

# School of Basic and Applied Sciences

Course Code : BSCC2001

Course Name: Organic Chemistry I

## BSCC2001 (ORGANIC CHEMISTRY I)

### Course Objectives:

The course develop a sound knowledge on Organic Chemistry. In this course to establish the applications of these concepts, the functional groups- alkanes, alkenes, alkynes and aromatic hydrocarbons- are introduced and the chemistry of these compounds will be explained with the help of various mechanism, reactions, energy diagrams and rules. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

### Course Outcomes

CO1	Explain the basics of organic compounds and various reaction involved in organic chemistry (K2)
CO2	Develop skills to illustrate various stereochemical processes, projections, optical isomerism and nomenclature. (K3)
CO3	Identify the chemistry and reactions of aliphatic hydrocarbons. (K3)
CO4	Apply the basic understanding in conformational analysis of alkanes and cyclohexane. (K3)
CO5	Simplify basic principles and different chemical reactions of aromatic compounds. (K4)
CO6	Elaborate the knowledge of recent advancement in the field of organic chemistry. (K6)

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<b>Unit-1: Basics of Organic Chemistry</b>	<b>10 hrs</b>
<i>Organic Compounds:</i> Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. <i>Electronic Displacements:</i> Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.	
<b>Unit-2: Stereochemistry</b>	<b>10 hrs</b>
Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules. <i>Optical Isomerism:</i> Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.	
<b>Unit-3: Chemistry of Aliphatic Hydrocarbons-I</b>	<b>10 hrs</b>
<b>A. Carbon-Carbon sigma bonds</b> Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.	
<b>B. Carbon-Carbon pi bonds:</b> Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. <i>Reactions of alkenes:</i> Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration- oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. <i>Reactions of alkynes:</i> Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.	

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<b>Unit-4: Chemistry of Aliphatic Hydrocarbons-I</b>	<b>8 hrs</b>
<b>Cycloalkanes and Conformational Analysis</b> Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.	
<b>Unit-5:Aromatic Hydrocarbon</b>	<b>8 hrs</b>
<b>Aromaticity:</b> Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.	
<b>Unit-6: Recent Advancement in Organic Chemistry</b>	<b>4 hrs</b>
Sustainable and Green Chemical reactions with applications	

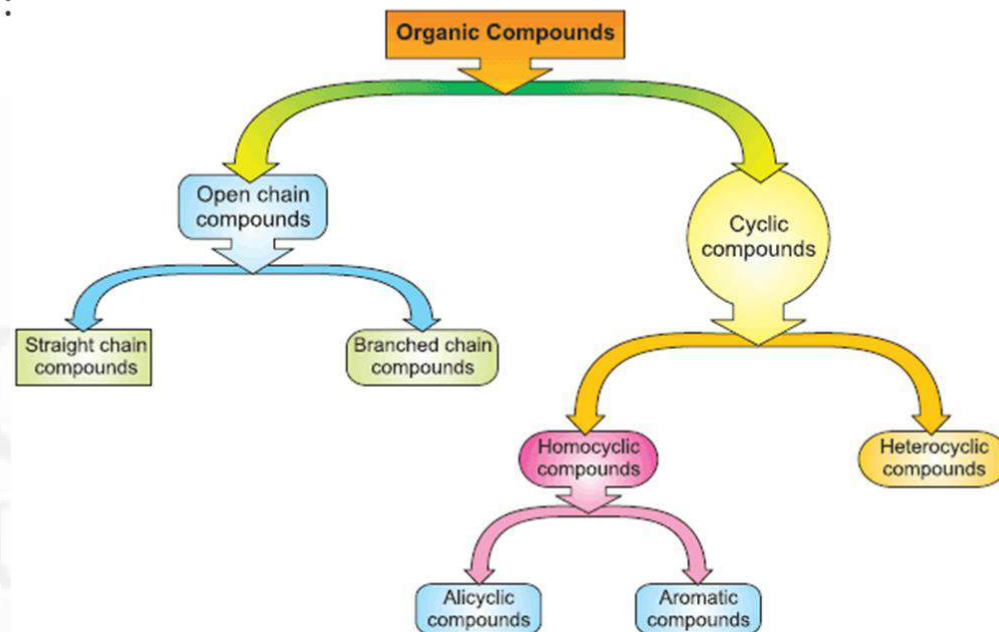
## Topics to be discussed

- *Organic Compounds*
- *Classification of Organic Compounds*
- *Nomenclature of Organic compounds*

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## What are Organic Compounds?

