Chapter 19
Carboxylic Acids

19.1

Carboxylic Acid Nomenclature

Table 19.1 (page 737)

systematic IUPAC names replace "-e" ending of alkane with "oic acid"

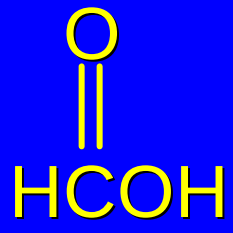
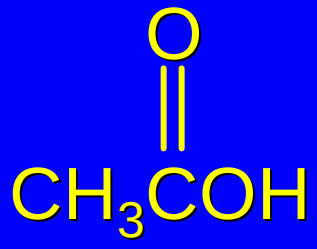
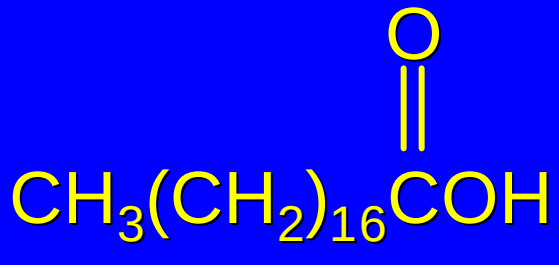
	Systematic Name
	methanoic acid
	ethanoic acid
	octadecanoic acid

Table 19.1 (page 737)

common names are based on natural origin rather than structure

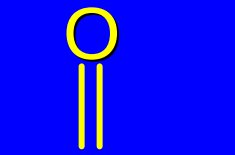
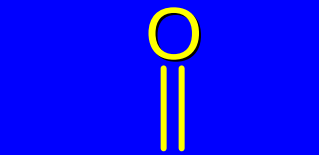
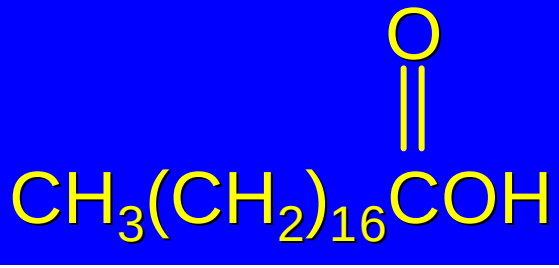
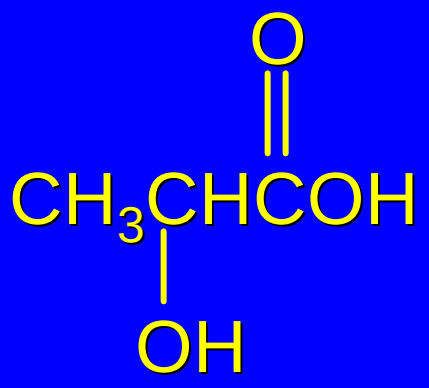
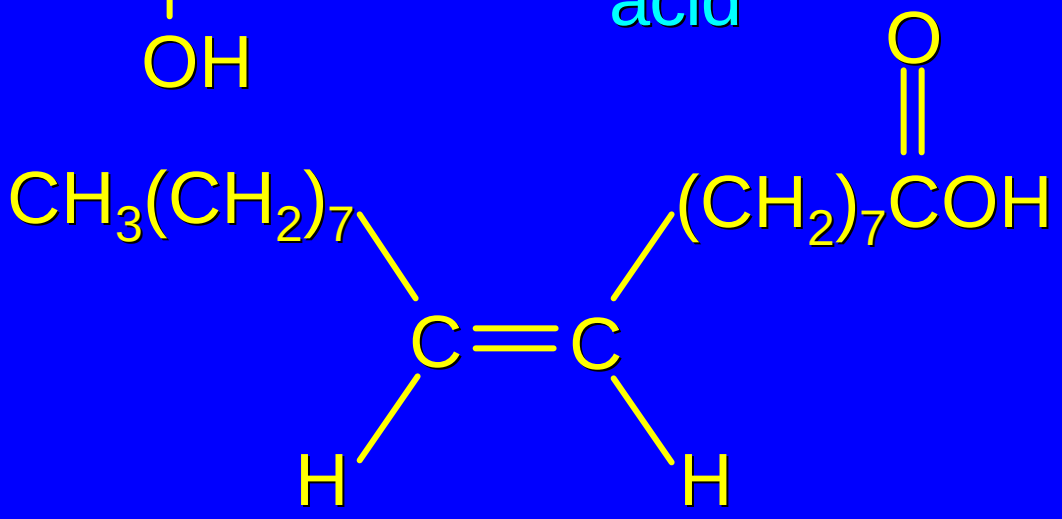
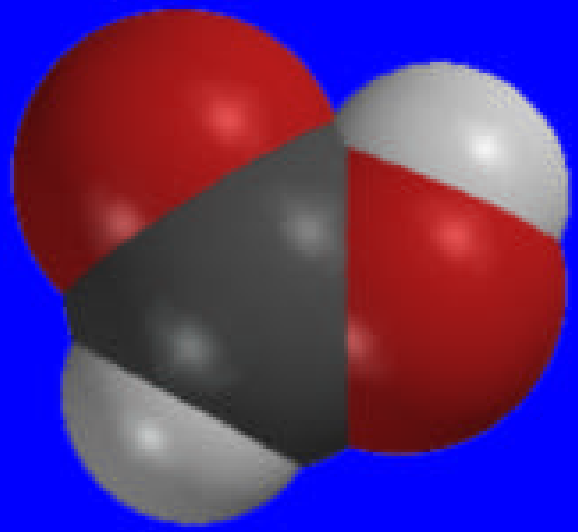
	Systematic Name	Common Name
	methanoic acid	formic acid
	ethanoic acid	acetic acid
	octadecanoic acid	stearic acid

