

Carbohydrate is a group of organic compounds occurring in living tissues and foods in the form of starch, cellulose, and sugars. The ratio of oxygen and hydrogen in carbohydrates is the same as in water i.e. 2:1. It typically breaks down in the animal body to release energy.

Carbohydrate Definition

$C_n(H_2O)_n$ is the generic formula for all carbohydrates. This formula is only valid for simple sugars, which are made up of the same amount of carbon and water. Originally the term carbohydrate was used to describe compounds that were literally “carbohydrates,” because they had the empirical formula CH_2O . Carbohydrates have been classified in recent years on the basis of carbohydrate structures, not their formulae. Such aldehydes and ketones are now known as polyhydroxy. Cellulose, starch, and glycogen are among the compounds that belong to this family.

The general formula for carbohydrates is $C_x(H_2O)_y$.

Carbohydrates (or sugars) were originally believed to be “hydrates of carbon,” because they have the general formula $C_x(H_2O)_y$.

Definition of Carbohydrates in Chemistry

Chemically, carbohydrates are defined as *“optically active polyhydroxy aldehydes or ketones or the compounds which produce units of such type on hydrolysis”*.

The substance most people refer to as “sugar” is the sucrose disaccharide, which is extracted either from sugar cane or beets. Sucrose is the disaccharide most sweet. It’s approximately three times sweet as maltose, and six times sweet as lactose. In recent years, in many consumer products, sucrose has been replaced with corn syrup, which is obtained when the polysaccharides in cornstarch are broken down. Corn syrup is primarily glucose, which is as sweet as sucrose only about 70 per cent. Carbohydrates are also called saccharides which is a Greek word it means sugar because almost all carbohydrates have a sweet taste.

Carbohydrates Definition in Science

The term carbohydrate or hydrates of carbon is derived from its basic elemental formula in which carbon is joined to hydrogen and oxygen present in the same ratio as in water. Chemically carbohydrates are polyhydroxy aldehydes or ketones, their simple derivatives or their polymers.

Carbohydrates in grains are classified based on their chemical structures or their digestibility when consumed by humans as food or by livestock as feed. Simple carbohydrates which are sweet and soluble in water are also known as sugars or disaccharides and the ending of the names of most sugars is -ose. Thus, we have such names as sucrose for ordinary table sugar, glucose for principal sugar in blood and maltose for malt sugar.

Carbohydrates Structure

Historically carbohydrates were defined as substances with the empirical formula $C_n(H_2O)_m$. The common sugars such as glucose and fructose or sucrose fit this formula, but nowadays the convention is to regard as a carbohydrate a polyhydroxy aldehydes or polyhydroxy ketone with the classical formula, a molecule closely related to it, or oligomers or polymers of such molecules. Their study evolved as a separate sub-discipline within organic chemistry for practical reasons – they are water-soluble and difficult to crystallise so their manipulation demanded different sets of skills from classical “natural products” such as terpenes, steroids, alkaloids, etc.

The term “monosaccharide” refers to a carbohydrate derivative possessing a single carbon chain; “disaccharide” and “trisaccharide” refer to molecules containing two or three such monosaccharide units joined together by acetal or ketal linkages. “Oligosaccharide” and “polysaccharide” refer to larger such aggregates, with “a few” and many monosaccharide units, respectively. Current usage seems to draw the distinction between “few” and many at around 10 units.

By the middle of the nineteenth century, a number of relatively pure carbohydrates such as sucrose, cellulose from cotton, starch, glucose, fructose, mannose and lactose were known to the chemists of Europe, especially in Germany. In 1878, Emil Fischer synthesized phenylhydrazine for his thesis at the University of Munich. In 1884 he further discovered that carbohydrates gave crystalline phenylosazone in which two phenyl hydrazines reacted with the aldehyde group and the carbon adjacent to the aldehyde group.

Carbohydrates Formula

Carbohydrates are large macromolecules consisting of carbon (C), hydrogen (H) and oxygen (O) and have the general $C_x(H_2O)_y$ formula. Carbohydrates have the general formula $C_x(H_2O)_y$. The hydrate of carbon is known as carbohydrates. They contain hydrogen and oxygen in the same

proportion as in water. It may be noted that there are some carbohydrates which do not conform to the formula $C_x(H_2O)_y$, for example, 2-deoxyribose $C_5H_{10}O_4$. However, most of them conform to the formula $C_x(H_2O)_y$.

