Lecture 2: Hydrocarbons & Stereochemistry

Naming Covalent Compounds

TABLE 3.4 Prefixes Used to Denote Numbers of Atoms in a Compound

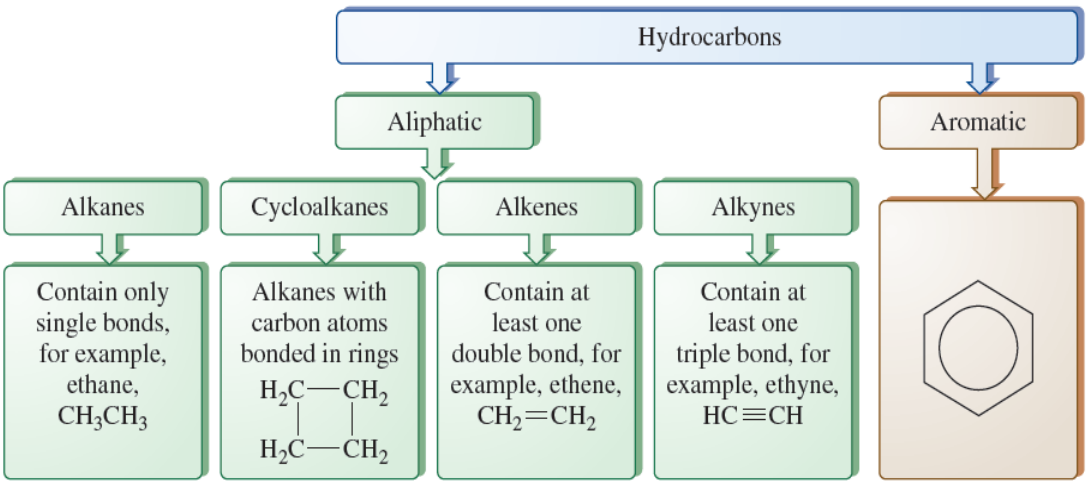
Prefix	Number of Atoms
Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10

The following are examples of other covalent compounds.

Formula	Name
N_2O	dinitrogen monoxide
NCl_3	nitrogen trichloride
SiO_2	silicon dioxide
CF_4	carbon tetrafluoride
CO	carbon monoxide
CO_2	carbon dioxide

The Chemistry of Carbon

- Organic chemistry is the study of carbon-containing compounds.
- All organic compounds are classified as hydrocarbons or substituted hydrocarbons.
- Vitamin A (retinol), a vitamin required for vision, contains a nine-carbon conjugated hydrocarbon chain. Vitamin K, a vitamin required for blood clotting, contains an aromatic ring.
- Classification of fatty acids
  -monounsaturated (having one double bond)
  -polyunsaturated (having two or more double bonds),
  -saturated (having single bonds only).



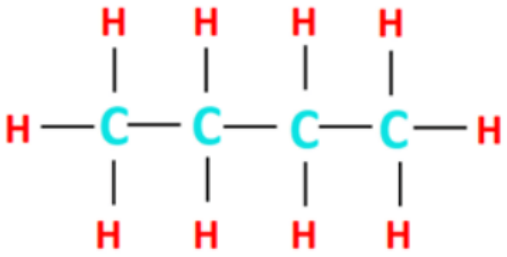
1. Alkanes

- Alkanes are saturated hydrocarbons with the general formula CnH2n+2.
- Alkanes are nonpolar, water-insoluble, and have low melting and boiling points.
- Cycloalkanes are organic molecules having C—C single bonds in a ring structure.

