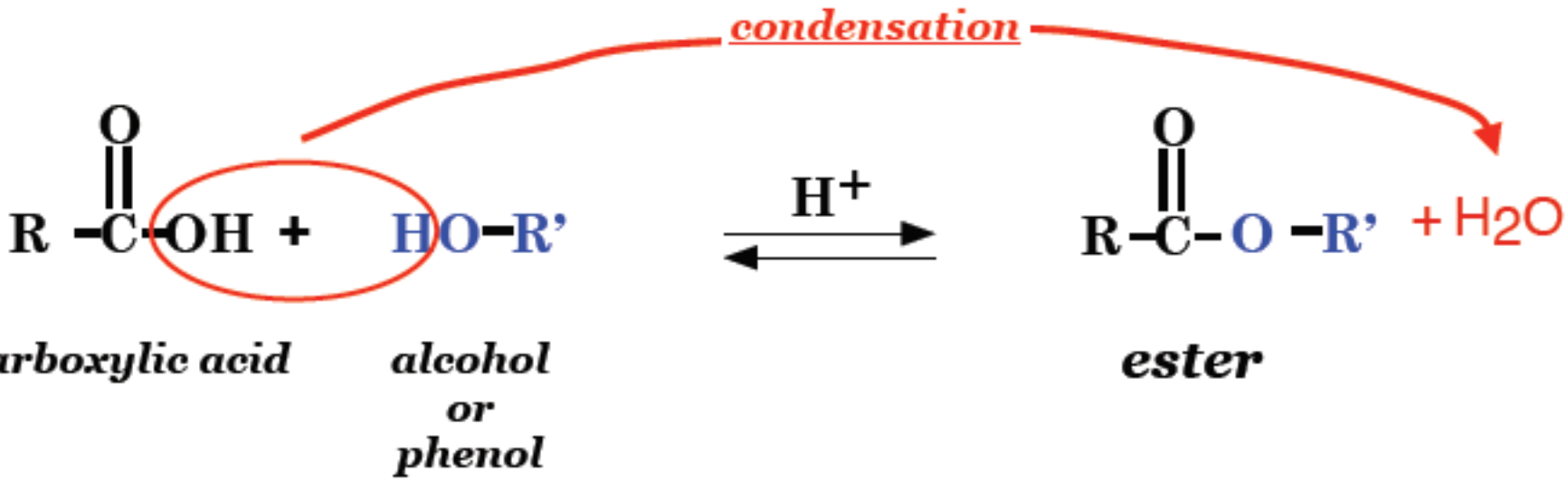
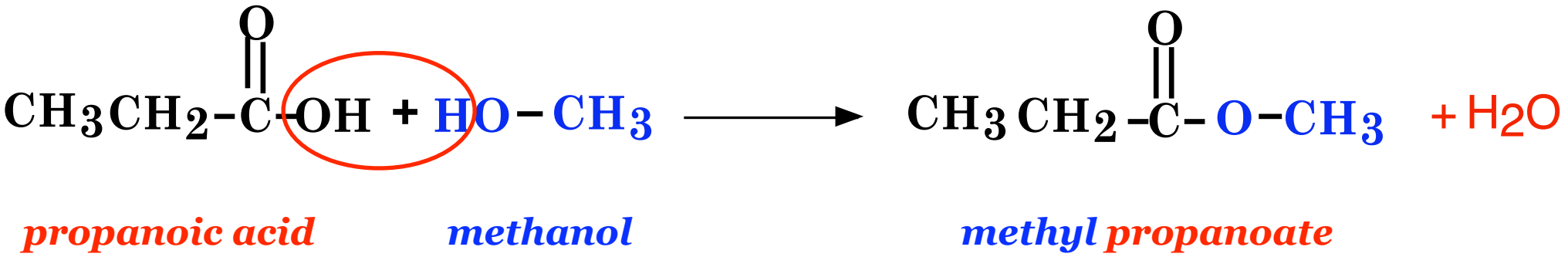
Carboxylic Acid Esters

Synthesized from a carboxylic acid and an alcohol:

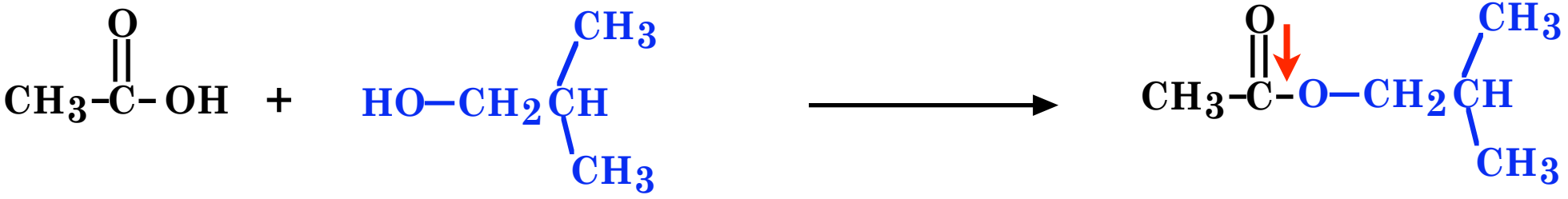


Nomenclature base on parent alcohol and carboxylic acid:

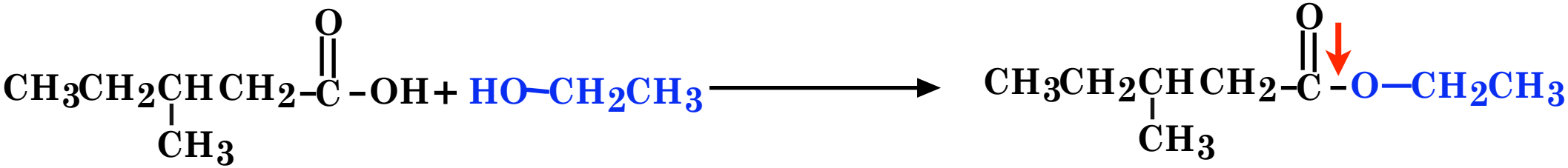


Carboxylic Acid Esters

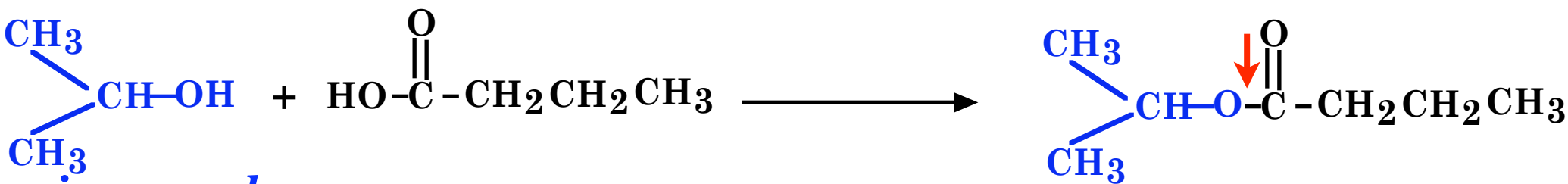
Additional Nomenclature examples:



acetic acid *isobutyl alcohol* *isobutyl acetate*

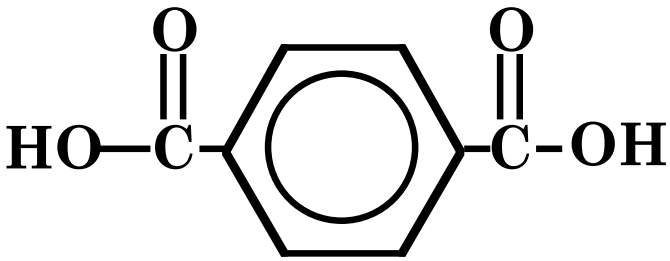


3-methyl pentanoic acid *ethyl alcohol* *ethyl 3-methyl pentanoate*



isopropyl alcohol *butanoic acid* *isopropyl butanoate*

A Diester Synthesis

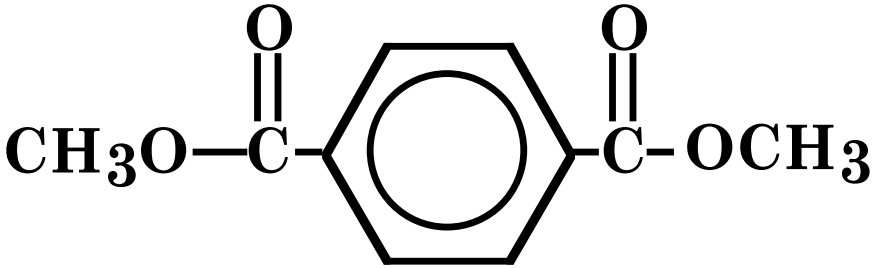


terephthalic acid

+ excess $HO-CH_3$

methyl alcohol

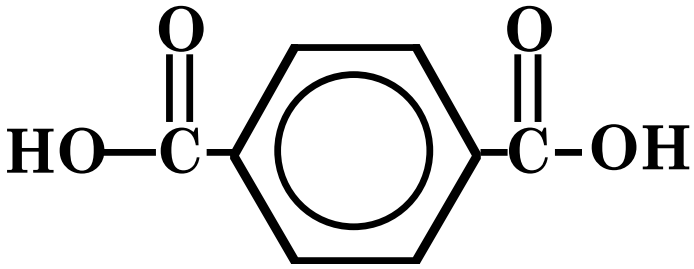
H^+



dimethyl terephthalate

+ 2 H_2O

A Polyester Synthesis

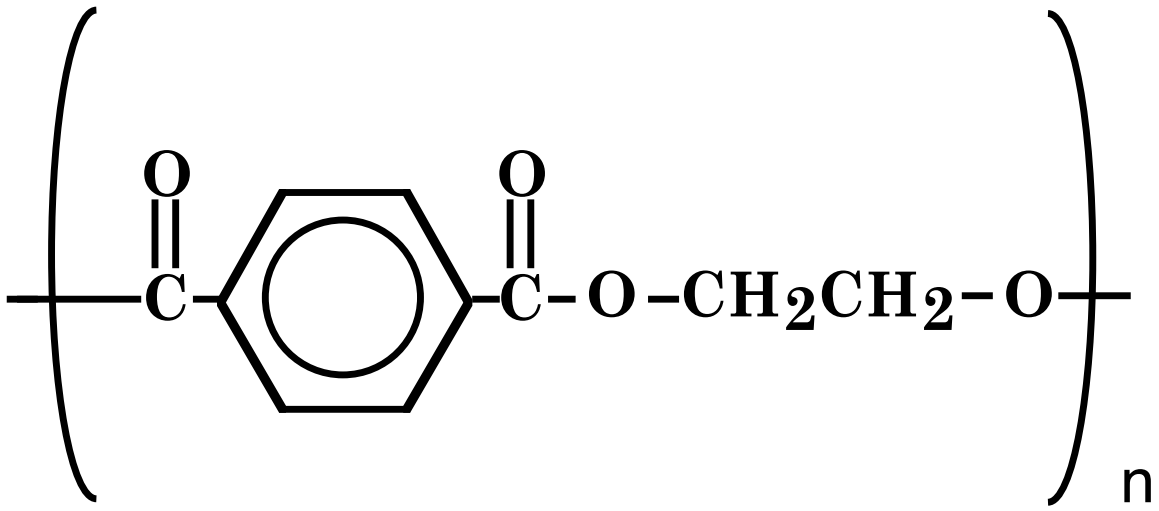


terephthalic acid

\+ excess

ethylene glycol
ethanediol

H+

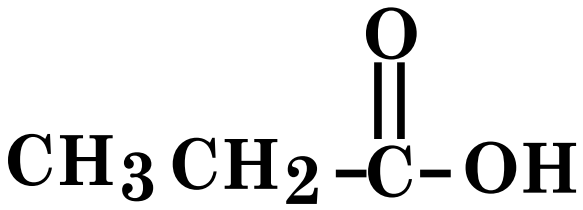


A polyester

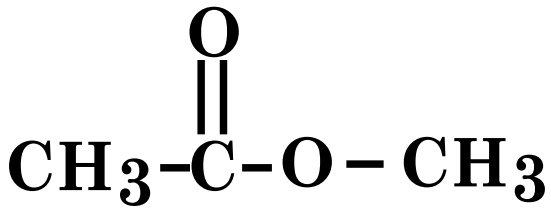
Physical Properties of Esters

Ester molecules cannot hydrogen bond to each other.