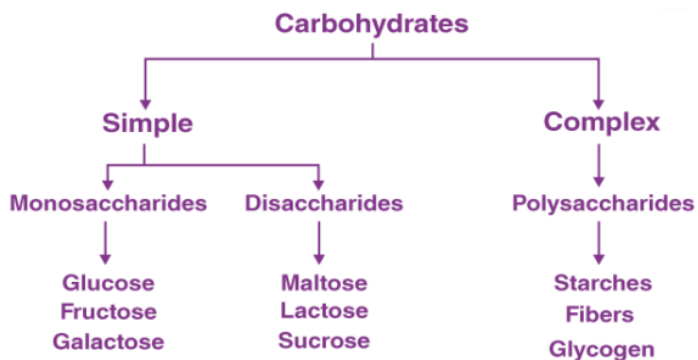
Carbohydrates are also called sugars in general some partially methylated sugars and amino sugars and amino sugars naturally and one natural nitro sugar is known. All carbohydrates are polyhydroxy aldehydes or ketones or substances that yield these on hydrolysis. Haworth projections represent the cyclic structures of monosaccharides. Monosaccharides contain either an aldehyde group (aldose) or a ketone group (ketose) and several -OH groups. Straight chain forms of sugars cyclize in solution to form ring structures containing an ether linkage. Glycosidic bonds form between monosaccharides forming disaccharides and polysaccharides. Carbohydrates are used as energy sources and energy reserves.

Sources of Carbohydrates

We know carbohydrates are an important part of any human's diet. Some common sources of carbohydrates are:

1. *Potatoes*
2. *Maze*
3. *Milk*
4. *Popcorn*
5. *Bread*

Types of Carbohydrates



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Types of Carbohydrates – Simple Carbohydrates

Simple carbohydrates are the basic type of carbs. Soft drinks, candy, cookies and other sweet snacks contain simple carbohydrates. These foods are often made with white sugar, a form of processed sugar.

Simple carbohydrates also are found in natural sugars. Fruit, milk and vegetables contain natural sugars. Honey is a natural sugar as well. People eat natural sugar in its original form. Simple carbohydrates are easier to handle because they are less (or simpler) complex. They come from fruit and sugar stuff, as well as pretty much anything else that's sweet. The human body can rapidly break down these things, and that is where some of the problems lie.

There is only one sugar unit in the monosaccharides, so they are the smallest of the carbohydrates. "The small size of monosaccharides gives them a special role in digestion and metabolism. (The prefix "mono-" "means" one.) Before they can be ingested into the gastrointestinal tract, food carbohydrates have to be broken down into monosaccharides and they also flow in monosaccharide form in the blood.

Complex Carbohydrates

Complex carbohydrates represent an important energy source for your body. They provide the sustained fuel your body needs for exercise, daily living activities and even rest.

Complex carbohydrates are often single units (monosaccharides), which are bound together. The oligosaccharides contain two to ten simple units of sugar. Polysaccharides contain hundreds and thousands of monosaccharides which are related. Complex carbohydrates have fairly long-lasting energy.

The different types of carbohydrates can be classified on the basis of their behaviour in hydrolysis. They are mainly classified into three groups:

1. *Monosaccharides*
2. *Disaccharides*
3. *Polysaccharides*

1. Monosaccharides

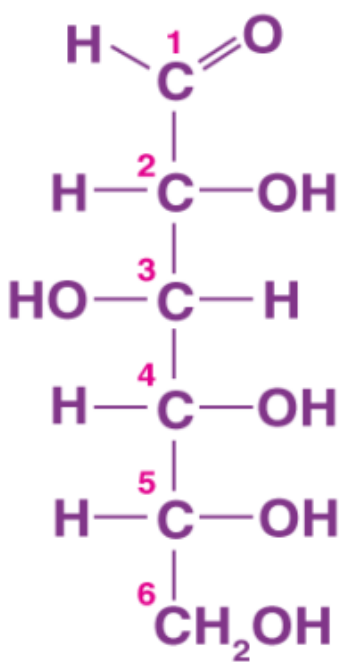
Monosaccharide carbohydrates are those carbohydrates that cannot be hydrolyzed further to give simpler units of polyhydroxy aldehyde or ketone. If a monosaccharide contains an aldehyde group then it is called aldose and on the other hand, if it contains a keto group then it is called a ketose.

