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Topic: Carbohydrate - Structure & classification

Carbohydrate - Structure & classification

- Carbohydrates are nature's most abundant organic substance.
- The principal source of energy for the body is carbohydrates.
- Our food mainly contains carbohydrates.
- Carbohydrates make up 75% of the dry weight of the plant world, upon which animal life primarily depends.
- Carbohydrates contain carbon combined with hydrogen and oxygen often in the same ratio as in water (1C: 2H: 1O).

Carbohydrates are usually divided into the following three classes:

1. **Monosaccharides or simple sugars**
2. **Oligosaccharides**
3. **Polysaccharides**

Classification of Carbohydrates

1. **Monosaccharides**
   - **A. Trioses ($C_3H_6O_3$)**
     a) Glyceraldehyde
     b) Dihydroxyacetone

B. Tetroses ($C_4H_8O_4$)

a) Erythrose

C. Pentoses ($C_5H_{10}O_5$)

b) Ribose

c) Arabinose

d) Xylose

e) Xylulose

D. Hexoses

a) Glucoses

b) Galactose

c) Fructose

d) Mannose

E. Oligosaccharides

A. Disaccharides ($C_{12}H_{22}O_{11}$)

i. Sucrose

ii. Maltose

iii. Lactose

iv. Cellobiose

B.Trisaccharides ($C_{18}H_{32}O_{16}$)

i. Raffinose

3. Polysaccharides

A. Homoglycan

1) Pentosans $(C_5H_8O_4)n$

i. Arabans

ii. Xylans

2) Hexosans $(C_6H_{10}O_5)n$

1) Glucans

i. Starch,$\propto$ - linked

ii. Dextrins ,$\propto$ - linked

iii. Glycogen,$\propto$ - linked

iv. Cellulose,β - linked

2) Fructans

i. Inulin

ii. Levan

3) Galactans

4) Mannans

B) Heteroglycan

i. Pectins ($\propto$ - linked)

ii. Hemicellulose (β – linked)

iii. Mucopolysaccharides

4. specialized compounds

i. chitin

Monosaccharides

- Most sugars have the general formula CH_2O.
- Sugars containing three carbons are known as **trioses,**those with four carbons as **Tetroses,**thoses with five carbons as **pentoses,** and those with six carbons as **hexoses.**
- Two **troises** namely **glyceraldehyde** and **dihydroxyacetone** are crucial intermediates in the metabolism of glucose in glycolytic cycle.
- **Erythrose** is a **tetrose** which forms the raw material for synthesis of anthocyanin and lignin.
- Pentose sugar **ribose** is found in every animal cell. It occurs in a number of compounds which play crucial roles in metabolism e.g., ATP, ADP, riboflavin and RNA . Its reduced form **deoxyribose** is found in DNA.
- The **hexoses** comprise a large group of sugars, several of which play a significant role in nutrition.
- All hexoses are aldoses (glucose,galactose and mannose),except fructose which is a ketose.
- The hexose glucose is the most important carbohydrate in the living world.
- The most important sugar occurring in animals is glucose.
- Simple sugar of the blood is glucose
- Immediate source of energy is glucose.
- Glucose is stored as glycogen in liver and muscles.
- Fructose is the fruit sugar; it is the sweetest among naturally occurring sugars.
- Sugars having a free aldehyde or ketone group can reduce Cu^{2+} to Cu^{+}. These are called reducing sugars.

- This property is the basis of **Benedict's** and **Fehling's test**to detect the presence of glucose in urine.
- Galactose occurs in milk as a component of the milk sugar,lactose.

Oligosaccharides

- Oligosaccharides are formed by condensation of 2-10 monosaccharides.
- Disaccharides are oligosaccharides with a combination of two molecules of monosaccharides.
- When two monosaccharide molecules link by means of a 1-4 glycosidic bond, a molecule of water is released,a disaccharide molecule is formed.
- The common disaccharides are **sucrose, maltose, lactose** and **cellobiose.**
- Sucrose is made up of glucose + fructose; it occurs in sugar cane and sugar beets, sources of commercial sugar.
- Sucrose has no free aldehyde or ketone groups; sucrose is not a reducing sugar.
- Maltose or malt sugar is found during germination of starchy seeds.
- A disaccharide that gives two molecules of glucose on hydrolysis is maltose.
- Lactose (glucose + galactose) is present in milk .
- Lactose does not occur in nature except as a product of the mammary gland.
- Compared to the milk of cow, buffalo and goat,lactose is highest in human milk .saccharin has a sweet taste, but not a sugar.

Polysaccharides

- Polysaccharides are polymers of monosaccharides.
- Glycogen and starch are both polymers of α - glucose.

- Starch common in plants and glycogen in animals are two food storage polysaccharides.
- Glycogen is known as **'animal starch'**.
- Glycogen found in liver and muscles store energy mammals.
- Glycogen is broken down by the hormone **glucagon** secreted by **islets of Langerhans.**
- Glycogen is water soluble gives a red colour with **iodine**.
- Most plants store their chemical energy in the form of starch.
- Starch is actually a mixture of two different polymers, **amylase** and **amylopectin.**
- **Cellulose** and **chitin** are two structural polysaccharides .
- Cellulose is an unbranched chain of glucose units joined by β (1-4) linkages.
- Cellulose is digested by termites and sheep by harbouring bacteria and protozoa that synthesize the necessary enzyme, cellulose.
- Man cannot digest cellulose.
- Cellulose is a **homoglycan hexosan.**
- Chitin is a polysaccharide and is the principal component of the exoskeleton of insects and crustaceans; it is a polymer of **N-acetyl glucosamine.**
- **Inulin (**Dahlia starch) is a carbohydrate, polymer of **fructose.**