

Glucose Hemi-Acetal and Acetal (Glycoside) Formation: Some Common Concepts in Carbohydrate ("Sugar") Chemistry

1. Carbohydrates:

- (Carbon + Hydrate) are molecules with three or more carbons and a general formula that approximates $C_nH_{2n}O_n$

2. Saccharides:

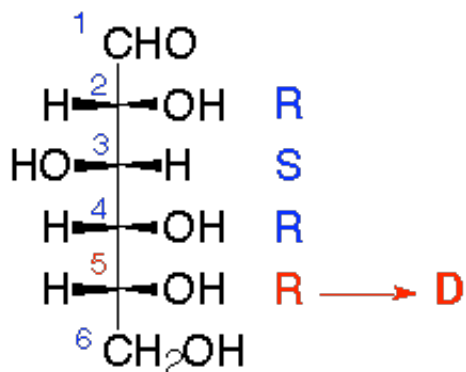
- are carbohydrates or sugars.
- **Monosaccharides** have one sugar moiety
- **Disaccharides** have two sugars linked together
- **Trisaccharides** have three
- **Tetrasaccharides** have four etc...
- **Polysaccharides** have an indeterminate number which can be hundreds of thousands or more.

3. Prefixes and Suffixes:

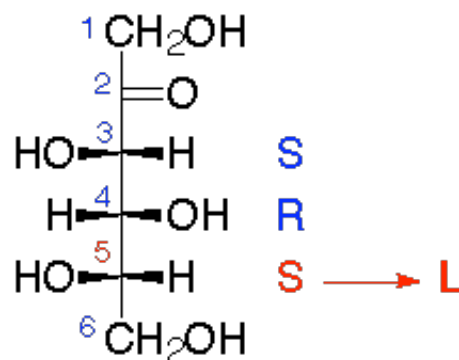
- The suffix (ending) for sugar names is: **-ose**
- The prefix defines the number of carbons:
 - **Triose** (3 carbons)
 - **tetrose** (4 carbons)
 - **pentose** (5 carbons)
 - **hexose** (6 carbons) etc
- A further prefix defines the types of carbonyl group in the sugar:
 - **aldo-** (aldehyde) or
 - **keto-** (ketone)
 - for example glucose (shown below) is an "aldohexose" whereas fructose is a "ketohehexose"
- The term **pyranose** means a six-membered sugar ring (hemiacetal or acetal - see below)
- the term **furanose** means a five-membered ring
- These terms are often prefixed as in "glucopyranose" which means glucose cyclized to its six-membered ring form (see below)

4. D- and L-Sugars:

This is a naming convention. If using standard nomenclature numbering, the **highest numbered stereogenic center** ("chiral center" or "asymmetric center") has **R configuration**, the sugar is a **D-sugar**; if it has S-configuration, the sugar is an L-sugar.



D-Glucose
an aldohexose

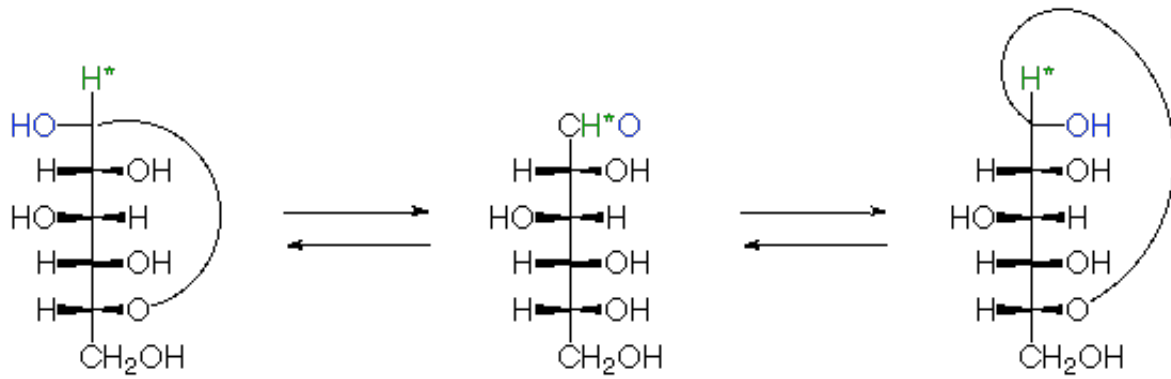


L-Sorbose
a ketohexose

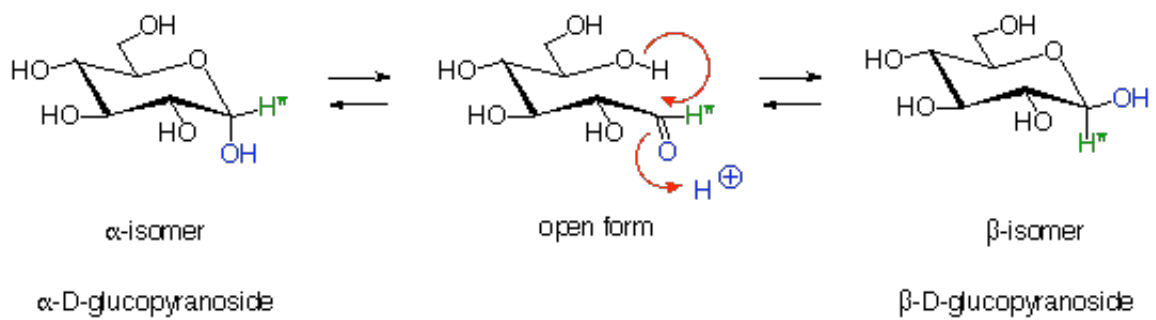
5. Glucose Hemi-Acetal Formation:

The open form of D-glucose (and many other sugars) can cyclize to form hemiacetals. These can be depicted in various ways as shown below. Under acidic conditions the hemiacetal form of glucose can react with other alcohols to give acetals known as glycosides. These are widely distributed in nature.

