Carbohydrates

- **Carbohydrates are polyhydroxy aldehydes or ketones, or substances that yield such compounds on hydrolysis.**

- **Have structural role such as cellulose in plants**

- **Have energy storage role such as starch in plant , glycogen in animals and bacteria.**

Classification of carbohydrates

- **Monosaccharide (simple sugar)**
  - Triose: (3C) Glyceraldehyde
  - Tetrose : (4C) Erythrose
  - Pentose : (5C) Arabinose
  - Hexose : (6C) aldose (glucose) ketose (fructose)
- **Disaccharide (2 molecule)**
  - Reducing sugar (have free aldehyde or ketone group) Maltose, lactose
  - Non-reducing sugar (lack free aldehyde or ketone group) Sucrose
- **oligosaccharide (3-10 molecule)**
- **Poly saccharide (>10 molecule)**
  - Starch
  - Dextrin
  - Glycogen
  - Cellulose

Effects of acid on carbohydrates

Disaccharide or polysaccharide

Acid \ heat

Monosaccharide (pentose or hexose)

$-3H_2O$

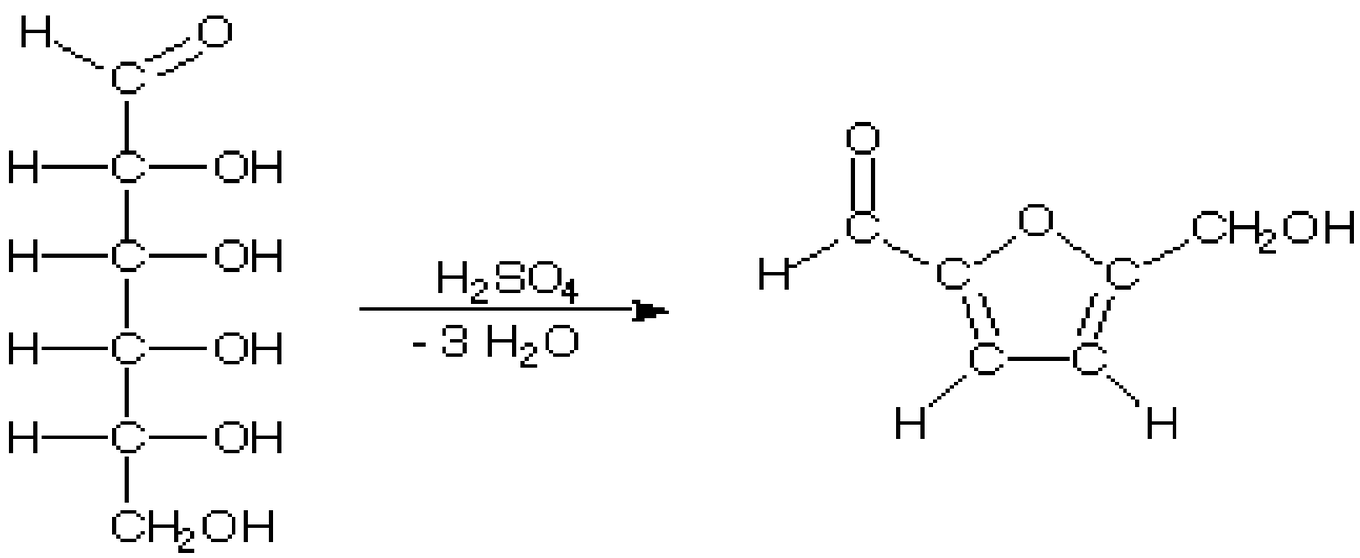
Ring formation (furfural derivatives)

Phenolic derivatives

Colored complex

Molish ’s test:

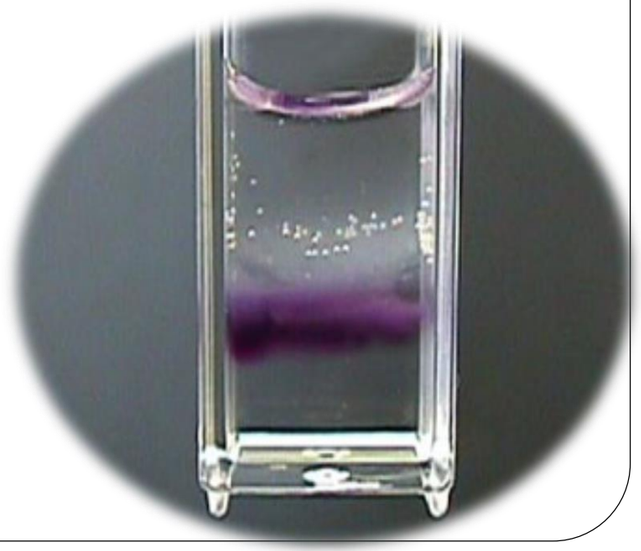
- General test for all carbohydrates.
- compounds give furfural derivatives in the presence of H_2SO_4 (con.) then react with α-naphthol to give purple ring.



