

Chemistry and uses of carbohydrates

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CARBOHYDRATES Chemistry & Uses Carbohydrates are the most abundant of the biomolecules though they form a smaller part of the human body. The term carbohydrate originates from German word Kohlenhydrate; meaning hydrates of water. They were originally thought to comprise of carbon and water in 1: 1 ratio. Today chemistry of carbohydrates is better known, the generic term is still in use (Lichtenthaler, 1).

A carbohydrate is a polyhydroxy aldehyde/ketone, with the empirical formula $C_nH_{2n}O_n$ (Stoker, 593).

Figure 1: Glucose to Fructose Isomerization

On the basis of molecular size or the number of polyhydroxy aldehyde or polyhydroxy ketone units, carbohydrates are classified as follows (Stoker, 594):

1. Monosaccharide e. g. glucose, fructose etc
2. Disaccharide e. g. sucrose, lactose etc
3. Polysaccharides e. g. Glycogen, starch etc

The unique characteristics of the chemistry of carbohydrates are:

1. Multiple functional groups; in fact one attached to each of the C-atoms as can be seen in the structure presented in the figure.
2. Chirality or handedness. Two form of the molecule are mirror images of each other.
3. Stereoisomerism or difference in the orientation of molecules in space

The chemical reactions exhibited by monosaccharides are:

Oxidation of the aldehyde or keto group to form acids.

Reduction of the keto or also groups to form sugar alcohols

In presence of acids they react with alcohols to form acetals (Stoker, 595).

Figure 2: Chirality in Glucose Molecule

In plants the carbohydrates are formed by the photosynthesis and contribute up to 75% of the dry mass. The carbohydrates form structural organs of plants in form of cellulose and are used as a source of energy in form of cellulose.

Animals acquire carbohydrates as dietary intake; herbivores from plants, carnivores from animals and omnivores from both. The carbohydrates in animals are oxidized to produce energy. A storage form of carbohydrates in animals is glycogen. After degradation they also provide carbon atoms for the synthesis of other biomolecules such as proteins, lipids and vitamins as well as the two nucleic acids DNA and RNA. In combination with lipid they form the glycolipids component of cell membranes and as glycoprotein, form the signal molecules that help in cell-cell/ cell-molecule recognition and signaling.

Reference

1. Lichtenthaler, F. W. " Carbohydrates: Occurrence, Structure and Chemistry." Ullmanns Encyclopedia of Industrial Chemistry (2010): 1-30.
2. Stoker, H. S. General, organic and biological chemistry. Cengage learning, 2012.