Therefore, esters have much lower boiling and melting points than those of carboxylic acids.



Propanoic acid, bp 141°C

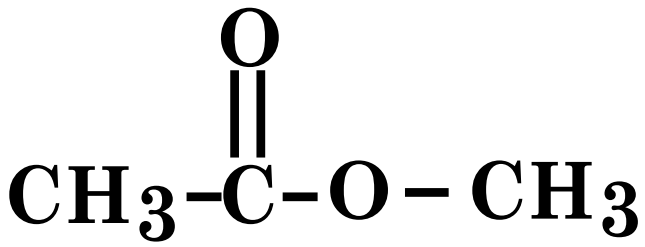


Methyl acetate, bp 57°C

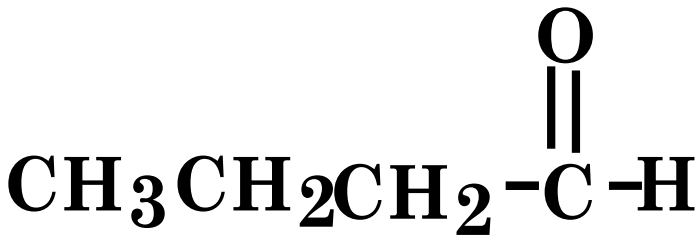
Esters are less soluble in water than are carboxylic acids because esters cannot form as many hydrogen bonds to water molecules as can carboxylic acids.

Physical Properties of Esters

The secondary forces in esters are weaker than those in aldehydes and ketones, and thus esters have lower melting and boiling points.



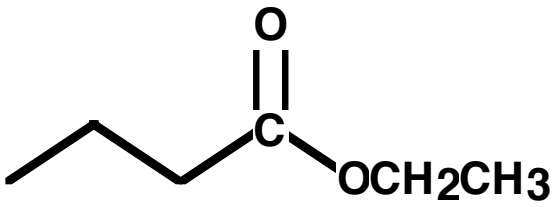
Methyl acetate, bp 57°C



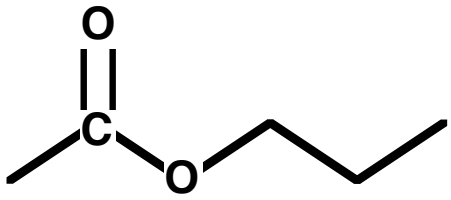
Butanal, bp 76°C

Esters have about the same water solubilities as aldehydes and ketones because all three hydrogen bond to water equally well.