Structure of Carbohydrates – Glucose

One of the most important monosaccharides is glucose. The two commonly used methods for the preparation of glucose are

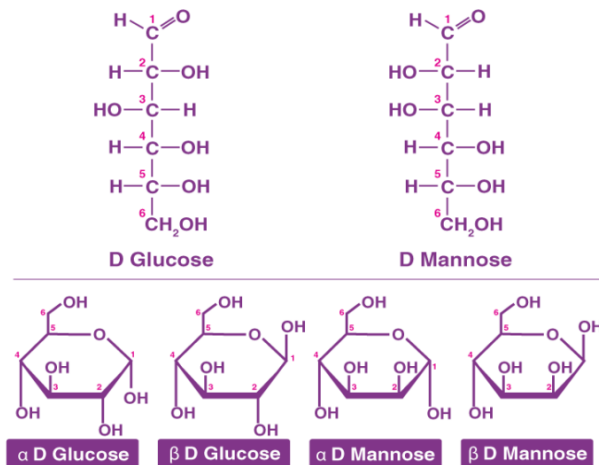
- **From Sucrose:** If sucrose is boiled with dilute acid in an alcoholic solution then we obtain glucose and fructose.
- **From Starch:** We can obtain glucose by hydrolysis of starch and by boiling it with dilute H_2SO_4 at 393K under elevated pressure.

Glucose is also called aldohexose and dextrose and is abundant on earth.



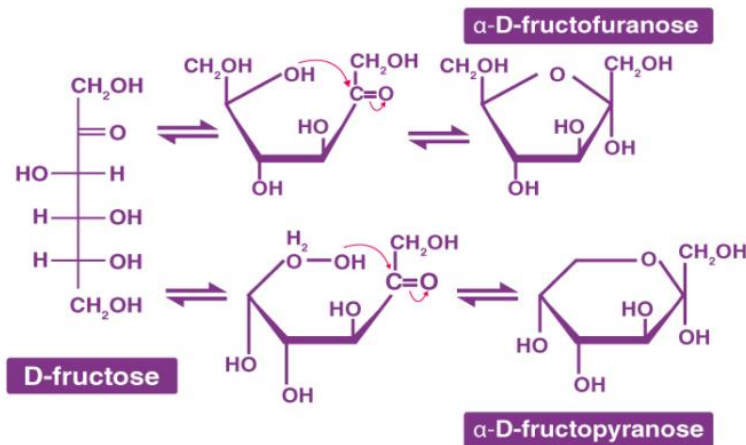
- Glucose is named as D (+)-glucose, D represents the configuration whereas (+) represents the *dextrorotatory* nature of the molecule.
- The ring structure of glucose can explain many properties of glucose which cannot be figured by open-chain structure.
- The two cyclic structures differ in the configuration of the hydroxyl group at C1 called anomeric carbon. Such isomers i.e. α and β form are known as anomers.
- The cyclic structure is also called pyranose structure due to its analogy with pyran.

The cyclic structure of glucose is given below:



Structure of Carbohydrates – Fructose

It is an important ketohexose. The *molecular formula of fructose is $C_6H_{12}O_6$ and contains a ketonic functional group at carbon number 2 and has six carbon atoms in a straight chain*. The ring member of fructose is in analogy to the compound Furan and is named furanose. The cyclic structure of fructose is shown below:



Examples of Carbohydrates

Here are a few examples of where you'll find the most carbs:

- **Dairy Products** – Yogurt, Milk, Ice cream
- **Fruits** – Fruit juice or Whole fruit
- **Grains** – Cereal, Bread, Wheat, Rice

- **Legumes** – Plant-based proteins, Beans
- **Starchy Vegetables** – Corn, Potatoes

2. Disaccharides

- On hydrolysis, disaccharides yield two molecules of either the same or different monosaccharides.
- The two monosaccharide units are joined by oxide linkage which is formed by the loss of water molecule and this linkage is called glycosidic linkage.
- Sucrose is one of the most common disaccharides which on hydrolysis gives glucose and fructose.
- Maltose and Lactose (also known as milk sugar) are the other two important disaccharides.
- In maltose, there are two α -D-glucose and in lactose, there are two β -D-glucose which are connected by an oxide bond.

3. Polysaccharides

- Polysaccharides contain long monosaccharide units joined together by glycosidic linkage.
- Most of them act as food storage for e.g. Starch. Starch is the main storage polysaccharide for plants.
- It is a polymer of α glucose and consists of two components-Amylose and Amylopectin.
- Cellulose is also one of the polysaccharides that are mostly found in plants.
- It is composed of β -D- glucose units joined by a glycosidic linkage between C1 of one glucose unit and C4 of the next glucose unit