glucose

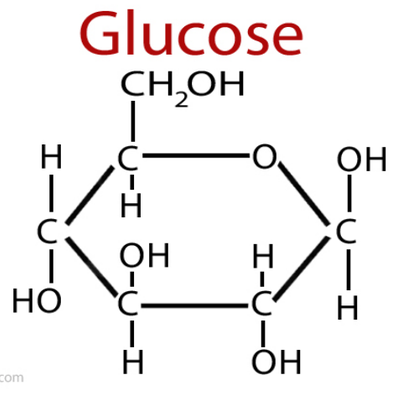
Furfural derivatives

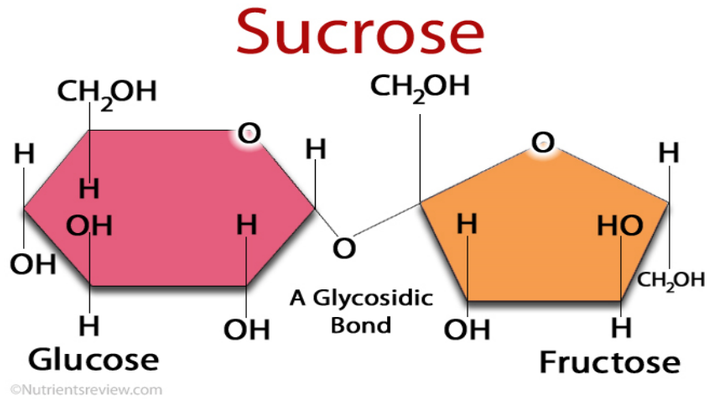
α-naphthol

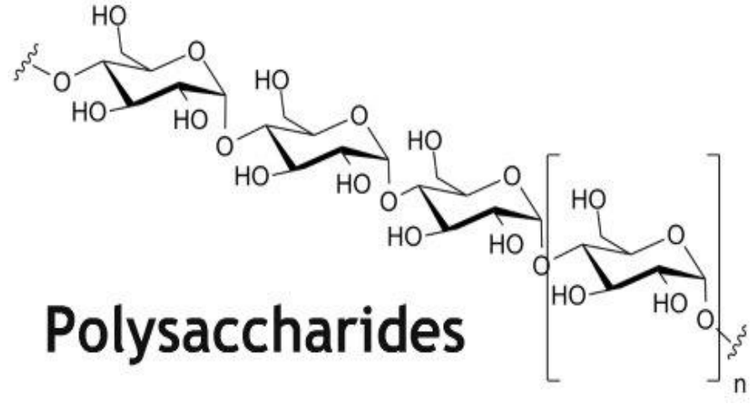


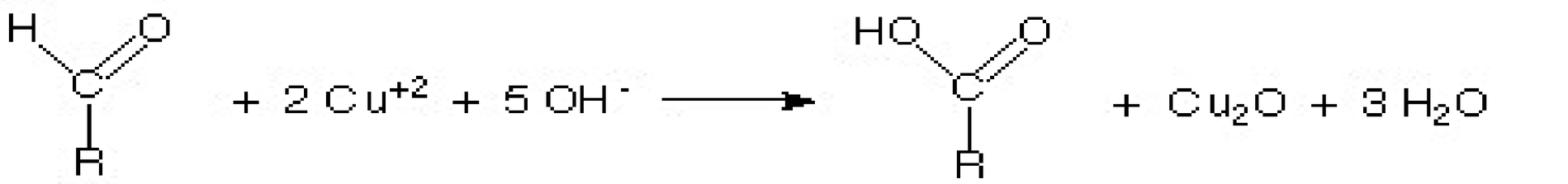
Benedict ’s test:

- Distinguish between reducing and non-reducing sugars.
- Reducing sugars have free aldehyde or ketone group.
- Heating a mixture of benedict reagent with reducing sugar in basic condition lead to reduce (Cu^{+2}) to (Cu^{+}) as (Cu_2O) as yellow then red color.
- Give red color (reducing sugar) .

