

Biology background research: Covalent bonding in sugars

Carbohydrates are essential components of all living organisms. The basic units of all carbohydrates are the monosaccharides. They can be synthesized from simpler substances in a process called gluconeogenesis, but ultimately nearly all biological molecules are the products of photosynthesis. (An endothermic reaction that uses energy from the sun to make sugars from carbon dioxide and water) Polysaccharides consist of many covalently linked monosaccharide units and have molecular masses ranging into the millions of Daltons. One major role of carbohydrates is in energy reserves such as starch in plants and glycogen in animals. Although carbohydrates play a passive role in the cell they are essential elements in many if not most biological processes. I am using a simplified form of carbohydrates in this lesson, and it does not take into account all the varied configurations of carbohydrates in nature. Carbohydrates are made up of monosaccharides linked together into polysaccharide chains by a type of covalent bond known as a glycosidic bond. These glycosidic bonds are formed in a dehydration synthesis reaction. It is when one sugar gives up a hydrogen atom from a hydroxyl group and the other sugar gives up the entire hydroxyl group. As H_2O is formed an oxygen atom is left between two covalent bonds linking the two sugars.

Monosaccharides can be linked together to form very long polysaccharide chains.

Monosaccharides have a general molecular formula that is some multiple of CH_2O . For example the formula for glucose is $\text{C}_6\text{H}_{12}\text{O}_6$ it has the two trademarks of a sugar: a number of hydroxyl groups and a carboxyl group. Hydroxyl groups are made up of a hydrogen atom bonded to an oxygen atom. The oxygen is bonded to the carbon section of a molecule. Organic compounds containing a hydroxyl group are called alcohols. A carboxyl group is a carbon atom linked by a double bond to an oxygen atom. Fructose has the same chemical formula as glucose, but differs in its configuration. The hydroxyl group makes a sugar an alcohol and the carboxyl group makes it an aldehyde or ketone based on its location. Glucose is an aldehyde, and fructose is a ketone. Seemingly minor differences like this give isomers different properties, such as the ability to react with other molecules. (isomers are two or more chemicals made from the same number and types of atoms, but have a different geometrical arrangement) In this case, the differences make fructose taste much sweeter than glucose.

Polysaccharides are very versatile and can be formed into helices as in starch and glycogen or in rod shapes as in cellulose. This rod shape links rods together through hydrogen bonds.

Although they are made from similar molecules (mainly glucose) the hydrogen bonds between the rod shape of the cellulose makes it difficult to hydrolyzed by animals.

Although cellulose is not absorbed nutritionally, it serves a purpose by providing our digestive tract with the fiber it needs to remain healthy.