# Carbohydrates

• **Carbohydrates:** *Are the most abundant and diverse class of organic compounds occurring in nature.*

• *They play* ***a key role in the evolution of life*** *due to creating a direct link between the sun and chemical energy.*

## The aim of the experiments:

• *Understanding simple tests for the* ***identification of carbohydrates*** *in a given sample.*

## Theory:

- ***Carbo****=Carbon,* ***Hydrate****=Water (Hydrogen+Oxygen)*
- ***General formula:*** *$(CH_2O)_n$*
- *They have important* ***structural and metabolic*** *roles in both* ***animals and plants.***
- *Commonly used for* ***food and energy storage.***

## Classification of carbohydrates

- ***Monosaccharides:*** *Cannot be hydrolyzed into a more simple form.*
- ***Disaccharides:*** *Products of* ***two*** *monosaccharide units.*
- ***Oligosaccharides:*** *Products of* ***three to ten*** *monosaccharides.*
- ***Polysaccharides:*** *Products of* ***more than ten*** *monosaccharide units.*

## *Examples of carbohydrates*

• Monosaccharides:
• Can be further classified into:

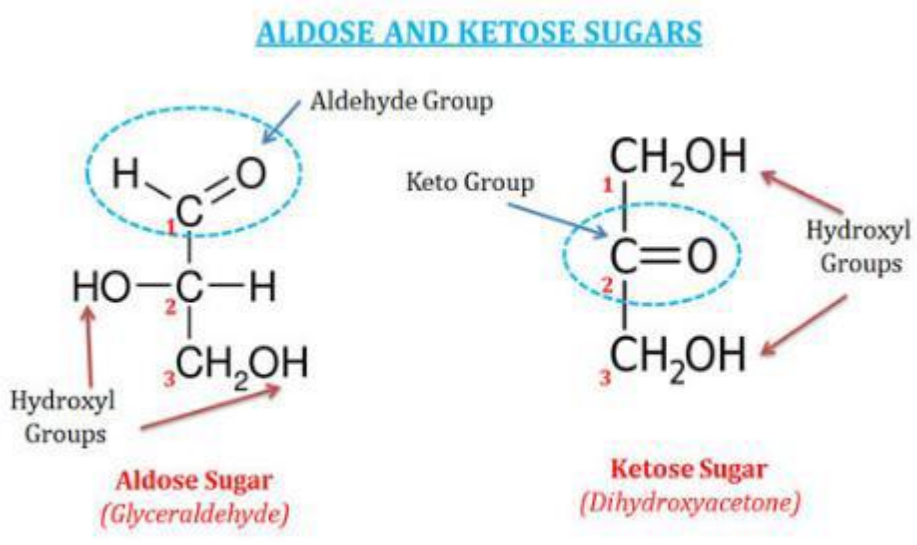
***No. of carbon atoms Trioses***

Tetroses – Pentoses – Hexoses – Heptoses

**Aldehyde or Ketone group**

Aldoses – Ketoses

## *Monosaccharides structure:*



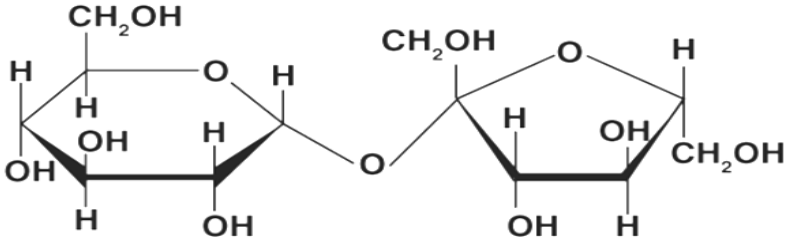

## *Monosaccharides examples:*

| | ***Aldoses*** | ***Ketoses*** |
|---|---|---|
| ***Trioses*** ($C_3H_6O_3$) | *Glyceraldehyde* | *Dihydroxyacetone* |
| ***Tetroses*** ($C_4H_8O_4$) | *Erythrose* | *Erythrulose* |
| ***Pentoses*** ($C_5H_{10}O_5$) | *Ribose* | *Ribulose* |
| ***Hexoses*** ($C_6H_{12}O_6$) | *Glucose* | *Fructose* |

**Other examples of carbohydrates include:**

• Disaccharides:

• *Lactose, Maltose, and Sucrose.*



• Polysaccharides:

- Starch and Dextrin.

Can be linear or branched polymers.