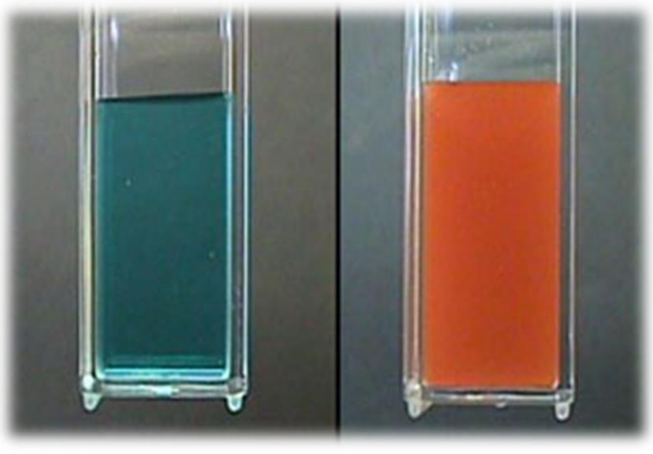








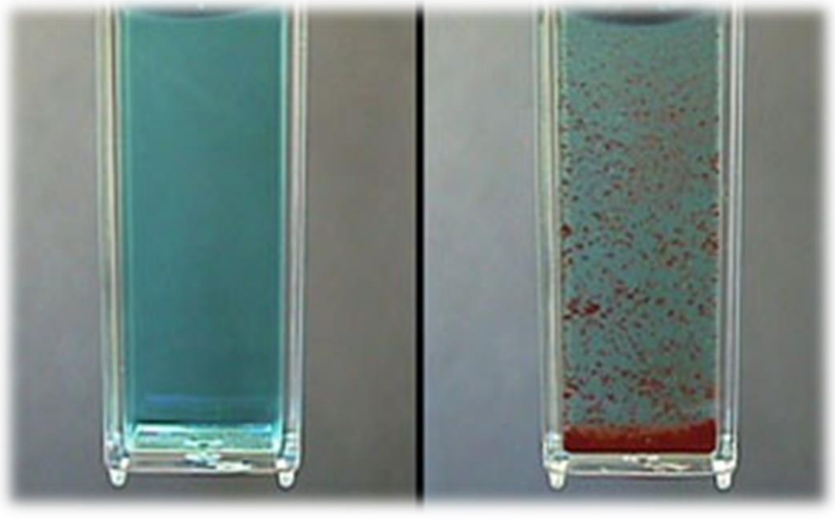
sugar benedict carboxylic copper (I) oxide



-Ve (blue) **+ Ve (red)**

Barfoed ’s test:

- Distinguish between mono- and disaccharides.
- Heating a mixture of barfoed reagent with monosaccharide in acidic condition lead to reduce (Cu^{+2}) to (Cu^{+}) as (Cu_2O) red ppt.
- Give red ppt (monosaccharide) .

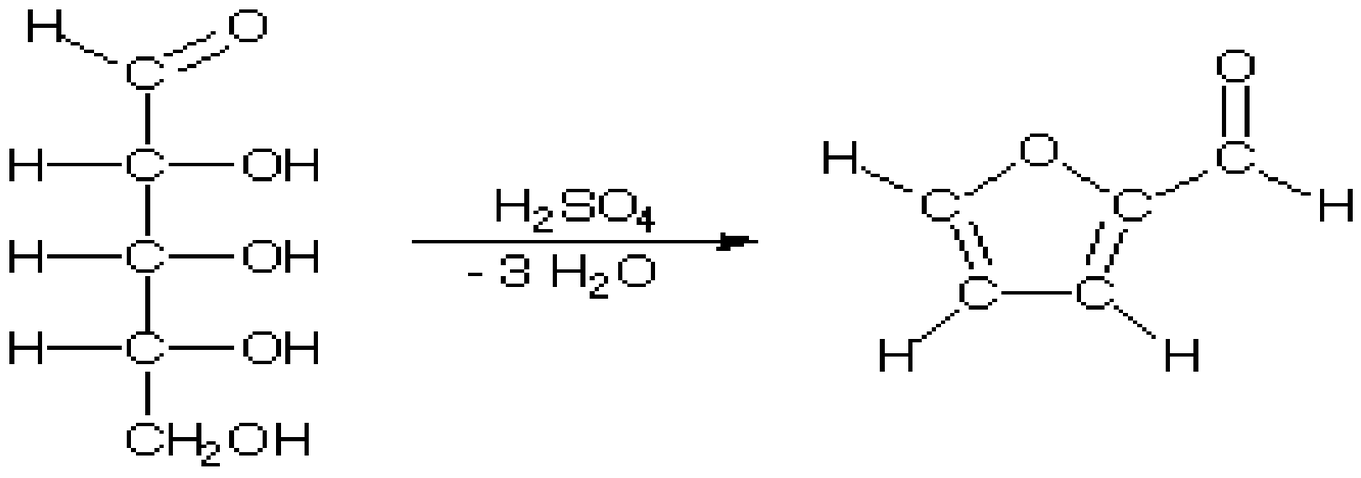


-Ve
(blue)

