

# CARBOHYDRATE CHEMISTRY

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# Carbohydrates

Carbohydrates are broadly defined as polyhydroxy aldehydes or ketones and their derivatives or as substances that yields one of these compounds

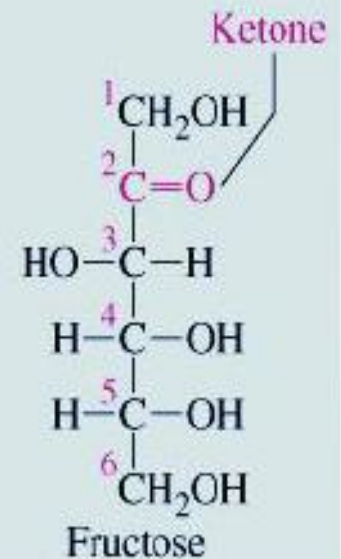
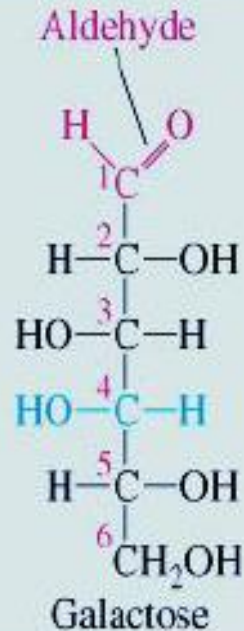
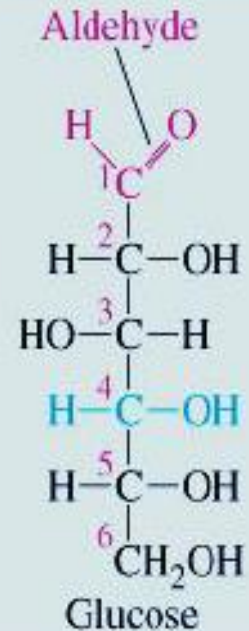
- Composed of carbon, hydrogen, and oxygen
- Functional groups present include hydroxyl groups
- -ose indicates sugar



Carbohydrates contained in foods such as pasta and bread provide energy for the body.

# Function of Carbohydrates in Cells

- ✓ Major source of energy for the cell
- ✓ Major structural component of plant cell
- ✓ Immediate energy in the form of GLUCOSE
- ✓ Reserve or stored energy in the form of GLYCOGEN



# Classification of Carbohydrates

- Carbohydrates are classified according to the number of subunits that make them up

## 3 Types of Carbohydrates

- Monosaccharides
- Oligosaccharides
  
- Polysaccharides

Disaccharides

Trisaccharides

Tetrasaccharides

Monosaccharides are simple sugars, or the compounds which possess a free aldehyde (CHO) or ketone (C=O) group and two or more hydroxyl (OH) groups. They are the simplest sugars and cannot be hydrolysed further into smaller units.

Monosaccharides contain a single carbon chain and are classified on the basis of number of carbon atoms they possess, and as aldoses or ketoses depending upon their groups.

# Monosaccharides

## Classification by Carbon Atoms

Sugar	Structure formula	Aldoses	Ketoses
1. Triose	$C_3H_6O_3$	Glyceraldehydes	Dehydroxy acetone
2. Tetroses	$C_4H_8O_4$	Erythrose, Threose	Erthrulose
3. Pentoses	$C_5H_{10}O_5$	Xylose Ribose Arabinose	Ribulose
4. Hexoses	$C_6H_{12}O_6$	Glucose Galactose Mannose	Fructose

# Monosaccharides

# Hexoses

## Glucose

- The essential energy source for all body functions.
- Other names: Dextrose and Blood Sugar.
- A component of each disaccharide.

## • Galactose

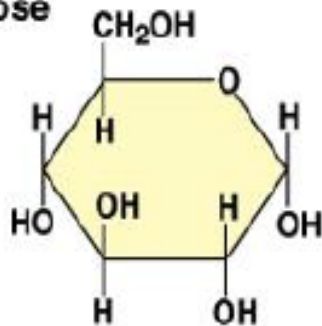
- Seldom occurs freely in nature
- Binds with glucose to form sugar in milk: lactose.
- Once absorbed by the body, galactose is converted to glucose to provide energy.

