

1. Functional Groups

Functional Groups

There are numerous functional groups that can be found in organic compounds. Often there are more than one in complex organic compounds.

- Functional groups can be an atom, group of atoms or type of bond in an organic molecule that react in a predictable manner.
- Symbol "R" is used to represent the hydrocarbon fragment of the organic molecule.

1. Alkyl Halides (as branches)

- In general, organic compounds containing halogens are called alkyl halide (group 17) *alpha order!

Where X = F, Cl, Br, I

- The prefixes are:

F = fluoro Cl = chloro Br = bromo I = iodo

Practice #1.

1. Parent Chain.

pentane

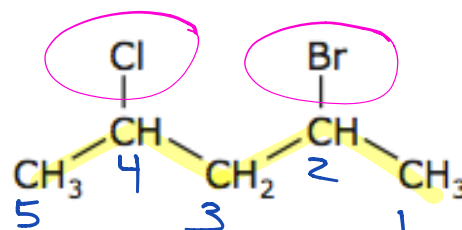
2. Number the parent chain.

3. Name the branches.

2 - bromo
4 - chloro

4. Name the compound

2-bromo-4-chloropentane



Practice #2.

1. Parent Chain.

benzene

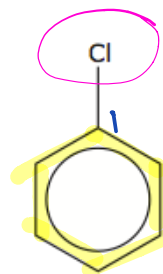
2. Number the parent chain.

3. Name the branches.

1 - chloro

4. Name the compound

1-chlorobenzene (or chlorobenzene)



2. Alcohols

- Organic compounds containing a hydroxyl (-OH) group are called alcohol

Naming alcohols:

- The parent chain **must contain the atom attached to the -OH** group. Number the carbon atoms in the parent chain so that the OH group is given the lower #
- The name of the parent chain ends with "ol" instead of "e"
- Name and identify positions of the branches.
- Name the compound

# of C Atoms	Prefix	Alcohol	Formula
1	Meth	Methanol	CH_3OH
2	Eth-	ethanol	$\text{C}_2\text{H}_5\text{OH}$
3	Prop-	propanol	$\text{C}_3\text{H}_7\text{OH}$
4	But-	butanol	$\text{C}_4\text{H}_9\text{OH}$
5	Pent-	pentanol	$\text{C}_5\text{H}_{11}\text{OH}$
6	Hex-	hexanol	$\text{C}_6\text{H}_{13}\text{OH}$
7	Hept-	heptanol	$\text{C}_7\text{H}_{15}\text{OH}$
8	Oct-	octanol	$\text{C}_8\text{H}_{17}\text{OH}$
9	Non-	nonanol	$\text{C}_9\text{H}_{19}\text{OH}$
10	Dec-	decanol	$\text{C}_{10}\text{H}_{21}\text{OH}$

Practice #1.

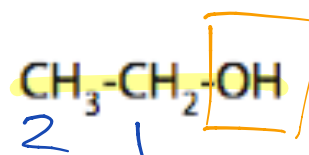
1. Parent Chain. ethanol

2. Number the parent chain.

3. Name the branches. N/A

4. Name the compound

1-ethanol (ethanol)



Practice #2.

1. Parent Chain. butanol

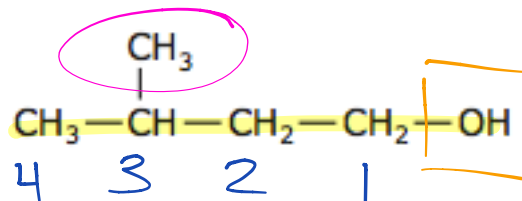
2. Number the parent chain.

3. Name the branches.

3-methyl

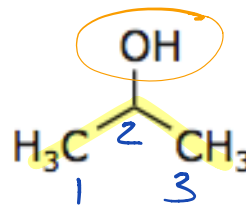
4. Name the compound

3-methyl-1-butanol



Practice #3.