Table 19.1 (page 737)

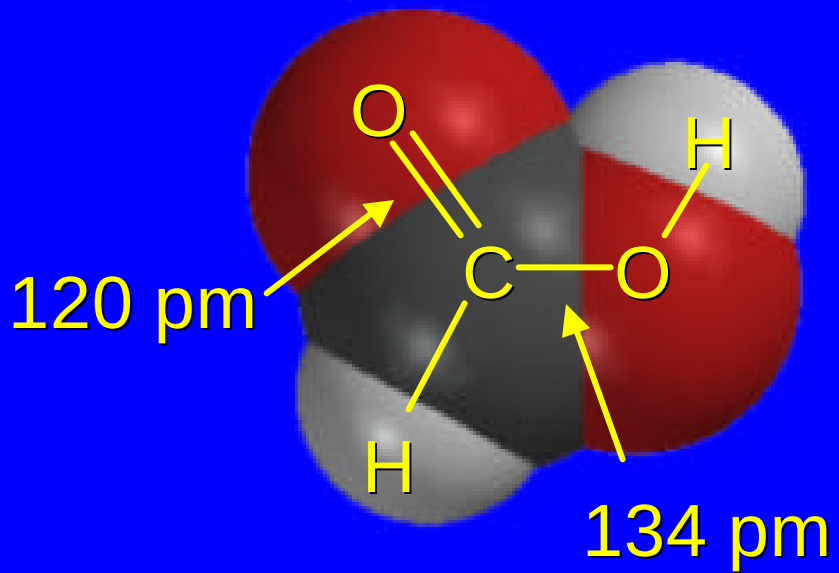
	Systematic Name	Common Name
	2-hydroxypropanoic acid	lactic acid
	(*Z*)-9-octadecenoic acid	oleic acid