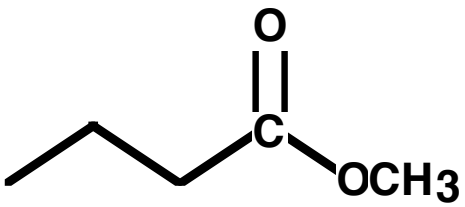
Esters Have Characteristic Odors



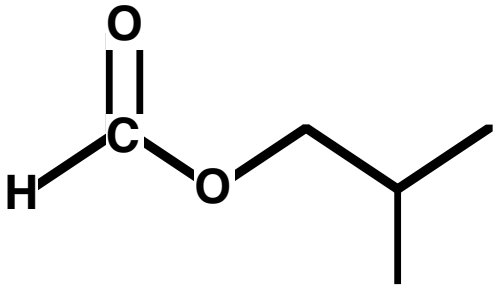
Pineapple



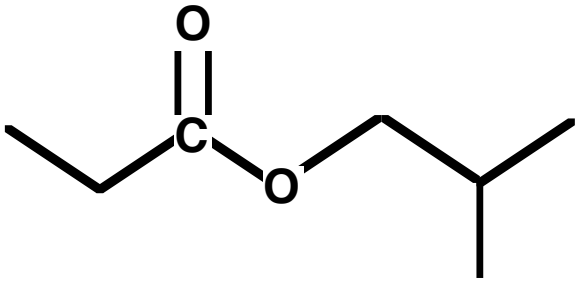
Pear



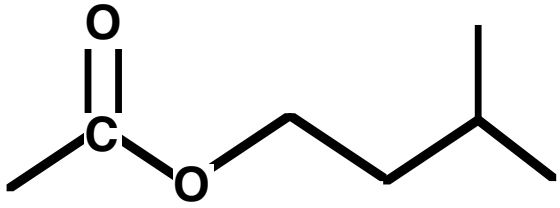
Apple



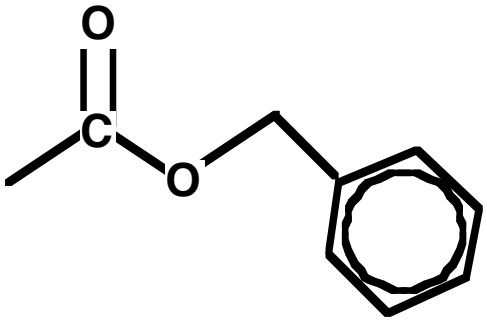
Raspberry



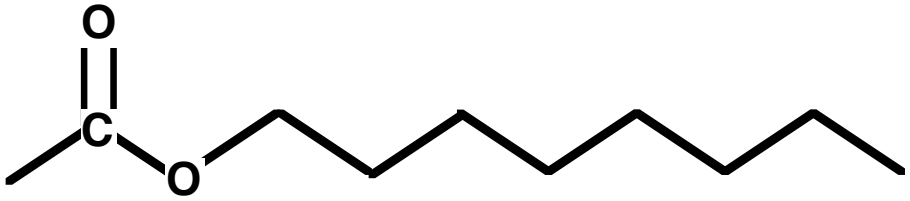
Rum



Banana



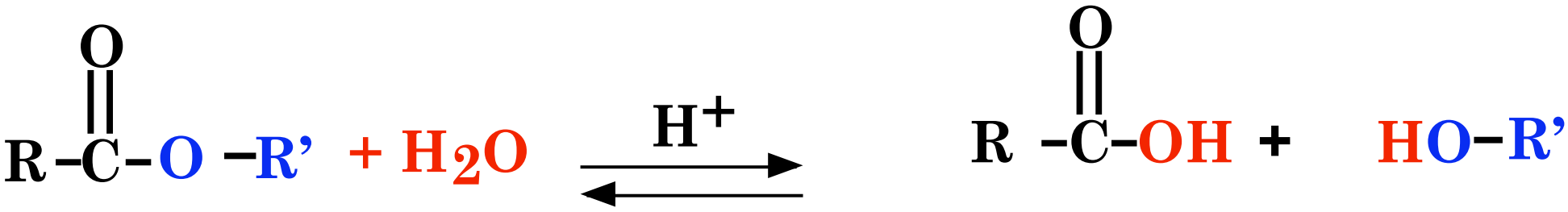
Peach



Orange

Hydrolysis Reaction of Esters

Hydrolysis of Esters Under Acidic Conditions



ester

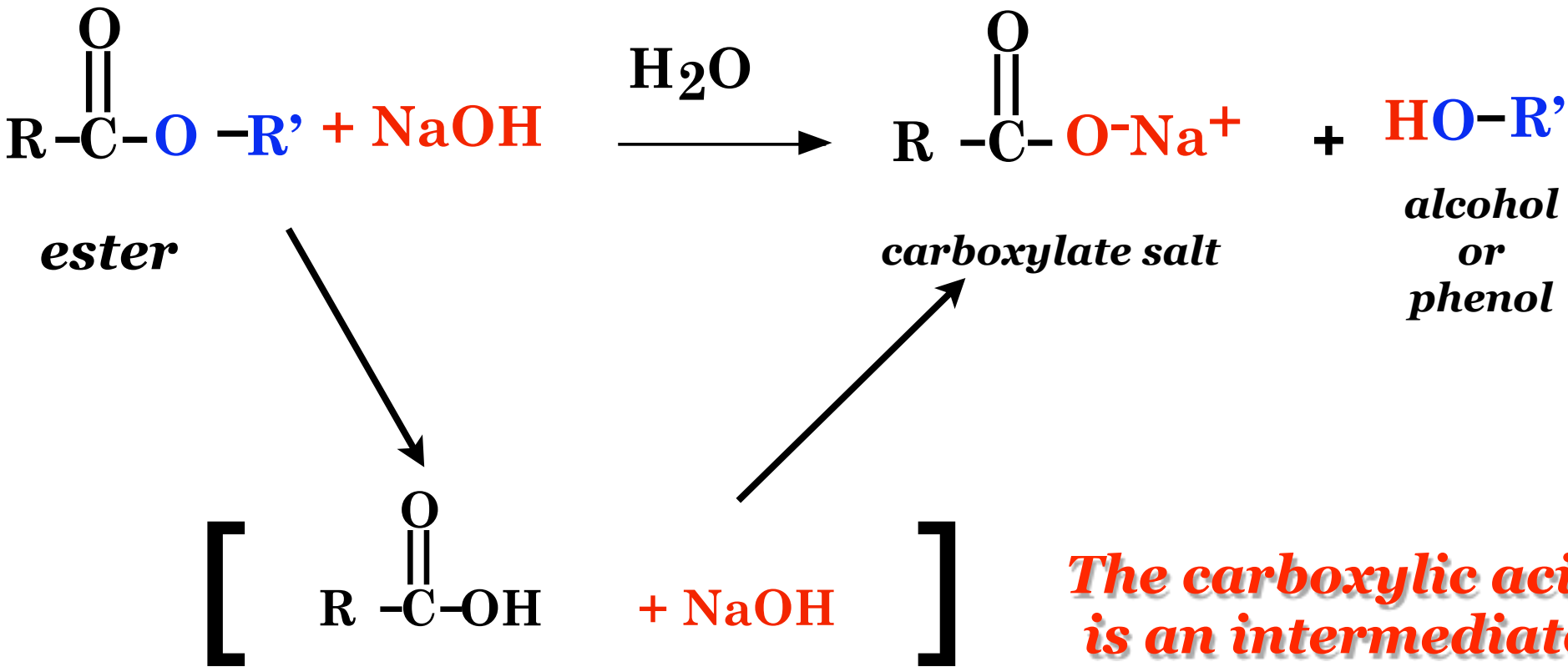
carboxylic acid

alcohol or phenol

Notice that this is the reverse of the condensation reaction used to synthesize an ester !!

