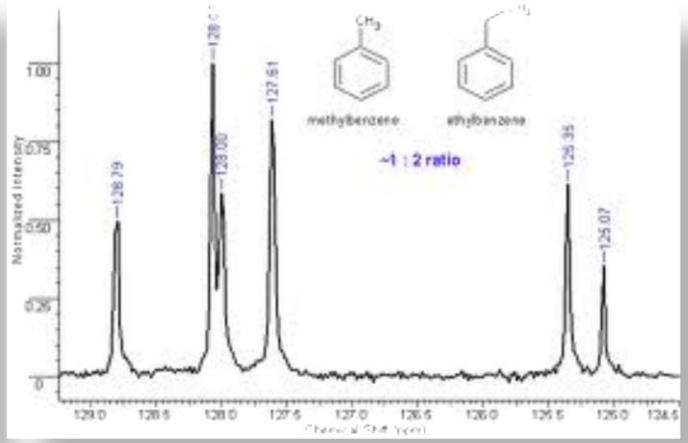
Basics of Natural Products (PHG220)



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PHG 220: Course Description

The following subjects will be covered :

1- Carbohydrates:

Chemical characters of different classes of carbohydrates and their biological significance

2- Plants containing Glycosides (botanical and chemical characters)

Introduction, Examples of medicinally important Glycosides and their importance as a "Lead Compounds" from the following groups:

Cardiac glycosides, Saponins, Anthracene derivatives, flavonoids and related compounds, Cyanogenic glycosides and thioglycosides.

3- Plants containing Alkaloids (botanical and chemical character)

Introduction, Examples of medicinally important Alkaloids and their importance as a "Lead Compounds" from the following groups:

Phenylalkylamine, Tropolone, Imidazole, pyridine, piperidine, tropane, quinoline, isoquinoline, Opium, Indole, Carboline, purine and steroidal alkaloids

PHG 220: Course Description

4- Unorganized drugs

5- Marine Derived Drugs

6- Toxicological Pharmacognosy (Poisonous plants)

Carbohydrates

Definition

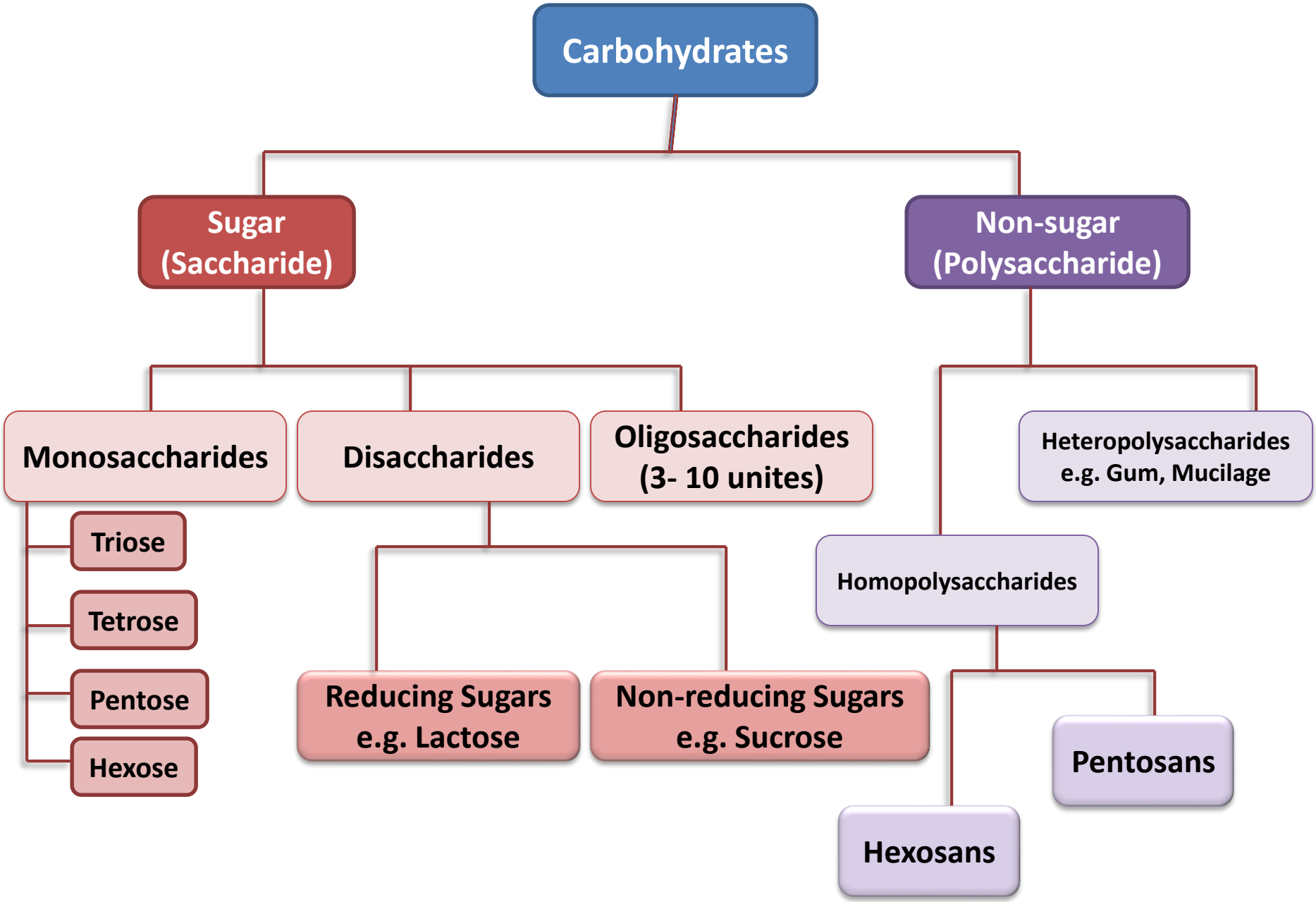
- Organic compounds composed of C, H and O with H and O present in the same ratio as in water. e.g. Glucose $C_6H_{12}O_6$.

