Organic Structures
2 - Functional Groups

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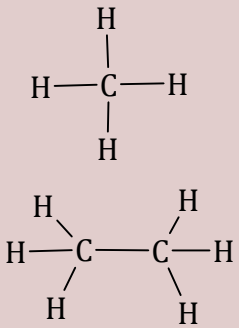
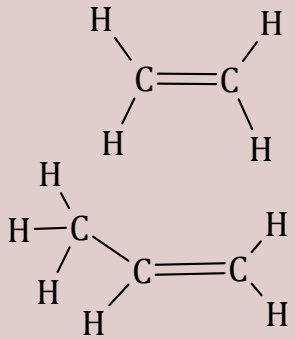
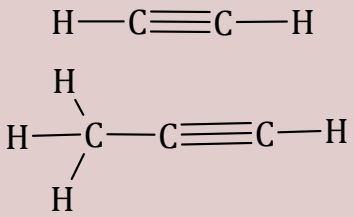
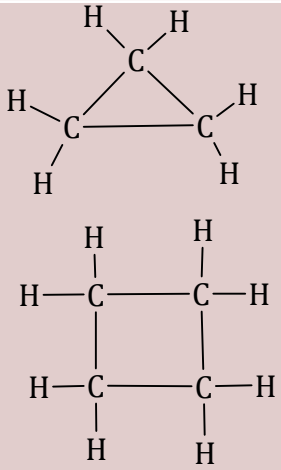
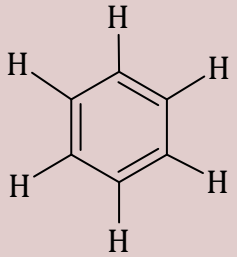
Classes of Compounds

Organic compounds have several functional groups. These groups are reactive and can be converted from one to another. All organic compounds will have carbon and hydrogen and may or not have a functional group.

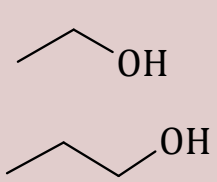
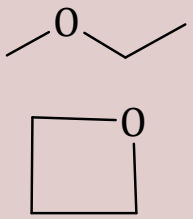
- Organic compounds are classified into these functional group. One compound can have more than one functional group.
- We will learn these functional groups in three broad classes:
  - Hydrocarbons – these just have hydrogen and carbons.
  - Compounds containing oxygen.
  - Compounds containing nitrogen.
- Organic compounds are classified also as aliphatic (straight chain) and aromatic (benzene like).
- Functional groups can be classified in "families" or homologous series. These series increase by 1 carbon to give the next compound.
- In hydrocarbons alkanes don't have a functional group and are the least reactive of all classes.

Functional Group - Hydrocarbons

Alkane	Alkene	Alkyne	Cycloalkane	Aromatic
C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}	C_nH_{2n}	
CH_4 C_2H_6 - CH_3CH_3 C_3H_8 - $CH_3CH_2CH_3$	C_2H_4 - CH_2CH_2 C_3H_6 - CH_2CHCH_3	C_2H_2 - CHCH C_3H_4 - $CHCCH_3$	C_3H_6 C_4H_8	
				
Sp^3, all single bonds, saturated	Sp^2, at least one double bond, unsaturated	Sp, at least one triple bond, unsaturated	Sp^3, all single bonds, saturated	Cyclic, has double bonds

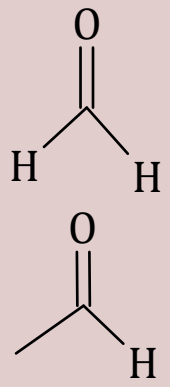
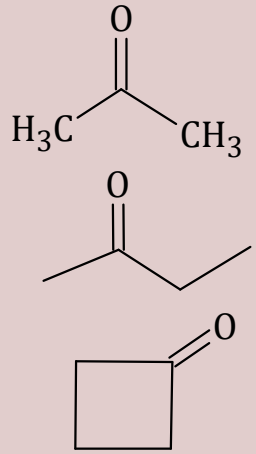
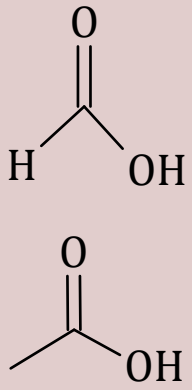
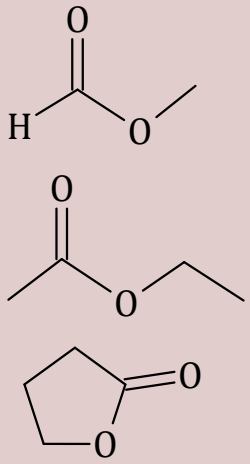
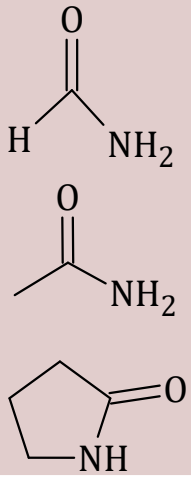
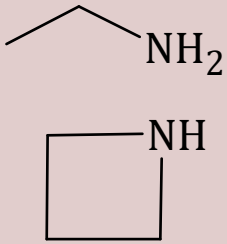
I am writing the Hs here in the structures just to make the structure clearer, but in a line structure we don't have to write Hs.

