

ORGANIC CHEMISTRY

FUNDAMENTALS

Types of Organic Compounds

Organic chemistry is the study of natural and synthetic materials that have carbon atoms as the key chemical feature. There are more than one million known organic compounds.

HYDROCARBON

ALKANE
 $\text{C}-\text{H}$
 $\text{C}-\text{C}$
 • Ethane: C_2H_6
 • Methyl (Me): $-\text{CH}_3$
 • Ethyl (Ety): $-\text{C}_2\text{H}_5$

ALKENE

• Ethene: C_2H_4
 • Diene: Two $\text{C}=\text{C}$
 • Triene: Three $\text{C}=\text{C}$

ALKYNE

• Ethyne: C_2H_2

AROMATIC

• Benzene: C_6H_6
 • Aroclor: C_6H_5 (Ar)

-O- ADDED

ALCOHOL

• Methanol: $\text{Me}-\text{OH}$ (methyl alcohol)
 • Phenol: $\text{Ar}-\text{OH}$
 • Diol/Glycol: (2 $-\text{OH}$)
 • Glycerol: (3 $-\text{OH}$)

ETHER

• Ethoxyethane: $\text{Et}-\text{O}-\text{Et}$ (diethyl ether)
 • Di-O-Et (diethyl ether)

EPOXY

• Oxirane: $\text{C}_2\text{H}_4\text{O}$ (ethylene oxide)

PEROXIDE

• Acetone Peroxide: $\text{C}_4\text{H}_8\text{O}_5$

• Benzoyl Peroxide: $\text{C}_{14}\text{H}_{18}\text{O}_5$

>C=O ADDED

ALDEHYDE

• Methanal: H_2CO (formaldehyde)
 • Benzaldehyde: $\text{Ar}-\text{CHO}$

KETONE

• 2-propanone: $\text{Me}-\text{CO}-\text{Me}$ (dimethyl ketone, acetone)
 • Diketone: $\text{R}-\text{CO}-\text{R}'-\text{CO}-\text{R}''$

>COO ADDED

CARBOXYLIC ACID

• Ethanoic Acid: $\text{Me}-\text{COOH}$ (acetic acid)
 • Acetate Ion: $\text{Me}-\text{COO}^-$
 • Benzoic Acid: $\text{Ar}-\text{COOH}$

Dicarboxylic Acid

• $\text{HOOC}-\text{R}-\text{COOH}$

ESTER

• Ethyl Acetate: $\text{Me}-\text{CO}-\text{OEt}$
 Other derivatives:
 • Peroxyacid: $\text{R}-\text{CO}-\text{OOH}$
 • Acid Anhydrides: $\text{RCO}-\text{O}-\text{CO}-\text{R}'$

NITROGEN ADDED

AMINE

• Methyl Amine: $\text{H}_3\text{C}-\text{NH}_2$
 • Phenyl amine: $\text{Ar}-\text{NH}_2$ (aniline)
 • $\text{R}-\text{NH}_2$ (1°), $\text{RR}'\text{NH}$ (2°), $\text{RR}'\text{R}''\text{N}$ (3°)

NITRO

$\text{R}-\text{NO}_2$

DIAZO

$\text{R}-\text{N}=\text{N}$

NITRILE

$\text{R}-\text{C}\equiv\text{N}$

• Methane Nitrile: $\text{Me}-\text{CN}$

AMIDE

• Acetamide: $\text{Me}-\text{CO}-\text{NH}_2$

SULFUR ADDED

• Thiol: $\text{R}-\text{SH}$
 • Thioether: $\text{R}-\text{S}-\text{R}'$
 • Disulfide: $\text{R}-\text{S}-\text{S}-\text{R}'$
 • Thio Ester: $\text{R}-\text{CO}-\text{SR}'$
 • Sulfide: $\text{R}-\text{SO}-\text{R}'$
 • Sulfone: $\text{R}-\text{SO}_2-\text{R}'$
 • Sulfonic Acids: $\text{R}-\text{SO}_3\text{H}$

