Functional Groups

**functional group:** an atom, or group of atoms (with specific connectivity), exhibiting identical chemical reactivity regardless of the molecule containing it; the reactivity of individual functional groups dictates the reactivity of the molecule of which they are a part

- divide organic compounds into classes
- sites of characteristic chemical reactions
- serve as basis for naming organic compounds

A. Alkanes

- contain only carbon-carbon and carbon-hydrogen single bonds

\[
\begin{align*}
  & \text{H} - \text{H} - \text{H} \\
  & \text{H} - \text{C} - \text{C} - \text{H} \\
  & \text{H} - \text{H} - \text{H} \\
\end{align*}
\]

Lewis structure  \hspace{1cm} \text{condensed structural formula}  \hspace{1cm} \text{fully condensed structural formula}

B. Alkenes

- contain a carbon-carbon double bond

\[
\begin{align*}
  & \text{H} - \text{C} = \text{C} - \text{H} \\
  & \text{H} - \text{H} \\
\end{align*}
\]

Lewis structure  \hspace{1cm} \text{condensed structural formula}  \hspace{1cm} \text{fully condensed structural formula}

C. Alkynes

- contain a carbon-carbon triple bond

\[
\begin{align*}
  & \text{H} - \text{C} = \text{C} - \text{H} \\
\end{align*}
\]

Lewis structure  \hspace{1cm} \text{condensed structural formula}  \hspace{1cm} \text{fully condensed structural formula}
D. Arenes

- contain a benzene group

\[
\begin{array}{c}
\text{H} \\
\text{H}_2\text{C-C-C-H} \\
\text{H}_2\text{C-C-C-H} \\
\text{H}
\end{array}
\]

benzene

E. Alcohols

- contain an \(-\text{OH} \text{ (“hydroxyl”) \ group bonded to a tetrahedral carbon atom}

\[
\begin{array}{ccc}
\text{H} & \text{H} & \text{H} \\
\text{H} & \text{C-C-OH} & \text{CH}_3-\text{CH}_2-\text{OH} & \text{CH}_3\text{CH}_2\text{OH} \\
\text{H} & \text{H} & \text{H}
\end{array}
\]

Lewis structure  condensation structural formula  fully condensed structural formula

a primary (1\(^\circ\)) alcohol  a secondary (2\(^\circ\)) alcohol  a tertiary (3\(^\circ\)) alcohol

F. Ethers

- contain an oxygen atom bonded to two carbon atom groups by single bonds

\[
\begin{array}{ccc}
\text{H} & \text{H} & \text{H} \\
\text{H} & \text{C-O-C-H} & \text{CH}_3-\text{O-CH}_3 & \text{CH}_3\text{OCH}_3 \\
\text{H} & \text{H} & \text{H}
\end{array}
\]

Lewis structure  condensation structural formula  fully condensed structural formula
G. Amines

- contain an “amino” group – a N atom bonded to 1, 2, or 3 carbon atom groups by single bonds

[Chemical structures of primary, secondary, and tertiary amines]

H. Aldehydes and Ketones

- contain a C=O (“carbonyl”) group

[Chemical structures of aldehydes and ketones, with notes on the placement of hydrogen atoms]

- note that in condensed structural formulas, the aldehyde group may be written as –CH=O or as –CHO

I. Carboxylic Acids

- contain a “carboxylic acid” group – a carbonyl (C=O) group bonded to a hydroxyl group at the carbonyl carbon atom

[Chemical structure of a carboxylic acid]

- note that in condensed structural formulas, the carboxylic acid group may be written as –COOH
J. Carboxylic Amides (Amides)

- contain an “amide” group – a carboxylic acid (-COOH) group where the -OH group is replaced with an amine

![Diagram of amides]

K. Carboxylic Esters (Esters)

- contain an “ester” group – a carboxylic acid (-COOH) group where the H atom is replaced with a carbon containing group

![Diagram of ester]

L. Carboxylic Anhydrides (Anhydrides)

- contain an “anhydride” group – an oxygen atom bonded to two C=O (“carbonyl”) groups

![Diagram of anhydrides]

M. Nitriles

- contain a “cyano” group (C≡N) bonded to a carbon atom group (i.e., at the carbon atom of the cyano group)

![Diagram of nitrile]