Introduction

Carbohydrates are among the most essential organic compounds produced by plants through the process of photosynthesis. They represent the primary source of energy for living organisms and participate in building important cellular structures such as the plant cell wall. In medicinal plants, carbohydrates play significant therapeutic and pharmaceutical roles. They form part of many active constituents including glycosides, mucilages, and plant gums.

Definition

Carbohydrates are organic compounds composed mainly of carbon, hydrogen, and oxygen, usually following the general formula $(CH_2O)n$.

They are commonly known as sugars, and can range from sweet-tasting simple sugars like glucose to non-sweet large molecules such as starch and cellulose

Classification of Carbohydrates:

A. Monosaccharides

These are the simplest units of carbohydrates and cannot be hydrolyzed into smaller sugars.

Examples:

Glucose

Fructose

Galactose

Importance:

They are the primary energy source for cells and serve as building blocks for more complex carbohydrates.

B. Disaccharides

Formed by the combination of two monosaccharides.

Examples:

Sucrose = Glucose + Fructose

Lactose = Glucose + Galactose

Maltose = Glucose + Glucose

C. Polysaccharides

Large molecules composed of many repeating monosaccharide units.

Examples:

Starch: Main storage carbohydrate in plants

Cellulose: Major component of the plant cell wall

Glycogen: Storage carbohydrate in animals.

Medicinal importance:

Plant gums and cellulose derivatives are used in pharmaceutical formulations as binders, stabilizers, and thickening agents.

Importance of Carbohydrates in Medicinal Plants

1-Primary energy source for plants and consuming organisms.

2-Precursors for secondary metabolites, including:

Glycosides

Saponins

Tannins

3-Some carbohydrates have direct therapeutic effects, such as:

Mucilage in Althaea officinalis (Marshmallow) for soothing throat and stomach irritation

Plant gums (e.g., Tragacanth) used in treating inflammation

4-Used widely in pharmaceutical industries as:

Tablet binders

Suspending agents

Fillers and stabilizers

5-Relationship Between Carbohydrates and Glycosides

Carbohydrates play a key role in forming glycosides, where a sugar part (glycone) is chemically linked to a non-sugar part (aglycone). This sugar component improves:

Solubility

Absorption

Stability

Biological activity

6-Plant Sources Rich in Carbohydrates

Dates (rich in glucose and fructose)

Rice and potatoes (rich in starch)

Mucilaginous herbs such as Althaea

Aloe vera (contains medicinal polysaccharides)

Glycosides of Carbohydrates

Definition: Glycosides are compounds containing a carbohydrate and a non- carbohydrate residue in the same molecule. In these compounds the carbohydrate residue is attached by an acetal linkage of carbon-1 to the non-carbohydrate residue. The non- carbohydrate residue present in the glycoside is called as **Aglycone**. The aglycones

present in glycosides vary in complexity from simple substances as methyl alcohol, glycerol, phenol or a base such as adenine to complex substances like sterols, hydroquinones and anthraquinones. The glycosides are named according to the carbohydrate they contain. If it contains glucose, forms glucoside. If galactose, it forms galactoside and so on.

1. **Formation of glycosides**
   a. Glycosidic bonds form when the **hydroxyl** group on the anomeric carbon of a monosaccharide reacts with an – OH or – NH group of another compound.
   b. **α-Glycosides** or **β-glycosides** are produced depending on the position of the atom attached to the anomeric carbon of the sugar.
2. ***O*-Glycosides**
   a. **Monosaccharides** can be linked via *O*-glycosidic bonds to another monosaccharide,

forming *O*-glycosides (Fig. 5b).

b. **Disaccharides** contain two monosaccharides. Sucrose, lactose, and maltose are the common disaccharides.

c. **Oligosaccharides** contain up to approximately 12 monosaccharides.

Polysaccharides contain more than 12 mono saccharides; for example, glycogen, starch, and glycosaminoglycans.

3. *N*-Glycosides

Mono saccharides can be linked via *N*-glycosidic bonds to compounds that are not carbohydrates. Nucleotides contain *N*-glycosidic bonds.

