4.S: Carbonyl-Containing Compounds (Summary)

To ensure that you understand the material in this chapter, you should review the meanings of the following bold terms in the summary and ask yourself how they relate to the topics in the chapter.

The **carbonyl group**, a carbon-oxygen double bond, is the defining feature of **aldehydes** (RCHO)and **ketones** (RCOR'). In aldehydes at least one bond on the carbonyl group is a carbon-hydrogen bond; in ketones, both available bonds on the carbonyl carbon atom are carbon-carbon bonds.

A **carboxylic acid** (RCOOH) contains the COOH functional group, called the **carboxyl group**. A carboxyl group has a hydroxyl attached to a carbonyl carbon atom. There are many familiar carboxylic acids. The R group may be a hydrogen atom (as in formic acid, HCOOH), an alkyl group (as in acetic acid, CH_2COOH), or an aryl group (as in benzoic acid, C_6H_5COOH). The location of substituents along the carbon chain is indicated by a Greek letter (for common names) or a number (for names from the International Union of Pure and Applied Chemistry). Carboxylic acids are weak acids that have strong, often disagreeable, odors. They are highly polar molecules and readily engage in hydrogen bonding, so they have relatively high boiling points.

An **ester** (RCOOR′) is a carboxylic acid derivative that has an OR′ group attached to a carbonyl carbon atom. Esters are pleasant-smelling compounds that are responsible for the fragrances of flowers and fruits. They have lower boiling points than comparable carboxylic acids because, even though ester molecules are somewhat polar, they cannot engage in hydrogen bonding. However, with water, esters can engage in hydrogen bonding; consequently, the low molar mass esters are soluble in water. Some of the most important esters in biochemistry are those formed from phosphoric acid.

Amides are also carboxylic acid derivatives. These compounds contain a functional group that has the carbon of a carbonyl group bonded to a nitrogen atom from NH_3 or an amine. A compound is considered a simple amide when the nitrogen of the functional group has two hydrogen atoms attached. If one of the hydrogen atoms is replaced with an alkyl or aryl group, the compound is referred to as a substituted amide. The carbon-nitrogen bond is referred to as an amide linkage (or a peptide linkage). Most amides are colorless and odorless, and the lighter ones are soluble in water. Because they are polar molecules, amides have comparatively high boiling points and melting points. The IUPAC names for substituted amides use N- as a locator for substituents bonded to the nitrogen of the functional groups instead of numbers.