

# Carboxylic Acids and Esters

Nomenclature

Physical Properties

Sources

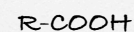
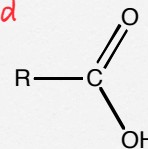
Reactions

Carboxylic Acid Derivatives

## General structure

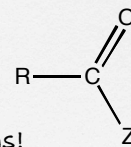
carboxylic acid

functional group

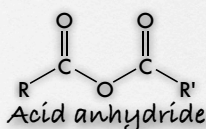
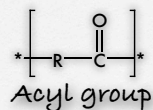
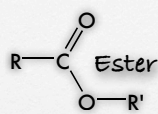
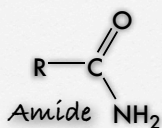
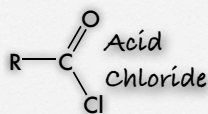


Carboxylic acid derivatives

where Z = could be a lot of things!



## Carboxylic derivatives

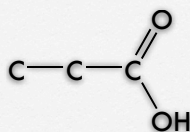


R groups can be replaced with Ar.

## Acid nomenclature

- Find the longest carbon chain that contains the COOH group.
- Drop the **-e** from the end of the hydrocarbon name and substitute **-oic acid**.
- Number and name any branches or other substituents.
- Number 1 carbon is acid carbon.
- Name and number other substituents.

## Examples



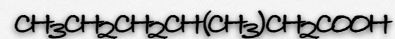
1. Longest chain containing carbonyl is 3.

propane

2. The **-e** ending is replaced with **-oic acid**.

propanoic acid

## Examples



Parent compound = 6 carbons, hexane

Drop **-e** and add **-oic acid**

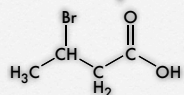
hexanoic acid

Carboxylic carbon is #1

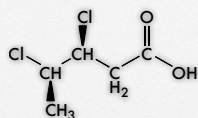
Name remaining substituents

3-methylhexanoic acid

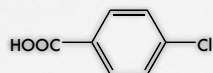
## Examples



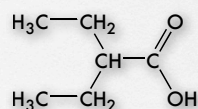
3-bromobutanoic acid



3,4-dichloropentanoic acid

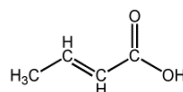


p-chlorobenzoic acid  
or 4-chlorobenzoic acid

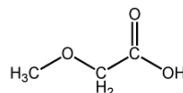


2-ethylbutanoic acid

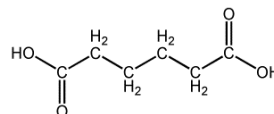
## More examples



trans-2-butenoic acid



methoxyethanoic acid



hexanedioic acid

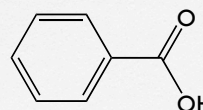
## Some common names

Common	IUPAC	Formula
Formic	methanoic	$\text{HCOOH}$
Acetic	ethanoic	$\text{CH}_3\text{COOH}$
Butyric	butanoic	$\text{CH}_3(\text{CH}_2)_2\text{COOH}$
Capric	decanoic	$\text{CH}_3(\text{CH}_2)_8\text{COOH}$
Lauric	dodecanoic	$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$
Steric	octadecanoic	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$

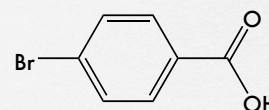
## Aromatic carboxylic acids

Commonly named as derivatives of benzene  
We also rely on a wide range of common names.

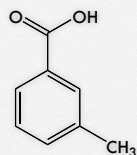
benzoic acid



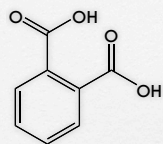
p-bromobenzoic acid



## Aromatic carboxylic acids



m-toluic acid



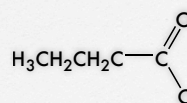
phthalic acid

Examples of aromatic common names.

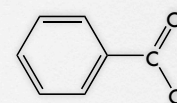
## Acid halides

-OH of acid is replaced with a F, Cl, Br or I.

Name like with acid but use **-oyl halide**.

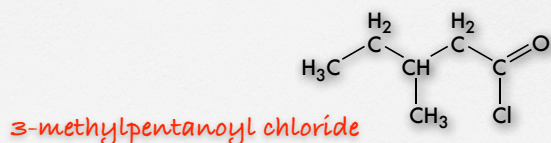
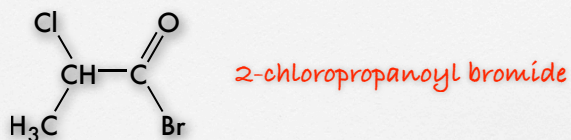


butanoyl chloride



benzoyl chloride

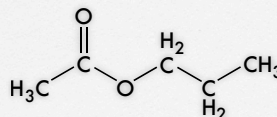
## Nomenclature examples



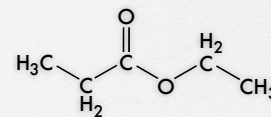
## Esters

-OH of acid is replaced with -OR group.