## Fructose:

- The sweetest of all sugars
  - (1.5 X sweeter than sucrose)
- Occurs naturally in fruits and honey “the fruit sugar”

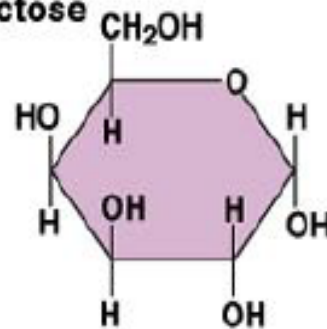
D-glucose  
“dextrose”  
Blood sugar

Glucose



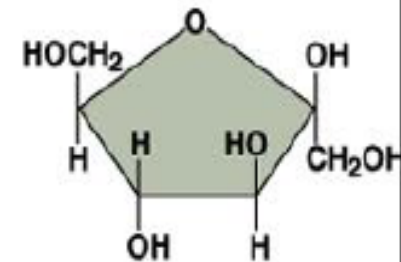
D-galactose

Galactose



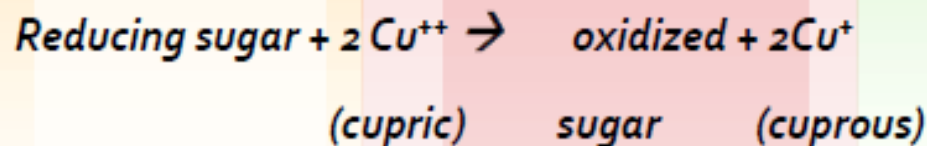
D-fructose  
“Levulose”  
Fruit sugar

Fructose



# Properties of monosaccharides

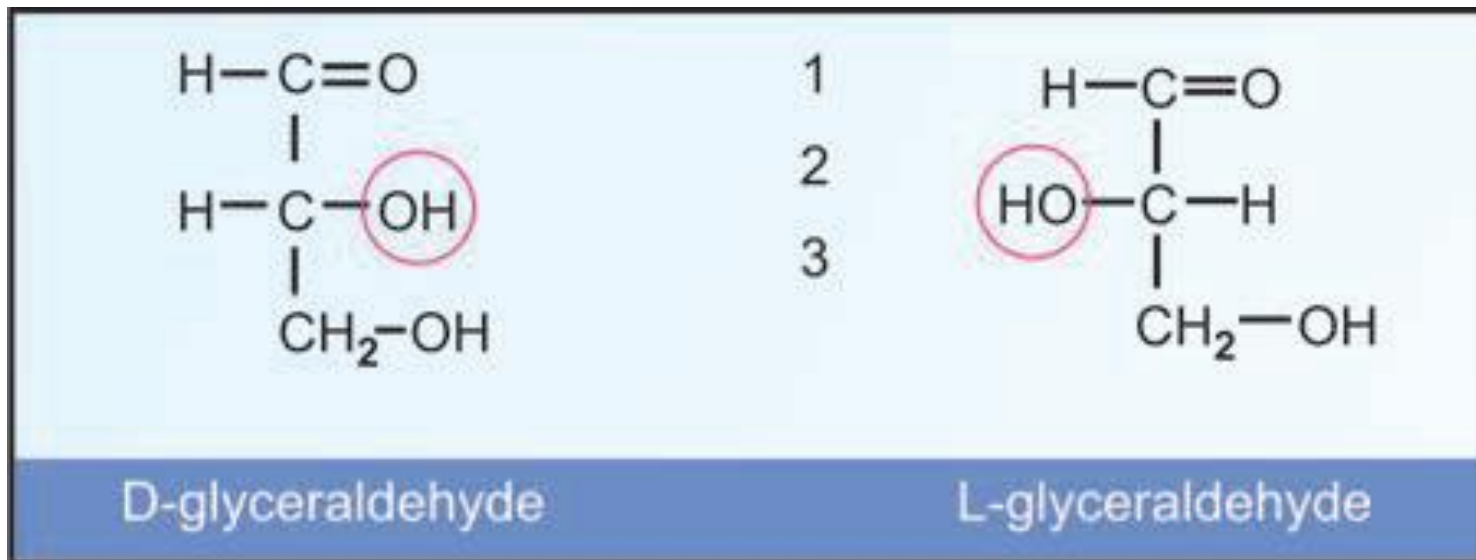
1. **Mutarotation** : when a monosaccharide is dissolved in water, the optical rotatory power of the solution gradually changes until it reaches a constant value. For ex : when D-glucose is dissolved in water, a specific rotation of  $+112.2^\circ$  is obtained, but this slowly changes , so that at 24h the value has become  $+52.7^\circ$ . This gradual change in specific rotation is known as mutarotation. This phenomenon is shown by number of pentoses, hexoses and reducing disaccharides.
2. **Glucoside formation** : when D-glucose solution is treated with methanol and HCl, two compounds are formed, these are  $\alpha$  - and  $\beta$ -D- glucosides. Thus, formed glucosides are not reducing sugar and also doesnot show phenomenon of mutarotation
3. **Reducing power** : Sugars having free or potentially free aldehyde or ketone group have an ability to reduce the cupric copper to cuprous



