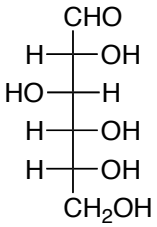
Carbohydrates (also known as sugars or saccharides) – See Handout

Approximately 0.02% of the sun's energy is used on this planet for photosynthesis in which organisms convert carbon dioxide (CO_2) and water (H_2O) to D-glucose ($C_6H_{12}O_6$) and oxygen (O_2). About 4 x 10^{11} metric tons of carbon dioxide are converted to glucose annually by plants, and glucose (as a subunit) is the most abundant organic compound on the planet. Learn the structure of D-glucose shown below.



Glucose (also called dextrose)

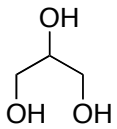
Carbohydrates occur in every living organism. The sugar in starch in food and the cellulose in wood, paper, and cotton, are carbohydrates. Modified carbohydrates form part of the coating in living cells, other carbohydrates are found in the DNA that carries genetic information, and still others are used in medicine.

The term carbohydrate is used to refer to a broad class of polyhydroxylated aldehydes and ketones commonly called sugars. Carbohydrates are also known as saccharides.

The general formula for a carbohydrate is approximated as $C_NH_{2N}O_N$. The number of carbons in the carbohydrate chain is also given special nomenclature.

3 carbons – Triose
4 carbons – Tetrose
5 carbons - pentose
6 carbons – hexose

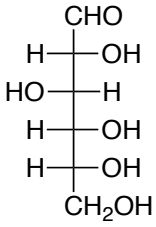
Example:



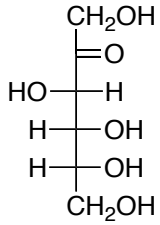
Glycerol

(a triose)

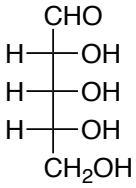
Carbohydrates can further be classified as either aldoses or ketoses. The –ose suffix is used to identify the carbohydrate, and the aldo- and keto- prefixes identify the nature of the carbonyl group. For example, glucose is an aldohexose, a six carbon aldehyde sugar; fructose is a ketohexose, a six carbon keto sugar; and ribose is an aldopentose, a five carbon aldehyde sugar. The most commonly occurring sugars are either aldopentoses or aldohexoses.



Glucose
(an aldohexose)



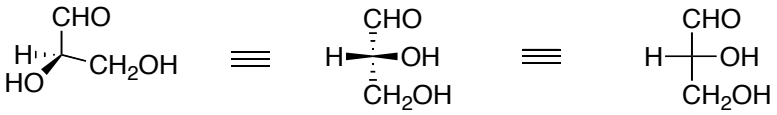
Fructose
(a ketohexose)



Ribose
(an aldopentose)

Configuration of Sugars: Fischer Projections

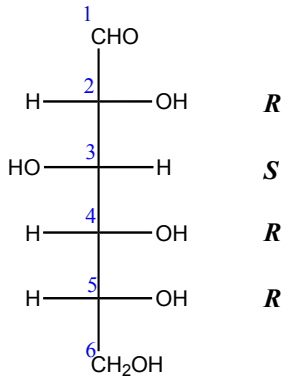
Fischer projections depict the stereogenic centers on a flat page surface. A Fischer projection is represented by two crossed lines, in which the horizontal line represents bonds coming out of the page, and the vertical lines represent bonds going into the page. By convention, the carbonyl is placed at or near the top of the Fischer projection. Shown below is the Fischer projection of (R)-glyceraldehyde.



(R)-glyceraldehyde

Fischer projection of
(R)-glyceraldehyde

D-glucose has the structure shown below (you must know its structure). It is an aldohexose ("aldo" since it contains aldehyde functionality and "hexose" since it is a six carbon sugar, numbered on structure).



It contains 4 stereogenic carbons (C2, C3, C4 and C5). The highest numbered stereogenic center tells you whether it is a D (if it is R configuration at that stereogenic center) or an L (if it's S configuration at that stereogenic center) sugar. For glucose, the highest numbered stereogenic center is C5. It has an R configuration. By convention, it is designated as a "D" sugar. Configurations of other stereogenic centers are also shown next to the structure.