+ Ve
(red ppt)

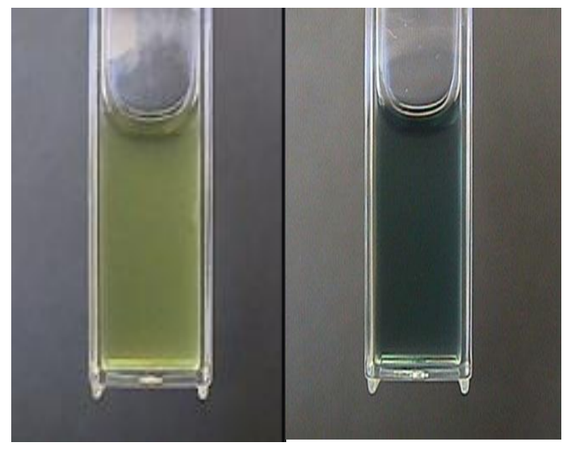
Bial ’s test:

- Distinguish between pentose and hexose sugars.
- compounds give furfural in the presence of H2So4 (con.) then react with orcinol.
- Give blue-green (pentose).



Ribose

Furfural

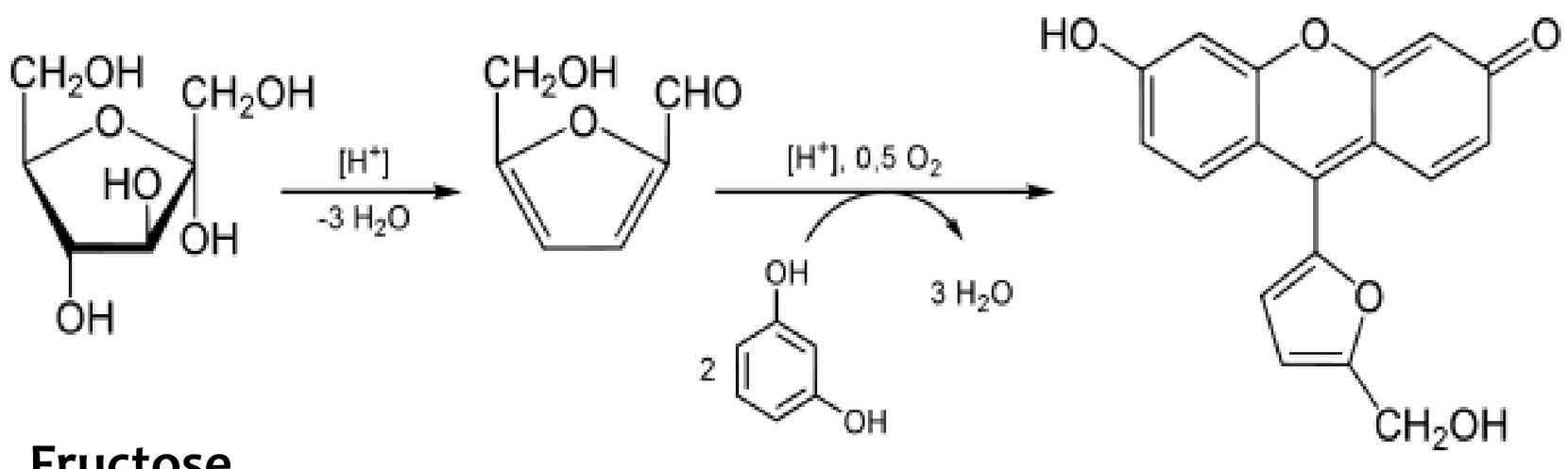


-Ve (yellow)

