**CARBOHYDRATES**

**General information**

Carbohydrates are the most abundant class of organic compounds found in living organisms. They originate as products of photosynthesis, an endothermic reductive condensation of carbon dioxide requiring light energy and the pigment chlorophyll.

A **carbohydrate** is a [biomolecules](https://en.wikipedia.org/wiki/Biomolecule) consisting of [carbon](https://en.wikipedia.org/wiki/Carbon) (C), [hydrogen](https://en.wikipedia.org/wiki/Hydrogen) (H) and [oxygen](https://en.wikipedia.org/wiki/Oxygen) (O) atoms, usually with a hydrogen–oxygen [atom](https://en.wikipedia.org/wiki/Atom) ratio of 2:1 (as in water) and thus with the [empirical formula](https://en.wikipedia.org/wiki/Empirical_formula) C*m*(H2O)*n* (where *m* may be different from *n*). This [formula](https://en.wikipedia.org/wiki/Chemical_formula) holds true for [monosaccharide](https://en.wikipedia.org/wiki/Monosaccharide). Some exceptions exist; for example, [deoxyribose](https://en.wikipedia.org/wiki/Deoxyribose), a sugar component of [DNA](https://en.wikipedia.org/wiki/DNA),[[1]](https://en.wikipedia.org/wiki/Carbohydrate%22%20%5Cl%20%22cite_note-1) has the empirical formula C5H10O4.[[2]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-2) The carbohydrates are technically [hydrates](https://en.wikipedia.org/wiki/Hydrate) of carbon; structurally it is more accurate to view them as [aldoses](https://en.wikipedia.org/wiki/Aldose) and [ketoses](https://en.wikipedia.org/wiki/Ketose).

The term is most common in [biochemistry](https://en.wikipedia.org/wiki/Biochemistry), where it is a synonym of **saccharide**, a group that includes [sugars](https://en.wikipedia.org/wiki/Sugar), [starch](https://en.wikipedia.org/wiki/Starch), and [cellulose](https://en.wikipedia.org/wiki/Cellulose). The saccharides are divided into four chemical groups: monosaccharide, [disaccharides](https://en.wikipedia.org/wiki/Disaccharide), [oligosaccharides](https://en.wikipedia.org/wiki/Oligosaccharide), and [polysaccharides](https://en.wikipedia.org/wiki/Polysaccharide).

Monosaccharides and disaccharides, the smallest (lower [molecular weight](https://en.wikipedia.org/wiki/Molecular_weight)) carbohydrates, are commonly referred to as sugars.[[3]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-3) The word *saccharide* comes from the [Greek](https://en.wikipedia.org/wiki/Greek_language) word (*sákkharon*), meaning "sugar".[[4]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-avenas-4) While the scientific nomenclature of carbohydrates is complex, the names of the monosaccharide and disaccharides very often end in the suffix [-ose](https://en.wikipedia.org/wiki/-ose), as in the monosaccharide [fructose](https://en.wikipedia.org/wiki/Fructose) (fruit sugar) and [glucose](https://en.wikipedia.org/wiki/Glucose) (starch sugar) and the disaccharides [sucrose](https://en.wikipedia.org/wiki/Sucrose) ([cane](https://en.wikipedia.org/wiki/Sugar_cane) or [beet](https://en.wikipedia.org/wiki/Sugar_beet) sugar) and [lactose](https://en.wikipedia.org/wiki/Lactose) (milk sugar).

**Terminology**

In scientific literature, the term "carbohydrate" has many synonyms, like "sugar" (in the broad sense), "saccharide", "ose",[[4]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-avenas-4) "glucide",[[9]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-9) "hydrate of carbon" or "[polyhydroxy](https://en.wikipedia.org/wiki/Hydroxy_group) compounds with [aldehyde](https://en.wikipedia.org/wiki/Aldehyde) or [ketone](https://en.wikipedia.org/wiki/Ketone)". Some of these terms, specially "carbohydrate" and "sugar", are also used with other meanings.