19.2
Structure and Bonding

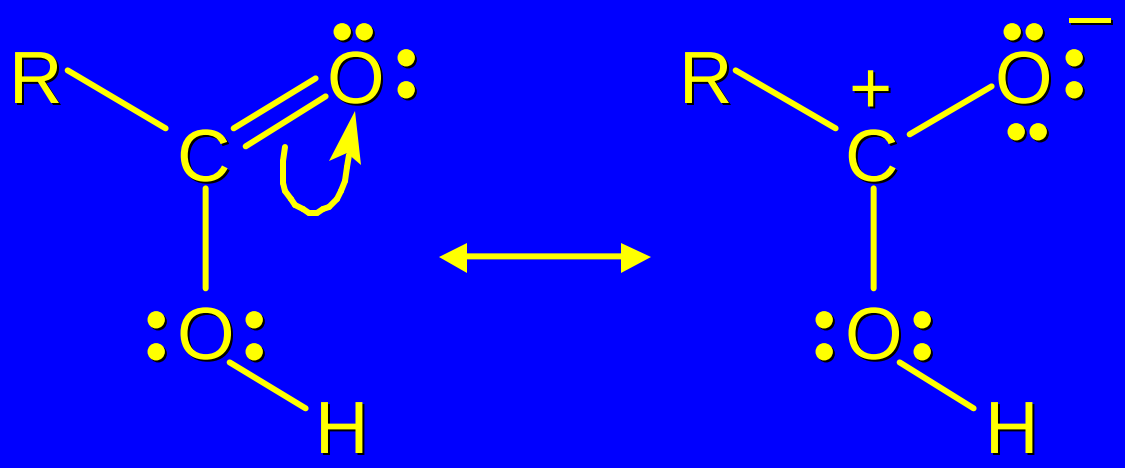
Formic acid is planar



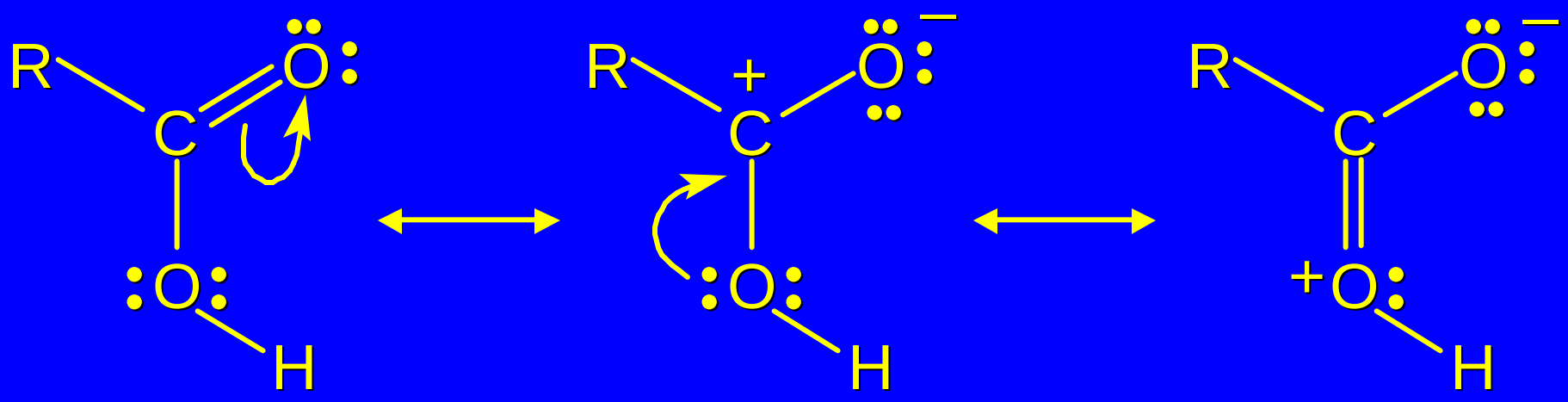
Formic acid is planar



Electron Delocalization



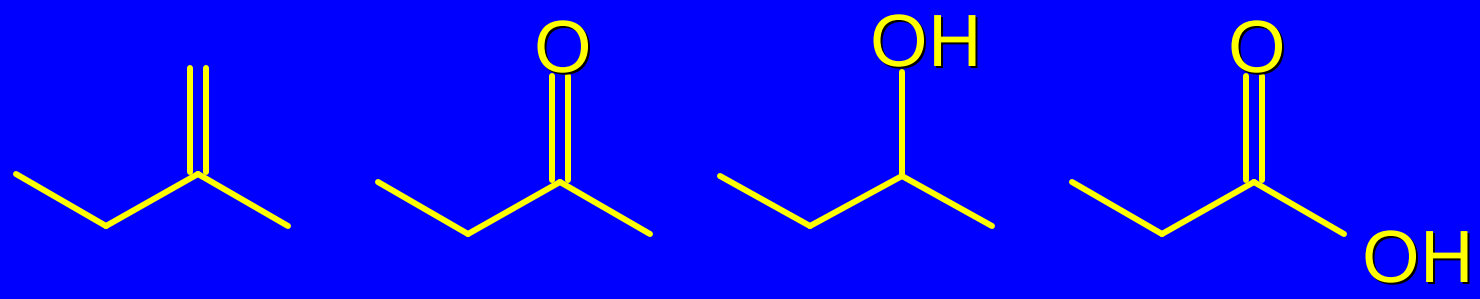
Electron Delocalization



stabilizes carbonyl group

19.3
Physical Properties

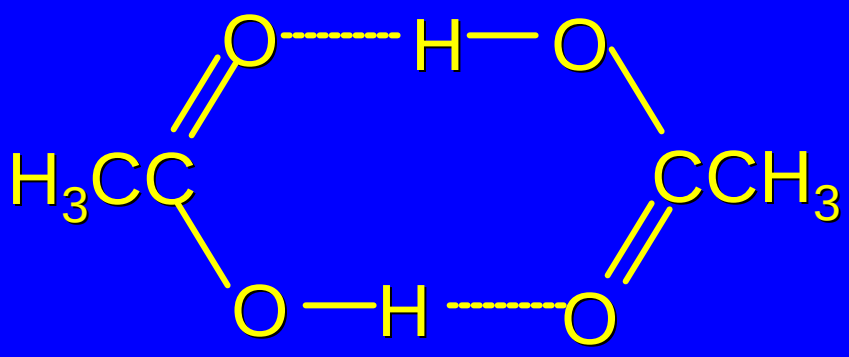
Boiling Points



bp (1 atm)	31°C	80°C	99°C	141°C

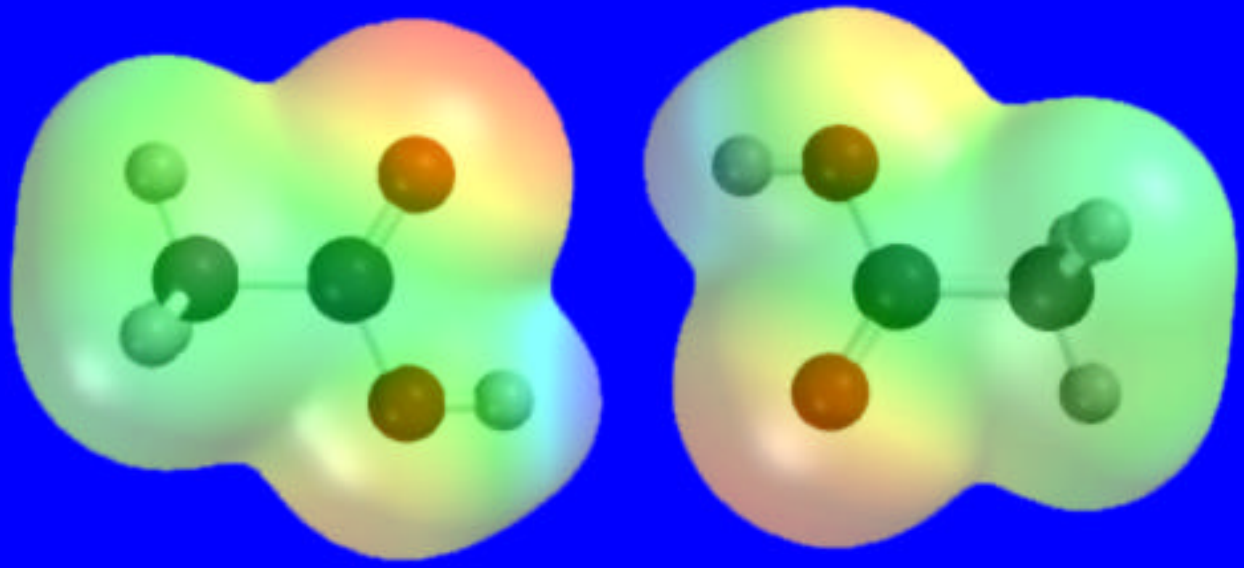
