

### TYPES OF ORGANIC COMPOUNDS

HYDROCARBON	O-ADDED	>C=O ADDED	>COO ADDED	NITROGEN ADDED	SULFUR ADDED
<b>ALKANE</b> $\text{C}-\text{C}$ <ul style="list-style-type: none"> <li>ethane: <math>\text{C}_2\text{H}_6</math></li> <li>methyl (Me): <math>-\text{CH}_3</math></li> <li>ethyl (Et): <math>-\text{C}_2\text{H}_5</math></li> </ul> <b>ALKENE</b> $\text{C}=\text{C}$ <ul style="list-style-type: none"> <li>ethene: <math>\text{C}_2\text{H}_4</math></li> <li>diene: two <math>\text{C}=\text{C}</math></li> <li>triene: three <math>\text{C}=\text{C}</math></li> </ul> <b>ALKYNE</b> $\text{C}\equiv\text{C}$ <ul style="list-style-type: none"> <li>ethyne: <math>\text{C}_2\text{H}_2</math></li> </ul> <b>AROMATIC</b> <ul style="list-style-type: none"> <li>benzene: <math>\text{C}_6\text{H}_6</math></li> <li>aromatic: <math>\text{C}_6\text{H}_5</math> (Ar-)</li> </ul>	<b>ALCOHOL</b> $\text{C}-\text{OH}$ <ul style="list-style-type: none"> <li>methanol: <math>\text{Me}-\text{OH}</math> (methyl alcohol)</li> <li>phenol: <math>\text{Ar}-\text{OH}</math></li> <li>diol/glycol: (2 -OH)</li> <li>glycerol: (3 -OH)</li> </ul> <b>ETHER</b> $\text{R}-\text{O}-\text{R}$ <ul style="list-style-type: none"> <li>ethoxyethane: <math>\text{Et}-\text{O}-\text{Et}</math> (diethyl ether)</li> </ul> <b>EPOXY</b> <ul style="list-style-type: none"> <li>cyclic ether</li> </ul> <b>PEROXIDE</b> $\text{R}-\text{O}-\text{O}-\text{R}'$	<b>ALDEHYDE</b> <ul style="list-style-type: none"> <li>methanal: <math>\text{H}_2\text{CO}</math> (formaldehyde)</li> <li>hexaldehyde: <math>\text{Ar}-\text{CHO}</math></li> </ul> <b>KETONE</b> <ul style="list-style-type: none"> <li>2-propanone: <math>\text{Me}-\text{CO}-\text{Me}</math> (dimethyl ketone, acetone)</li> <li>diketone: <math>\text{R}-\text{CO}-\text{R}'-\text{CO}-\text{R}''</math></li> </ul>	<b>CARBOXYLIC ACID</b> <ul style="list-style-type: none"> <li>ethanoic acid: <math>\text{Me}-\text{COOH}</math> (acetic acid)</li> <li>acetic acid: <math>\text{Me}-\text{COOH}</math></li> <li>benzoic acid: <math>\text{Ar}-\text{COOH}</math></li> </ul> <b>Dicarboxylic acid</b> $\text{HOOC}-\text{R}-\text{COOH}$ <b>ESTER</b> <ul style="list-style-type: none"> <li>ethyl acetate: <math>\text{Me}-\text{CO}-\text{OEt}</math></li> </ul> <b>Other derivatives:</b> <ul style="list-style-type: none"> <li>Amide: <math>\text{R}-\text{CO}-\text{NH}_2</math></li> <li>Acid anhydride: <math>\text{RCO}-\text{O}-\text{CO}-\text{R}'</math></li> </ul>	<b>AMINE</b> <ul style="list-style-type: none"> <li>methyl amine: <math>\text{H}_3\text{C}-\text{NH}_2</math></li> <li>phenyl amine: <math>\text{Ar}-\text{NH}_2</math> (aniline)</li> <li><math>\text{R}-\text{NH}_2</math> (1°), <math>\text{RR}'\text{NH}</math> (2°), <math>\text{RRR}''\text{N}</math> (3°)</li> </ul> <b>NITRO</b> $\text{R}-\text{NO}_2$ <b>DIAZO</b> $\text{R}-\text{N}=\text{N}$ <b>NITRILE</b> $\text{R}-\text{C}\equiv\text{N}$ <ul style="list-style-type: none"> <li>methane nitrile: <math>\text{Me}-\text{CN}</math></li> </ul> <b>AMIDE</b> <ul style="list-style-type: none"> <li>acetamide: <math>\text{Me}-\text{CO}-\text{NH}_2</math></li> </ul>	<ul style="list-style-type: none"> <li>thiol: <math>\text{R}-\text{SH}</math></li> <li>thioether: <math>\text{R}-\text{S}-\text{R}'</math></li> <li>disulfide: <math>\text{R}-\text{S}-\text{S}-\text{R}'</math></li> <li>thiol ester: <math>\text{R}-\text{CO}-\text{SR}'</math></li> <li>sulfide: <math>\text{R}-\text{SO}-\text{R}'</math></li> <li>sulfone: <math>\text{R}-\text{SO}_2-\text{R}'</math></li> <li>sulfonic acid: <math>\text{R}-\text{SO}_3\text{H}</math></li> </ul> <b>HALOGEN ADDED</b> <ul style="list-style-type: none"> <li>haloalkane: <math>\text{R}-\text{X}</math> (Me-Cl chloromethane)</li> <li>halobenzene: <math>\text{Ar}-\text{X}</math> (chlorobenzene: <math>\text{Ar}-\text{Cl}</math>)</li> <li>acyl halide: <math>\text{R}-\text{CO}-\text{X}</math></li> <li>aryl halide: <math>\text{Ar}-\text{X}</math></li> </ul>