In [food science](https://en.wikipedia.org/wiki/Food_science) and in many informal contexts, the term "carbohydrate" often means any food that is particularly rich in the complex carbohydrate [starch](https://en.wikipedia.org/wiki/Starch) (such as cereals, bread and pasta) or simple carbohydrates, such as sugar (found in candy, [jams](https://en.wikipedia.org/wiki/Jam), and desserts).

Often in lists of [nutritional information](https://en.wikipedia.org/wiki/Nutritional_information), such as the [USDA National Nutrient Database](https://en.wikipedia.org/wiki/USDA_National_Nutrient_Database), the term "carbohydrate" (or "carbohydrate by difference") is used for everything other than water, protein, fat, ash, and ethanol.[[10]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-10) This includes chemical compounds such as [acetic](https://en.wikipedia.org/wiki/Acetic_acid) or [lactic acid](https://en.wikipedia.org/wiki/Lactic_acid), which are not normally considered carbohydrates. It also includes [dietary fiber](https://en.wikipedia.org/wiki/Dietary_fiber) which is a carbohydrate but which does not contribute much in the way of [food energy](https://en.wikipedia.org/wiki/Food_energy) ([kilocalories](https://en.wikipedia.org/wiki/Calorie)), even though it is often included in the calculation of total food energy just as though it were a sugar.

In the strict sense, "[sugar](https://en.wikipedia.org/wiki/Sugar)" is applied for sweet, soluble carbohydrates, many of which are used in food.

**Structure**

Formerly the name "carbohydrate" was used in [chemistry](https://en.wikipedia.org/wiki/Chemistry) for any compound with the formula C*m* (H2O)*n*. Following this definition, some chemists considered [formaldehyde](https://en.wikipedia.org/wiki/Formaldehyde) (CH2O) to be the simplest carbohydrate,[[11]](https://en.wikipedia.org/wiki/Carbohydrate#cite_note-coulter-11) while others claimed that title for [glycolaldehyde](https://en.wikipedia.org/wiki/Glycolaldehyde). Today, the term is generally understood in the biochemistry sense, which excludes compounds with only one or two carbons and includes many biological carbohydrates which deviate from this formula. For example, while the above representative formulas would seem to capture the commonly known carbohydrates, ubiquitous and abundant carbohydrates often deviate from this.

For example, carbohydrates often display chemical groups such as: *N*-acetyl (e.g. chitin), sulphate (e.g. glycosaminoglycans), carboxylic acid (e.g. sialic acid) and deoxy modifications (e.g. fucose and sialic acid).

Natural saccharides are generally built of simple carbohydrates called [monosaccharide](https://en.wikipedia.org/wiki/Monosaccharide) with general formula (CH2O)*n* where *n* is three or more. A typical monosaccharide has the structure H–(CHOH)*x*(C=O)–(CHOH)*y*–H, that is, an [aldehyde](https://en.wikipedia.org/wiki/Aldehyde) or [ketone](https://en.wikipedia.org/wiki/Ketone) with many [hydroxyl](https://en.wikipedia.org/wiki/Hydroxyl) groups added, usually one on each [carbon](https://en.wikipedia.org/wiki/Carbon) [atom](https://en.wikipedia.org/wiki/Atom) that is not part of the aldehyde or ketone [functional group](https://en.wikipedia.org/wiki/Functional_group). Examples of monosaccharide are [glucose](https://en.wikipedia.org/wiki/Glucose), [fructose](https://en.wikipedia.org/wiki/Fructose), and [glyceraldehydes](https://en.wikipedia.org/wiki/Glyceraldehyde). However, some biological substances commonly called "monosaccharide" do not conform to this formula (e.g. [ironic acids](https://en.wikipedia.org/wiki/Uronic_acid) and deoxy-sugars such as [fucose](https://en.wikipedia.org/wiki/Fucose)) and there are many chemicals that do conform to this formula but are not considered to be monosaccharide (e.g. formaldehyde CH2O and [inositol](https://en.wikipedia.org/wiki/Inositol) (CH2O)6).