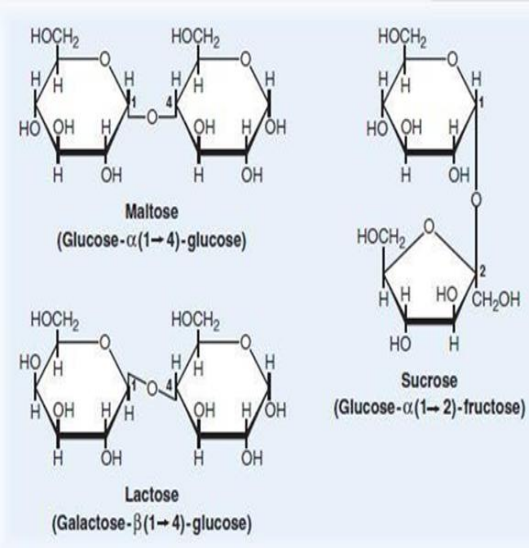


Figure 5a: The most common disaccharides bond.

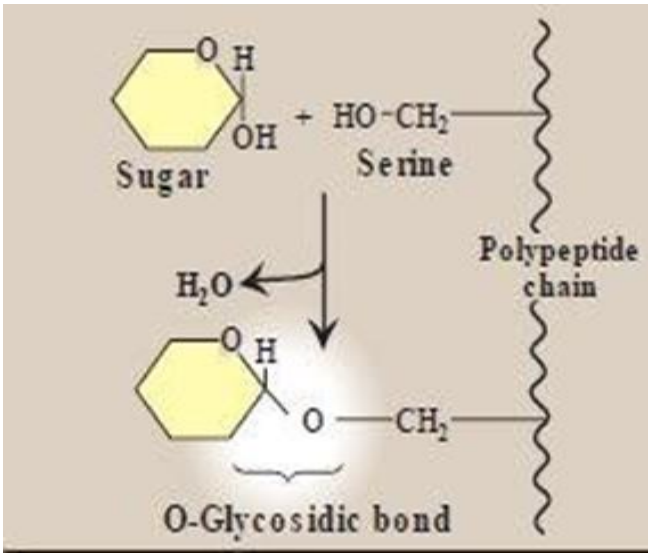


Figure 5b: *O*-Glycosides

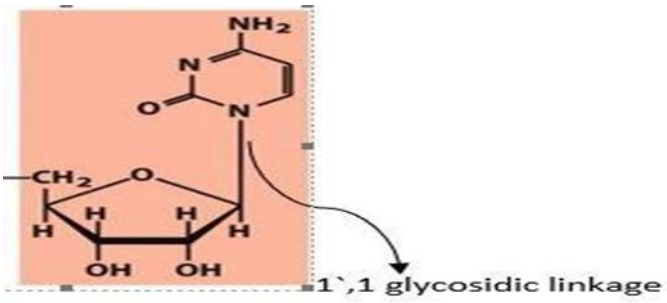


Figure 5c: N-Glycosidic bonds.

Biomedical importance of amino sugars:

- Glucosamine is the chief organic constituent of cell wall of fungi.
- Galactosamine occurs as N-acetyl-Galactosamine in chondroitin sulphates which are present in cartilages, bones, tendons and heart valves. Hence Galactosamine is also known as Chondrosamine.
- Antibiotics: Certain antibiotics, such as Erythromycin, carbomycin, contain amino sugars. Erythromycin contains dimethyl amino sugar and carbomycin 3-amino-D-Ribose. It is believed that amino sugars are related to the antibiotic activity of these drugs.

Biological Importance of Monosaccharide

A-Trioses:

- occur in the form of phosphate *esters,* as intermediates in glycolysis.
- They are also the precursors of glycerol, which the organism synthesises.
- incorporates into various types of lipids.

B-Tetroses: occurs as an intermediate in hexose monophosphate shunt which is an alternative pathway for glucose oxidation.

C- Pentoses

- is a constituent of nucleic acid RNA
- as a constituent of certain coenzymes, e.g. FAD, NAD, coenzyme A.
- Deoxyribose is a constituent of DNA.

D- Hexoses

1- **D-Glucose: (Synonyms: Dextrose, Grape Sugar)**

- It is the chief physiological sugar present in normal blood continually and at fairly constant level, i.e. about 0.1 per cent.
- All tissues utilise glucose for energy. Erythrocytes and Brain cells utilise glucose solely for energy purposes.
- Occurs as a constituent of disaccharide and polysaccharides.
- Stored as glycogen in liver and muscles mainly.

2- **D-Fructose:**

-It is a ketohexose and commonly called as **fruit sugar**, as it occurs free in fruits.

