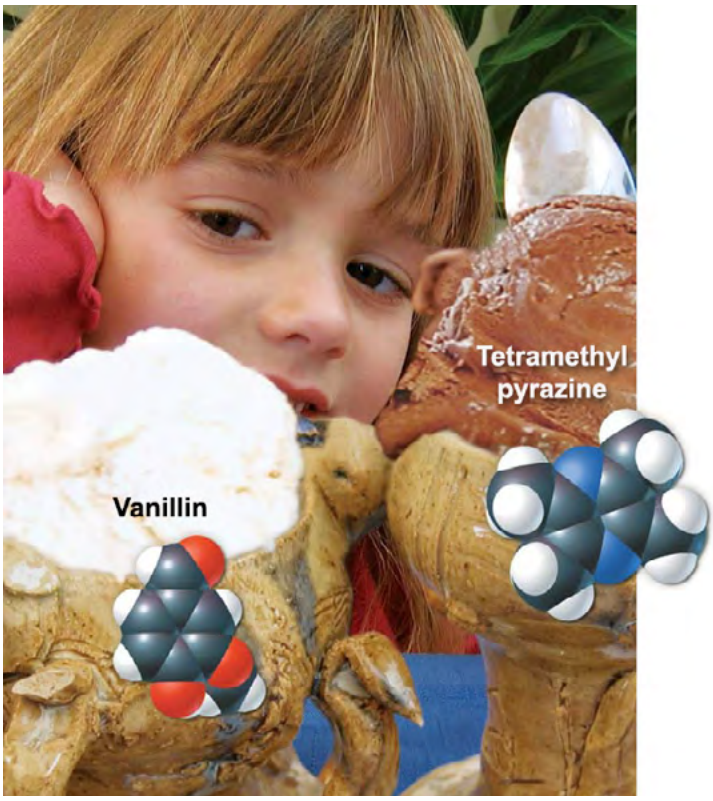


Chapter 12

Organic Compounds

THE MAIN IDEA

Carbon can form a limitless number of chemical structures.

12.5 Amines and Alkaloids

Amines are organic compounds that contain the amine group, which is a nitrogen atom bonded to one, two, or three saturated carbons. Amines are typically less soluble in water than are alcohols, because the nitrogen–hydrogen bond is not as polar as the oxygen–hydrogen bond. The lower polarity and weaker hydrogen bonding of amines also means their boiling points are typically lower than those of alcohols of similar formula mass. **Table 12.4** lists three simple amines.

One of the most notable physical properties of many low formula mass amines is their offensive odor. **Figure 12.18** shows two appropriately named amines, putrescine and cadaverine, which are responsible, in part, for the odor of decaying flesh.

Amines are typically *alkaline*, because the nitrogen atom readily accepts a hydrogen ion, as **Figure 12.19** illustrates. A class of alkaline amines found in nature are the *alkaloids*. Because many alkaloids have

READING CHECK

What atoms are in an amine group?

Table 12.4 Three Simple Amines

STRUCTURE	NAME	MELTING POINT (°C)	BOILING POINT (°C)
NH_2	Ethylamine	−81	17
H N	Diethylamine	−50	55
N	Triethylamine	−7	89

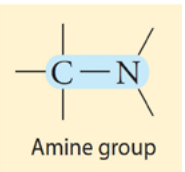
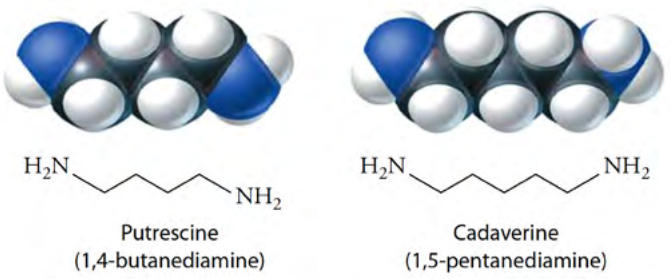


Figure 12.18 >

Low-formula-mass amines such as these tend to have offensive odors.



FOR YOUR INFORMATION

As we discuss in Chapter 14, nearly all pharmaceuticals that can be administered orally contain the nitrogen heteroatom in the water-soluble salt form.

medicinal or other biological effects, there is great interest in isolating these compounds from the plants or marine organisms that contain them. As shown in **Figure 12.20,** an alkaloid, such as caffeine, reacts with an acid to form a salt that is usually quite soluble in water. This is in contrast to the unionized form of the alkaloid, known as a *free base*, which is typically insoluble in water.

Most alkaloids exist in nature not in their free-base form, but rather as the salts of naturally occurring acids known as *tannins*. The alkaloid salts of these acids are usually much more soluble in hot water than in cold water. The caffeine in coffee and tea exists in the form of the tannin salt, which is why coffee and tea are more effectively brewed in hot water. As **Figure 12.21** relates, tannins are also responsible for the stains caused by these beverages.

Figure 12.19 >

Ethylamine acts as a weak base and accepts a hydrogen ion from water to become the ethyl ammonium ion. This reaction generates a small amount of hydroxide ions, which slightly increases the pH of the solution.

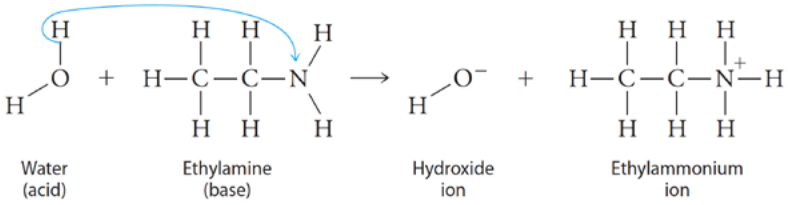
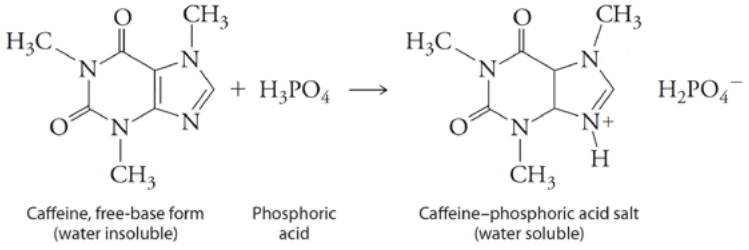


Figure 12.20 >

All alkaloids are bases that react with acids to form salts. An example is the alkaloid caffeine, shown here reacting with phosphoric acid; both are common ingredients in soda beverages.



Λ Figure 12.21

Tannins are responsible for the brown stains in coffee mugs or on a coffee drinker's teeth. Because tannins are acidic, they can be readily removed with an alkaline cleanser such as baking soda.

CONCEPT CHECK

Why do most caffeinated soft drinks also contain phosphoric acid?

CHECK YOUR ANSWER The phosphoric acid reacts with the caffeine to form the caffeine–phosphoric acid salt, which is much more soluble in cold water than the naturally occurring tannin salt. Interestingly, it also adds a desirable tingle to the tongue.