Exceptions:

- Deoxy sugars such as Rhamnose $C_6H_{12}O_5$, digitoxose $C_6H_{12}O_4$
- Some non carbohydrates follow the definition:
  - » Acetic acid $C_2H_4O_2$
  - » Formaldehyde HCHO
  - » Lactic acid $C_3H_6O_3$

- **New definition:**

  Optically active Polyhydroxy aldehydes or ketones, or substances that hydrolyze to yield polyhydroxy aldehydes or ketones.


Carbohydrates
Sugar (Saccharide)
Non-sugar (Polysaccharide)
Monosaccharides
Disaccharides
Oligosaccharides (3- 10 unites)
Heteropolysaccharides e.g. Gum, Mucilage
Triose
Tetrose
Pentose
Hexose
Reducing Sugars e.g. Lactose
Non-reducing Sugars e.g. Sucrose
Homopolysaccharides
Pentosans
Hexosans

Physical Characters

Condition:

Sugars are white, crystalline in shape and with sharp melting points, while polysaccharides are white amorphous solids.

Taste:

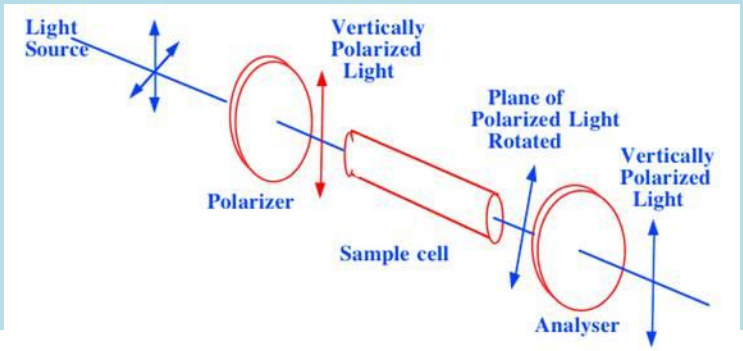
Sugars have a sweet taste. Polysaccharides are tasteless.

Solubility:

Monosaccharides are soluble in cold water and hot alcohol. Polysaccharides are partially soluble in hot water.

Optical activity:

A compound is optically active when, in solution, it is capable to rotate the plane of polarized light either to right (**dextrorotatory, *+*** or ***d***) or to the left (**levorotatory, -** or ***l***).