Fischer Projection:

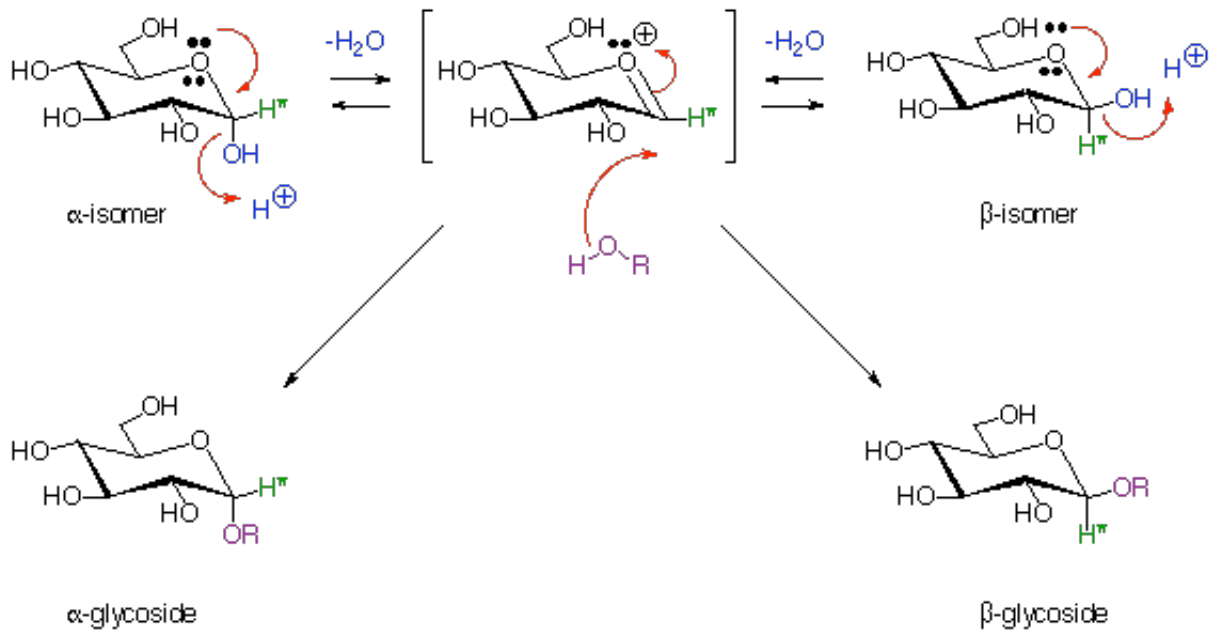


Same as Above in 3D View:

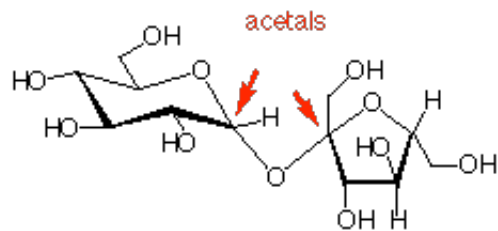


All of the above structures can be referred to as "D-glucose"

6. Glucose Acetal (Glycoside) Formation:



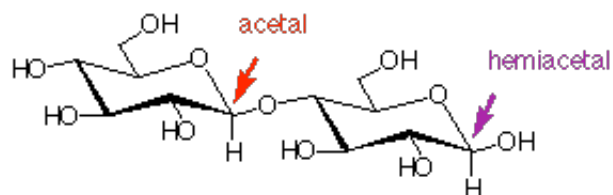
7. Examples of Disaccharides:



Sucrose (Table Sugar)

α -D-glucopyranosyl- β -D-fructofuranoside

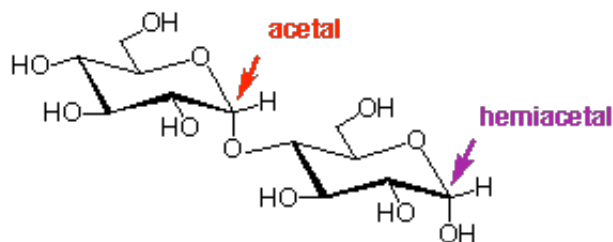
a non-reducing sugar



Cellobiose (from Cellulose)

β -D-glucopyranosyl- β -D-glucopyranoside

a reducing sugar



Maltose (a disaccharide made from starch)

α -D-glucopyranosyl- α -D-glucopyranoside

a reducing sugar

In the above structures, the anomeric carbons (acetal or hemiacetal) are indicated by coloured arrows. The full systematic names of the sugars are given below their common names.