***Also,*** *sometimes they are classified as* ***Hexosans*** *or* ***Pentosans*** *depending on their yield when hydrolyzed.*

# *Qualitative and Quantitative tests for carbohydrates*

***To identify the presence of carbohydrates in a sample:***

*1 - Molisch's test*
*2 - Fehling's test*
*3 - Benedict's test*
*4 - Tollen's test*
*5 - Iodine test*

# *Carbohydrate identification tests*

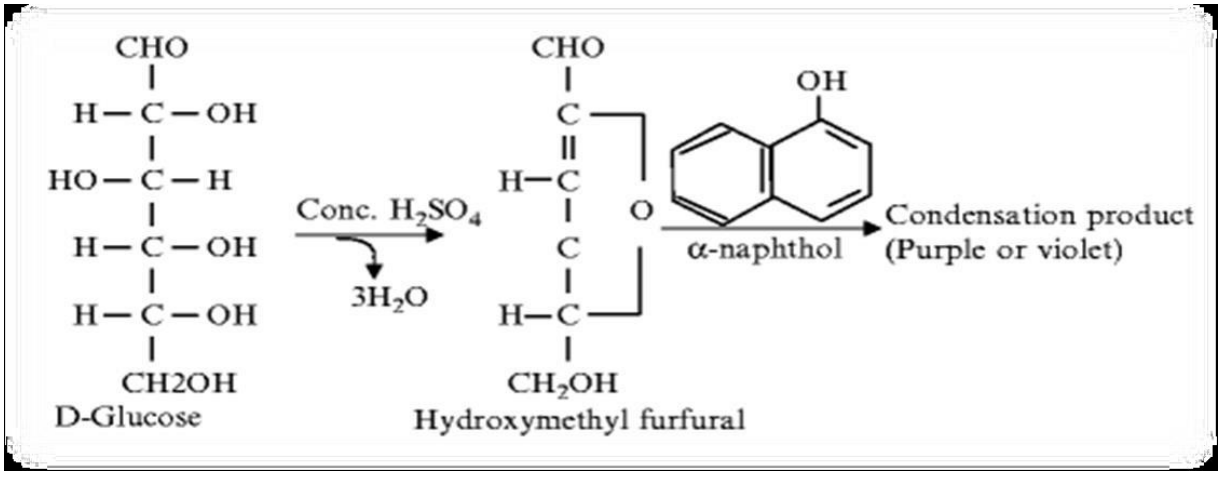
## 1 - Molisch's test:

***General*** *test for carbohydrates.*

*Concentrated* ***sulfuric acid*** *converts the carbohydrate into* ***furfural*** *or any of its' derivatives, which in turn* ***reacts with α–naphtol*** *to form a* ***purple colored product****.*

***Purple or violet ring is a positive result*** *for the presence of carbohydrates in the sample.*

## Molisch's chemical reaction:




## Molisch's Procedure:

1. *Take **2ml of the given sample solution** in a clean test tube.*

2. *Add **2-3 drops of Molisch reagent** slowly.*

3. *Add **concentrated sulfuric acid** along the sides of the test tube.*

4. *Notice the **separation** of the sample (Acid: bottom, sample: top).*

5. *If a **violet ring** is observed in the middle, then the **presence of carbohydrates** is confimed.*

## 2. Fehling's test:

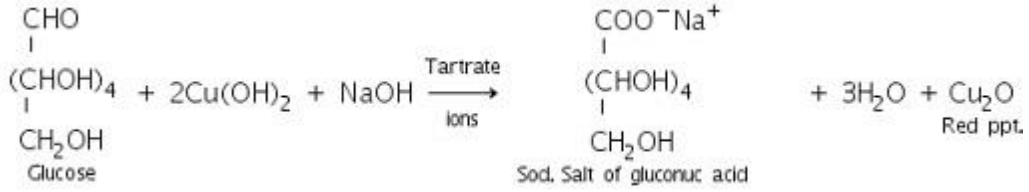
*This test identifies **reducing sugars.***

*Needs **boiling water bath.***

*The copper ions in Fehling's solution (+3) state is reduced to (+2) oxidation state, and **red cuprus oxide** is precipitated in the **alkaline medium.***

***Red precipitate is a positive result** for the presence of reducing sugars and carbohydrates.*

***Fehling's chemical reaction*:**




***Fehling's Procedure:***

*1. Take **2ml of the given sample solution** in a clean test tube.*

*2. Add **1ml of Fehling A solution** slowly.*

*3. Add **1ml of Fehling B solution** slowly.*

*4. Keep the solution in a boiling water bath for ≈10 minutes.*

*5. If a **red precipitate** is observed, then the **presence of carbohydrates and reducing sugars** is confimed.*