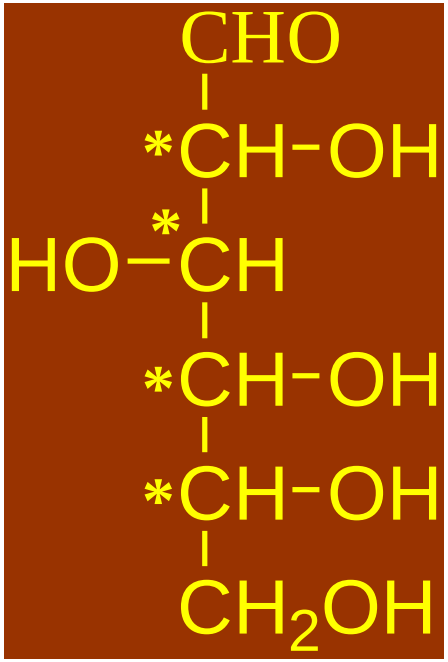


Sugar isomers

- Hexoses like glucose have 4 asymmetric (chiral) carbons.
- Number of isomers can be calculated from the formula:

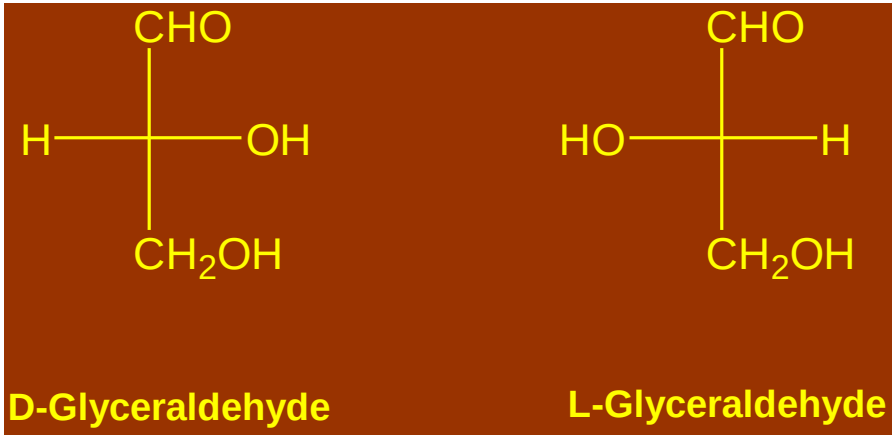
  Number of isomers = 2^n

  $= 2^4 = 16$



D and L in Sugars

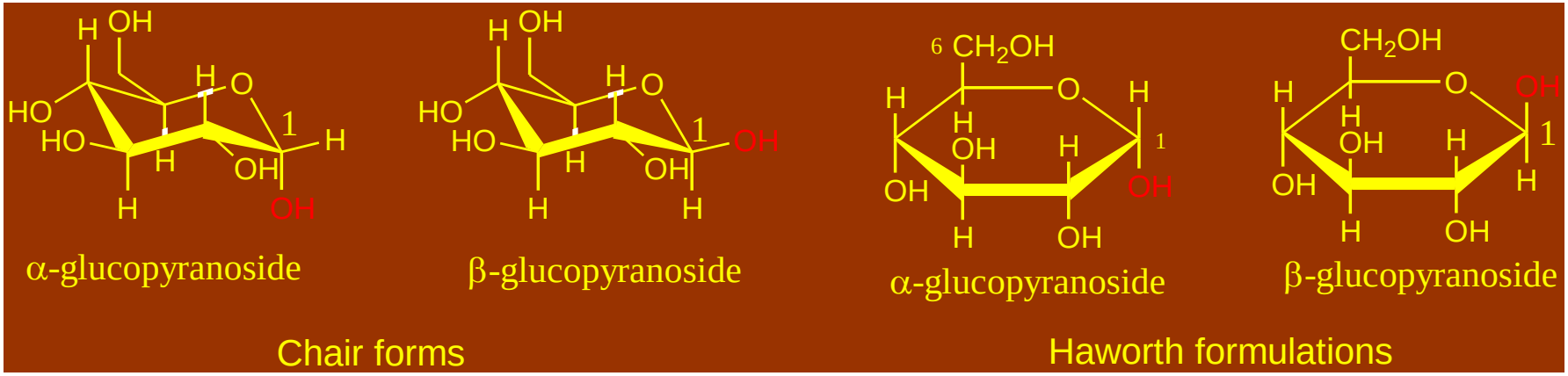
A monosaccharide in which the OH group attached to the carbon atom next to the CH_2OH (farthest asymmetric carbon atom from the carbonyl group) is always to the right is designated as a "D-sugar" and that with the same OH to the left as "L -sugar".



