2.11 Simple Carbohydrates

As shown in the figure below, simple carbohydrates can be further divided into monosaccharides and disaccharides. Mono- means one, thus monosaccharides contain one sugar. Di- mean two, thus disaccharides contain 2 sugar units.

Figure 2.111 Overview of Carbohydrates

**Monosaccharides**

The 3 monosaccharides are: glucose, fructose and galactose. Notice that all are 6-carbon sugars (hexoses). However, fructose has a five member ring, while glucose and galactose have 6 member rings. Also notice that the only structural difference between glucose and galactose is the position of the alcohol (OH) group that is shown in red.

Table 2.111 Monosaccharides
Glucose - Product of photosynthesis, major source of energy in our bodies

Fructose - Commonly found in fruits & used commercially in many beverages

Galactose - Not normally found in nature alone, normally found in disaccharide lactose

**Web Link**

*Not familiar with ring structures, see how glucose’s ring is closed*

### Disaccharides

Disaccharides are produced from 2 monosaccharides through a dehydration reaction. This means water is produced during the reaction. As shown in the figure below, glucose contributes the hydrogen (H), and galactose contributes an alcohol group (OH). Together these form water (H₂O). In the example below, the two monosaccharides galactose and glucose form the disaccharide lactose.

![Figure 2.112 Dehydration reaction between galactose and glucose to form lactose.](image)

The commonly occurring disaccharides are:

- **Maltose** (glucose + glucose, aka malt sugar) - seldom found in foods, present in alcoholic beverages and barley

- **Sucrose** (glucose + fructose, aka table sugar) - only made by plants.

- **Lactose** (galactose + glucose, aka milk sugar) - primary milk sugar
The formation of each disaccharide is shown below:

![Diagram of disaccharide formation](image)

Figure 2.113 The formation of the 3 disaccharides

Each of these disaccharides contains glucose and all the reactions are dehydration reactions. Also notice the difference in the bond structures. Maltose and sucrose have alpha-bonds, which are depicted as v-shaped above. You might hear the term glycosidic used in some places to describe bonds between sugars. A glycoside is a sugar, so glycosidic is referring to a sugar bond. Lactose, on the other hand, contains a beta-bond. We need a special enzyme, lactase, to break this bond, and this leads to a problem of lactose intolerance.

**High-Fructose Corn Syrup**

Food manufacturers are always searching for cheaper ways to produce their food. One method that has been popular is the use of high-fructose corn syrup as an alternative to sucrose. High-fructose corn syrup is approximately 50% glucose and 50% fructose, which is the same as sucrose. Nevertheless, because an increase in high-fructose corn syrup consumption (see figure below) has coincided with the increase in obesity in the U.S., there is a lot of controversy surrounding its use.
Opponents claim that high-fructose corn syrup is contributing to the rise in obesity rates. As a result, some manufactures have started releasing products made with natural sugar. You can read about this trend in the following New York Times article in the link below. Also, manufacturers have rebranded high-fructose corn syrup as corn sugar to get around the negative perception of the name. But just recently the FDA rejected the Corn Refiners Association request to change the name officially to corn sugar as described in the third link.

Web Links
- Sugar is back on labels, this time as a selling point
- No new name for high-fructose corn syrup

References & Links

Links
Not familiar with Ring structures, see how glucose's ring is closed - http://en.wikipedia.org/wiki/File:Glucose_Fisher_to_Haworth.gif
Sugar is back on labels, this time as a selling point - http://www.nytimes.com/2009/03/21/dining/21sugar.html?_r=1&ref=nutrition
No new name for high-fructose corn syrup - http://well.blogs.nytimes.com/2012/05/31/no-new-name-for-high-fructose-corn-syrup/