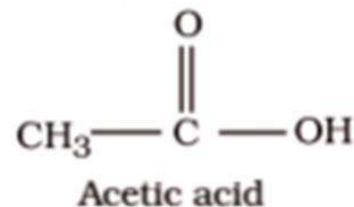
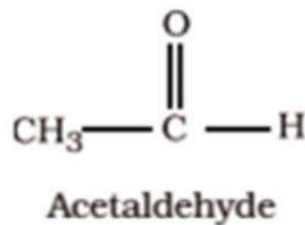
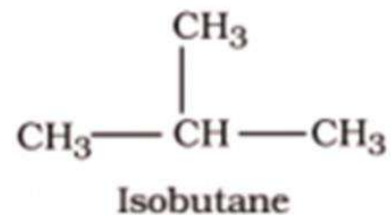
The compounds in solid, liquid or gaseous state which contain carbon in its molecule are known as organic compounds. There are a large number of organic compounds and therefore a proper systematic classification was required. Organic compounds can be broadly classified as acyclic (open chain) or cyclic (closed chain). Moving on to their classification in detail:



## 1. Acyclic or Open Chain Compounds

These compounds are also known as aliphatic compounds, they have branched or straight chains. Following are the examples in this category.

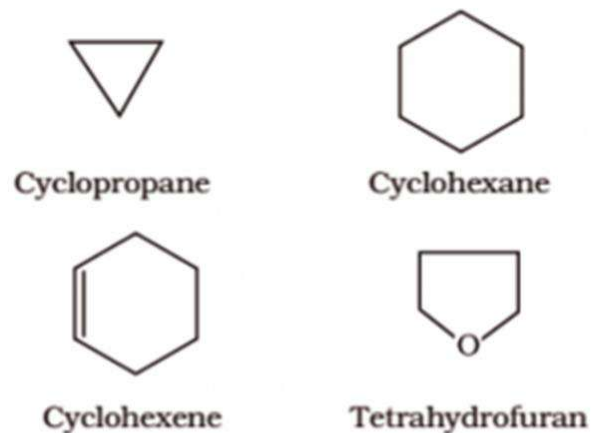
Examples of Acyclic or open chain compounds





## 2. Alicyclic or Closed Chain or Ring Compounds

- These are cyclic compounds which contain carbon atoms connected to each other in a ring (homocyclic). When atoms other than carbon are also present then it is called as heterocyclic.
- Examples of this type are as follows:



Examples of Alicyclic or closed chain or ring compounds

- They exhibit some properties similar to aliphatic compounds.

## 3. Aromatic Compounds

➤ They are a special type of compounds which contain benzene and other ring related compounds. Similar to alicyclic, they can also have heteroatoms in the ring. Such compounds are called heterocyclic aromatic compounds.

➤ Some of the examples are as follows:

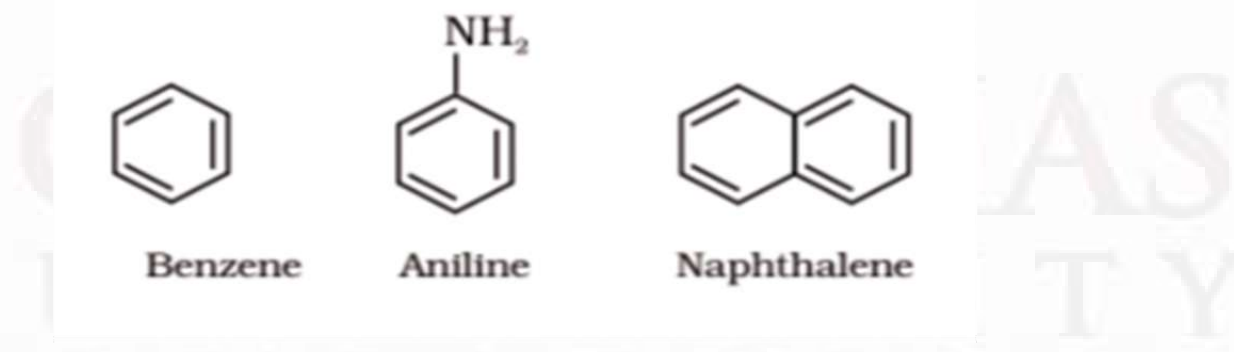
(a) Benzenoid aromatic compounds

(b) Non-benzenoid aromatic compounds



## Benzenoid aromatic compound

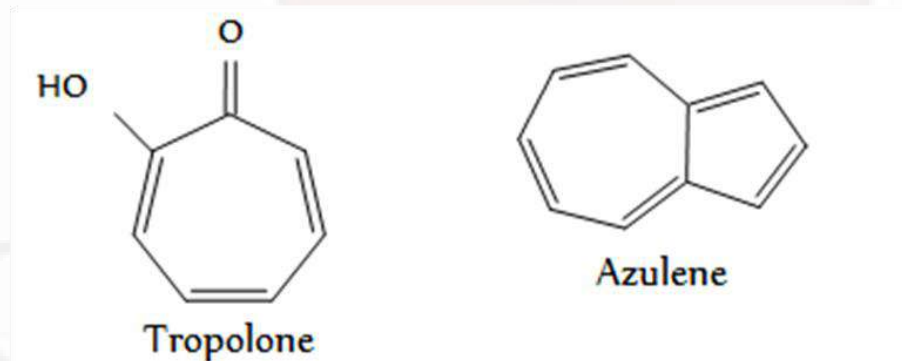
- They are characterized by the presence of one or more fused or isolated benzene rings as well as their derivatives in their structure.
- Depending upon the number of benzene rings that are fused together in their structure, they can be further classified as Monocyclic, Bicyclic, Tricyclic.



Examples of Aromatic compounds

## Non-benzenoid aromatic compounds

- There are aromatic compounds, which have structural units different from benzenoid type and are known as Non-benzenoid aromatics e.g. Tropolone, azulene etc..

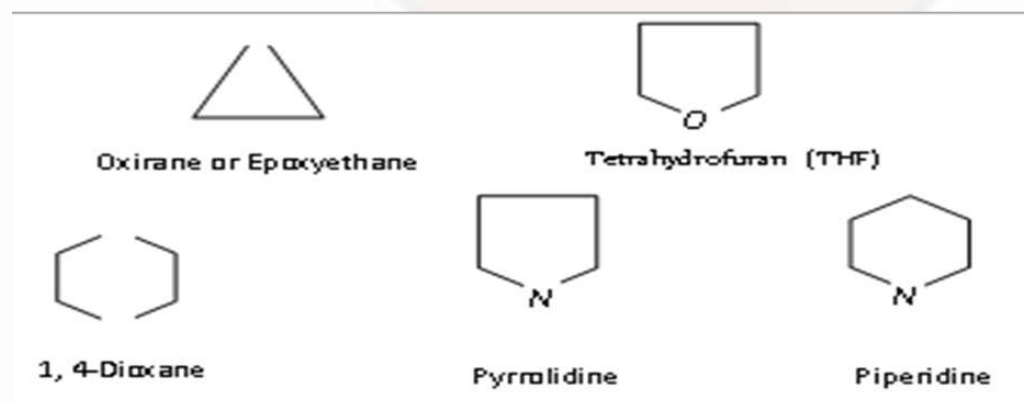


Example of Non-benzenoid aromatic compound

## 4. Heterocyclic Aromatic Compounds

➤ When one or more heteroatoms such as oxygen, nitrogen, sulphur, boron, silicon etc, are present in the ring such compounds are known as heterocyclic compounds.