- Biomedical Importance: Seminal fluid is rich in fructose and sperms utilise fructose for energy. Fructose is formed in the seminiferous tubular epithelial cells from glucose.

Biomedical Importance of Carbohydrates

- Chief source of energy.
- Constituents of compound lipids and conjugated proteins.
- Degradation products act as “promoters” or ‘catalysts’.
- Certain carbohydrate derivatives are used as drugs like cardiac glycosides/antibiotics.
- Lactose principal sugar of milk—in lactating mammary gland.
- Degradation products utilised for synthesis of other substances such as fatty acids, cholesterol, amino acid, etc.

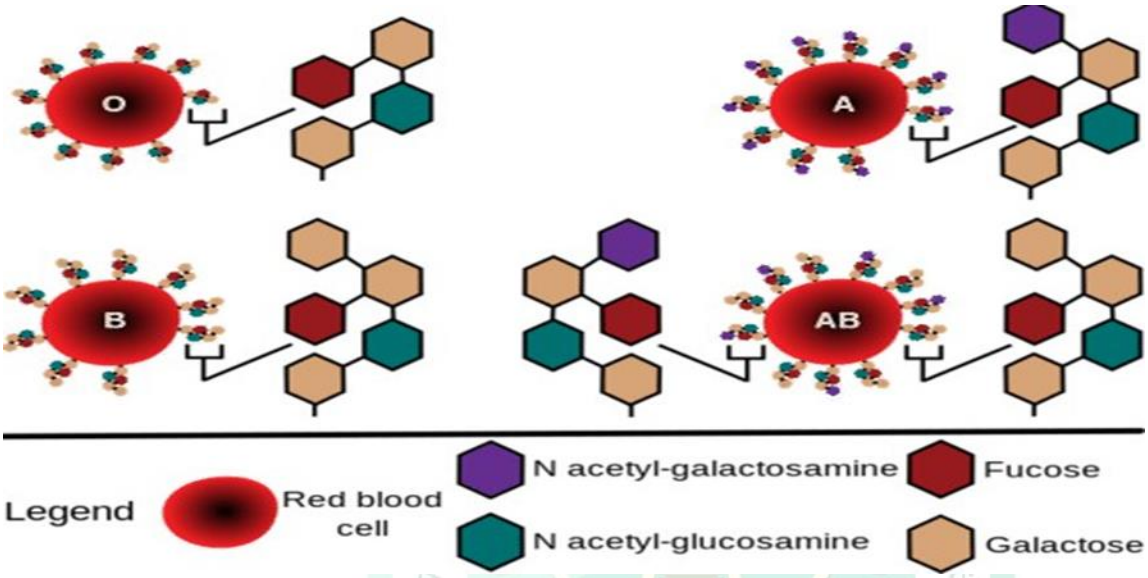
- Constituents of mucopolysaccharides which form the ground substance of mesenchymal tissues.
- Inherited deficiency of certain enzymes in metabolic pathways of different carbohydrates can cause diseases, e.g. galactosemia, glycogen storage diseases (GSDs), lactose intolerance, etc.
- Derangement of glucose metabolism is seen in diabetes mellitus.

Examples of Foods That Contain a Lot of Free Monosaccharaides

- Fruits and fruit juices (glucose, fructose)
- Honey (glucose, fructose)
- Candies (glucose)
- Syrups: liquid glucose; corn syrup and invert sugar (glucose and fructose); fructose syrup, high fructose corn syrup (HFCS), agave nectar and blackstrap molasses (high in fructose)
- Sweet wines (glucose, fructose)
- Foods with added simple sugars: soft drinks, sport drinks, energy drinks, liquers, chocolate, sweetened dairy products, desserts (mainly glucose)

Carbohydrates attached to red blood cells also determine blood type (see figure below). Of the four blood types, type O has the fewest types of saccharides attached to it while type AB has the most. As a result, type O blood is considered the universal donor because it doesn't have any saccharides present that will appear as foreign when transfused into blood of another type. The reverse is not true. For example, if type A blood is given to a patient with type O blood, it will be rejected by the body because there is an unknown species being introduced to the body. Type A blood cells contain N-acetyl-galactosamine which is not present in type O blood. A person with type O blood would undergo rejection upon receiving type A blood. The Rhesus factor (Rh) in blood also affects donor and acceptor properties but it does not depend on carbohydrates. The Rh factor is determined by the presence (Rh+) or absence (Rh-) of a

specific protein on the surface of red blood cells.




Thank you!