Introduction

The chemistry of carbohydrates most closely resembles that of alcohol, aldehyde, and ketone functional groups. As a result, the modern definition of a CARBOHYDRATE is that the compounds are polyhydroxy aldehydes or ketones. The chemistry of carbohydrates is complicated by the fact that there is a functional group (alcohol) on almost every carbon. In addition, the carbohydrate may exist in either a straight chain or a ring structure. Ring structures incorporate two additional functional groups: the hemiacetal and acetal.

A major part of the carbon cycle occurs as carbon dioxide is converted to carbohydrates through photosynthesis. Carbohydrates are utilized by animals and humans in metabolism to produce energy and other compounds.

Photosynthesis is a complex series of reactions carried out by algae, phytoplankton, and the leaves in plants, which utilize the energy from the sun. The simplified version of this chemical reaction is to utilize carbon dioxide molecules from the air and water molecules and the energy from the sun to produce a simple sugar such as glucose and oxygen molecules as a by product. The simple sugars are then converted into other molecules such as starch, fats, proteins, enzymes, and DNA/RNA i.e. all of the other molecules in living plants. All of the "matter/stuff" of a plant ultimately is produced as a result of this photosynthesis reaction.

Di- and Poly-Carbohydrates

- **Monosaccharides** contain one sugar unit such as glucose, galactose, fructose, etc.
- **Disaccharides** contain two sugar units. In almost all cases one of the sugars is glucose, with the other sugar being galactose, fructose, or another glucose. Common disaccharides are maltose, lactose, and sucrose.
- **Polysaccharides** contain many sugar units in long polymer chains of many repeating units. The most common sugar unit is glucose. Common poly saccharides are starch, glycogen, and cellulose.

<table>
<thead>
<tr>
<th>Name</th>
<th>Derivation of name and Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>From Greek word for sweet wine; grape sugar, blood sugar, dextrose.</td>
</tr>
<tr>
<td>Galactose</td>
<td>Greek word for milk--&quot;galact&quot;, found as a component of lactose in milk.</td>
</tr>
<tr>
<td>Fructose</td>
<td>Latin word for fruit--&quot;fructus&quot;, also known as levulose, found in fruits and honey; sweetest sugar.</td>
</tr>
<tr>
<td>Ribose</td>
<td>Ribose and Deoxyribose are found in the backbone structure of RNA and DNA, respectively.</td>
</tr>
</tbody>
</table>

**Disaccharides** - contain two monosaccharides

<table>
<thead>
<tr>
<th>Name</th>
<th>Derivation of name and Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sucrose</td>
<td>French word for sugar--&quot;sucre&quot;, a disaccharide containing glucose and fructose; table</td>
</tr>
</tbody>
</table>
Name | Derivation of name and Source
--- | ---
sugar, cane sugar, beet sugar.

**Lactose** | Latin word for milk--"lact"; a disaccharide found in milk containing glucose and galactose.

**Maltose** | French word for "malt"; a disaccharide containing two units of glucose; found in germinating grains, used to make beer.

### Common Polysaccharides

**Starch** | Plants store glucose as the polysaccharide starch. The cereal grains (wheat, rice, corn, oats, barley) as well as tubers such as potatoes are rich in starch.

**Cellulose** | The major component in the rigid cell walls in plants is cellulose and is a linear polysaccharide polymer with many glucose monosaccharide units.

**Glycogen** | This is the storage form of glucose in animals and humans which is analogous to the starch in plants. Glycogen is synthesized and stored mainly in the liver and the muscles.

### Metabolism

**Metabolism** occurs in animals and humans after the ingestion of organic plant or animal foods. In the cells a series of complex reactions occurs with oxygen to convert for example glucose sugar into the products of carbon dioxide and water and ENERGY. This reaction is also carried out by bacteria in the decomposition/decay of waste materials on land and in the water.

**Combustion** occurs when any organic material is reacted (burned) in the presence of oxygen to give off the products of carbon dioxide and water and ENERGY. The organic material can be any fossil fuel such as natural gas (methane), oil, or coal. Other organic materials that combust are wood, paper, plastics, and cloth.

The whole purpose of both processes is to convert chemical energy into other forms of energy such as heat.

### Contributors

- Charles Ophardt, Professor Emeritus, Elmhurst College; Virtual Chembook