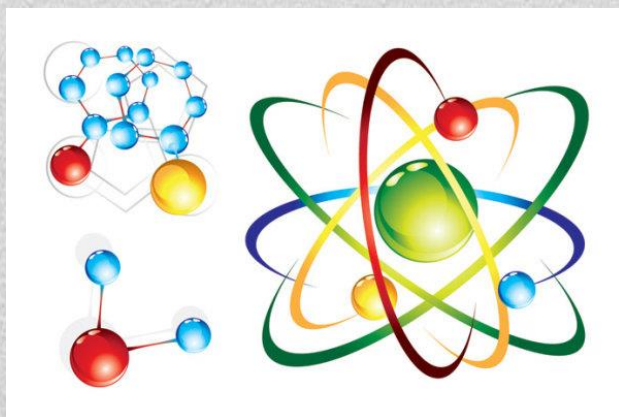


Philadelphia University
Faculty of Pharmacy

Introduction to Glycosides

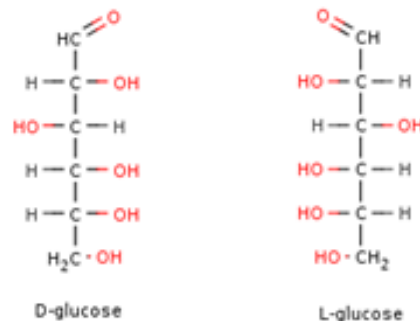
Pharmacognosy and Phytochemistry

Dr. Yousef Abusamra

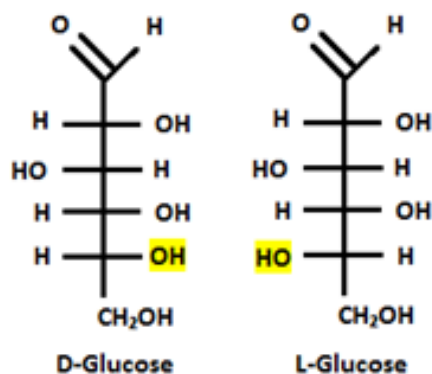


Monosaccharides

- **Monosaccharides:** also called **simple sugars**, are the most basic units of carbohydrates.
 - They are fundamental units of carbohydrates and cannot be further hydrolyzed to simpler compounds.
 - The general formula is $C_nH_{2n}O_n$.
 - Examples of monosaccharides include glucose (dextrose), fructose (levulose) and galactose.
 - Monosaccharides are the building blocks of disaccharides (such as sucrose and lactose) and polysaccharides (such as cellulose and starch).
 - Each carbon atom that supports a hydroxyl group (so, all of the carbons except for the primary and terminal carbon) is chiral, giving rise to a number of isomeric forms, all with the same chemical formula.
-
- The **Fischer projection** is a systematic way of drawing the skeletal formula of an acyclic monosaccharide.
 - Each stereoisomer of a simple **open-chain** monosaccharide can be identified by **the positions (right or left)** in the Fischer diagram of the chiral hydroxyls (the hydroxyls attached to the chiral carbons).
 - There are 16 distinct aldohexose **stereoisomers**, but the name "glucose" means a specific pair of mirror-image aldohexoses.
 - In the **Fischer projection**, one of the two glucose isomers has the hydroxyl at **left** on **C3**, and at **right** on **C4** and **C5**; while the other isomer has the reversed pattern.

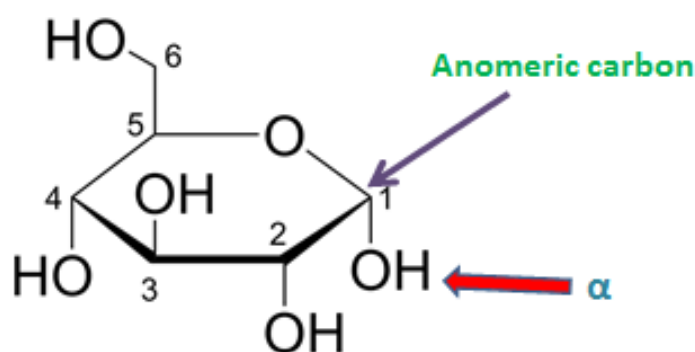


- In the Fischer projection, the D- and L- prefixes specifies the configuration at the **carbon atom that is second from bottom**: **D-** if the hydroxyl is on the right side, and **L-** if it is on the left side.



A **Haworth projection** is a common way of writing a structural formula to represent the **cyclic structure** of **monosaccharides** with a simple three-dimensional perspective.