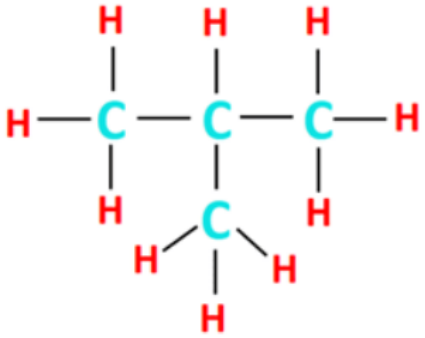
2. Alkenes and Alkynes

- Alkenes and alkynes are unsaturated hydrocarbons because they have at least one C=C double bond (alkenes) or triple bond (alkynes). Alkenes have the general formula CnH2n and alkynes have the general formula CnH2n- 2.
- Two organic molecules with the same molecular formula but different bonding patterns have different physical and chemical properties. Such molecules are structural or constitutional **(Isomers).**
- **Types of isomer**
  1. **Structural (constitutional) isomers**
  2. **Stereoisomers**

Constitutional isomers of Butane (C_4H_{10})

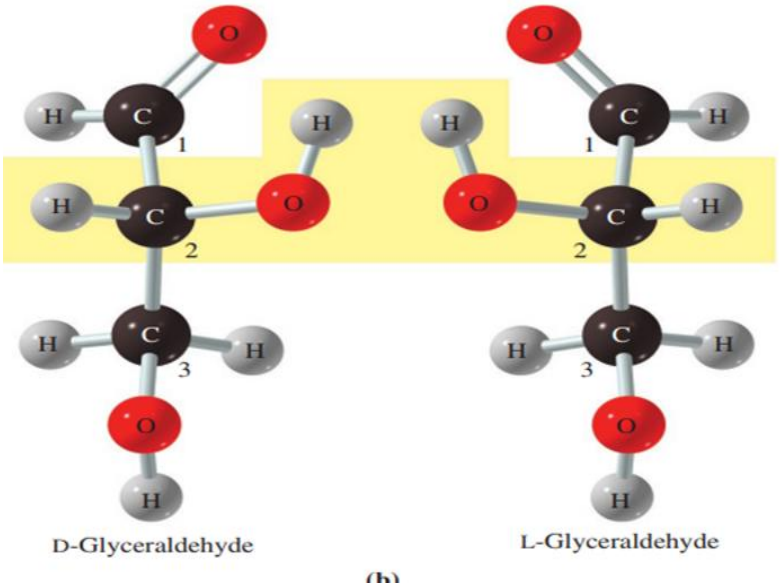


n-butane



iso-butane

Stereochemistry: is the study of the different spatial arrangements of atoms.

