

CHAPTER 3
CARBOHYDRATES

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3.1 OVERVIEW

More than half of all the organic carbon on Earth is stored in just two carbohydrate molecules—starch and cellulose. As the word carbohydrate suggests, they are hydrated carbon, or carbon with water added to it. As may be expected, carbohydrates have the general formulae $(CH_2O)_n$, where $n=3$ or more. Carbohydrates constitute a versatile class of molecules.

3.2 ROLE OF CARBOHYDRATES

There are a lot of biological roles of carbohydrates in nature. First of all, carbohydrates can be a major energy source for living organisms (eg: glucose is a principal energy source in animals and plants). Other than that, as a means of transporting energy (eg: sucrose in plant tissues), as a structural material (eg: cellulose in plants, chitin in insects, building blocks of nucleotides), carbohydrates can act as a precursor for other biomolecules production (eg: purine, pyrimidine).

3.3 HOW ARE CARBOHYDRATES NAMED?

Carbohydrates generally can be classified into three groups: **monosaccharides** (and their derivatives), **oligosaccharides**, and **polysaccharides** (Figure 3.1). The monosaccharides are also called simple sugars. Monosaccharides cannot be broken down into smaller sugars under mild conditions. Oligosaccharides are formed when a few (2 to 10) monosaccharides are linked, while polysaccharides are formed when repeating units (mono- or di-saccharides) are bonded/joined together. The reaction that adds monosaccharide units to a growing carbohydrate molecule involves the loss of one water molecule for each new link formed.

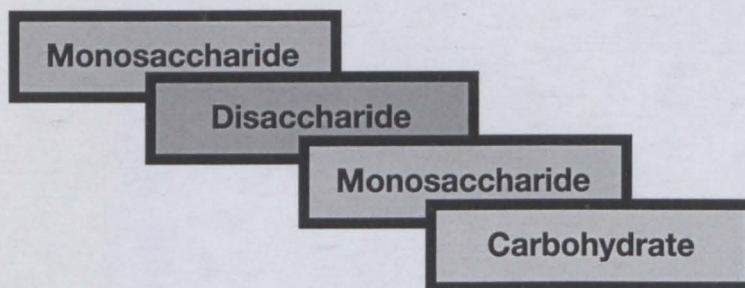
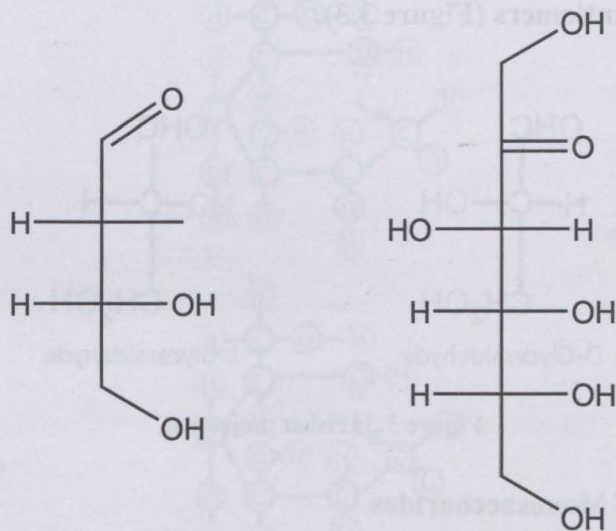


Figure 3.1: Classifications of Carbohydrates.

3.4 MONOSACCHARIDES

3.4.1 Properties and Classification

Monosaccharides are colorless and crystalline solids. It is soluble in water but insoluble in nonpolar solvents. One of the carbon atoms is double-bonded to an oxygen atom to form a carbonyl group; each of the other carbon atoms has a hydroxyl group. Carbohydrates with an aldehyde (-CHO) functional group are called *aldoses*, e.g. D-Erythrose and those with a keto group (-C=O) are *ketoses*, e.g. D-Fructose (**Figure 3.2**). Monosaccharides can be classified according to the number of carbon atoms they contain (**Table 3.1**).



D-Erythrose (Aldose)

D-Fructose (Ketose)

Figure 3.2: Examples of Aldose and Ketose.

Table 3.1: Classification of Monosaccharides

Carbon atoms	General Terms	Aldehydes	Ketones
3	Triose	Aldotriose	Ketotriose
4	Tetrose	Aldotetrose	Ketotetrose
5	Pentose	Aldopentose	Ketopentose
6	Hexose	Aldohexose	Ketohexose
7	Heptose	Aldoheptose	Ketoheptose