Functional Group – Halogens and Oxygen

Haloalkane	Alcohol	Ether
RX	ROH	ROR
CH_3Cl (or) CH_3Br CH_3CH_2Cl	CH_3OH CH_3CH_2OH	CH_3OCH_3 $CH_3OCH_2CH_3$
		
Sp^3, all single bonds, saturated X can be 1^o, 2^o, 3^o	OH can be 1^o, 2^o, 3^o	Ether is an internal group*; can be in a ring

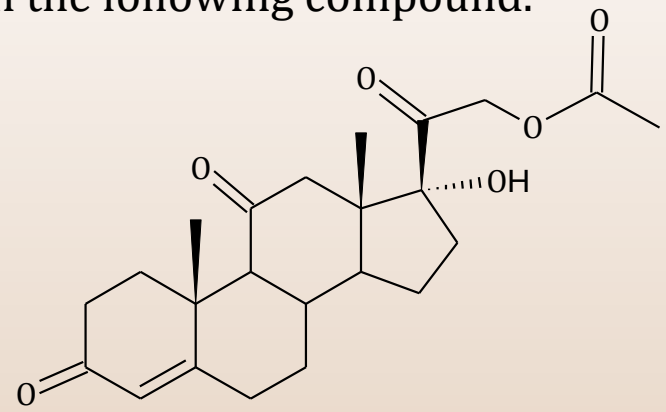
***R** group is a carbon fragment. It can be as small as one carbon or large as 6 or a ring or 12 carbons or a complicated carbon structure.*
** An internal group means a functional group in between at least two carbons.*

Functional Group – C=O and Nitrogen

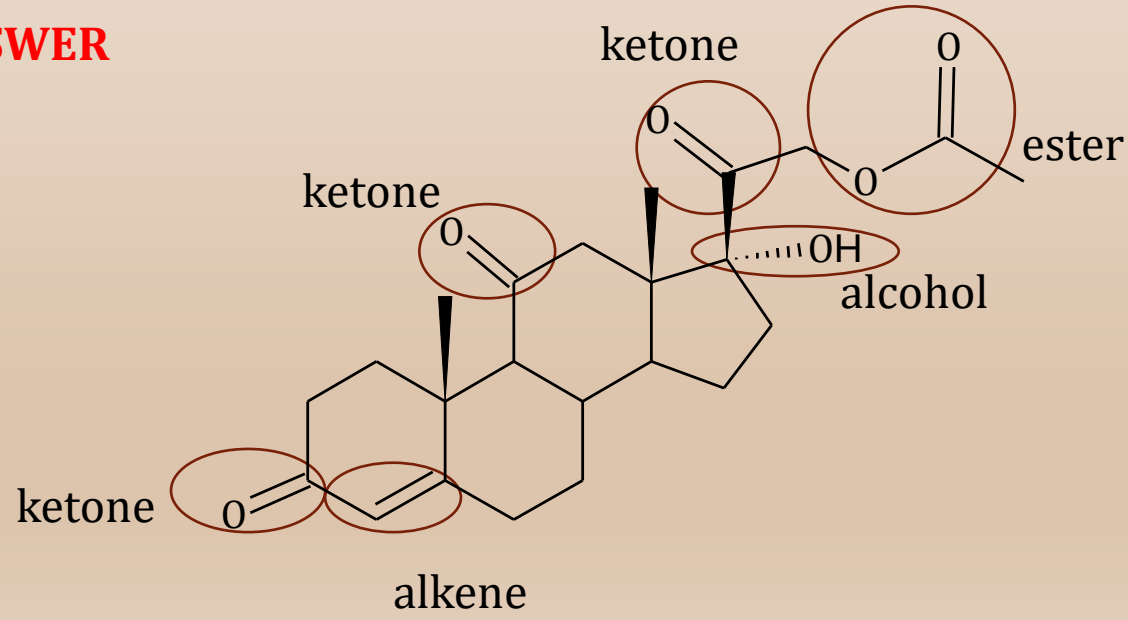
Aldehyde	Ketone	Carboxylic Acid	Carboxylic Ester	Amide	Amines
RCHO	RCOR	RCOOH	RCOOR	$RCONH_2$	RNH_2
HCHO CH_3CHO	CH_3COCH_3 $CH_3COCH_2CH_3$	HCOOH CH_3COOH CH_3CH_2COOH	$HCOOCH_3$ $CH_3COOCH_2CH_3$ $CH_3CH_2COOCH_2CH_3$	$HCONH_2$ CH_3CONH_2 $CH_3CONHCH_3$	CH_3NH_2 $CH_3CH_2NH_2$ $(CH_3)_2NH$ $(CH_3)_3N$
					
At least one C=O, CHO is terminal group	At least one C=O, CO group is internal; can be in a ring	At least one COOH; COOH group is terminal	Esters are internal groups; can be in a ring	At least one CON; CON is internal group; can be in a ring	N is sp^3; N can be 1^o, 2^o, 3^o ; amine can be terminal or internal group

Solved Example: Identifying functional groups

Circle and name all the functional groups in the following compound.



ANSWER



Key Words/Concepts

Functional Groups

- Alkanes
- Alkenes
- Alkynes
- Haloalkanes
- Aromatics
- Alcohols
- Ethers
- Aldehydes
- Ketones
- Carboxylic acids
- Carboxylic esters
- Amides
- Amines