Ionic	Soluble, basic	Amines	Amino acids, nucleic acids
Sulfhydryl		Weak polar	Disulfide bonds	Thiols	Amino acids
Phosphate		Ionic	Soluble in water, acidic, energetic	Phosphoric acids	Lipids, nucleic acids
Amide		Polar	Soluble in water, peptide bonds, not acidic	Amides	Amino acids

Polymers

In addition to the formation of isomers, functional groups also allow for similar molecules called monomers to bond together and form more complex structures called polymers. Some of the important macromolecules in biology that are polymer carbohydrates such as glycogen and starch, nucleic acids, and proteins. Lipids are not considered polymers. The synthesis or breakdown of polymers occurs through dehydration reactions or hydration reactions (hydrolysis) respectively. As polymers are synthesized from monomers, specific functional groups from one monomer will lose a -H and a corresponding functional group on another monomer will lose an -OH. As H^+ and OH^- ions are lost, they will combine to form water (H_2O) and their loss is replaced with a new covalent bond between the two monomers. For this reason, this synthesis reaction is called dehydration synthesis. In contrast, when polymers are broken down, water molecules are split to yield a -H and an -OH and those ions are "put back on" each specific monomer which acts to replace the covalent bond between the two monomers which causes them to break apart. This process is called hydrolysis.