

Chemistry of carbohydrates



Introduction



- Carbohydrates (or saccharides) consist of only carbon, hydrogen and oxygen
- Carbohydrates come primarily from plants, however animals can also biosynthesize them
- The “Carbon Cycle” describes the processes by which carbon is recycled on our planet
- Energy from the sun is stored in plants, which use photosynthesis to convert carbon dioxide and water to glucose and oxygen
- In the reverse process, energy is produced when animals oxidize glucose during respiration

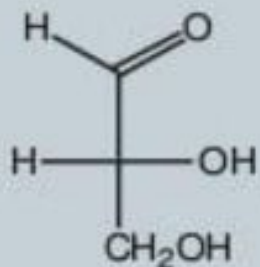
Definition



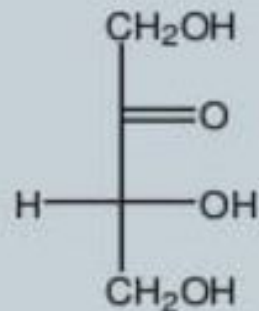
- **Carbohydrates** – poly hydroxy aldehydes or poly hydroxy-ketones of formula $(\text{CH}_2\text{O})_n$, or compounds that can be hydrolyzed to them.

Classification of Monosaccharides

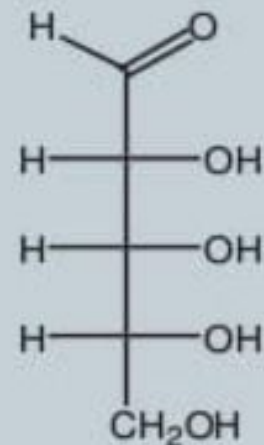
- Monosaccharides have 3-8 carbons in a chain, with **one carbon** in a **carbonyl group**, and the **other carbons** attached to **c groups**
 - An **aldose** has the carbonyl C₁ (an aldehyde)
 - A **ketose** has the carbonyl on C₂ (a ketone)
 - The number of carbons is indicated as follows: triose (3 C's), tetrose (4 C's), pentose (5 C's), hexose (6 C's)



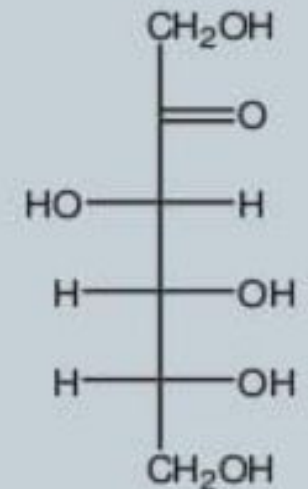
Glyceraldehyde
(aldotriose)



Erythrulose
(ketotetrose)



Ribose
(aldopentose)



Fructose
(ketohexose)

Types of carbohydrates



- **Monosaccharides** – carbohydrates that **cannot be hydrolyzed** to simpler carbohydrates; eg. Glucose or fructose.
- **Disaccharides** – carbohydrates that can be **hydrolyzed into two monosaccharide units**; eg. Sucrose, which is hydrolyzed into glucose and fructose.
- **Oligosaccharides** – carbohydrates that can be hydrolyzed into a **few monosaccharide** units.
- **Polysaccharides** – carbohydrates that are **polymeric sugars**; eg Starch or cellulose.

Monosaccharides



- Monosaccharides are classified by their number of carbon atoms

Name	Formula
Triose	$C_3 H_6 O_3$
Tetrose	$C_4 H_8 O_4$
Pentose	$C_5 H_{10} O_5$
Hexose	$C_6 H_{12} O_6$
Heptose	$C_7 H_{14} O_7$
Octose	$C_8 H_{16} O_8$

Three Important Monosaccharides



- **D-Glucose** is the most common monosaccharide
 - Primary fuel for our cells, required for many tissues
 - Main sources are fruits, vegetables, corn syrup and honey
 - Blood glucose is maintained within a fairly small range
 - Some glucose is stored as glycogen, excess is stored as fat



- **D-Galactose** comes from hydrolysis of the disaccharide lactose
 - Used in cell membranes of central nervous system
 - Converted by an enzyme into glucose for respiration (lack of this enzyme causes *galactosemia*, which can cause retardation in infants if not treated by complete removal from diet)



- **D-Fructose** is the sweetest carbohydrate
 - Converted by an enzyme into glucose for respiration
 - Main sources are fruits and honey
 - Also obtained from hydrolysis of the disaccharide sucrose

Glycosidic Bonds

The anomeric hydroxyl and a hydroxyl of another sugar or some other compound can join together, splitting out water to form a glycosidic bond:



E.g., methanol reacts with the anomeric OH on glucose to form methyl glucoside (methyl-glucopyranose).

