CHAPTER 2

CARBOHYDRATES

Definition

The definition of the carbohydrates is given as:

"carbohydrates are polyhydroxy aldehydes or ketones or their complex substances which on hydrolysis give polyhydroxy aldehydes or ketones"

The carbohydrates are the organic compounds. They are made up of carbon, hydrogen, oxygen. The literally meanings of carbohydrates are the hydrated carbons. Carbohydrates also called sugar"

General formula

As the carbohydrates are the hydrated carbons so the no. of water molecules attach to the carbon are equal in number to the no. of carbon atoms. Thus the general formula is given as Cn (H_2O) n. here "n" is the whole number.

Exception to the general formula and definition

There are some such carbohydrates which contain nitrogen, phosphorous or sulphur also in addition to carbon. Rhamnose has a Formula $C_6H_{12}O_5$.
Also all the compounds having formula $C_n(H_2O)_n$ may not be carbohydrates formic, acetic and lactic acids are some examples of such compounds.

Characteristics of carbohydrates

In general carbohydrates are white solids, sparingly soluble in organic liquids but except for certain polysaccharides are soluble in water. Many carbohydrates of low molecular weight have a sweet taste.

Functional groups of carbohydrates

The carbohydrates have two major categories on the basis of functional group. Two functional groups.

Aldehyde group: "-CHO" it is on the first carbon and the carbohydrate with aldehyde group is called aldoses (aldose suger)

Keto group:

$$\mathbf{R\text{-}\overset{\overset{\mathbf{O}}{\|}}{C}\text{-}R}$$

is on the second carbon, the sugars with ketonic group are called ketoses (keto-suger)

Source of carbohydrates

Carbohydrates are the natural compounds and their basic source is plants. The chief source of carbohydrates is the cereals. Starch is the abundant in the cereals.

The other source of carbohydrates is:

(i) **Vegetables**: e.g. potato, carrot, beats etc.

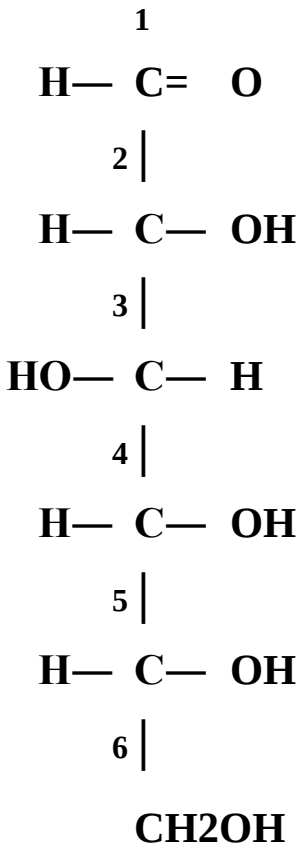
(ii) **Legumes:** e.g. peanut, lenticle etc.

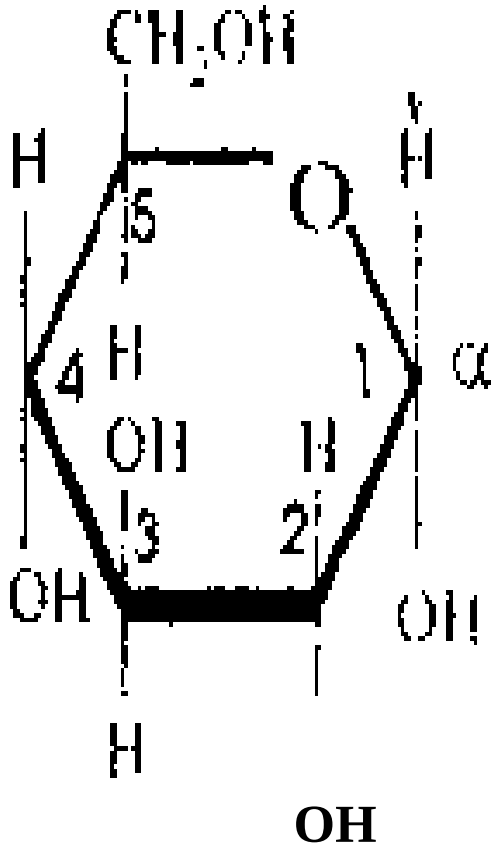
(iii) **Fruits:** both sweet and non-sweet fruits provide carbohydrates.

Chain or cyclic structure of carbohydrates

Carbohydrates are both in cyclic forms and chain forms and they both forms are in equilibrium state.

Straight chain carbohydrates → Cyclic carbohydrates





Occurrence of carbohydrates

Carbohydrates are the 2nd most occurring substance in nature after water. The surprising quantity of carbohydrates can be known by considering the point that cell wall of all plants made up of cellulose 50-80% of dry weight of plants is due to cellulose.

Natural production of carbohydrates

The carbohydrates are prepared by the plants by the process of photosynthesis. The photosynthesis involves the following reaction.