➤ **Alicyclic heterocyclic compounds:** Aliphatic heterocyclic compounds that contain one or more heteroatoms in their rings



Examples of Heterocyclic aliphatic compounds

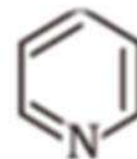
➤ **Aromatic heterocyclic compounds:** Aromatic heterocyclic compounds that contain one or more heteroatoms in their ring skeleton



Furan



Thiophene



Pyridine

Examples of Heterocyclic aromatic compounds

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## Nomenclature of Organic Compounds

### **NOMENCLATURE:**

Early organic chemists often assigned names related to the origin or properties of new compounds. Some of these names are still in common use. Citric acid is found in citrus fruit; uric acid is present in urine; formic acid is found in ants (from the Latin word for ant, formica); and morphine induces sleep (from Morpheus, the ancient Greek god of sleep). As thousands upon thousands of new compounds were synthesized, it became apparent that a system of common names was unworkable. Following several interim systems, one recommended by the International Union of Pure and Applied Chemistry (IUPAC) was adopted.

## RULES IN NAMING ORGANIC COMPOUNDS

### In absence of functional group

1. Select the longest continuous carbon chain in the molecule, and use the hydrocarbon name of this chain as the base name. Except for the common names methane, ethane, propane, and butane, standard Greek prefixes relate the name to the number of C atoms in the chain, as in pentane (C5 ), hexane (C6 ), heptane (C7 ), octane (C8 ),...
2. Numbering starts from that direction in which side chain gets lowest number possible
3. If more than one side chains are present then alphabetic order is followed for numbering
4. Name each substituent according to its chemical identity and the numbers of the C atom to which it is attached. For identical substituents use di, tri, tetra, and so on, and write the appropriate carbon number for each substituent.
5. Separate the numbers from one another by commas, and from letters by hyphens.