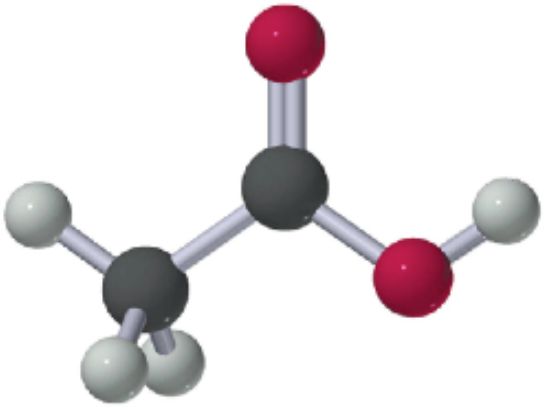
Hydrolysis Reaction of Esters

Hydrolysis of Esters Under Basic Conditions

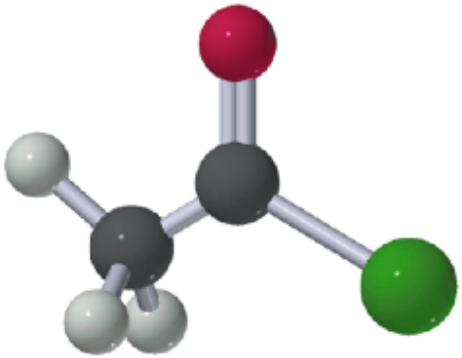


The carboxylic acid is an intermediate but reacts with the basic NaOH !!

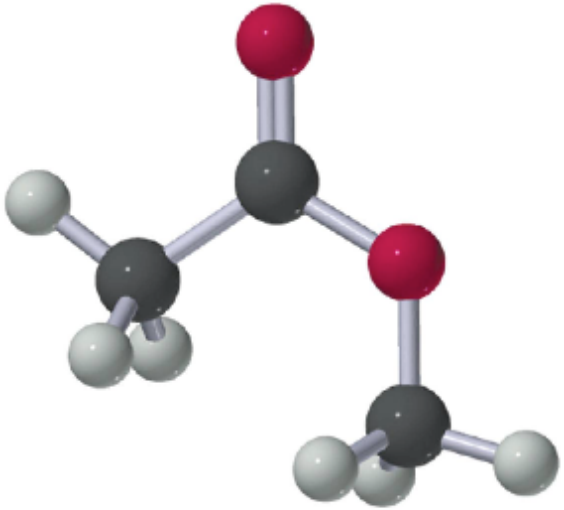
Carboxylic Acids and Their Derivatives



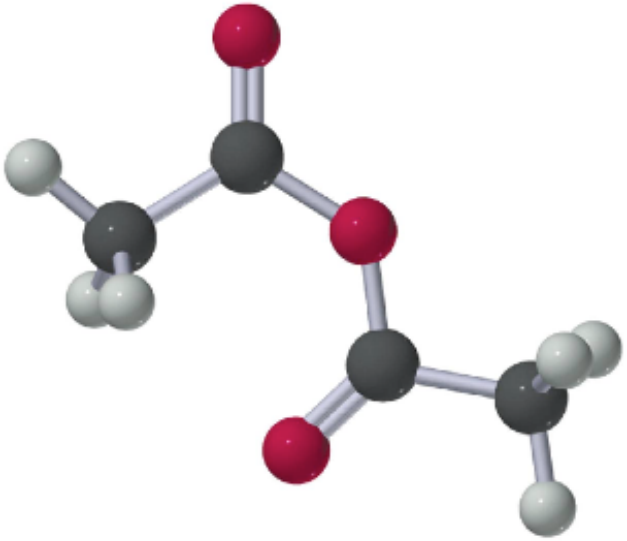
acetic acid



acetyl chloride



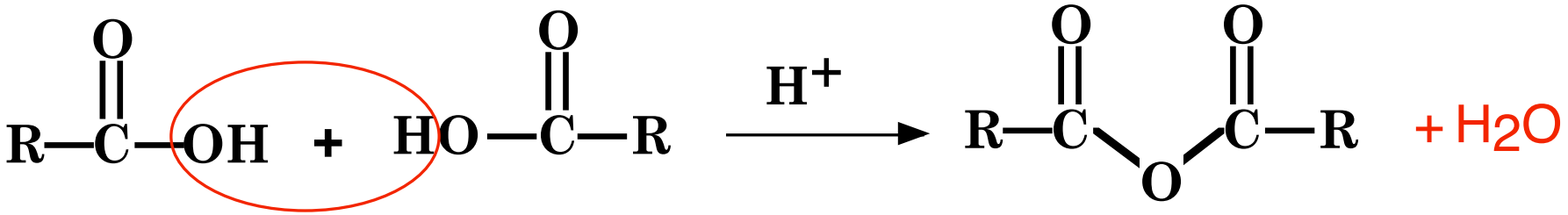
methyl acetate



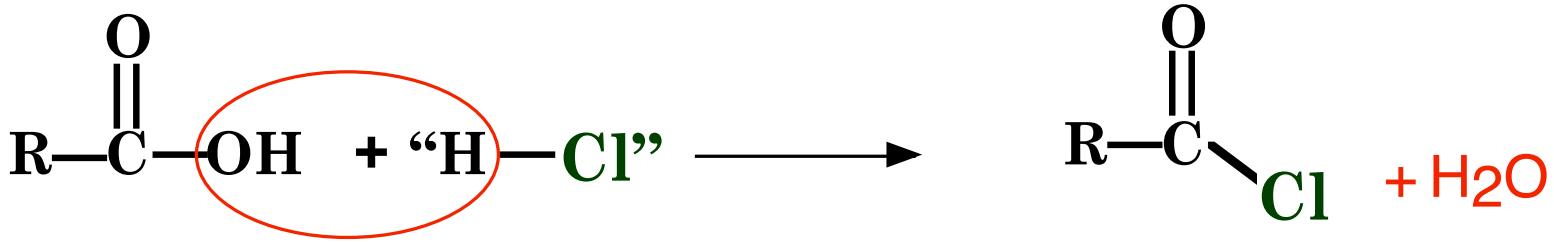
acetic anhydride

Carboxylic Acid Anhydrides and Halides

Synthesis from a carboxylic acid:



carboxylic acid *carboxylic acid* *carboxylic acid anhydride*

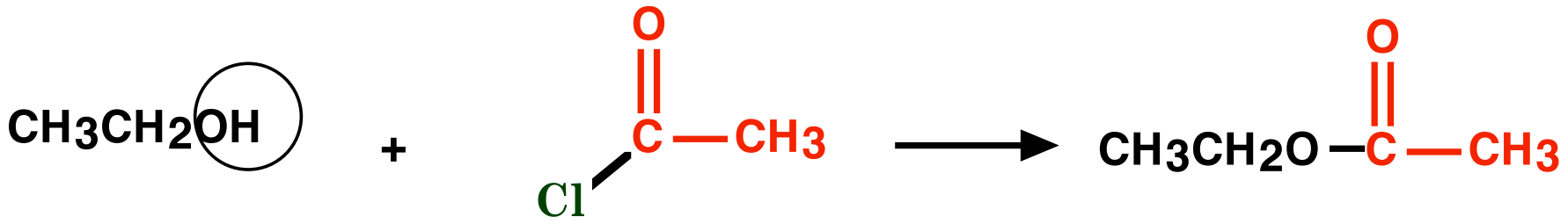


carboxylic acid *carboxylic acid chloride*

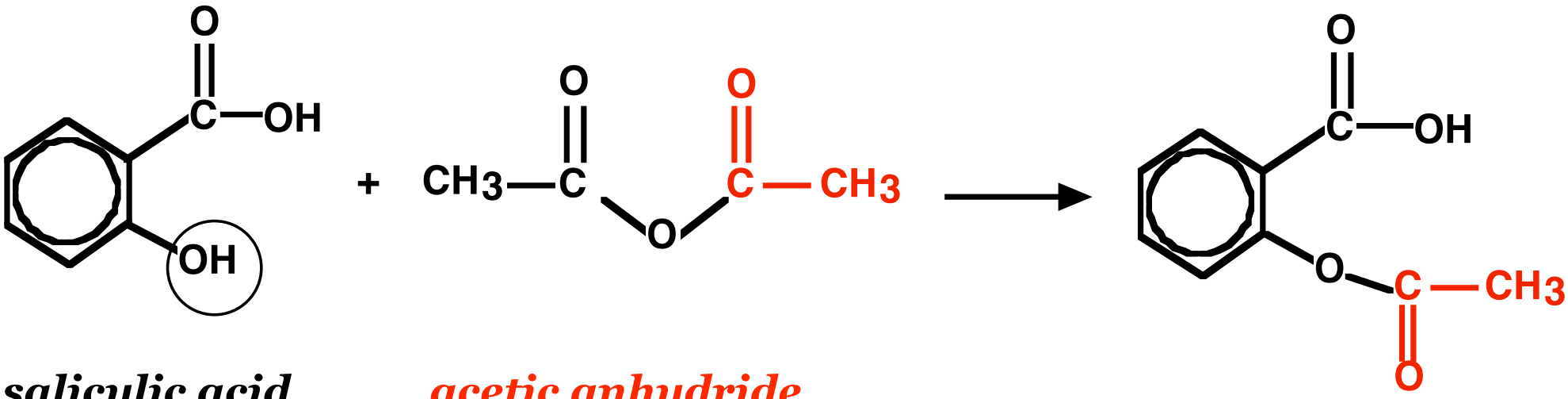
Very unstable; very "reactive"
Low boiling points and melting points
"Lachrymators"
Generate the starting acids upon hydrolysis

Carboxylic Acid Anhydrides and Halides

Used to Synthesize Esters



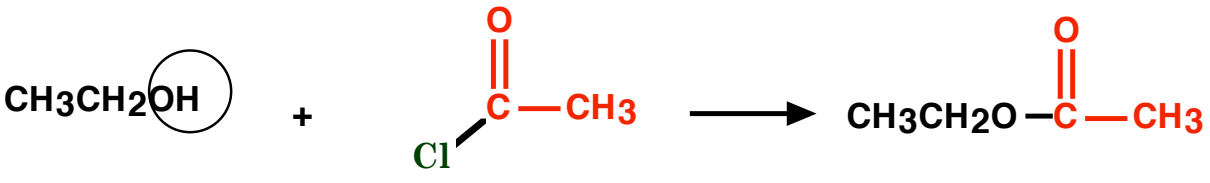
ethyl alcohol *acetyl chloride* *ethyl acetate*

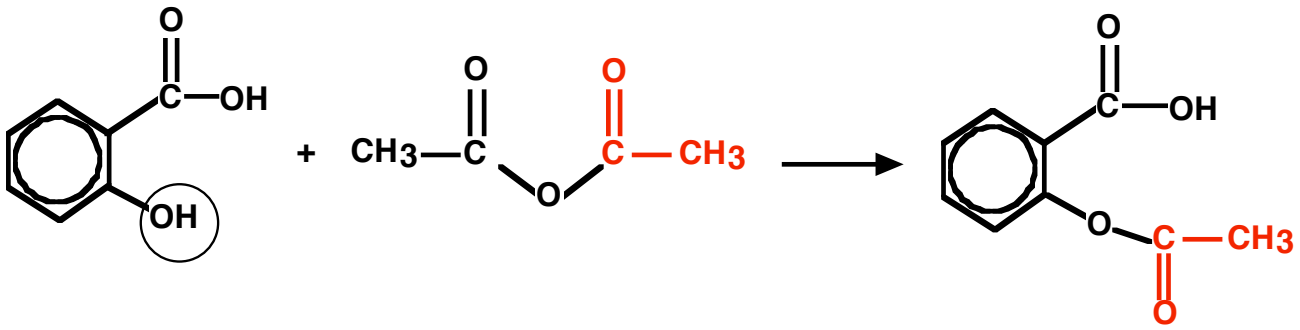


salicylic acid *acetic anhydride*

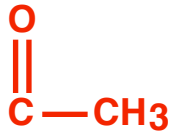
salicyl acetate
acetyl salicylic acid
aspirin

Carboxylic Acid Anhydrides and Halides





These highly reactive compounds are use to transfer the acetyl group to an alcohol group.