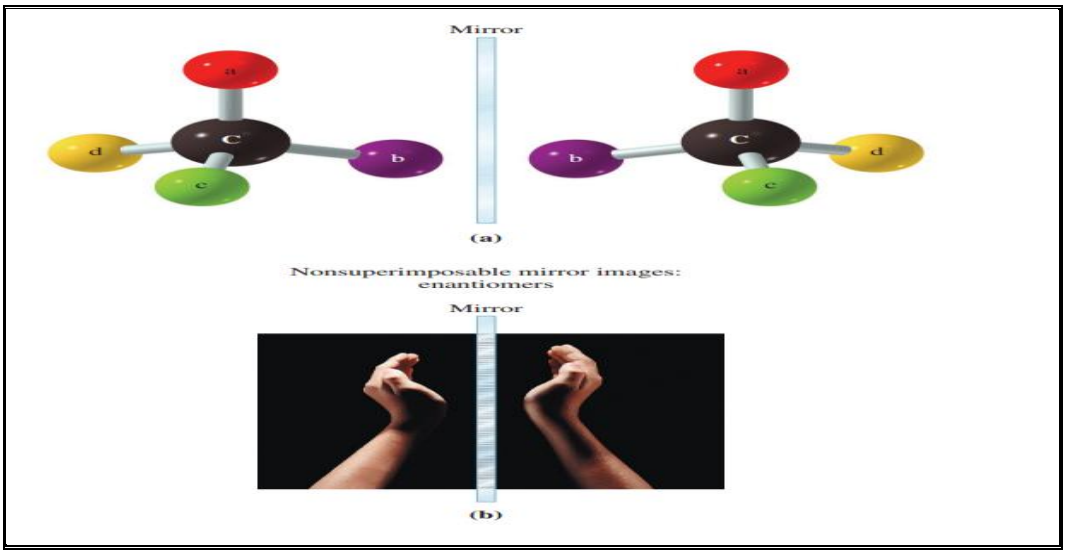


D-Glyceraldehyde L-Glyceraldehyde

Structural formulas of D- and L-glyceraldehyde

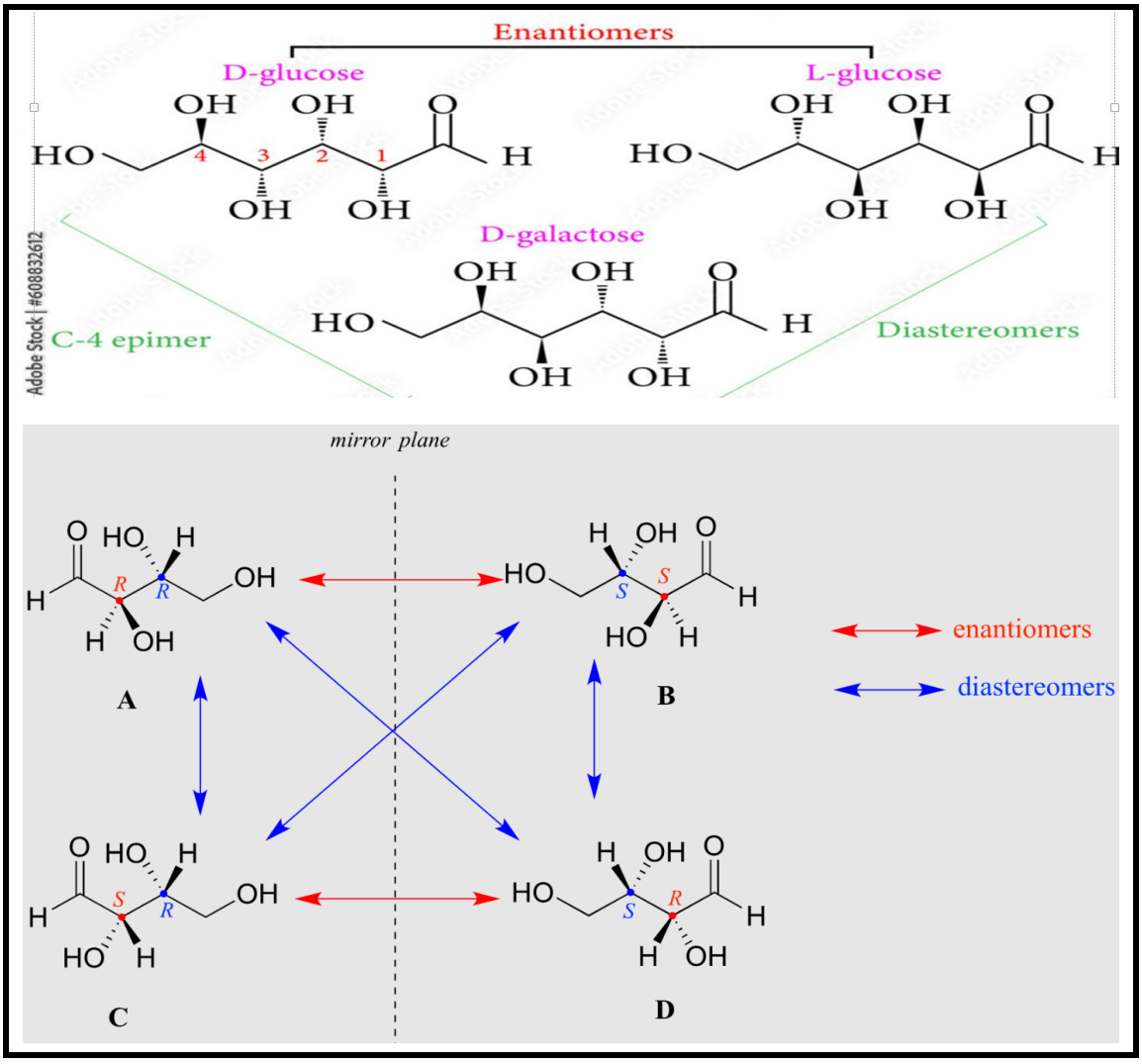
- **Stereoisomers**: are molecules that have the same structural formulas and bonding patterns but different arrangements of atoms in space
- A carbon atom that has four different groups bonded to it is called a **chiral carbon atom.** Any molecule containing a chiral carbon is a chiral molecule and will exist as a pair of enantiomers.