α- and β- anomers of Glucose

When sugars undergo cyclization C-1 became a new chairal carbon and two isomers exist. They are called " Anomers".

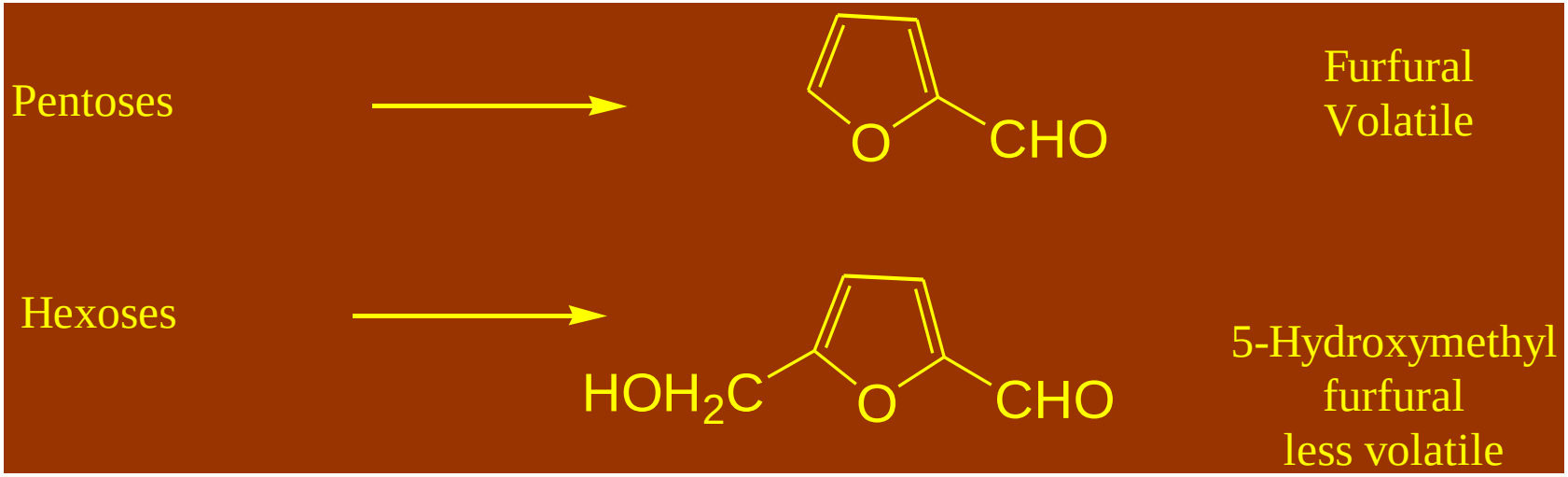
- **In the α-anomer the OH group is directed downside and in the β-anomer is directed to the upper side.**
- **These two forms have different specific rotation, in solution an equilibrium exists between the two forms (mutarotation phenomenon).**



Chemical Reaction for Carbohydrates

1- Effect of conc. acids:

Treatment with **conc. mineral acid** (HCl or H_2SO_4) leads to **dehydration of sugars** and formation of the corresponding **furfural**.



Reaction of furfural with amines resulted in Shiff's bases with different colours used as colour tests such as:

1- Molisch's test:

- **Any carbohydrate + Alcoholic α-naphthol then add conc. H_2SO_4 on the wall of the test tube ⟶ Violet ring between the two layers.**

2- Resorcinol test (for keto-hexoses):

- **Sugar solution + few crystals of Resorcinol + Equall volume of conc. HCl and warm on water bath ⟶ Rose Red Colour.**

3- Furfural test (Differentiate between Pentoses and Hexoses):