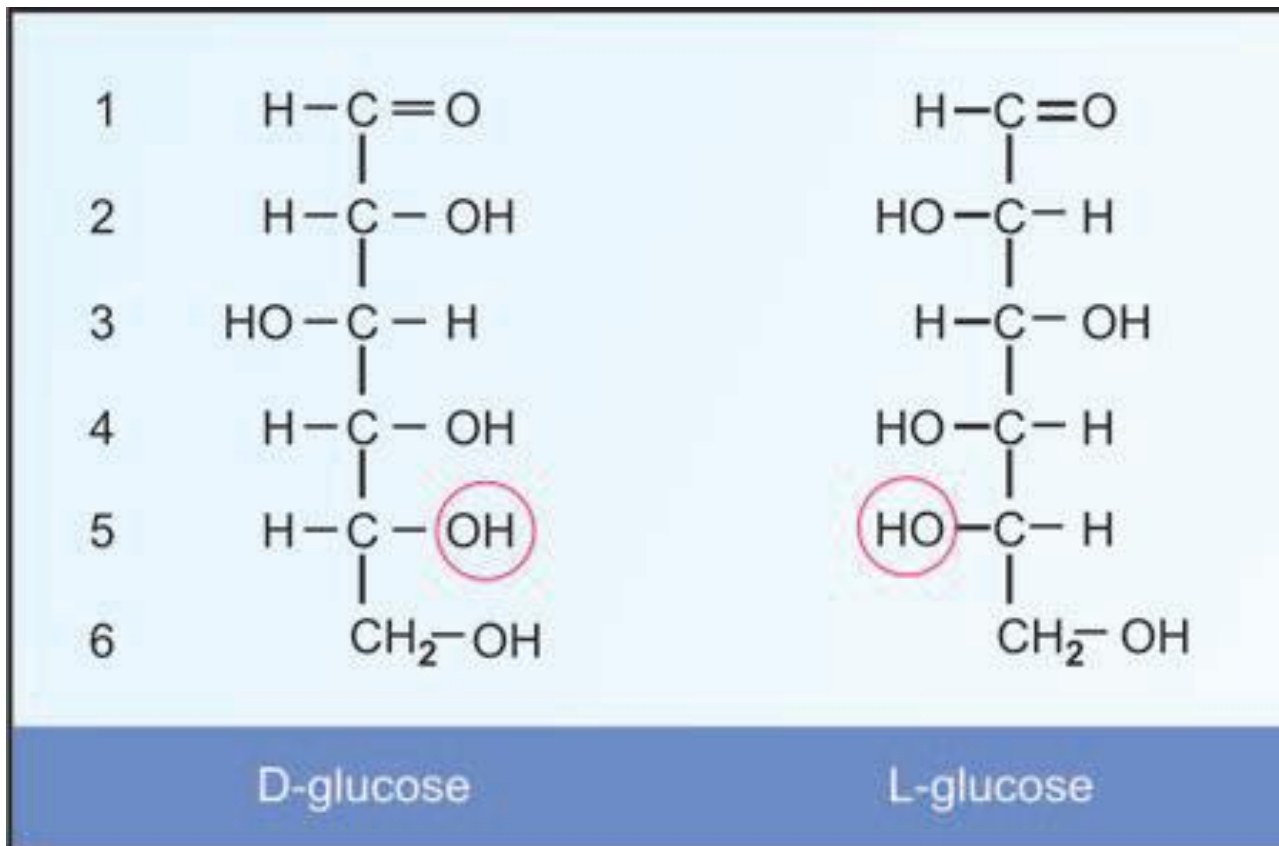
4. **Oxidation / Reduction**: The alcoholic OH, aldehyde (COH) or keto (C=O) group are oxidized to carboxyl group with certain oxidizing agents. The oxidation may be brought under mild or with vigorous oxidizing condition
  - i. With mild oxidant like  $\text{BrH}_2\text{O}$  : In this group only aldehyde is oxidized to produce gluconic acid (monocarbonic). Ketoses do not respond to this reaction.

# Stereoisomers

- Compounds having same structural formula, but differ in spatial configuration (arrangement of atoms in space)



# Isomers of glucose



# Hexoses of physiological importance

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## **Sugar**

## **Importance**

**D-Glucose**

**Blood sugar. Main source of energy in body.**

**D-Fructose**

**Constituent of sucrose, the common sugar.**

**D-Galactose**

**Constituent of lactose, glycolipids and glycoproteins.**

**D-Mannose**

**Constituent of globulins, mucoproteins and glycoproteins.**

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