- Molecule C-abcd is formed from the bonding of a central carbon to four different groups: a, b, c, and d. This results in two possible ways to arrange the groups, rather than one. Each isomer is bonded together through the exact same bonding pattern, yet the two molecules are not identical. If they were identical, they would be superimposable. This means you can place the two molecules on top of one another and every atom and every bond of the two lie in the same space. If they cannot be superimposed, they are **stereoisomers**.

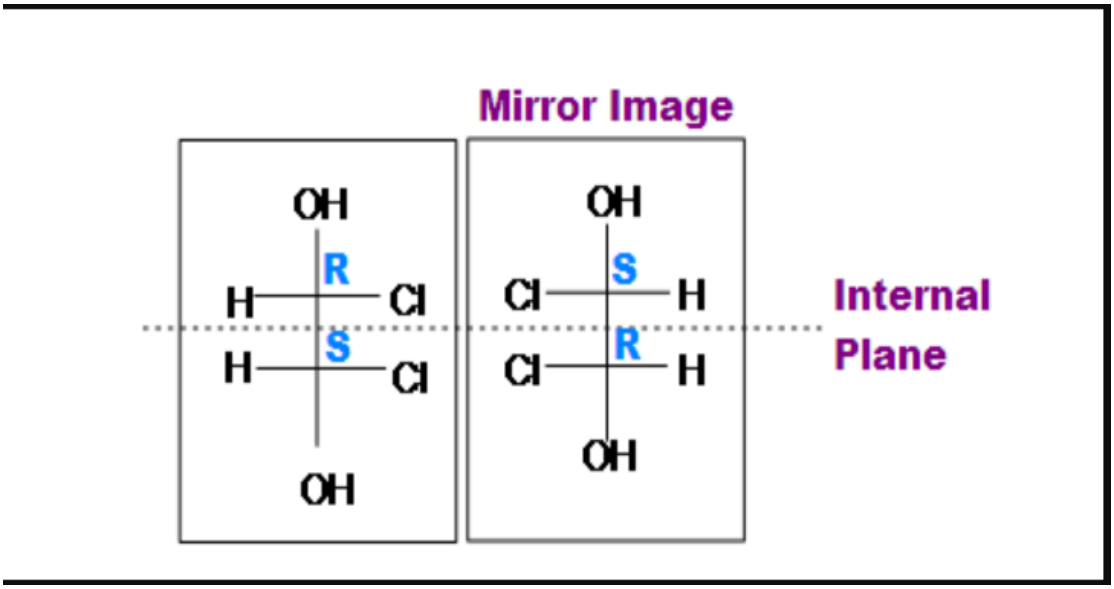


- These two stereoisomers have a mirror-image relationship that is analogous to the mirror-image relationship of the left and right hands.
- Two stereoisomers that are nonsuperimposable mirror images of one another are called a pair of **enantiomers**.
- **Rotation of Plane-Polarized Light:** Stereoisomers can be distinguished from one another by their different optical properties. Each member of a pair of stereoisomers will rotate plane-polarized light in a different direction
- **Polarimeter** is used to measure the direction of rotation of plane-polarized light.
- Compounds that rotate light in a clockwise direction are termed dextrorotatory (D) and are designated (+).
- Compounds that rotate light in a counterclockwise direction are termed levorotatory (L) and are designated (-).

- A mixture of equal amounts of a pair of enantiomers is a **racemic mixture**
- **Diastereomers** are stereoisomers with more than one chiral center that are not mirror images of one another.
- **Meso compounds** have two chiral carbons and an internal plane of symmetry. As a result, they are achiral.