### FORMULAS AND ISOMERS

**Molecular formula:** Elemental symbols with subscripts denote the composition of a compound  
**Empirical formula:** Subscripts denote the relative elemental composition

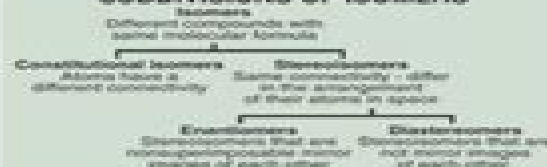
#### Graphical depiction:

- Dash formula:** Diagram all atoms, bonds as dashes
- Bond line formula:** Hide H, show carbon skeleton as lines, other atoms explicit



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

#### SUBDIVISIONS OF ISOMERS



**constitutional isomers:** different bonding connectivity (ex. rings, bonds, branching, substituent positions)  
**tautomers:** easily interconverted structural isomers (ex. keto-enol for ketones)

**chiral:** not identical with mirror image

**achiral:** has plane of symmetry (superimposable on mirror-image)

**epimers:** a pair of diastereomers which differ only in the configuration of one atom

#### More than 1 chiral center:

- $n$  chiral centers,  $2^n$  stereoisomers
- meso:** two chiral centers, 4 isomers: 3 stereoisomers, 1 achiral (mirror-plane)

### FORMULAS AND ISOMERS



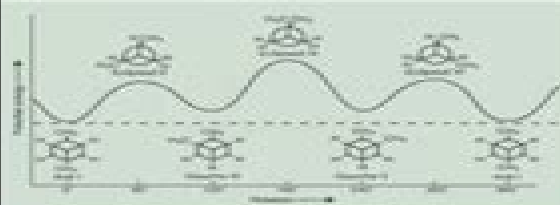
**R/S notation:** The four different atoms or groups attached to a central atom are ranked a,b,c,d, by molar mass. The lowest (d) is directed away from the viewer and the sequence of a-b-c produces clockwise (R) or counter-clockwise (S) configuration.

- chiral (optically active):** + or - 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; example: 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), gauche (intermediate energy).



### COMMON TERMS

**aliphatic:** non-aromatic  
**aromatic:** benzene ring  
**heterocyclic:** non-carbon atom in the ring structure  
**hydrocarbon:** compound of H and C  
**paraffin:** alkane  
**olefin:** alkene  
**saturated:** maximum # of H's (all C-C single bonds)  
**unsaturated:** at least one C-C multiple bond

### NOMENCLATURE

**IUPAC - standard guidelines for naming compounds.**  
**Nomenclature Strategy -** find longest carbon chain, identify and note location of functional groups and substituents by chain position number.

**Classes of compounds** are defined by the functional group. There are many common names and functional group names. Multiple names are possible.

#### CARBON CHAIN PREFIXES

Ends	Ends	Ends
1	methyl	methyl
2	ethyl	ethyl
3	propyl	propyl
4	butyl	butyl
5	pentyl	pentyl
6	hexyl	hexyl
7	heptyl	heptyl
8	octyl	octyl
9	nonyl	nonyl
10	decyl	decyl

**cyclo-** ring structure; example: cyclopentane 3-carbon ring molecule

**iso-** two methyl groups on the

**terminal** of a chain

**n-** normal straight chain

**i-** tertiary alkyl group

**vic** (vicinally) two substituents

on adjacent carbons

**gem** (geminally) two substituents

on the same carbon

**alkene isomers:** cis or trans

**benzene substitution positions:**

ortho (1,2), meta (1,3), para (1,4)

#### Carbon Position



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**Zhe Xu**



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## **Table of Contents Organic Chemistry Study Cards 3**

1. Understanding the eBook Organic Chemistry Study Cards 3
  - The Rise of Digital Reading Organic Chemistry Study Cards 3
  - Advantages of eBooks Over Traditional Books
2. Identifying Organic Chemistry Study Cards 3
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Organic Chemistry Study Cards 3
  - User-Friendly Interface
4. Exploring eBook Recommendations from Organic Chemistry Study Cards 3
  - Personalized Recommendations
  - Organic Chemistry Study Cards 3 User Reviews and Ratings
  - Organic Chemistry Study Cards 3 and Bestseller Lists
5. Accessing Organic Chemistry Study Cards 3 Free and Paid eBooks
  - Organic Chemistry Study Cards 3 Public Domain eBooks
  - Organic Chemistry Study Cards 3 eBook Subscription Services
  - Organic Chemistry Study Cards 3 Budget-Friendly Options
6. Navigating Organic Chemistry Study Cards 3 eBook Formats

- ePub, PDF, MOBI, and More
- Organic Chemistry Study Cards 3 Compatibility with Devices
- Organic Chemistry Study Cards 3 Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Organic Chemistry Study Cards 3
  - Highlighting and Note-Taking Organic Chemistry Study Cards 3
  - Interactive Elements Organic Chemistry Study Cards 3
- 8. Staying Engaged with Organic Chemistry Study Cards 3
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Organic Chemistry Study Cards 3
- 9. Balancing eBooks and Physical Books Organic Chemistry Study Cards 3
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Organic Chemistry Study Cards 3
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Organic Chemistry Study Cards 3
  - Setting Reading Goals Organic Chemistry Study Cards 3
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Organic Chemistry Study Cards 3
  - Fact-Checking eBook Content of Organic Chemistry Study Cards 3
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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