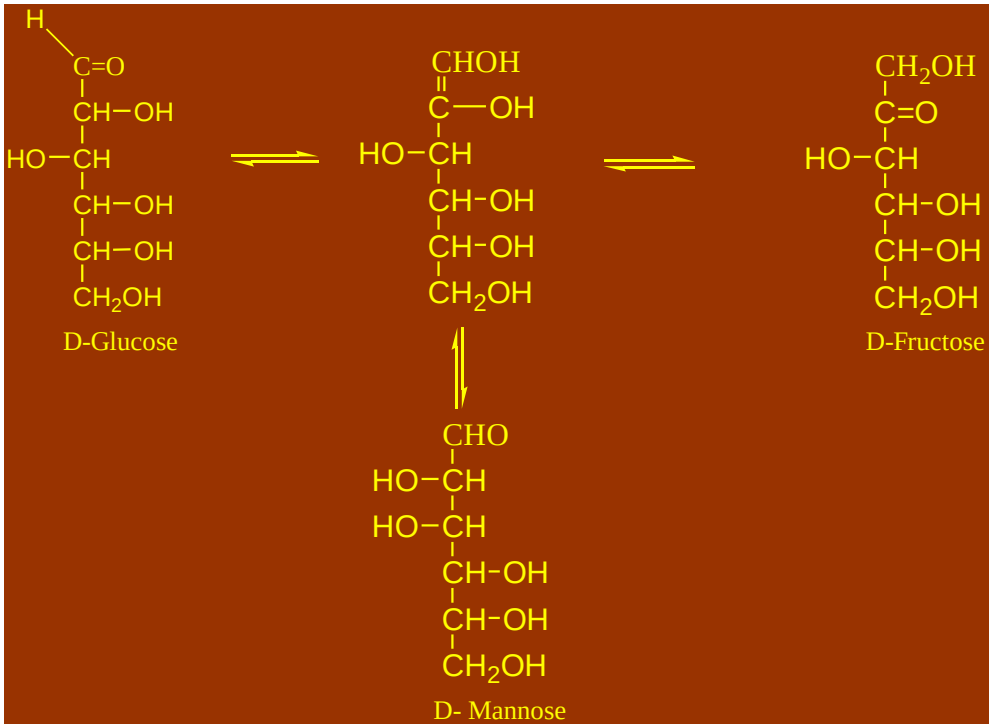
- **Pentose + Conc. Acid and heat, expose the vapours to Aniline acetate paper ⟶ Red colour**
- **Hexoses give negative result.**

Chemical Reaction for Carbohydrates (Cont.)

2- Effect of alkali:

a- Strong alkalis: Polymerization.

b- Weak alkalis: Isomerization.

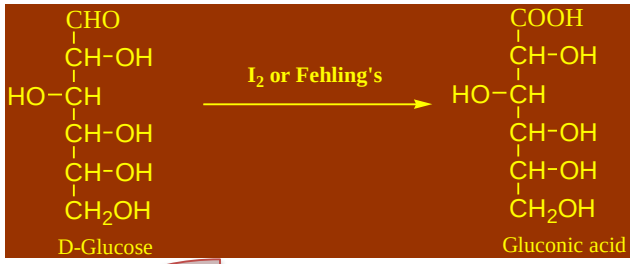


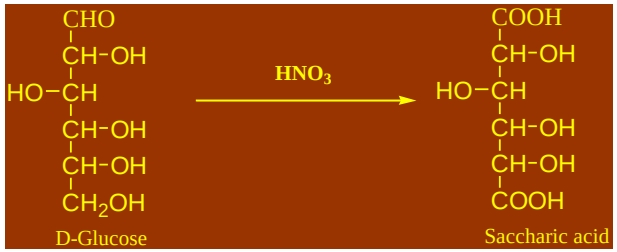
3- Oxidation

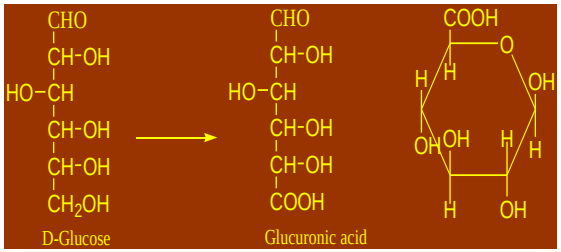
Mild These are oxidizing agents like **Bromine water** that convert the CHO group to COOH to produce **"onic acids".**

Strong These are oxidizing agents like **HNO_3** that convert the CHO and CH_2OH group to COOH to produce **"aric acids"**.