***3. Benedict's test:***

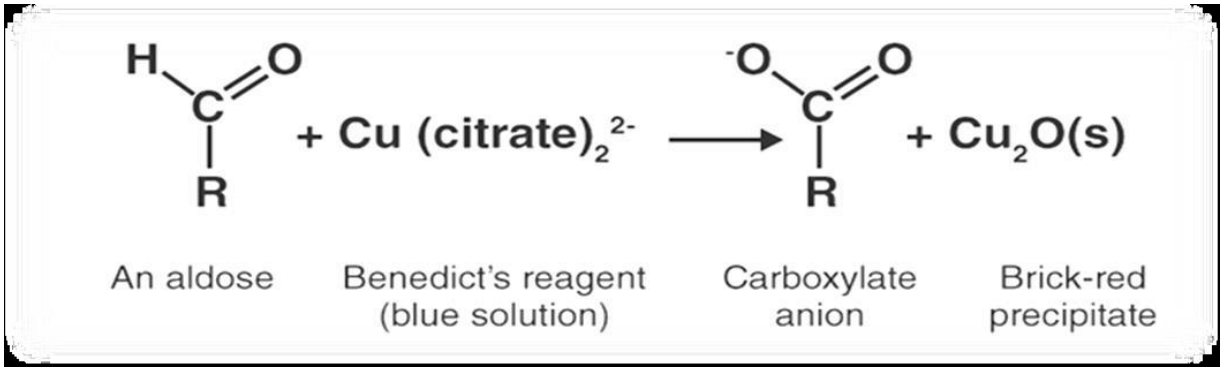
*This test identifies **reducing sugars.***

*In **Alkaline medium, sodium carbonate** converts glucose to **enediol**, which in turn reduces **cupric to cuprous** forming **cuprous hydroxide**.*

*Upon boiling, **red precipitate of cuprous oxide** is formed.*

***Red precipitate is a positive result** for the presence of reducing sugars and carbohydrates.*

***Benedict's chemical reaction:***



***Benedict's Procedure:***

*1. Take 3**ml of the given sample solution** in a clean test tube.*

*2. Add 3**ml of Benedict's reagent.***

*3. Boil the solution for ≈2 minutes.*

*4. Cool the solution and observe the test tube.*

*5. If a **red/green/yellow precipitate** is observed, then the **presence of carbohydrates and reducing sugars** is confimed.*

***4. Tollen's test:***

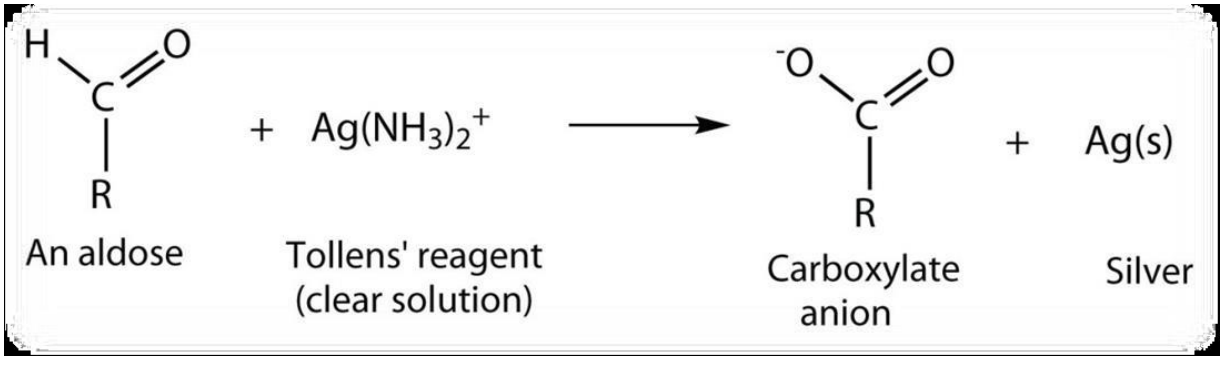
*This test identifies **reducing sugars.***

*Reacts with carbohydrates to form a **silver mirror** along the inner walls of the tube.*

***Silver ions** are reduced to **metallic silver.***

***Silver mirror is a positive result** for the presence of reducing sugars and carbohydrates.*

***Tollen's chemical reaction:***




***Tollen's Procedure:***

*1. Take **3ml of the given sample solution** in a clean test tube.*

*2. Add **3ml of Tollen's reagent.***

*3. Keep the test tube in boiling water for ≈10 minutes.*

*4. If a **shiny silver mirror** is observed, then the **presence of carbohydrates and reducing sugars** is confimed.*

### *5 - Iodine test:*

*This test identifies **starch.***
***Starch** reacts with **Iodine solution ,** and upon **cooling** a blue color appears.*
***Blue color is a positive result** for the presence of starch.*

***Iodine test chemical reaction:***

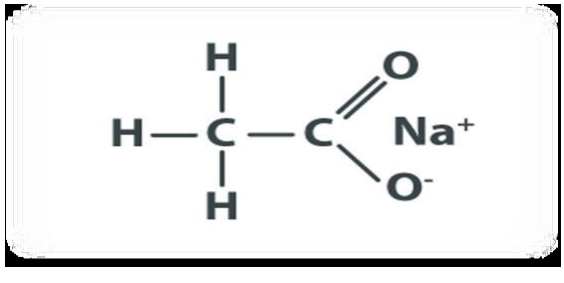

***Iodine Test Procedure:***

*1. Take **3ml of the given sample solution** in a clean test tube.*

*2. Add **3 drops of Iodine solution.***

*3. Observe the change in color.*

*4. If a **blue color** is observed, then the presence of **starch** is confimed.*




***Sodium acetate***