3

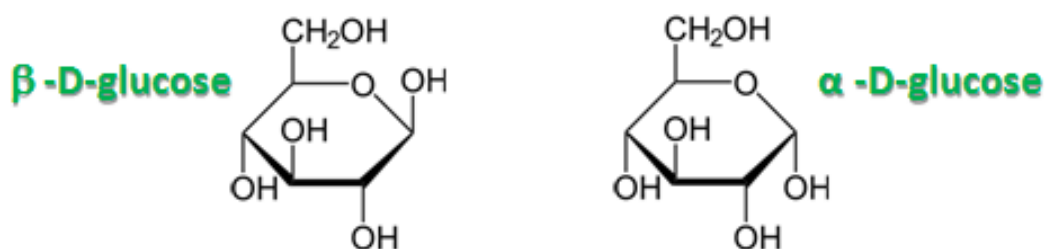


A Haworth projection of the structure for α -D-glucopyranose.

Pyranose is a collective term for carbohydrates that have a chemical structure that includes a six-membered ring consisting of five carbon atoms and one oxygen atom.

4

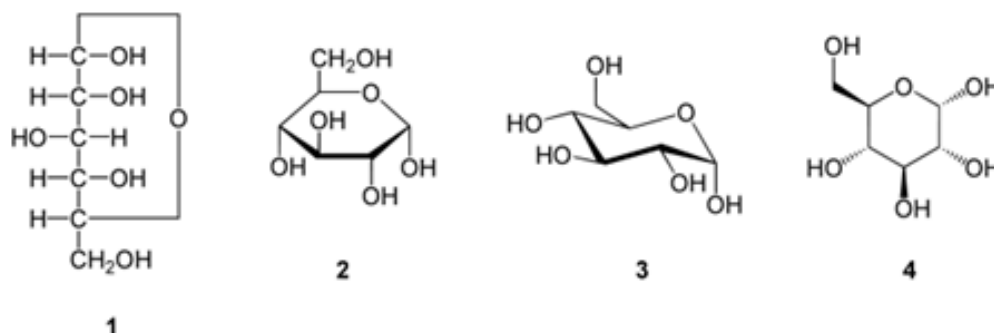
- Accordingly, the sugar is α or β depends on the 3-dimensional configuration of atom/s at the anomeric center.



- **The anomeric carbon** is the carbon derived from the **carbonyl** carbon (the ketone or aldehyde functional group) of the open-chain form of the carbohydrate molecule.
- **Anomerization** is the process of conversion of one anomer to the other.

5

- Note that the structures are almost identical, except that in the α form, the OH group on the far right is **down**, and, in the β form, the OH group on the far right is **up**.



Different projections of α -D-glucopyranose:

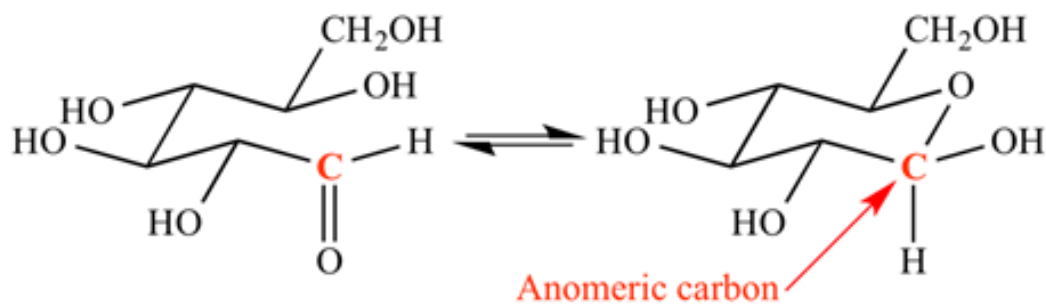
1 = Fischer projection with C-1 at the top the anomeric centre. **C-5** is the anomeric reference atom.

2,3 = Haworth projections.

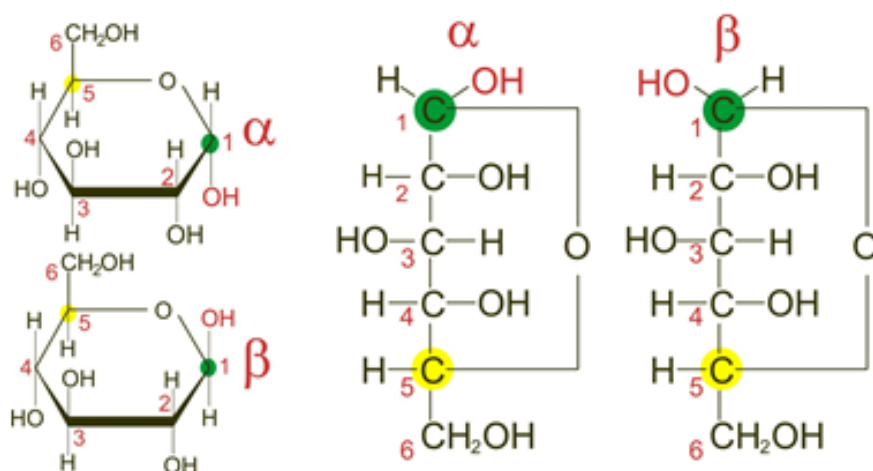
4 = Mills projection.