Enzymatic Takes place in plants and resulted in the oxidation of the primary alcohol group only producing **"uronic acids".**







Colour test based on this reaction: Fehling's reduction test:

Sugar solutions + Fehling's A ($CuSO_4$) + Fehling's B (NaOH, NaK tartarate rochell salt), heat on water bath ⟶ Red Precipitate of Cu_2O

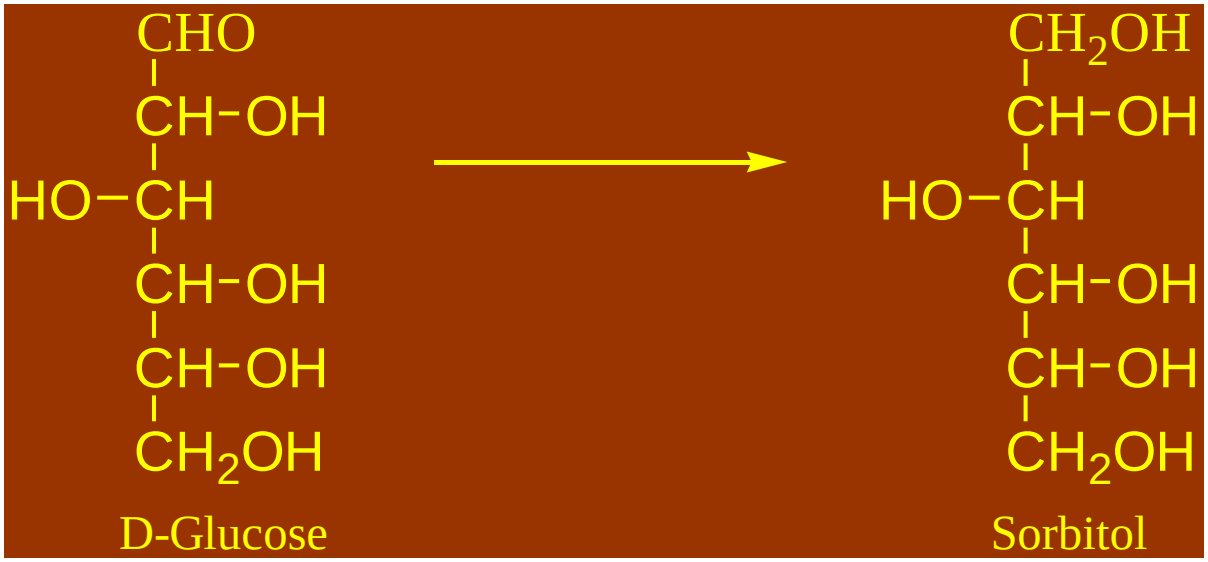
4- Reduction

This resulted in the reduction of the CHO to CH_2OH producing "Sugar Alcohols". Sodium borohydride or H2/Pt are examples of reducing agents.