Intermolecular forces, especially hydrogen bonding, are stronger in carboxylic acids than in other compounds of similar shape and molecular weight

Hydrogen-bonded Dimers



Acetic acid exists as a hydrogen-bonded dimer in the gas phase. The hydroxyl group of each molecule is hydrogen-bonded to the carbonyl oxygen of the other.

Hydrogen-bonded Dimers

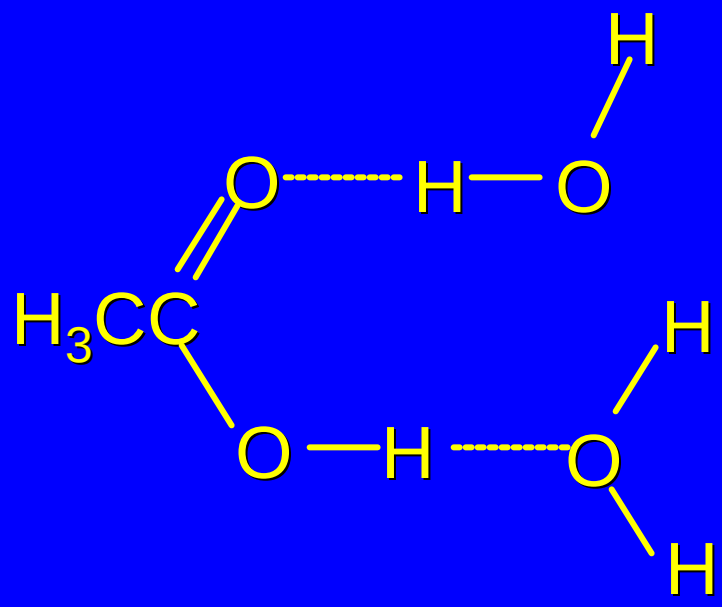


Acetic acid exists as a hydrogen-bonded dimer in the gas phase. The hydroxyl group of each molecule is hydrogen-bonded to the carbonyl oxygen of the other.