6

❖ **Anomeric carbon:** In a cyclic carbohydrate, the carbon that was the carbonyl carbon in **acyclic** form. In the cyclic form, the anomeric carbon can be found next to the oxygen atom in the pyranose or furanose ring, but on the opposite side from the carbon that carries the acyclic CH_2O group (e.g., the CH_2OH group in the example shown below).



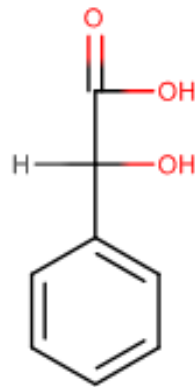
7



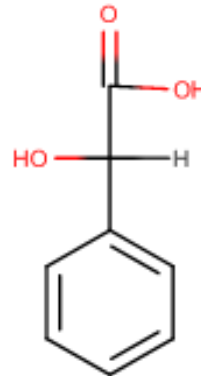
➤ The glycosides are either α or β .

8

D-mandelic acid



L-mandelic acid



9

Glycosides:

Dr. Yousef Abusamra

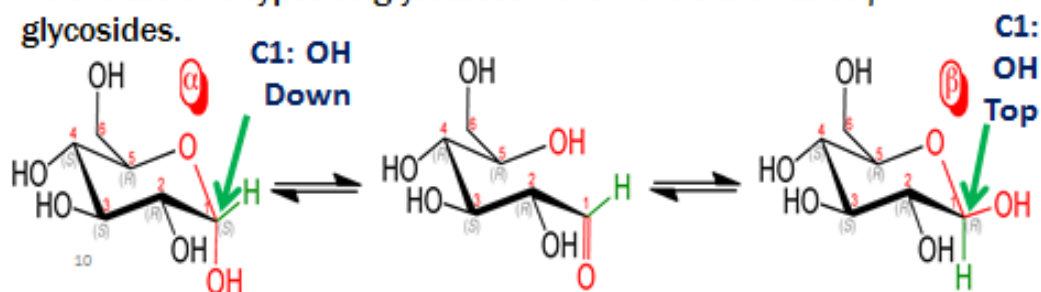
+++++

Definition: compounds which consist of two parts the **aglycone**: an organic compound which is attached to sugar (**glycon**) by glycosidic linkage through either, C, O, N or S, atom.

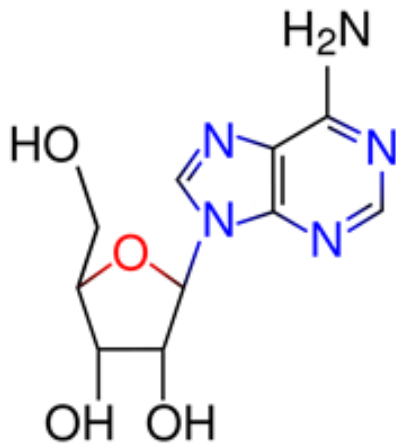
Also, the **aglycone** may be called the **genin**. ❖

The general name for these compounds is **glycosides** but when ❖ the sugar moiety is **glucose**, they could be named **glucosides**.

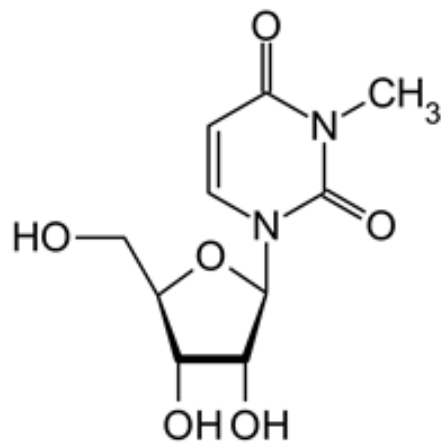
There are two types of glycosides which are either α - or β - ❖ glycosides.