Glucose → Sorbitol

Galactose → Dulcitol

Mannose → Mannitol

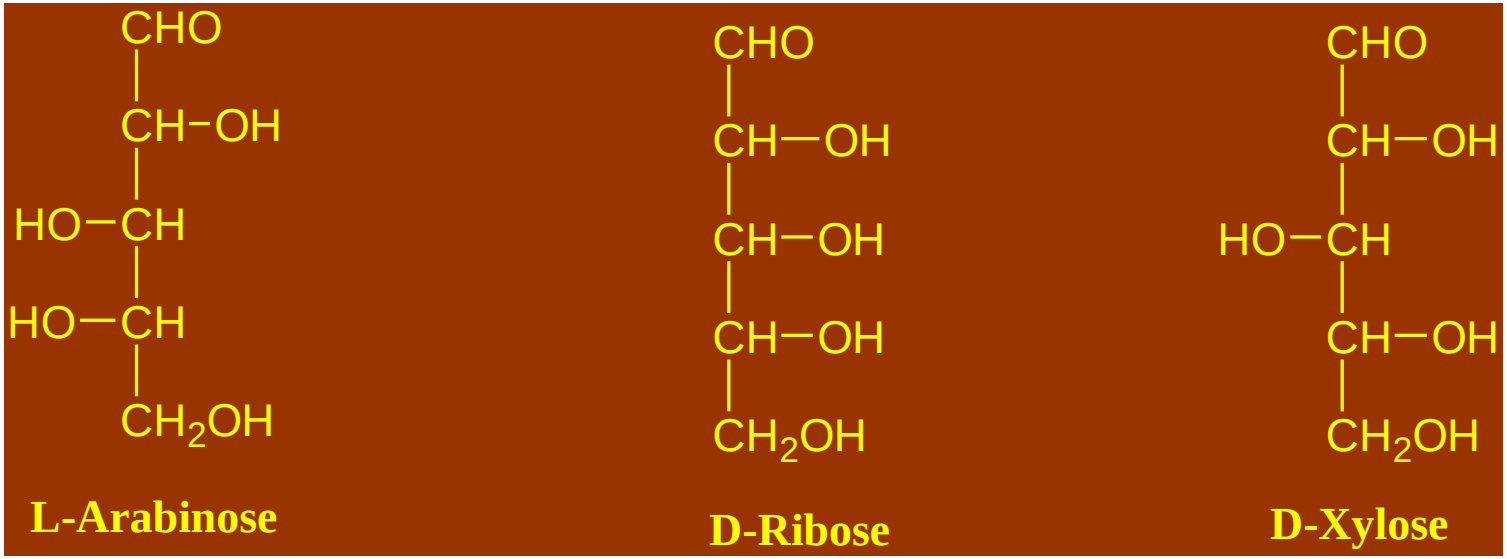


Monosaccharaides

1- Pentoses

Examples:

- **α-D-Ribose:** found in all plant and animal cells as the carbohydrate part of nucleic acids e.g. ribonucleic acid (RNA).
- **α-D-Xylose** (or wood sugar)**:** prepared from corncobs, bran, straw (or any woody material)
- **α-L-Arabinose** (or pectin sugar)**:** found in gums, pectic substances, accompanying hemicelluloses and forms the sugar part of several glycosides.



2- Hexoses

A- α-D-Glucose
(dextrose, grape sugar, blood sugar or cornmon sugar)

Occurrence:

Widely distributed in nature. Present in Grape and blood.

Preparation:

D-Glucose is **commercially** prepared from **starch** by:

- **Autoclaving** (at **150 ^{0}C**) an aqueous starch suspension (15-20%) with **dilute acid** (0.03 N hydrochloric acid) for **30 minutes** (complete hydrolysis).

Uses:

- **As source of energy either by mouth or IV injection.**
- **IV solutions to restore blood volume.**
- **Shocks following insulin administration.**
- **As osmotic diuretic.**
- **Sweetening agent for Pharmaceutical preparations, ice-cream and candy.**

Liquid glucose

Preparation:

It is prepared by **partial acid hydrolysis of starch** using **dilute hydrochloric acid** and **heating** for **20 minutes** at about **30 pounds pressure**.

Composition:

It consists of a mixture of **glucose, dextrin, maltose and water**.

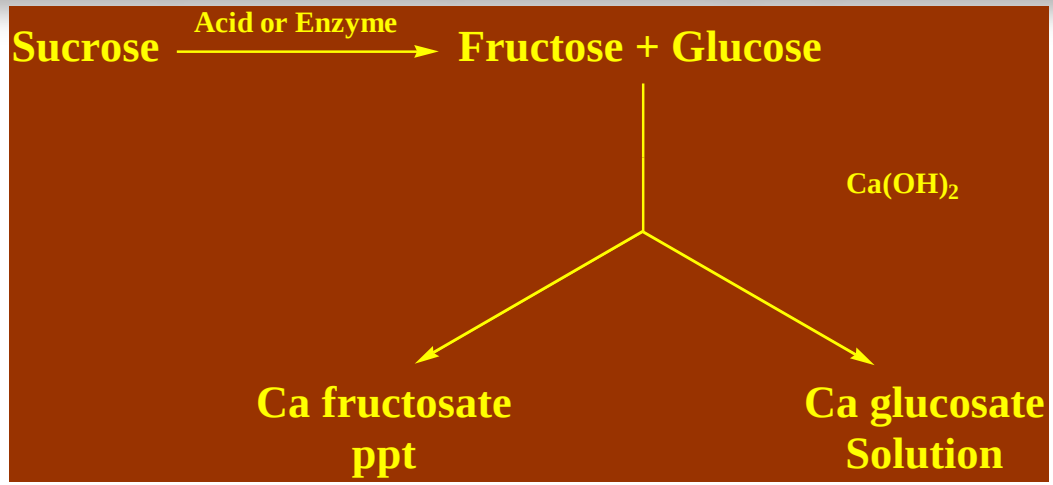
Uses:

Used as sweetening agent, as substitute for sucrose and as an excipient in massing pills.