1. Parent Chain. propanol
2. Number the parent chain.
3. Name the branches. N/A
4. Name the compound
2-propanol



For the following functional groups, it is expected that you can recognize them in various molecules. You will not be required to know how to name or draw them.

3. Ethers

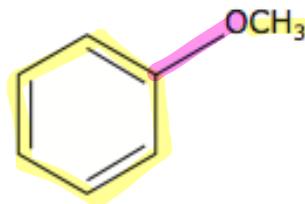
R = hydrocarbon fragment

- Two hydrocarbon fragments connected by an oxygen atom

In general..



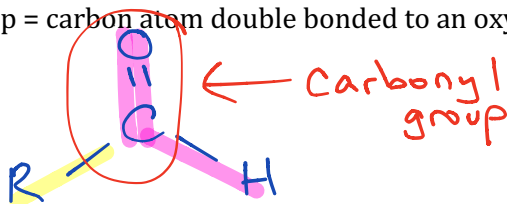
Examples:



4. Aldehydes

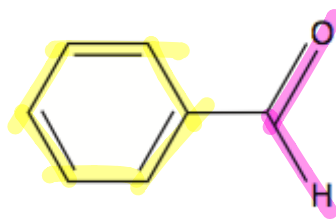
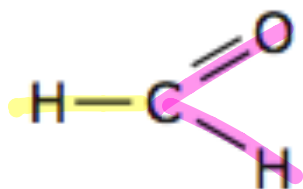
- An organic compound containing a carbon atom double bonded to an oxygen atom at the end of a carbon chain.
- Carbonyl group = carbon atom double bonded to an oxygen

In general..



Examples:

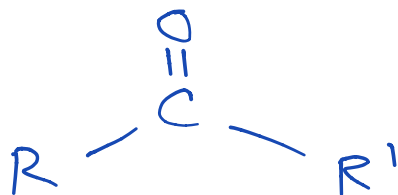
H
↓
H at the other end



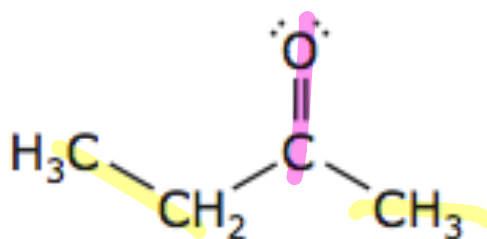
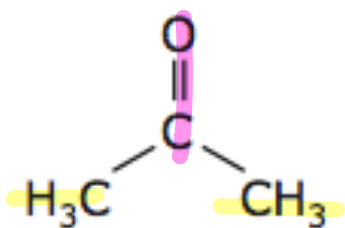
5. Ketones

- An organic compound containing a **carbon atom double bonded to an oxygen atom**
- Unlike an aldehyde, this carbonyl group is **not at the end of the carbon chain**

In general..



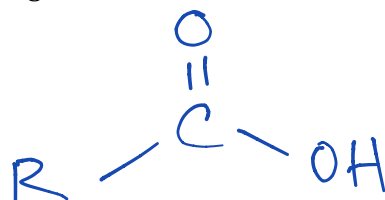
Examples:



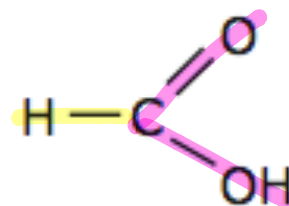
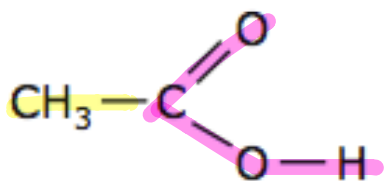
6. Carboxylic Acid

- An organic compound containing a **carboxyl group (-COOH)** and found at the end of compounds
- Sometimes called organic acids

In general..