Solubility in Water

carboxylic acids are similar to alcohols in respect to their solubility in water

form hydrogen bonds to water

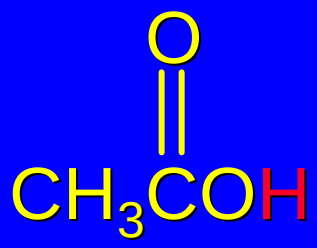


19.4
Acidity of Carboxylic Acids

Most carboxylic acids have a pK_a close to 5.

Carboxylic acids are weak acids

but carboxylic acids are far more acidic than alcohols



$CH_3CO\mathbf{H}$

$K_a = 1.8 \times 10^{-5}$

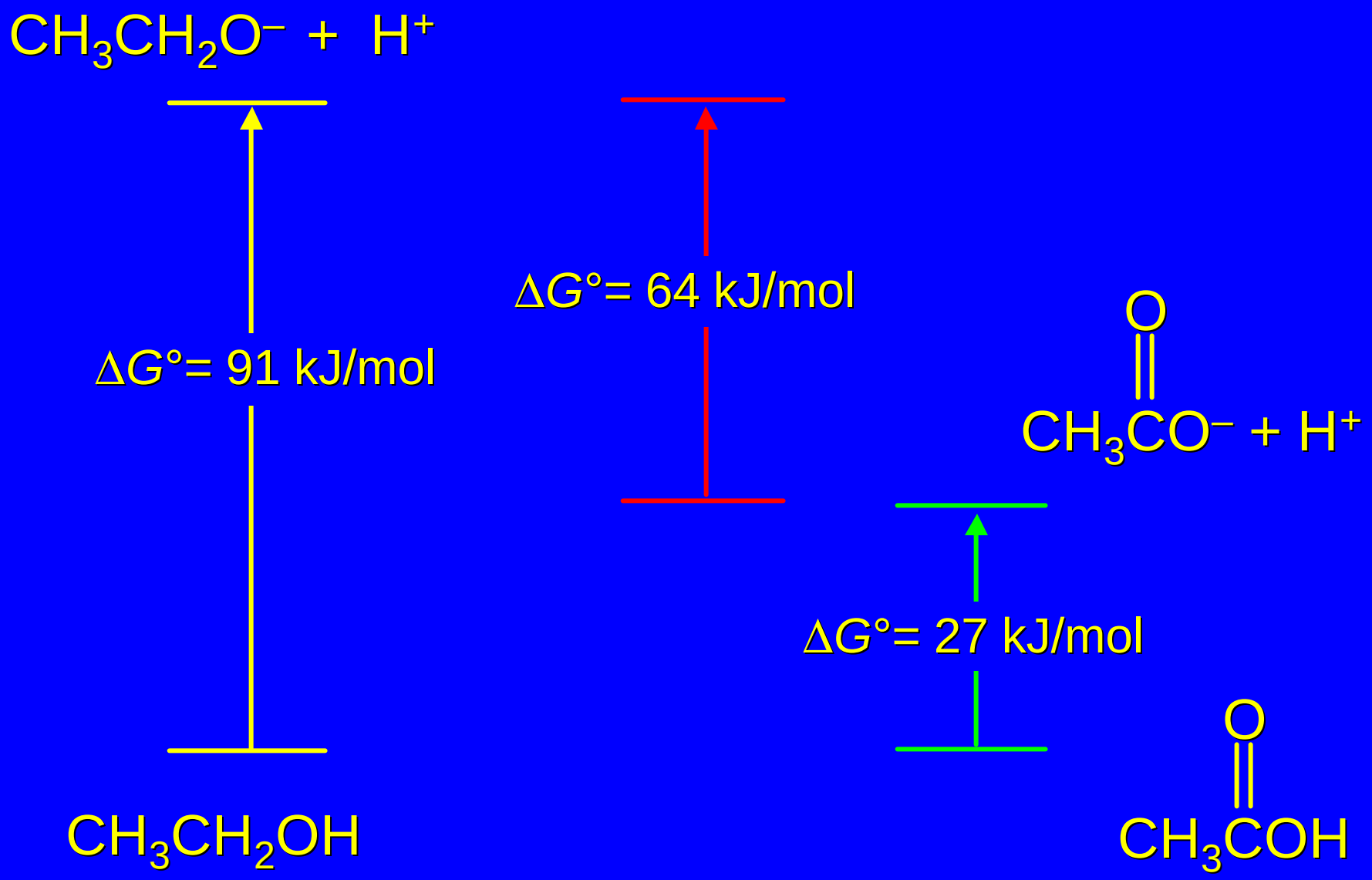
$pK_a = 4.7$

$CH_3CH_2O\mathbf{H}$

$K_a = 10^{-16}$

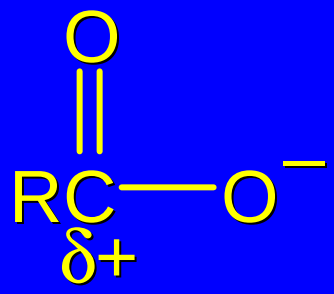
$pK_a = 16$

Free Energies of Ionization



Greater acidity of carboxylic acids is attributed stabilization of carboxylate ion by