• **Example of different glycosides linkages:**



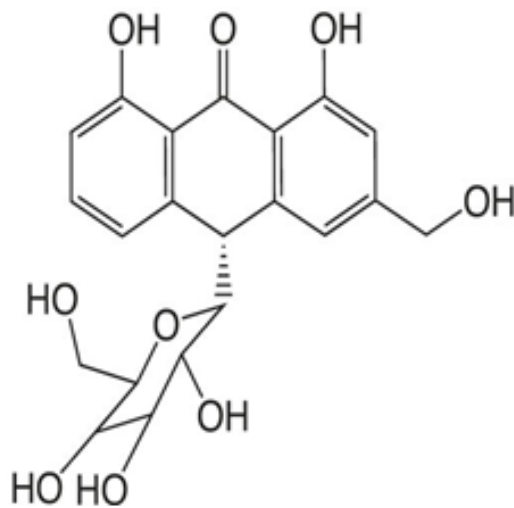
Adenosine



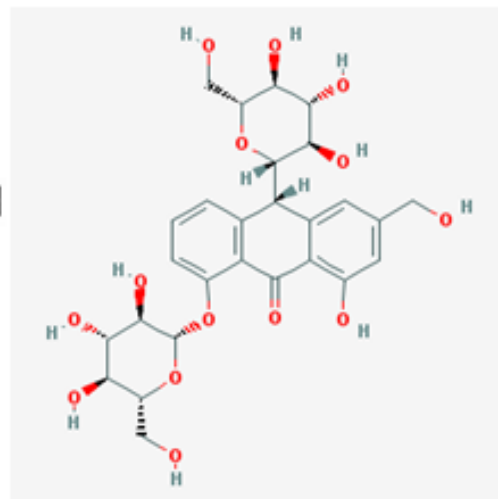
3-methyluridine

N-glycosides

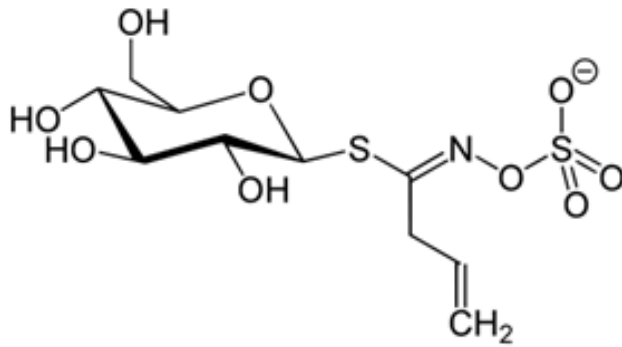
Example: anthraquinone glycosides:



Barbaloin
C-glycoside



Cascaroside A
O-glycoside



Sinigrin
S-glycoside

➤ O-glycosides are the most popular type.

Differentiation:

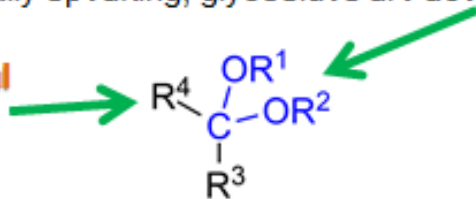
➤ It is possible to differentiate between α - & β -glycosides by **enzyme hydrolysis**.

For example: one popular enzyme is **emulsin** special for **β -glycosides**, other enzymes react on α - & not β -glucoside.

➤ While, **acid hydrolysis** will not differentiate between α - & β -ones.

➤ Chemically speaking, glycosides are acetals.

Tetrahedral Geometry



❖ An **acetal** is a functional group with the following connectivity: $R_2C(OR)_2$, where both **R** groups (**R1 and R2**) are organic fragments. The central carbon atom has **four** bonds to it, and is therefore saturated (**tetrahedral geometry**).

❖ The two **RO** groups may be equivalent to each other or not.

❖ The two **R** groups (**R3 and R4**) can be equivalent to each other (a "**symmetric acetal**") or not (a "**mixed acetal**").

➤ There are different types of glycosides depending on the *atom* through which the linkage is done.

➤ The most popular glycoside are the **O-glycoside**.

Functions of Glycosides in the Plants:

➤ Formation of glycosides in different parts of plants has:

1. *Pharmacological activity*.
 2. *Role in the life of plants*; including regulation, protection and sanitary (health) function.
- Generally, **pharmacological action** of glycosides, is associated with and due to the **aglycone**.
- The **role of sugar** in the molecule is normally one of the **stabilization** and **solubilization**, although the resulting change in physical properties may in some instances *modify* the pharmacodynamic properties of the aglycone.
- For administration specially by *oral* route, as a medicinal agent, the **sugar portion** of the glycoside is in most cases necessary to **carry** the aglycone to the site of action at a particular organ or tissue, where the pharmacological action is intended.