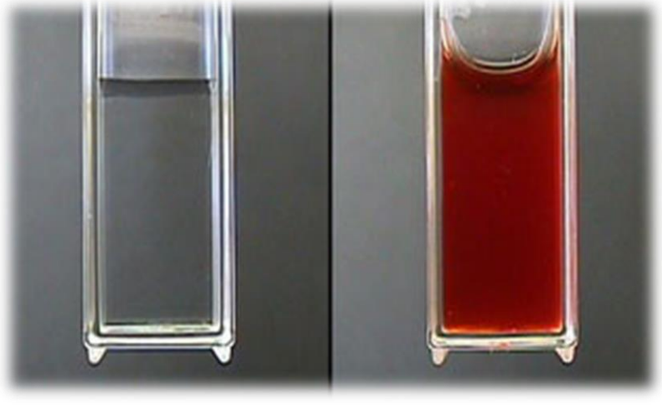
+ Ve (blue-green)

Seliwanoff ’s test:

- ❖ Distinguish between ketose and aldose sugars.
- ❖ Compounds give furfural derivatives in the presence of HCl (con.) then react with resorcinol to give orange color.
- ❖ Give orange color (ketose).



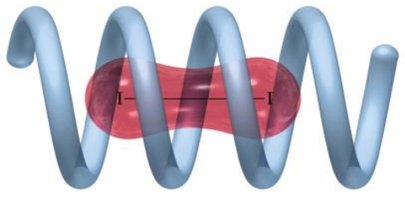
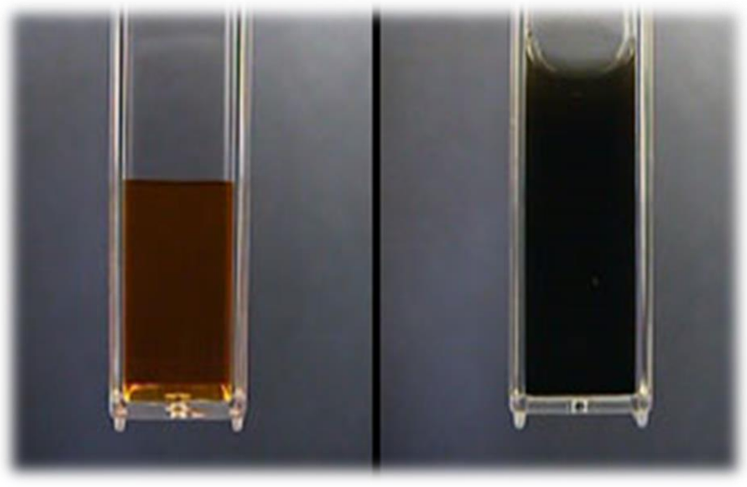
Fructose



-Ve (pale yellow) **+ Ve (orange color)**

Iodine ’s test:

- Test for polysaccharide .
- Amylose (Linear chain) with I_2 give helically coiled polysaccharide chain and iodine (amylose-iodine complex).

sugar $\xrightarrow{I_2}$  Amylose-iodine complex $\rightarrow$ 

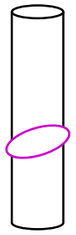
+Ve (deep orange) Dextrin

+ Ve (blue) starch

Carbohydrate Tests

1- Molish 's Test :
(general test for carbohydrate)

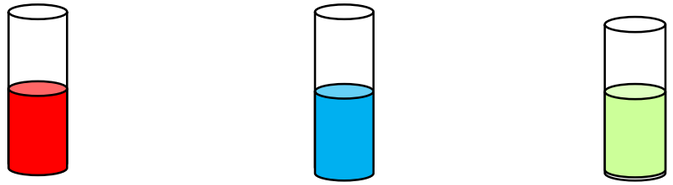
(2ml) of sugar
(0.5 ml) molish reagent
(2 drops) H_2SO_4 (con.) on wall



Purple ring

2- benedict 's Test :
(for reducing suger)

(2ml) of sugar
(1 ml) benedict reagent
heat for (3 min) in water bath



arabinose
(+) red

Starch
(-) blue

Sucrose
(-) green

3- barfoed 's Test :
(for mono-suger)

(1 ml) of sugar
(1 ml) barfoed reagent
heat for (5 min) in water bath

Mono suger
(+) red ppt

Di suger
(-) blue

4- bial 's Test :
(for pentose suger)

(1ml) of sugar
(1 ml) bial reagent
heat for (10 min) in water bath

Arabinose
(+) green-blue

Glucose
(-) orange

5- seliwanoff 's Test :
(for ketose suger)

(1ml) of sugar
(1 ml) seliwanoff reagent
heat for (5 min) in water bath

fructose
(+) red

glucose
(-) yellow

6- iodine 's Test :
(for poly suger)

(1ml) of sugar
(2 drops) iodine reagent

Dextrin
(+) red

Starch
(+) blue