inductive effect of carbonyl group



resonance stabilization of carboxylate ion

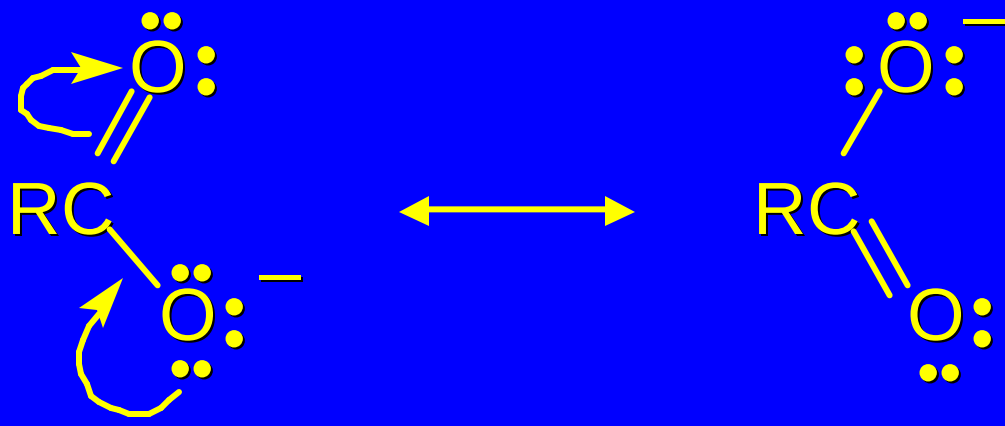
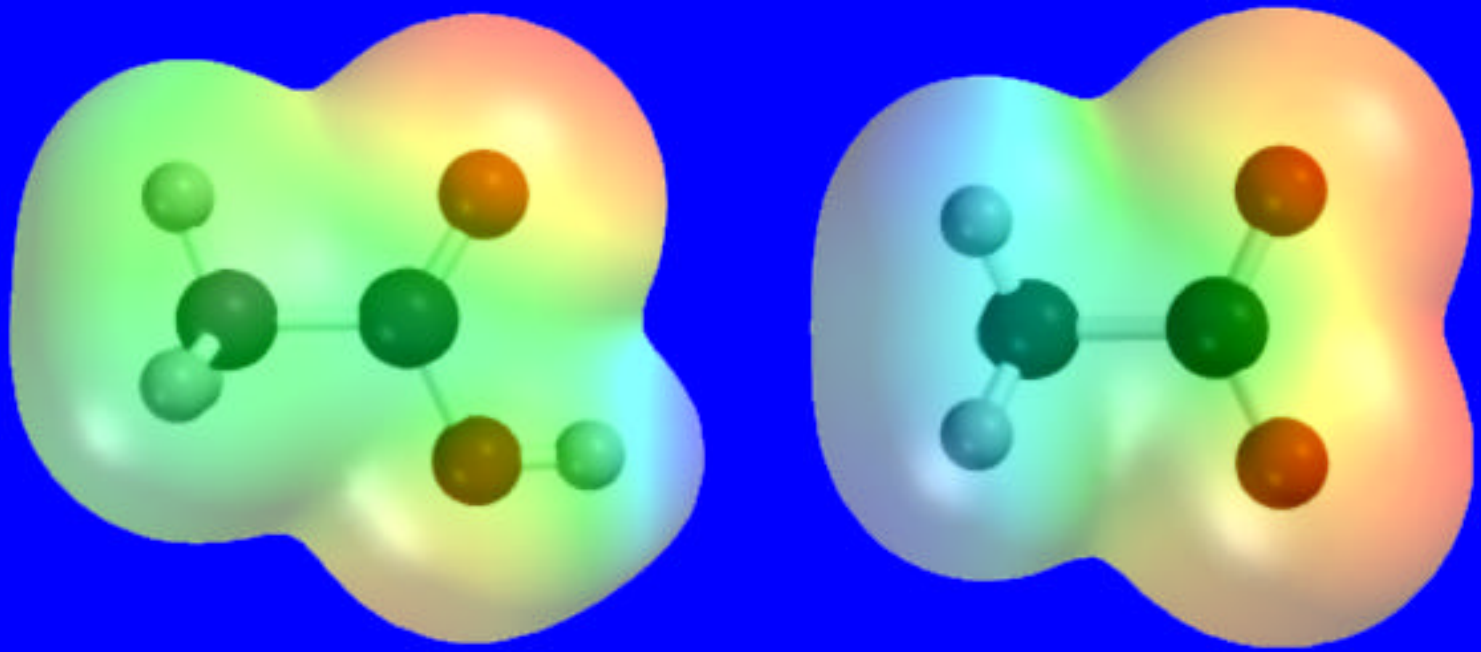


