Carbohydrates Metabolism

Carbohydrate are the major components in plant tissues. they comprise up to **70%** or more of the dry matter of forages. higher concentrations (up to **85%**) may be found in some seeds, especially cereal grains. carbohydrates, containing mainly of glucose and glycogen, make up less than **1%** of the weight of an animals.

Metabolism

Preparation for absorption:

Digestion in the small intestine: only monosaccharides can be absorbed from the GIT except in newborn animals capable of absorbing larger molecules. thus, for absorption to occur, poly, tri and disaccharides must be hydrolyzed by digestive enzymes elaborated by the host or by microflora inhabiting the GIT of the host.

Microflora of the rumen of ruminants and the cecum and colon of some no ruminants, such as the horse and rabbit, produce cellulase, which is capable of hydrolyzing the glucose -4-beta-glucoside linkage of cellulose. consequently, these species can utilize large quantities of cellulose. other no ruminants, including humans and swine, also utilize cellulose by anaerobic fermentation in large intestine by virtue of the production of cellulase by some of the microorganisms residing in the lower intestinal tract but not by mammalian cells.

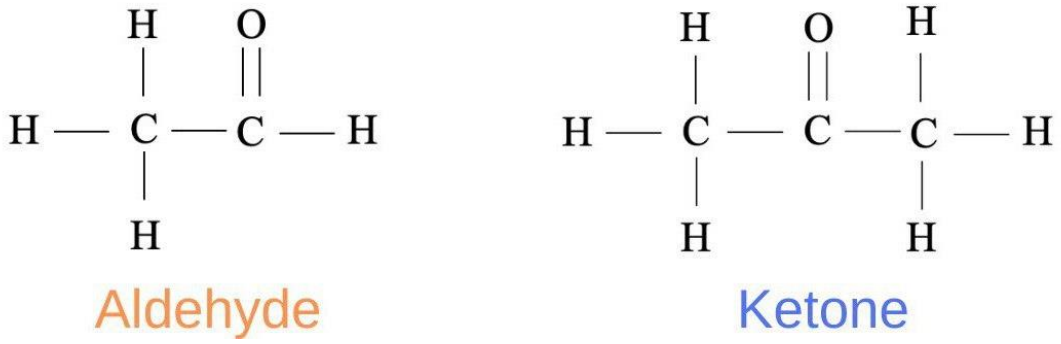
Definition of carbohydrates: Carbohydrates may be defined as polyhydroxy aldehyde, ketones or acids and their derivatives or compounds that yield these derivatives on hydrolysis. The carbohydrates are neutral chemical compounds containing the element carbon, hydrogen and oxygen, with the last two elements present in the same proportion as in water mostly, but not at all One of the example of carbohydrate where such ratio is not found in the sugar deoxyribose which is a constituent of DNA. The carbohydrates serve as both structural and reserve material in the plant. The animal body contains less than **(1)** percent carbohydrate, which are present in blood, muscles and liver. The carbohydrate present in animal body is also known as animal starch or glycogen.

Based upon their digestibility and solubility, the carbohydrates can be divided into two groups:

(a) Soluble carbohydrates: They are called nitrogen free extract **(NFE)** and include simple sugar, starch and hemicellulose, which are easily digestible in the body.

(b) Insoluble carbohydrates: They include hard fibrous substance like crude fiber, cellulose and lignin. They are less digestible by non-ruminants and easily digested in ruminants by rumen microflora and microfauna.

The term carbohydrate was originally coined because these molecules were believed to be hydrates of carbon, having the general formula Cn (H_2O) n. **Structural characteristics common to carbohydrates are: (1)** the carbon skeleton is unbranched; **(2)** all but one carbon bears a hydroxyl group; and **(3)** one carbon exists as a carbonyl group which if on a terminal carbon gives rise to an aldehyde but if on an internal (centrally placed) carbon, typically carbon **2** it creates a ketone, are known as aldoses and ketoses, respectively.



Sugars of five or more carbons in length have a strong propensity to form a ring structure through the reaction of a hydroxyl group on one carbon with the aldehyde or ketone to produce an internal hemiacetal or hemiketal and thereby a furanose or pyranose ring. In so doing, a new asymmetric or chiral center is generated. This carbon is known as the anomeric carbon and the hydroxyl group generated may exist in an or configuration (Fig. 1).