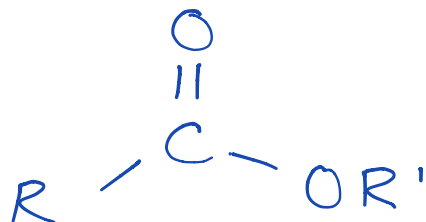
Examples:



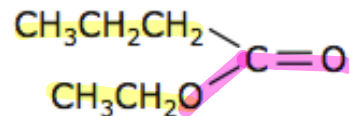
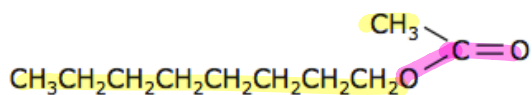
7. Esters

- An organic compound in which a **-COO-** group connects two other hydrocarbon fragments
- Strong fruity odors – used in perfumes and flavourings

In general..



Examples:



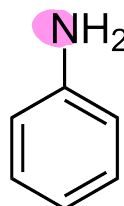
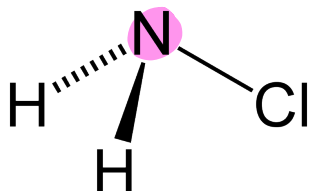
8. Amines

- An organic compound containing **only single bonds and nitrogen** atoms attached to a carbon atom

In general..



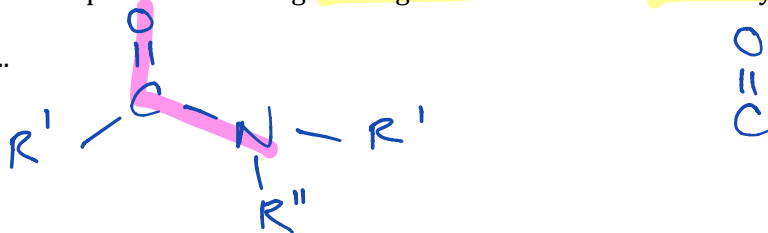
Examples:



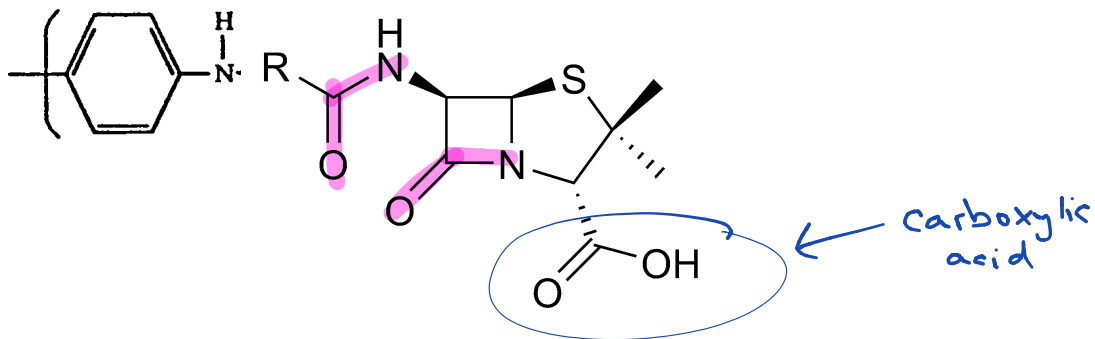
9. Amides

- An organic compound containing a **nitrogen atom** bonded to a **carbonyl group**