Summary of reactivity of carboxylic acid related functional groups:

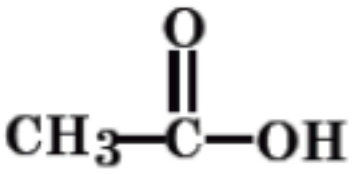
Acid Anhydrides
Acid Halides

> Carboxylic Acid Esters

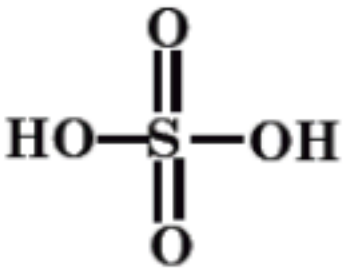
> Carboxylic Acid Amides

> Carboxylic Acids

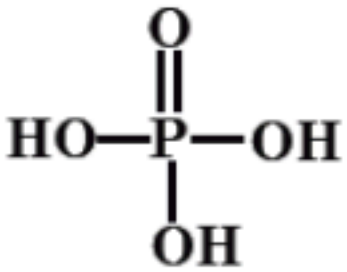
Similar Derivatives of Inorganic Acids



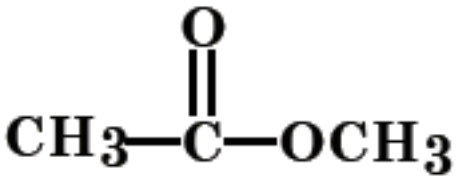
acetic acid



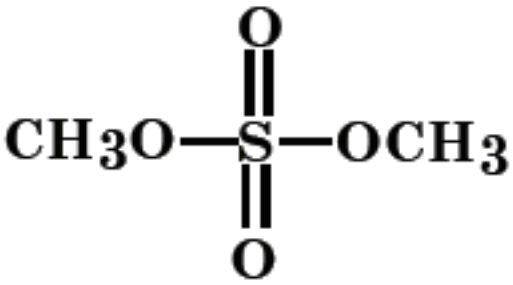
sulfuric acid



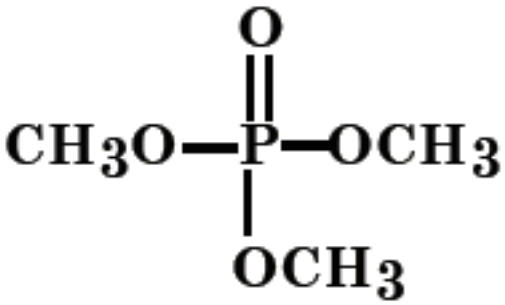
phosphoric acid



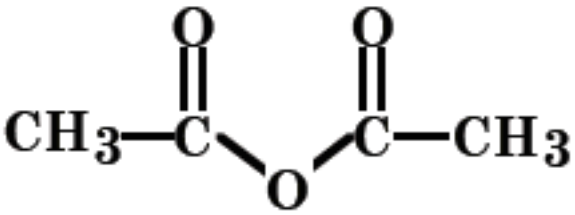
