Pearson

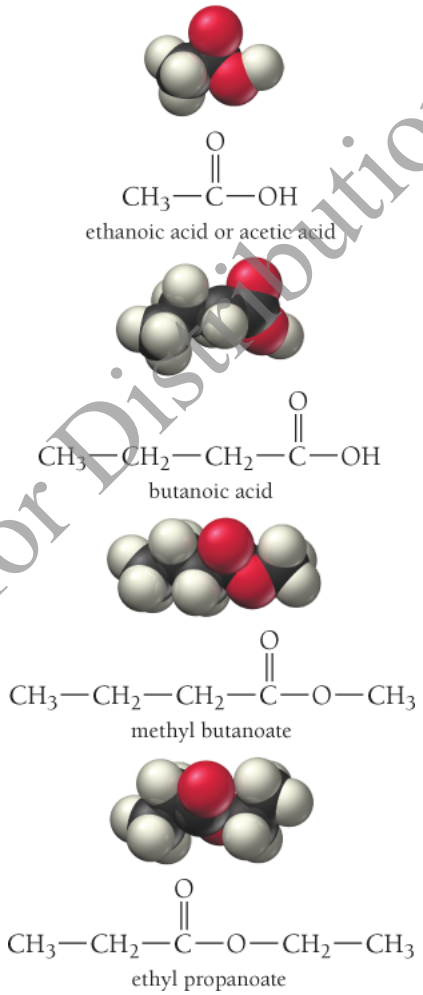
21.11: Carboxylic Acids and Esters

Carboxylic acids and **esters** have the general formulas:

The condensed structural formula for carboxylic acids is RCOOH; for esters it is RCOOR.

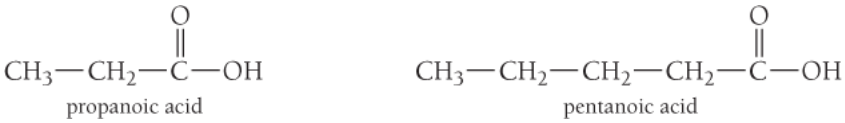
Figure 21.10 shows the structures of some common carboxylic acids and esters.

Figure 21.10 Common Carboxylic Acids and Esters

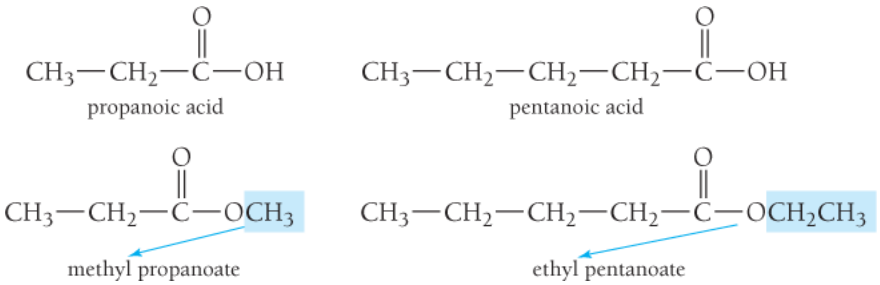


Naming Carboxylic Acids and Esters

We name carboxylic acids according to the number of carbon atoms in the longest chain containing the —COOH functional group. We form the base name by dropping the *-e* from the name of the corresponding alkane and adding the ending *–oic acid*:



We name esters as if they were derived from a carboxylic acid by replacing the H on the OH with an alkyl group. The R group from the parent acid forms the base name of the compound. We change the *-ic* on the name of the corresponding carboxylic acid to *-ate*, and drop *acid*, naming the R group that replaced the H on the carboxylic acid as an alkyl group with the ending *-yl*, as shown in the following examples:

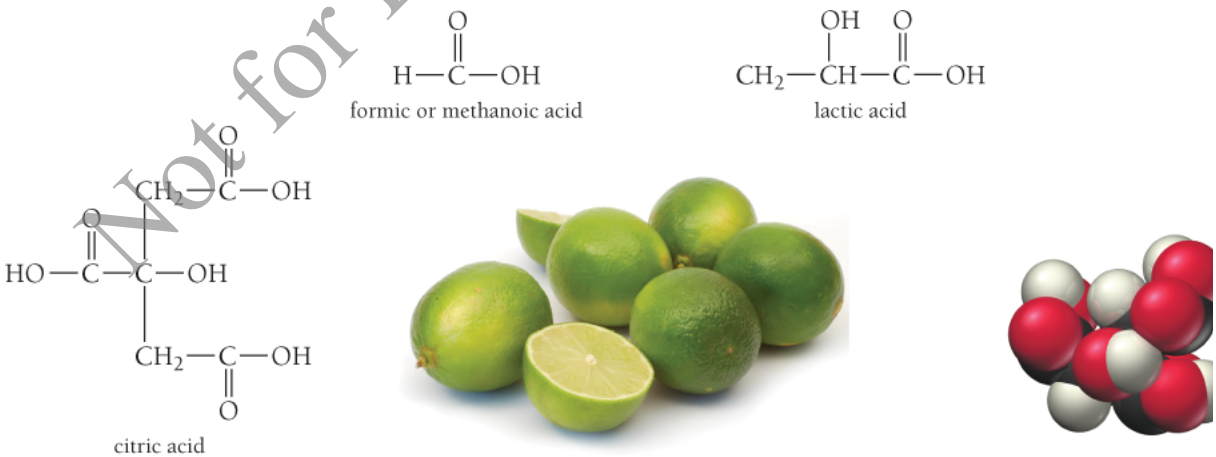


About Carboxylic Acids and Esters

Like all acids, carboxylic acids taste sour. The most familiar carboxylic acid is ethanoic acid, better known by its common name, acetic acid. Acetic acid is the component in vinegar that imparts its characteristic flavor and aroma. Acetic acid can form by the oxidation of ethanol, which is why wines left open to air become sour. Some yeasts and bacteria also form acetic acid when they metabolize sugars in bread dough. These are added to bread dough to make sourdough bread. Other common carboxylic acids include methanoic acid (formic acid), present in ant bites; lactic acid, which collects in muscles after intense exercise causing soreness; and citric acid, found in limes, lemons, and oranges (Figure 21.11).

Figure 21.11 The Tart Taste of Limes

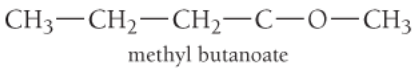
Citric acid is partly responsible for the sour taste of limes.

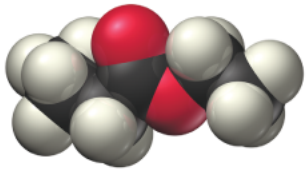


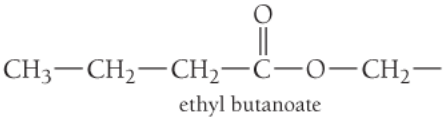
Esters are best known for their sweet smells. Methyl butanoate is largely responsible for the smell and taste of apples, and ethyl butanoate is largely responsible for the smell and taste of pineapples (see Figure 21.12).

Figure 21.12 The Aroma of Pineapple

Ethyl butanoate is partly responsible for the aroma of pineapples.







Carboxylic Acid and Ester Reactions

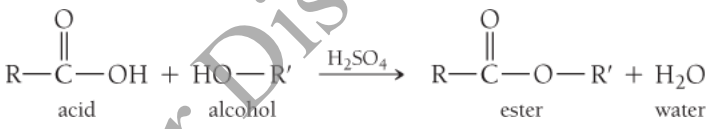
Carboxylic acids act as weak acids in solution:

$$\mathrm{RCOOH}\,(aq) + \mathrm{H_2O}\,(l) \rightleftharpoons \mathrm{H_3O^+}\,(aq) + \mathrm{RCOO^-}\,(aq)$$

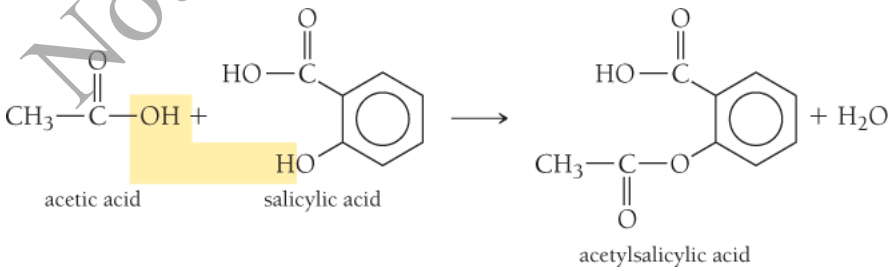
Like all acids, carboxylic acids react with strong bases via neutralization reactions. For example, propanoic acid reacts with sodium hydroxide to form sodium propanoate and water.

$$\mathrm{CH_3CH_2COOH}\,(aq) + \mathrm{NaOH}\,(aq) \rightarrow \mathrm{CH_3CH_2COO^-Na^+}\,(aq) + \mathrm{HOH}\,(l)$$

A carboxylic acid reacts with an alcohol to form an ester via a **condensation reaction**—a reaction in which two (or more) organic compounds join, often with the loss of water (or some other small molecule):



An important example of this reaction is the formation of acetylsalicylic acid (aspirin) from ethanoic acid (acetic acid) and salicylic acid (originally obtained from the bark of the willow tree):



If we subject a carboxylic acid to high temperatures, it undergoes a condensation reaction with itself to form an acid anhydride (*anhydride* means "without water"):

$$\mathrm{RCOOH}\,(aq) + \mathrm{HOOCR}\,(aq) \rightarrow \underset{\text{acid anhydride}}{\mathrm{RCOOOCR}\,(aq)} + \mathrm{HOH}\,(aq)$$

We can add water to an acid anhydride to reverse the reaction just shown and regenerate the carboxylic acid molecules.

Conceptual Connection 21.4 Oxidation

Interactive