Figure 19.4: Electrostatic potential maps of acetic acid and acetate ion

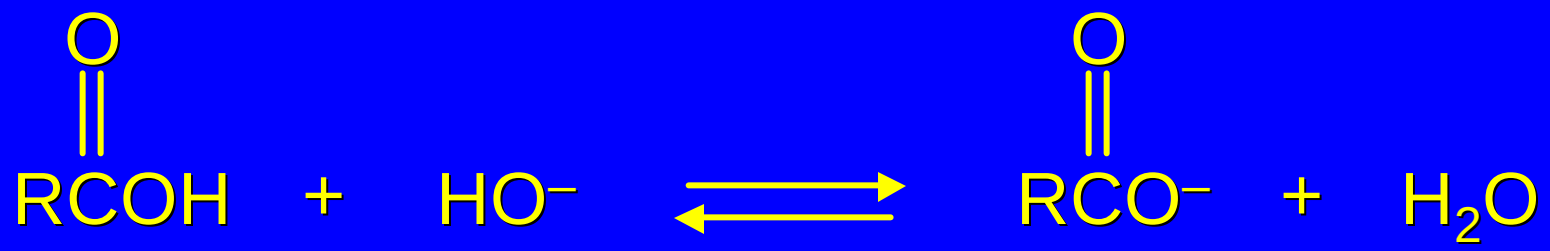


Acetic acid

Acetate ion

19.5
Salts of Carboxylic Acids

Carboxylic acids are neutralized by strong bases



stronger acid

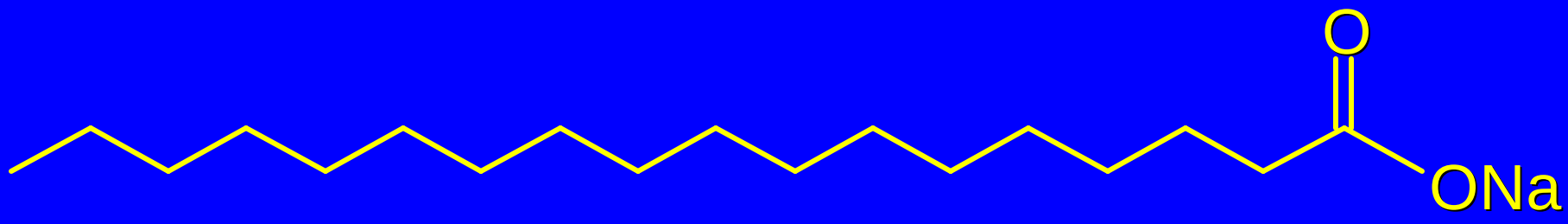
weaker acid

equilibrium lies far to the right; *K* is ca. 10^{11}

as long as the molecular weight of the acid is not too high, sodium and potassium carboxylate salts are soluble in water

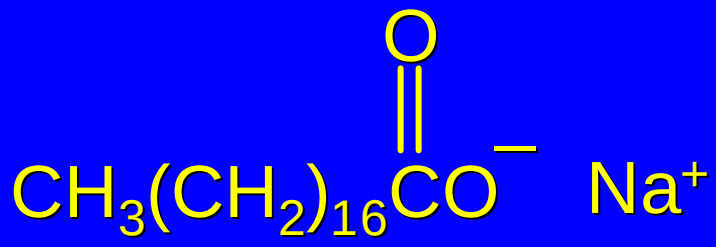
Micelles

unbranched carboxylic acids with 12-18 carbons give carboxylate salts that form *micelles* in water