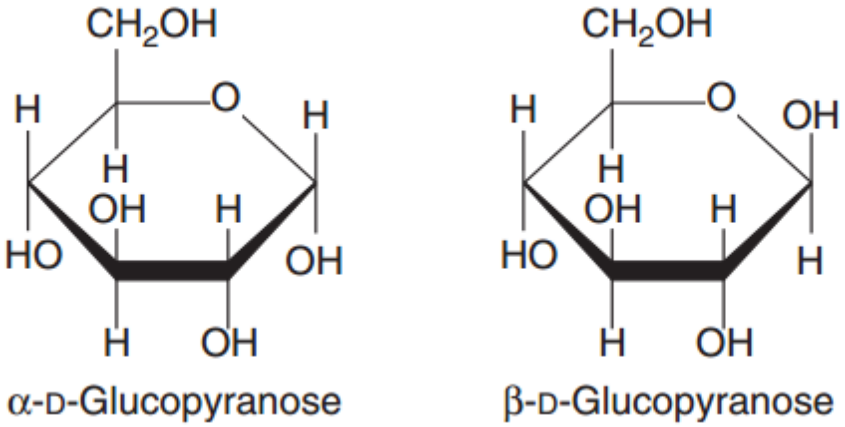


Fig. 1. Alpha and Beta-D-glucose are anomers whose sole configurational difference resides in the steroid arrangement about carbon atom 1; this 'carbonyl' carbon is also called the anomeric carbon atom.

General

A. Carbohydrates make up 75% of dry weight of many plants on which many animals primarily depend on.

B. Carbohydrates make up 70-80% of swine diets (and also poultry diets), thus important from a nutritional standpoint as well as an economic standpoint.

Functions of Carbohydrates

1. Carbohydrates serve as a major source of energy in animal body.

2. They are essential components of production, temperature control and proper functioning of the different parts of the animal body.

3. They are essential components of milk as lactose.

4. They are stored as glycogen, excess of carbohydrates in the diet is converted into fat and stored in the fat depot. These are reserve energy materials of the body in liver and muscles of animals and starch in plants.

5. Carbohydrates are helpful in absorption of calcium and phosphorus in younger animals.

6. They help the secretion of digestive juices in gastrointestinal tract.

7. They provide suitable environment for the growth of rumen bacteria and protozoa.

8. They help in peristaltic movement of food.

9. They maintain the glucose level of plasma.

10. They are also component of several important bio-chemical compounds such as nucleic acids, coenzymes and blood group substance.

11. They play a key role in the metabolism of amino acids and fatty acids.

Classification

Based on the No. of sugar units & carbon atoms per sugar unit (Maynard et al., 1979):

Items	Number of C	Types
1. Monosaccharides (single glycose unit)	Trioses ($C_3H_6O_3$)	Glyceraldehyde, Dihydroxyacetone
	Tetrose ($C_4H_8O_4$)	Eryhrose
	Pentoses ($C_5H_{10}O_5$)	Ribose, Arabinose, Xylose, and Xylulose
	Hexoses ($C_6H_{12}O_6$)	Glucose, Galactose, Mannose, and Fructose
2. Oligosaccharides (2 to 10 glycose units)	Disaccharides ($C_{12}H_{22}O_{11}$)	Sucrose, Maltose, Cellobiose, and Lactose
	Trisaccharides ($C_{18}H_{32}O_{16}$)	Raffinose
	Tetrasaccharides ($C_{24}H_{42}O_{21}$)	Stachyose
	Pentasaccharides ($C_{30}H_{52}O^{26}$)	Verbascose
3. Polysaccharides (10 glycose units)	Pentosanes ($C_5H_8O_4$)n	Arabans, and Xylans
	Hexosans ($C_6H_{10}O_5$)n	Starch , Dextrins , Glycogen , Cellulose , Inulin , Levan
	Heteroglycan	Pectins , Hemicellulose , Mucilages , Mucopolysaccharides

Nutritionally Important Sugars

- **Trioses**, **glyceraldehyde & dihydroxyacetone,** are important intermediates in energy metabolism
- **Ribose**: **1.** Occurs in a No. of compounds such as ATP, ADP, DNA, RNA, etc.
  2. Can be synthesized by animals.

Galactose

(a) One of the sugar units in lactose.

(b) No free form in the nature.

(c) Converted to glucose in the liver.

Fructose

a) One of the sugar units of sucrose.
b) A ketose sugar.
c) Relative sweetness (sucrose = 1).

Cellulose

1. The most abundant carbohydrate in nature.
2. A structural component of cell walls.
3. A polymer of 1,4-linked D-glucose, and 6 carbon atoms in the trans position.
4. Has an extensive H-bonding, which results in a tightly bound, crystalline structure.
5. Hydrolyzed only by microorganisms, and limited usage by no ruminant species.

Hemicellulose

1.A complex, heterogeneous mixture of different polymers of monosaccharides.
2. Found in cell walls.
3.Contains primarily xyloglucans, but also contains xylene, glucomannans & galactoglucomannes.