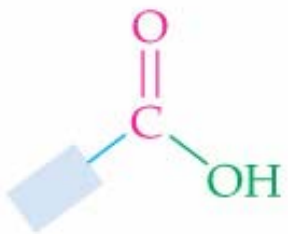
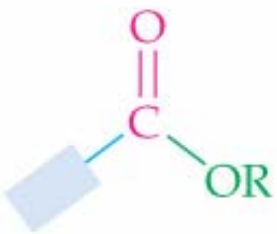
17.1 Carboxylic Acids and Their Derivatives: Properties and Names

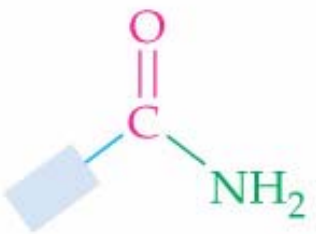
- Caboxylic acids have an –OH group bonded to a carbonyl group. In their derivatives, OH is substituted by other group. Such as,
- Esters have a –OR group bonded to a carbonyl group.
- Amides have an $–NH_2$ group bonded to a carbonyl group.



Carboxylic acid



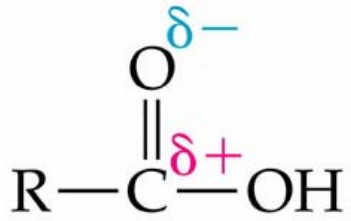
Ester



Amide

- Carboxylic acid their derivatives all contain polar functional group, as a result they have higher boiling points than alkanes.
- Carboxylic acid their derivatives all participate in carbonyl-group substitution reaction, in which the group bonded to the carbonyl group is replaced by another group.
- The parts of molecules the alkyl group is bonded to the carbonyl group is known as an acyl group, RC=O.

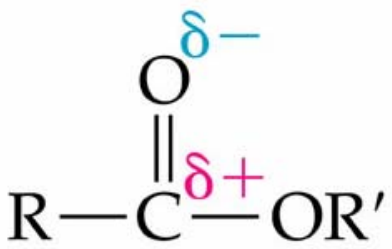
Carboxylic Acids



Carboxylic acid
(RCOOH or RCO_2H)

- Carboxylic acids donate proton to bases.
- Carboxylic acids hydrogen bond with each other. As a result of hydrogen bonding, they have higher boiling points than similar alkanes.

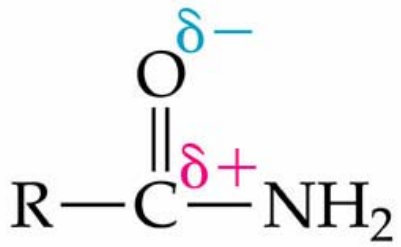
Esters



Ester
(RCOOR′ or RCO_2R')

In carboxylic acid, OH group of is replaced with OR group to create an ester. Esters can not form hydrogen bonds with each other. Therefore, esters have lower boiling points than the carboxylic acids from which they are derived.

Amides



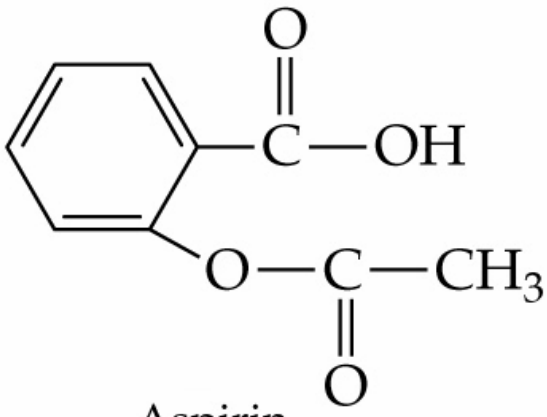
Amides
($RCONH_2$, $RCONHR'$, $RCONHR_2'$)

- Amides may contain $–NH_2$ group or one or both of the hydrogen replaced with alkyl groups.
- Unsubstituted amides, $RCONH_2$, can form three hydrogen bonds to other amide molecules and are thus have higher melting and boiling points than the acids from which they are derived.

- Monosubstituted amides, RCONHR', can form hydrogen bonds to other amide molecules.
- Disubstituted amides, $RCONR'_2$, can not form hydrogen bonds to other amide molecules, therefore, they have lower boiling points.

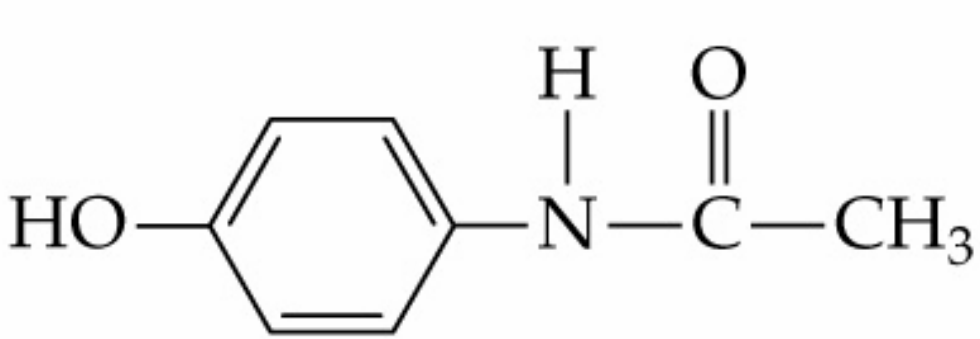
17.5 Aspirin and Other Over-the-Counter Carboxylic Acid Derivatives

Aspirin: A member of a group of drugs known as salicylates. Aspirin is an analgesic (relief pains), antipyretic (reduces fever), and anti-inflammatory (reduces inflammation). Salicylates are esters of salicyclic acid.



Aspirin

Acetaminophen: An amide that also contain a hydroxyl group. It is best known as Tylenol. An alternative to Aspirin for pain relief but it unlike aspirin it is not an anti-innflammatory agent.



Acetaminophen

17.6 Hydrolysis of Esters and Amides

Esters and amides undergo hydrolysis to give back the carboxylic acid and alcohol or amine.

Ester hydrolysis: Ester hydrolysis reactions can be catalyzed by either an *acid* or a *base*.

Acid catalyzed ester hydrolysis is simply the reverse of esterification reaction. In this reaction, an ester is treated with water in the presence of a strong acid catalyst such as sulfuric acid.

Base catalyzed ester hydrolysis with a base such as NaOH or KOH is known as *saponofication.* The product of saponification reaction is a carboxylate anion rather then a free carboxylic acid.

17.8 Phosphoric Acid Derivatives

- Phosphoric acid is an inorganic acid with three ionizable hydrogen atoms allowing it to form three different anions.
- Phosphoric acids react with alcohols to form phosphate esters.
- Phosphoric acid produces mono, di, or triester by reacting with one, two, or three molecules of alcohols respectively.

- Phosphate mono and diesters are acids because they still contain acidic hydrogen atoms. In biochemical reactions and equations, the phosphate groups are thus written in their ionic forms.
- Two molecules of phosphoric acid lose water between them and form a phosphoric acid anhydride. The resulting phosphoric acid anhydride (also an acid) reacts with another molecule of phosphoric acid in a similar reaction to produce a triphosphoric acid.

- Transfer of a phosphoryl group, $-PO_3^{2-}$, from one molecule to another is known as *phosphorylation*.
- In biochemical reaction, phosphorylation reactions provide energy. Such as ATP, a triphosphate, converting to ADP, a diphosphate, releases energy that is used by other biochemical reactions body.