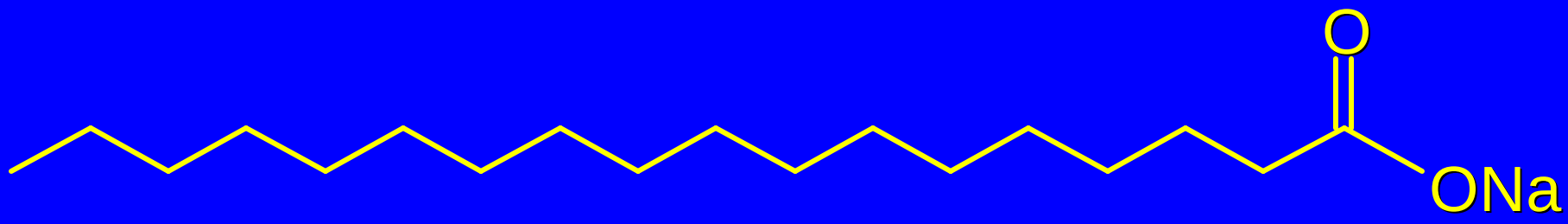


sodium stearate

(sodium octadecanoate)



Micelles



nonpolar — polar

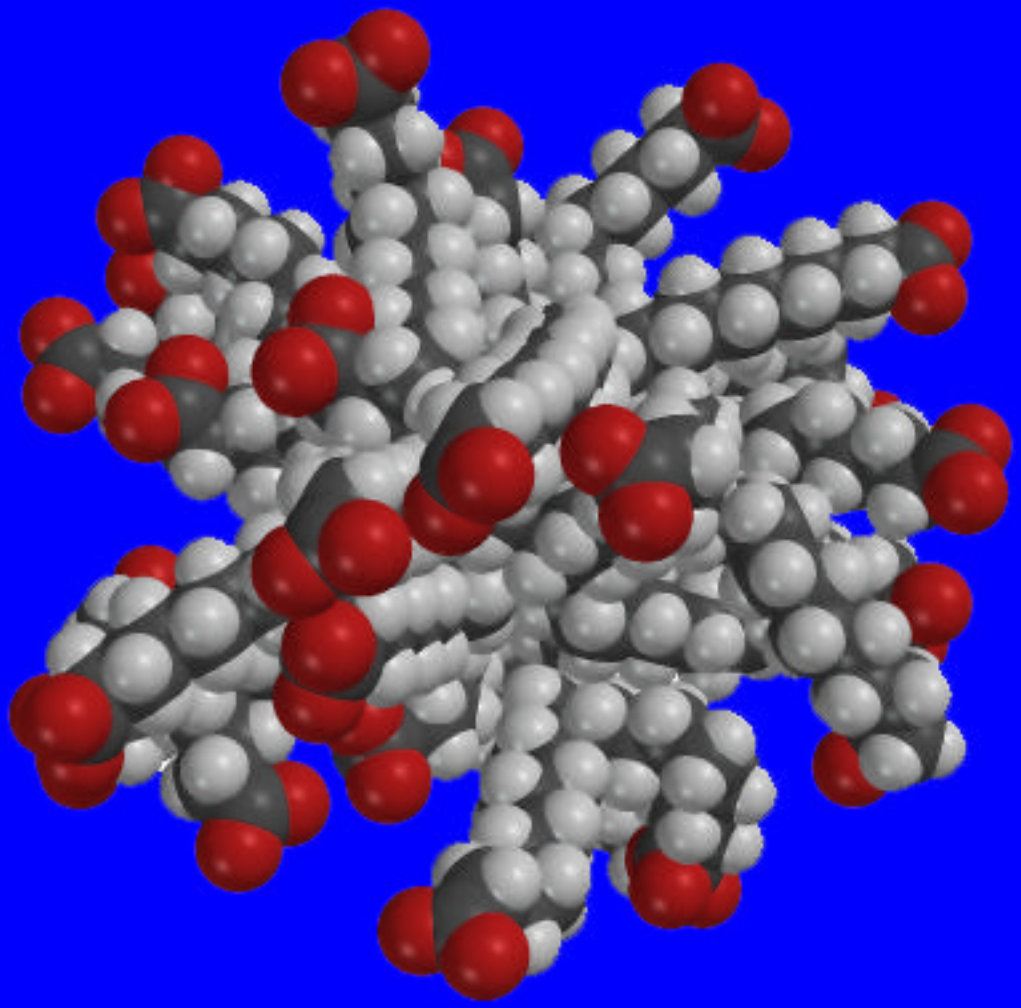
sodium stearate has a polar end (the carboxylate end) and a nonpolar "tail"

the polar end is "water-loving" or hydrophilic

the nonpolar tail is "water-hating" or hydrophobic

in water, many stearate ions cluster together to form spherical aggregates; carboxylate ions on the outside and nonpolar tails on the inside

Figure 19.5 (page 744) A micelle



Micelles

The interior of the micelle is nonpolar and has the capacity to dissolve nonpolar substances.

Soaps clean because they form micelles, which are dispersed in water.

Grease (not ordinarily soluble in water) dissolves in the interior of the micelle and is washed away with the dispersed micelle.