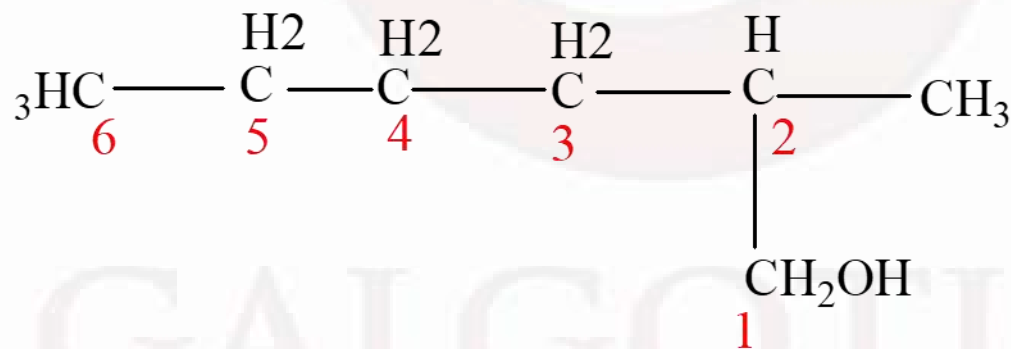




## RULES IN NAMING ORGANIC COMPOUNDS

### In presence of functional group

1. Numbering will be given in such a way that carbon atom present in functional group gets less number.



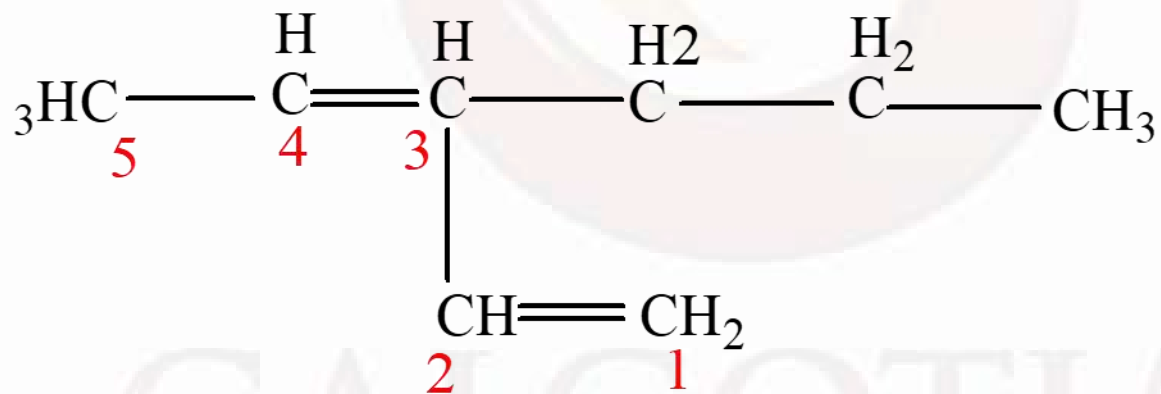
2-Methyl Hexanol-1

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2. Selection of main chain will be done in such a way that the main chain contains large number of functional group



3-Propyl-1,3- Penta diene

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3. If functional groups are present in the chain then their seniority order will be as follows

Priority table of functional groups of organic chemistry [www.vaxasoftware.com](http://www.vaxasoftware.com)

Formula	Function	Suffix (main function)	Prefix (secondary function)	Example
$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{OH} \end{array}$	Acid	-oic acid	carboxyl-	$\text{CH}_3-\text{COOH}$ Ethanoic acid
$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{O}-\text{R}' \end{array}$	Ester	-yl -oate		$\text{CH}_3-\text{COO}-\text{CH}_3$ Methyl ethanoate
$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{NH}_2 \end{array}$	Amide	-amide	carboxamido-	$\text{CH}_3-\text{CH}_2-\text{CONH}_2$ Propanamide
$\text{R}-\text{C}\equiv\text{N}$	Nitrile	-nitrile (cyanide)	cyano-	$\text{CH}_3-\text{CN}$ Ethanenitrile Methyl cyanide
$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{H} \end{array}$	Aldehyde	-al	oxo-	$\text{CH}_3-\text{CH}_2-\text{CHO}$ Propanal
$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{R}' \end{array}$	Ketone	-one	oxo-	$\text{CH}_3-\text{CO}-\text{CH}_3$ Propanone
$\text{R}-\text{OH}$	Alcohol	-ol	hydroxi-	$\text{CH}_3-\text{CH}_2\text{OH}$ Ethanol
$\text{R}-\text{NH}_2$	Amine	-amine	amino-	$\text{CH}_3-\text{CH}_2-\text{NH}_2$ Ethylamine
$\text{R}-\text{O}-\text{R}'$	Ether	-yl ...yleter	oxa-	$\text{CH}_3-\text{O}-\text{CH}_2-\text{CH}_3$ Ethylmethyleter
$\text{>C=C}<$	Alkene	-ene		$\text{CH}_3-\text{CH}=\text{CH}_2$ Propene
$-\text{C}\equiv\text{C}-$	Alkyne	-yne		$\text{CH}_3-\text{C}\equiv\text{CH}$ Propyne
$\text{R}-\text{NO}_2$	Nitro		nitro-	$\text{CH}_3-\text{CH}_2-\text{NO}_2$ Nitroethane
$\text{R}-\text{X}$	Halide		fluoro-, chloro-, bromo-, iodo-	$\text{CH}_3-\text{CH}_2\text{Br}$ Bromoethane
$-\text{R}$	Radical		yl-	$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_3-\text{CH}-\text{CH}_3 \end{array}$ Methylpropane

[www.vaxasoftware.com](http://www.vaxasoftware.com)

## References :

2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition,

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The logo of Galgotias University is a circular emblem with a stylized 'G' shape in the center. The 'G' is composed of several curved segments in shades of yellow, orange, and blue. The background of the emblem is a light, multi-colored gradient.

**Thank You**

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