B- Fructose (Levulose, Fruit Sugar)

Preparation:

- Acid hydrolysis of Inulin.
- Hydrolysis of Sucrose.



Uses:

- Infant food.
- Diabetic food.
- Diet control.

Some Monosaccharide Derivatives in Pharmacy and Medicine

1- Gluconic acid and its salts:

Preparation:

Gluconic acid is prepared from glucose by **mild oxidation** using either dilute HNO_3 or Br_2/Na_2CO_3 or Electrically or by **fermentation** using *Acetobacter aceti*.

Uses:

- **Ca gluconate** is used (by i.v. or orally) for treatment **calcium deficiency**.
- **Ferrous gluconate,** (orally or by i.v.) is used in **iron deficiency**.

- These salts are characterized by being more easily absorbed than other Ca or Fe salts.

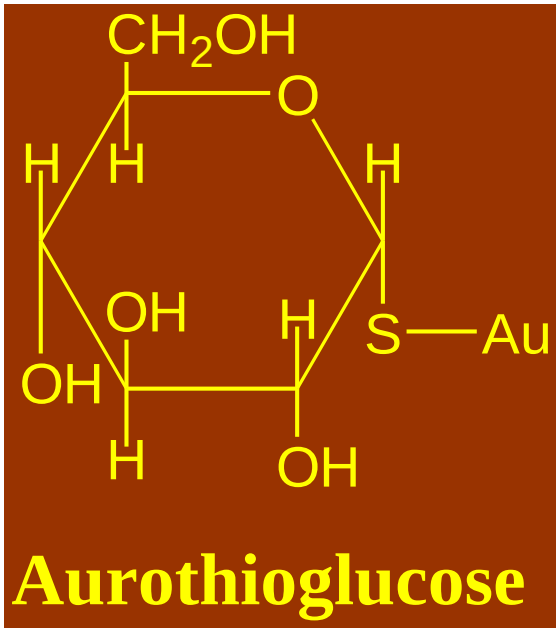
2- Glucuronic Acid:

- Naturally present in Gums and Mucilage's. It can be prepared by Enzymatic oxidation of glucose.
- Uses:

  Treatment of certain arthritic condition as it is a component of cartilages, joint capsules and fluids, nerve sheath and tendons.

3- Aurothioglucose:

- Treatment of rheumatic arthritis by IM injection.

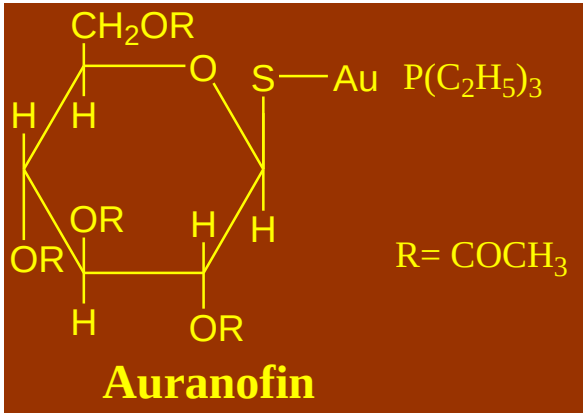


Aurothioglucose

4-Auranofin:

It is the alkyl Phosphine Gold complex with Acetylated thioglucose.

Treatment of rheumatic arthritis



Auranofin

5- Sorbitol and Mannitol:

Preparation: **Sorbitol is prepared by reduction of glucose and mannitol by reduction of mannose.**

Uses of sorbitol:

- **Mild laxative, osmotic diuretic**
- **Sweetening agent**
- **in some food and cosmetics industries.**

Uses of mannitol:

- **osmotic diuretic, laxative**
- **Vasodilator**
- **in laboratory diagnosis of kidney function.**