14. Basic principles of Organic Chemistry

Can you recall?

- Which is the essential element in all organic compounds ?
- What is the unique property of carbon that makes organic chemistry a separate branch of chemsitry?
- Which classes of organic compounds are often used in our daily diet ?

14.1 Introduction : Of all the elements, only carbon is able to form an immense array of compounds, ranging from methane having one carbon atom to deoxyribonucleic acid (DNA) with billions of carbon atoms. Crude oil is a complex mixture of compounds called hydrocarbons. The pharmaceutical industry is one of the most important chemical industries that provides us medicines which are organic compounds. We need to study the organic compounds for they are interesting in their own right and their functions are greatly important to life.

Try this

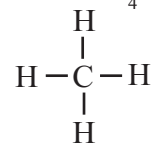
Find out the structures of glucose, vanillin, camphor and paracetamol using internet. Mark the carbon atoms present in them. Assign the hybridization state to each of the carbon and oxygen atom. Identify sigma (σ) and pi (π) bonds in these molecules.

14.2 Structural Representation of organic molecules

Try this

- Draw the structural formula of ethane.
- Draw electron-dot structure of propane.

In the previous standards you learnt how to write structural formulae and electron dot structure of hydrocarbons. Structural formula of a molecule shows all the constituent atoms denoted with their symbols and all covalent bonds therein represented by a dash joining mutually bonded atoms. For example, structural formula of CH_4 is :



In the electron dot structures of molecules, the valence electrons of all the atoms are shown as dots around them. Two dots drawn in between two atoms indicate one covalent bond between them. For example, the electron dot structure of methane is as shown here

Electron dot structures are called Lewis structures and the dash formula represents simplified Lewis formula. Chemists have developed some more ways to represent organic molecules fulfilling specific requirements.

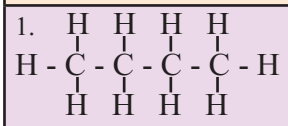
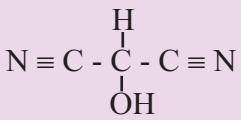
14.2.1 Condensed formula : The complete structural formula can be further simplified with hiding of some or all the covalent bonds and indicating the number of identical groups attached to an atom by a subscript. The resulting formula of a compound is known as **condensed formula**. For example : condensed formula of ethane can be written as CH_3 - CH_3 or CH_3CH_3.

14.2.2 Bond line formula or zig-zag formula

In this representation of a molecule symbols of carbon and hydrogen atoms are not written. The lines representing carbon-carbon bonds are drawn in a zig-zag manner and the terminals of the zig-zag line represent methyl groups. The intersection of lines denotes a carbon atom bonded to appropriate number of hydrogen which satisfy the tetravalency of carbon atoms. For example : propane is represented by the zig-zag formula  . However the heteroatoms or hydrogen atoms bonded to heteroatoms are written clearly. For example : The bond line formula of C_2H_5OH is  OH.

Try this Complete the Table 14.1

Table 14.1 : Representation of structural formula

Dash formula	Condensed formula A	Condensed formula B	Bond line or zig-zag formula
1. 	$CH_3(CH_2)_2CH_3$	CH_3- CH_2 - CH_2- CH_3	
2.	.....	.....	
3.	$CH_3(CH_2)_2CHO$	.....	.....
4.	$CH_3CH_2CH(CH_3)OH$	.....	.....
5. 	.....	.....	.....

14.2.3 Drawing the molecules in three dimensions : Most organic molecules have three dimensional shapes. Four different methods are used to represent three dimensional molecules on plane paper.

I. Wedge formula : The three dimensionl (3-D) view of a molecule can be represented on plane paper by representing the single bonds using solid wedge (▬), dashed wedges (┅┅) and normal line (–). A solid wedge is used to represent a bond projecting up from the paper towards the reader. A dashed wedge is used to represent a bond going backward, below the paper away from the reader. Normal lines depict bonds in the plane of the paper. See Fig. 14.1 (for convenience solid and dashed wedge can be replaced by solid/bold and dashed lines.)

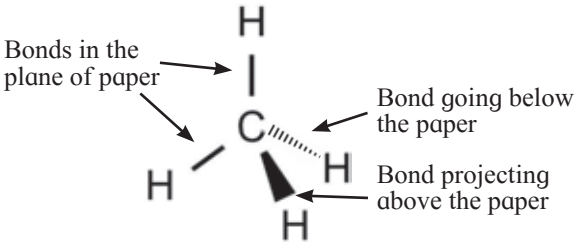


Fig. 14.1 : Wedge formula

II. Fischer projection formula or cross formula : In this representation a three dimensional molecule is projected on plane of paper. A Fischer projection formula can be drawn by visualizing the molecule with its main carbon chain vertical. Each carbon on the vertical chain is represented by a cross. The convention is that the horizontal lines of the cross represent bonds projecting up from the carbon and the vertical lines represent the bonds going below the carbon. Figure 14.2 illustrates the conventions of Fischer projection formula.

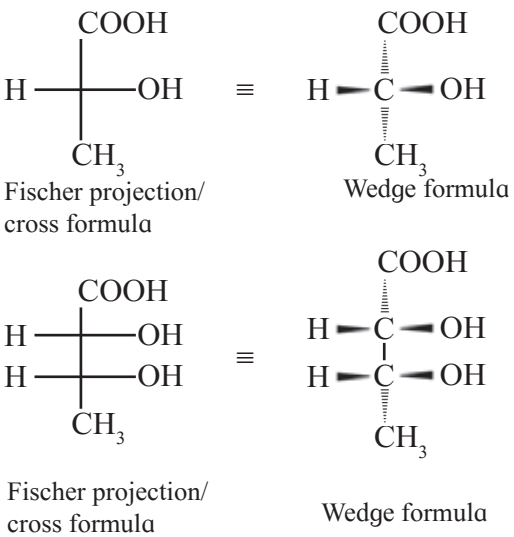


Fig 14.2 : Fischer projection (cross) formula

Fischer projection formula is more commonly used in carbohydrate chemistry

III Newman projection formula : In this method projection of a three dimensional molecule on the plane of the paper is drawn by visualizing the molecule by looking through a