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

Carbohydrates Major source of energy

Carbohydrates are the macronutrients as 55% of our daily calories come from carbohydrates. 1g of carbohydrates provides 4 cal.
"when the molecules are oxidized so produced a high amount of energy " this is the principle used by carbohydrates to give energy. The process of oxidation of carbohydrates (also all other nutrients) is called respiration. The reaction involve in respiration

$$\underset{\text{Glucose}}{\mathbf{C_6H_{12}O_6}} + \mathbf{O_2} \longrightarrow \mathbf{CO_2 + H_2O + E}$$

How carbohydrates supply energy

The simple sugars are absorbed directly by the small intestine into blood stream. But the disaccharide and polysaccharide do not absorbed in blood directly first convert into monosaccharide. This bond breaking also provides energy. Then the monosaccharides are absorbed by blood.

Function of carbohydrates in animal body

The carbohydrates form the following major role in the living body.

- Construction of body organs.
- Assist in body's absorption of calcium.
- Helps in lowering cholesterol level.
- Provides nutrients to the friendly bacteria in digestive track that help in digestion.
- Balance water-mineral balance.

Sweetness in carbohydrates

Carbohydrates who has lower molecular mass are sweet in taste as the complexity and molar mass increases the sweetness decreases. In fruits the sweetness very from time to time sweetness increases as fruits ripen e.g. banana and apple b/c during ripening the starch converted to simple sugar.

Classification of carbohydrates

The carbohydrates are classified into three groups.

(i) **Monosaccharide :** having one sugar molecule and cannot hydrolyze to smaller units

(ii) **Disaccharide:** Having two sugar molecule and give two monosaccharide on hydrolysis.

(iii) **Oligosaccharides:** Having 3-10 sugar molecules. on hydrolysis yield 3-10 monosaccharides.

(iv) **Polysaccharide:** having more than ten sugar molecules and give disaccharide on hydrolysis and on further hydrolysis the monosaccharide are met.

Monosaccharide

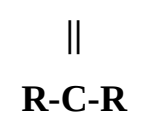
Mono ----------one

Saccharides----------sugar

1. They are sweet in taste.
2. It cannot further hydrolysis.
3. Generally they are water soluble.
4. Two types of functional group are present in it.

i) Aldehyde group: **(–CHO)**

ii) Keto group:



Classification of monosaccharide

Monosaccharide can be classified on the basis of functional group

i) Aldose ii) Ketose

Aldose

i) Glucose: ($C_6H_{12}O_6$)

It is also called grape sugar. It is widely distributed in nature. It combines with other sugars to form important disaccharides such as sucrose, maltose, and lactose. It is commercially obtained from starch. It is the main sugar of human body. Normal blood glucose level of human in fasting 80_100mg% and in random is 100__120mg%.

Glucose is also called dextrose.

ii) Ribose:

iii) Erythrose:

iv) Glucoheptose:

Ketose

i) Fructose: ($C_6H_{12}O_6$)

The most common source of fructose is sucrose. It is sweetest of all the sugars. Pure honey contains fructose. It is present in appreciable amount in seminal fluid and act as source of energy for spermatozoa.

ii) Erythrulose:

iii) Ribulose:

iv) Sedoheptulose

Disaccharides

Definition:

Having two sugar molecules, give Two monosaccharide on hydrolysis Disaccharides occur naturally. They are less sweet than monosaccharide. The two monosaccharide units with glycosidic linkage they are white crystalline solids. They are soluble in (H_2O) water .Their molecular mass greater than monosaccharide.

Classification of disaccharides

Homogeneous

If all sugar molecules in disaccharides are same it is called homogeneous disaccharides .e.g. maltose.

Heterogeneous

If all sugar molecules are different in disaccharides called heterogeneous e.g. sucrose.

Examples of disaccharides

Sucrose. (Glucose + fructose)

It is also called saccharine. It is a common table sugar.

Lactose. (Glucose + galactose)

It is also called milk sugar.

Maltose.

It is composed of two monosaccharide (glucose + glucose)

It is also called fruit sugar.

Oligosaccharides

On hydrolysis these sugars yield three to ten monosaccharide units.

Not important physiologically.

Polysaccharides

Definition

Having more than ten sugar molecules and give disaccharides on hydrolysis and on further hydrolysis the monosaccharide are met.

Many saccharides join to form poly saccharides. They are tasteless and not optically active

Classification of polysaccharides

There are two types of polysaccharide.

(i)**Homopolysaccharides:**

The polysaccharides which yield one type of monosaccharide on hydrolysis is called homopolysaccharides.e.g Starch , Glycogen

(ii) **Heteropolysaccharides:**

The polysaccharides which yield different types of monosaccharide on hydrolysis called heteropolysaccharides.e.g Mucilage's, Hemi cellulose

Examples of polysaccharides

Cellulose: Most abundant on earth present in cell wall of plants.

Starch: It is stored food material in plants, in corns, grains etc.

Glycogen: It mainly occurs in animal muscles and liver.

Starch: It occurs in grains, seeds and tubers