- Name R group like a side chain (with a space).
- Then name acid portion with **-oate** ending



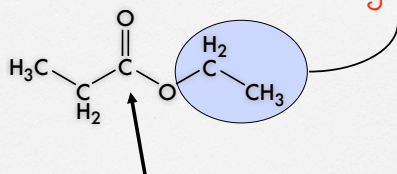
propyl ethanoate



ethyl propanoate

## Esters

This part is treated like a branch with a **-yl** ending.

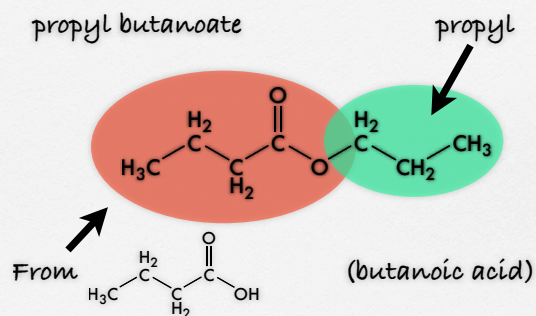


Look for this carbon

It is the number one carbon on the original acid - it is given the **-oate** ending.

## Esters

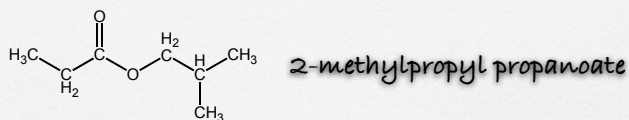
propyl butanoate



(butanoic acid)

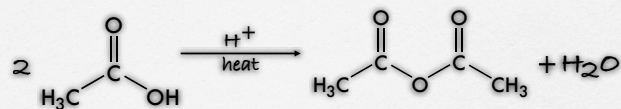
so you would use butanoate.

## Nomenclature examples



## Acid anhydrides

Formed from the combination of two acids and the loss of water.



2 ethanoic acids

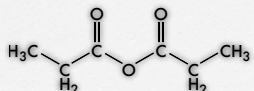
ethanoic anhydride

## Acid anhydrides

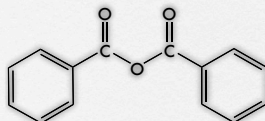
### Nomenclature

Simple example: both halves are from the same acid.

Name by changing **acid** ending to **anhydride**.



propanoic  
anhydride

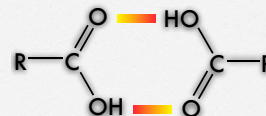


benzoic  
anhydride

## Properties

### Acids

- Very polar with high boiling points
- Exhibit hydrogen bonding



- Can dissociate - acid character  
 $R-COOH \rightleftharpoons R-COO^- + H^+$

## Properties

### Derivatives

#### Acid chlorides

Noxious, irritating, slightly polar  
React violently with water

#### Esters

Slightly polar, pleasant odor  
Low MW species are water soluble

#### Acid anhydrides

Not as polar as acids  
May decompose in water

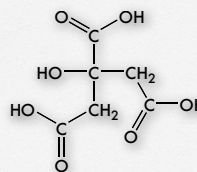
## Sources of carboxylic acids

### Natural Sources

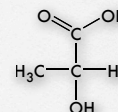
Formic acid - ants

Low MW acids - tart and citrus fruit.

Fatty acids - found in fats, milk, plant oil



citric acid

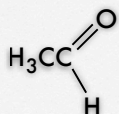
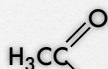
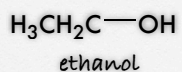


lactic acid

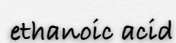
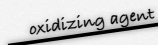
## Sources of carboxylic acids

### Industrial

Oxidation of ethanol or ethanal



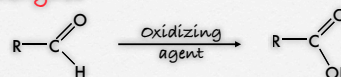
ethanal



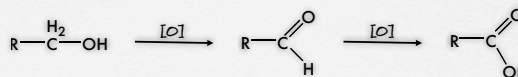
ethanoic acid

## Laboratory sources

Produced by oxidation of  
**aldehydes**



### primary alcohols



1° alcohol

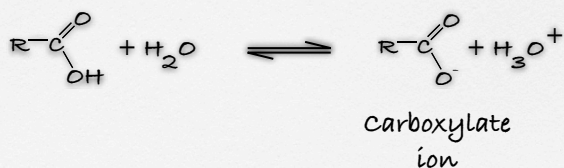
aldehyde

carboxylic acid

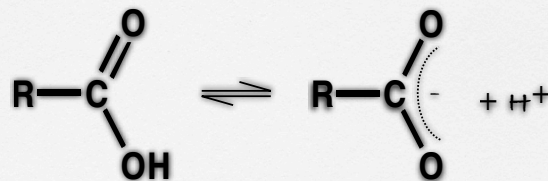
## Reactions of carboxylic acids

All are weak acids.