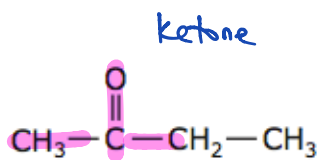
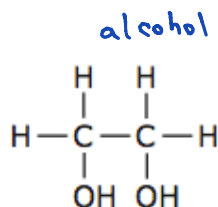
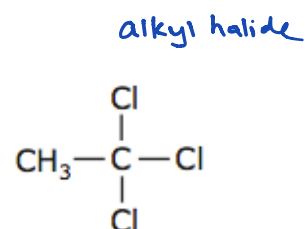
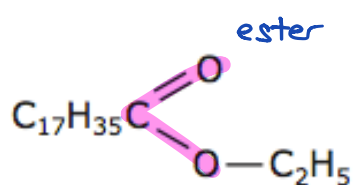
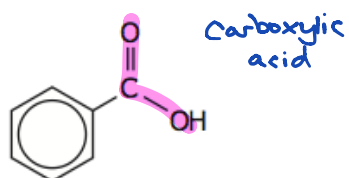
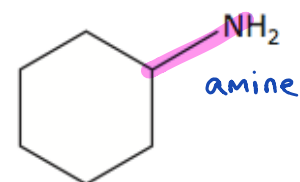
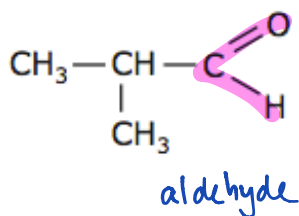
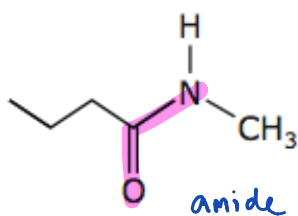
In general..



Examples:

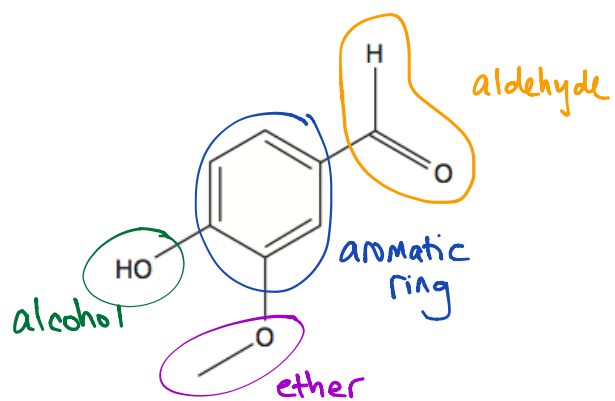


Classify the following molecules according to their functional group.

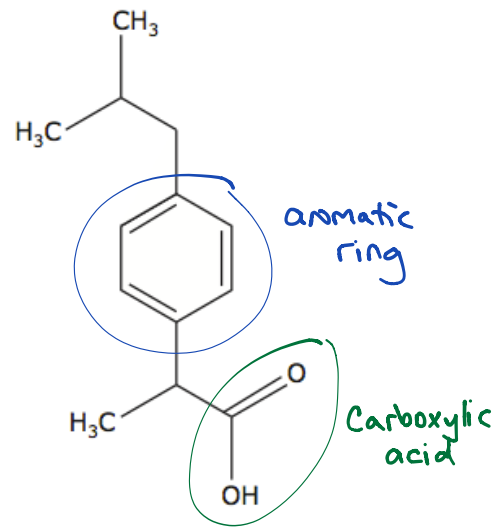


The following molecules are common organic compounds. For each molecule, circle and identify each functional group. These molecules contain more than one functional group.

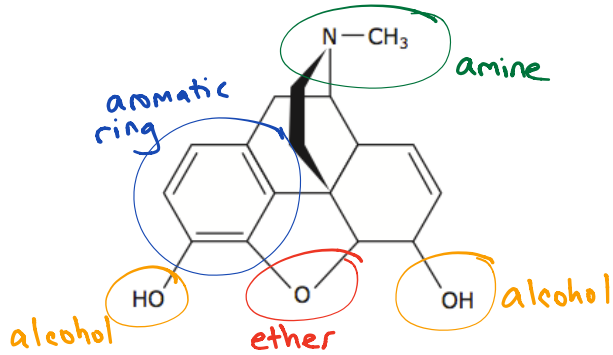
1. Vanillin (a food flavouring)