methyl acetate



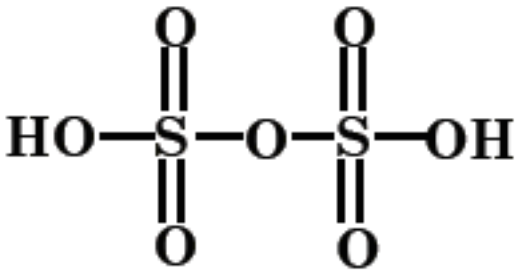
dimethyl sulfate



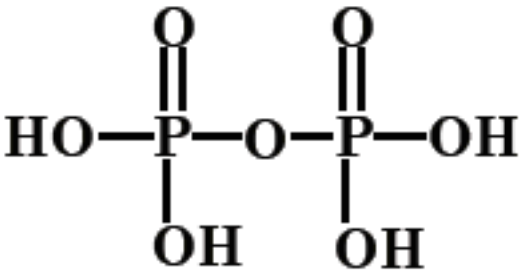
trimethyl phosphate



acetic anhydride

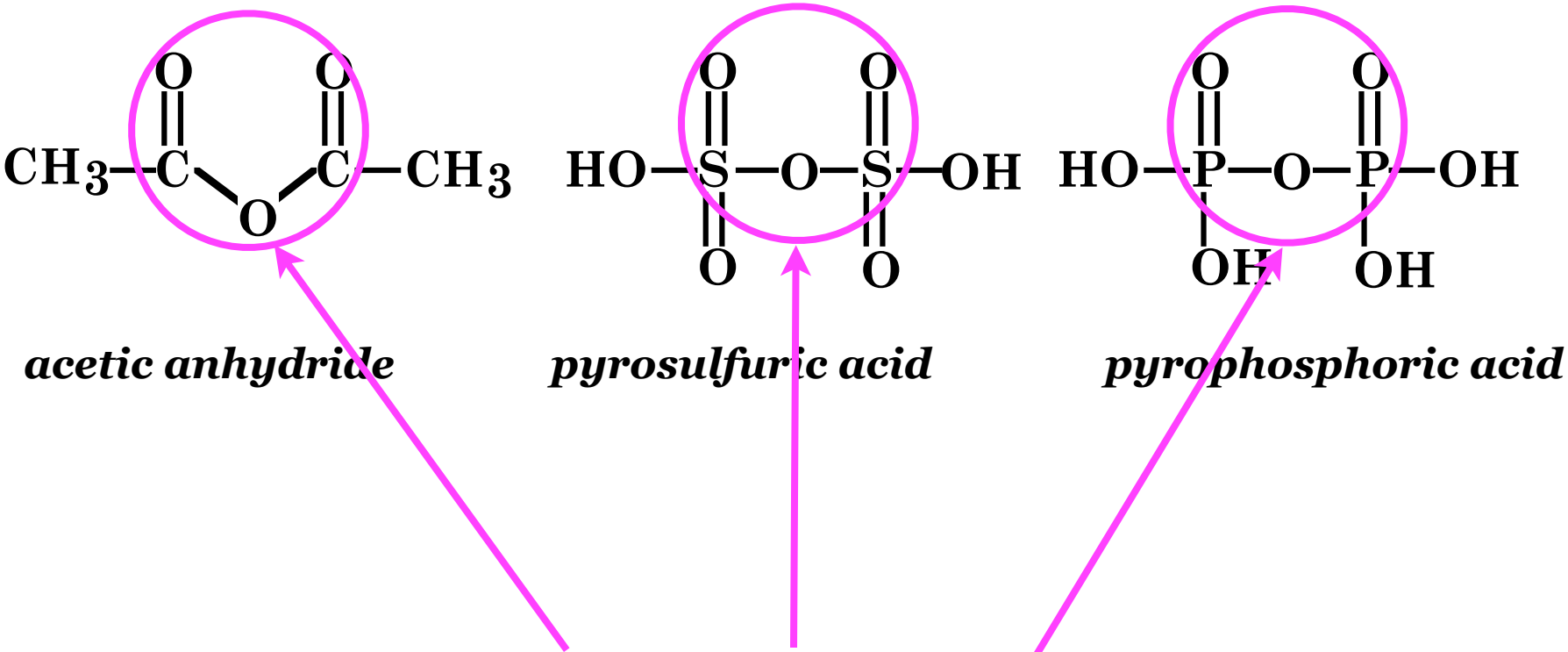


pyrosulfuric acid



pyrophosphoric acid

Similar Derivatives of Inorganic Acids

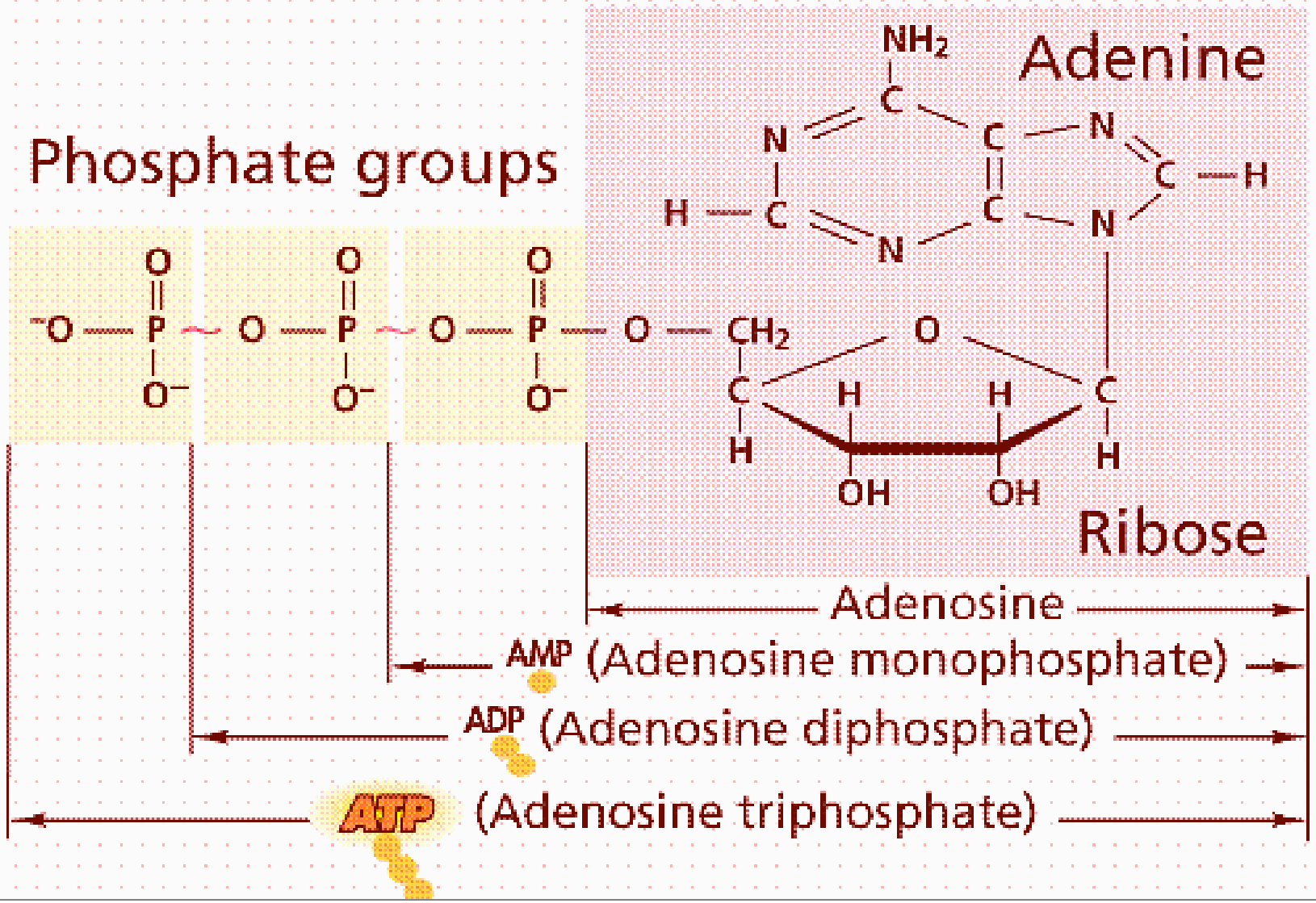


ANHYDRIDE LINKAGES

"REACTIVE LINKAGES"

"HIGH ENERGY BONDS"

What is ATP??


Phosphate groups
Adenine
Ribose
Adenosine
AMP (Adenosine monophosphate)
ADP (Adenosine diphosphate)
ATP (Adenosine triphosphate)