Dissociation in water.



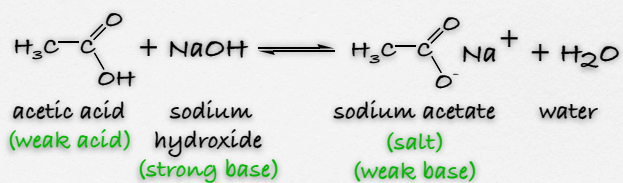
## Carboxylate ion



## Reactions of carboxylic acids

Reaction with a strong base

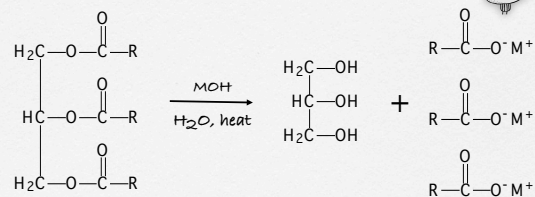
Salt formation.



## Reactions of carboxylic acids

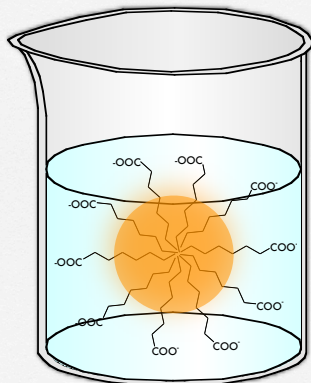
Soap formation

Produced from long-chain acids



$\text{M} = \text{Na}^+ \text{ or } \text{K}^+$

## How soap works



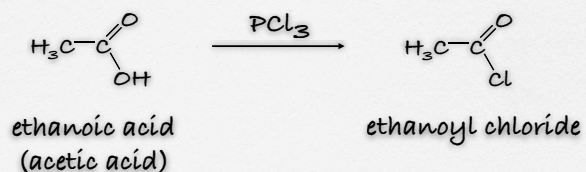
Nonpolar tail dissolves in oil.

Polar 'heads' are attracted to the water.

## Reactions of carboxylic acids

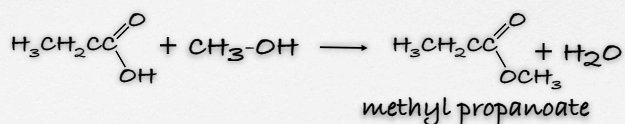
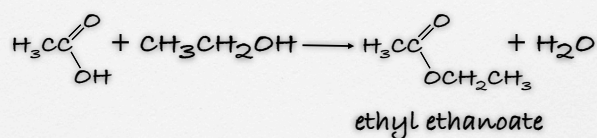
Formation of derivatives

Acid chlorides



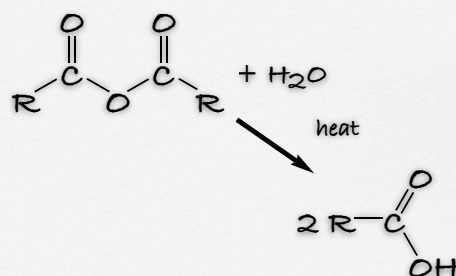
## Reactions of carboxylic acids

### Formation of Esters



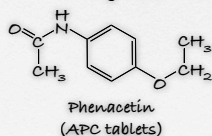
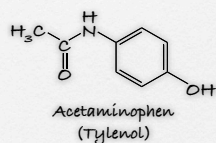
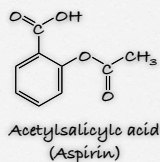
## Reactions of carboxylic acids

### Hydrolysis of acid anhydrides



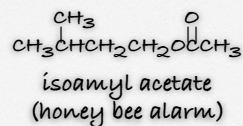
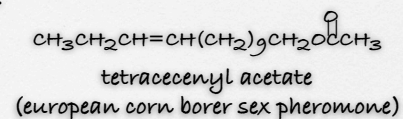
## Some significant examples

**Analgesics** - pain killers  
**Antipyretics** - fever reducers



## More examples, pheromones

**Pheromones** - chemicals secreted by animal and insects that alter the behavior of other members of the same species.



## Smelly stuff