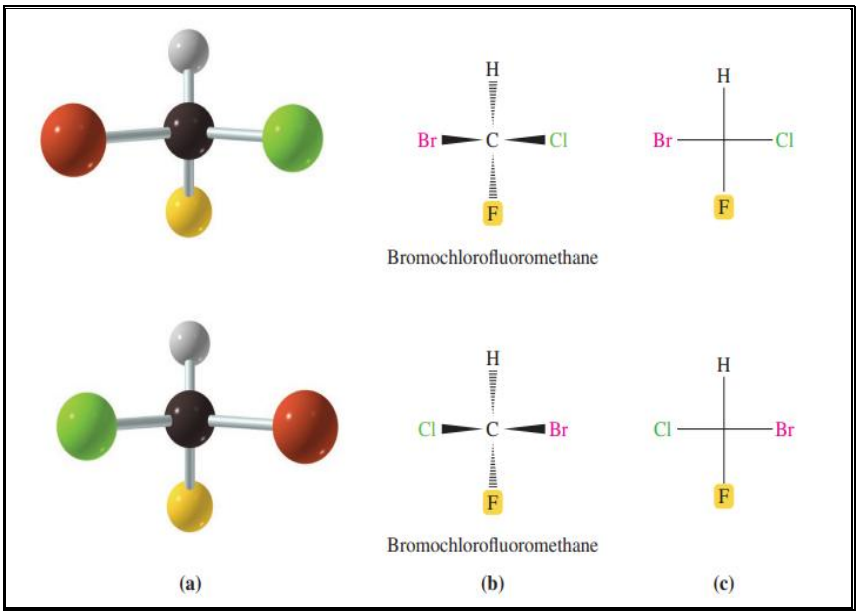


Enantiomers and Diastereomers (للاطلاع فقط)



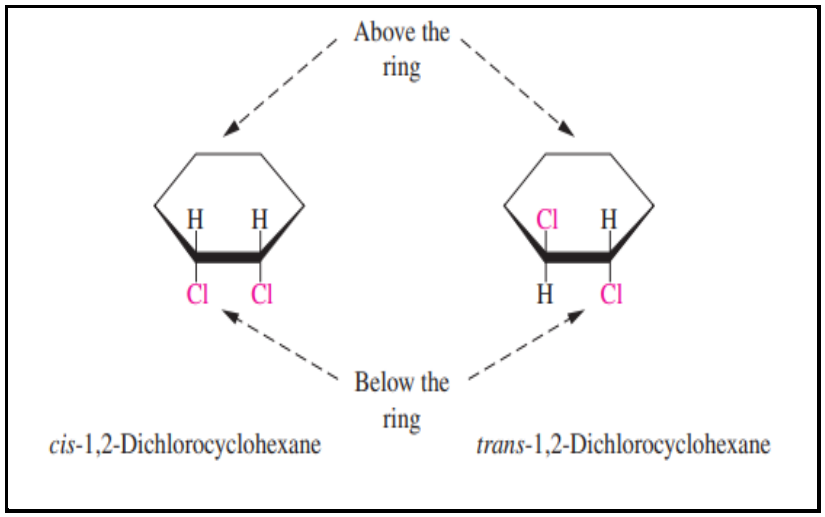
Meso compounds (للاطلاع فقط)

- **A Fischer Projection** is a two-dimensional drawing of a molecule that shows a chiral carbon at the intersection of two lines. **1.Horizontal** lines represent bonds projecting out of the page **2.Vertical** lines represent bonds that project into the page.



Drawing a Fischer Projection. (a) The ball-and-stick models for the stereoisomers of bromochlorofluoromethane. (b) The wedge-and-dash and (c) Fischer Projections of these molecules.

- **Geometric isomers** are a type of stereoisomer. The cis-trans isomers of cycloalkanes are stereoisomer that differ from one another in the arrangement of substituents in space. Consider the following two views of the cis- and trans-isomers of 1,2-dichlorocyclohexane:



The Biochemical Importance of Chirality

- The human body is structurally chiral, with the heart lying to the left of center and the liver to the right. Chirality in molecules, Carbohydrates, nucleotides, phospholipids and proteins have chirality
- Most pharmaceuticals are chiral. Usually only one mirror-image form of a drug provides the desired effect. The other mirror image form is often inactive or, at best, less active. In some cases, the other mirror-image form of a drug actually has severe side effects or toxicity. Moreover, selecting one enantiomer by physical separation as effective drug.