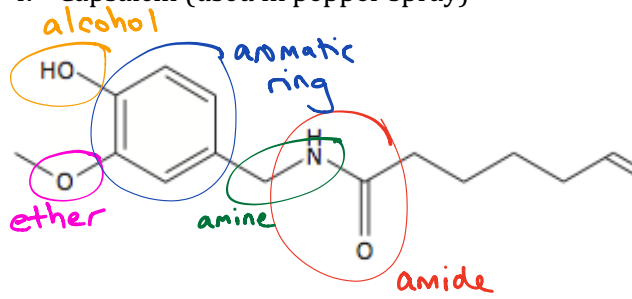
2. Ibuprofen (a painkiller)



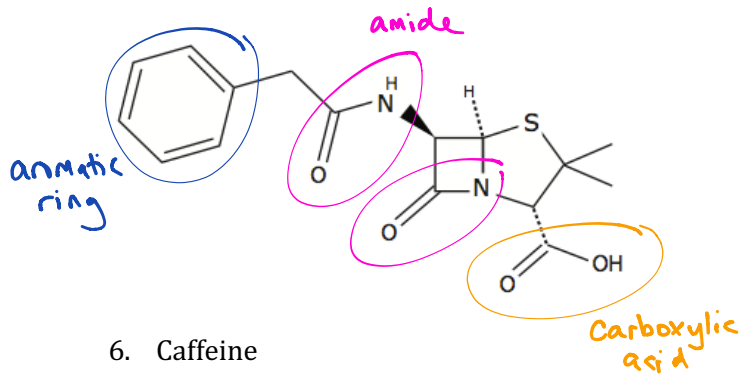
3. Morphine (a painkiller)



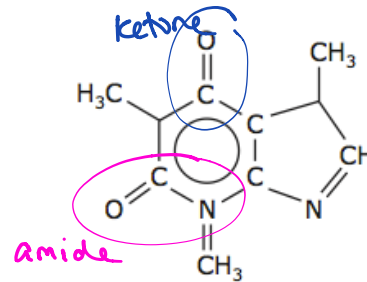
4. Capsaicin (used in pepper spray)



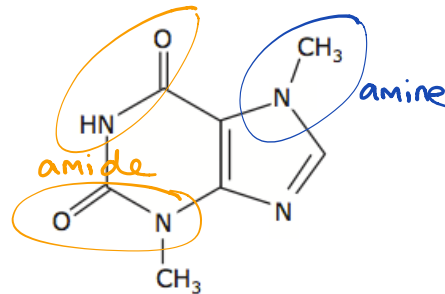
5. Penicillin G (an antibiotic)



6. Caffeine



7. Theobromine (found in chocolate)



Functional Group Summary

Table 8.2.3 summarizes what you have learned about the functional groups described in this section.

Table 8.2.3 Functional groups

Functional Group	Classification of Organic Compound
$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ -\text{C}-\text{C}- \\ \quad \\ \text{H} \quad \text{H} \end{array}$	alkane
$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ -\text{C}=\text{C}- \\ \quad \end{array}$	alkene
$-\text{C}\equiv\text{C}-$	alkyne
$\begin{array}{c} \text{H} \quad \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H}-\text{C} \quad \quad \text{C}- \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{H} \end{array}$	aromatic hydrocarbon
$\begin{array}{c} \text{X} \\ \\ -\text{C}- \\ \end{array}$	alkyl halide
$\begin{array}{c} \text{OH} \\ \\ -\text{C}- \\ \end{array}$	alcohol
$\begin{array}{c} \quad \quad \\ -\text{C}-\text{O}-\text{C}- \\ \quad \quad \end{array}$	ether
$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{H} \end{array}$	aldehyde
$\begin{array}{c} \text{O} \\ \\ -\text{C}- \end{array}$	ketone
$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OH} \end{array}$	carboxylic acid
$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{O}-\text{C}- \\ \end{array}$	ester
$\begin{array}{c} \text{NH}_2 \\ \\ -\text{C}- \\ \end{array}$	amine
$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{NH}_2 \end{array}$	amide