HALOGEN ADDED

• Haloalkane: $\text{Me}-\text{Cl}$ chloromethane
 • Halohydrate: $\text{Ar}-\text{X}$
 • Chloroalkane: $\text{Ar}-\text{Cl}$
 • Acyl Halide: $\text{R}-\text{CO}-\text{X}$
 • Aryl Halide: $\text{Ar}-\text{X}$

Formulas & Isomers

- Molecular Formula:** Elemental symbols with subscripts denote the composition of a compound
- Empirical Formula:** Subscripts denote the relative elemental composition
- Graphical depiction**
 - Dash Formula:** Diagram all atoms, show bonds as dashes
 - Bond-Line Formula:** Hide H; carbon atoms are depicted as lines, but other atoms are shown explicitly



- Newman Projection:** 2-d depiction
- 3-dimensional:** Wedges of same bond denote structure

SUBDIVISIONS OF ISOMERS



- Constitutional Isomers:** Different bonding connectivity (e.g., rings, bonds, branching, substituent positions)
- Tautomers:** Easily interconverted structural isomers (e.g., keto-enol for ketones)
- Chiral:** Not identical with its mirror image
- Achiral:** Has a plane of symmetry (i.e., superimposable on its mirror image)
- Epimers:** Pair of diastereomers which differ only in the configuration of one atom
- More than 1 chiral center
 - n chiral centers, $\leq 2^n$ stereoisomers
 - Meso: 2 chiral centers, 4 isomers: 3 stereoisomers, 1 achiral (mirror-plane)

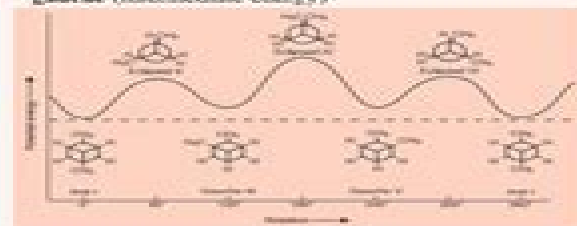


- R/S Notation:** The 4 different atoms or groups attached to a central atom are ranked (a), (b), (c), and (d), by molar mass. The lowest (d) is directed away from the viewer and the sequence of a-b-c produces clockwise (R) or counter-clockwise (S) configuration
- Chiral (Optically Active):** + or - the rotation of plane polarized light, R/S: opposite effects

- Racemic:** 50/50 mixture of stereoisomers (no net optical activity)
- Nomenclature:** Note R/S and +/- in the compound name (e.g., R (+) bromochloromethanol)
- Fischer-Projection:** Diagram depicts chiral/3-D structure
- Molecular Conformations:** Molecule exhibits structural variation due to free rotation about C-C single bond



- Newman Diagram:** Depict rotation about a C-C bond; eclipsed (high energy), anti (low energy), and gauche (intermediate energy)



Common Terms

Aliphatic: Non-aromatic
Aromatic: Benzene ring
Conjugation: Sequence of alternating double (or triple) and single bonds
Dielectric Effect: Polar solvent stabilizes ion formation
Exergonic Reaction: Chemical reaction

that loses energy during the process of the reaction
Heterocyclic: Non-carbon atom in the ring structure
Hydrocarbon: Compound of H and C
Ketone: Molecule made up of a monosaccharide bonded to a ketone

Monosaccharide: Carbohydrate that cannot be reduced by hydrolysis into another simple sugar
Olefin: Alkene
Paraffin: Alkane
Radioisotope: Isotope that is radioactive

Saturated: Maximum # of Hs (all C-C single bonds)
Tetrose: Monosaccharide with four carbon atoms
Unsaturated: At least one C-C multiple bond
Zymology: The study of the process of fermentation

Organic Chemistry Fundamentals Study Guide

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