# Carbohydrates and related products

## Introduction of Carbohydrate

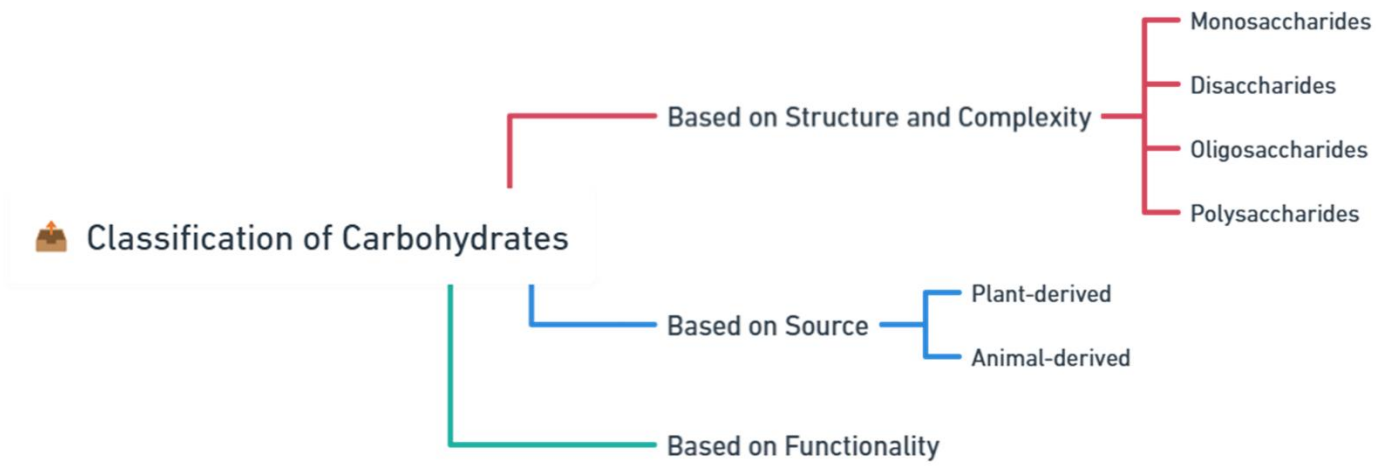
### Overview

- Carbohydrates are one of the most abundant organic compounds found in nature and serve as essential biomolecules in both plants and animals.
- In pharmacognosy, carbohydrates form the primary metabolites that are fundamental in the structural and physiological makeup of plants.
- They are integral components of medicinal plants and serve various pharmaceutical roles, such as excipients, binders, thickeners, sweeteners, and drug delivery agents.
- Additionally, they form the structural framework for secondary metabolites like glycosides and antibiotics.



- Carbohydrates are chemically defined as polyhydroxy aldehydes or ketones or compounds that yield these upon hydrolysis.
- They range from simple monosaccharides (e.g., glucose) to complex polysaccharides (e.g., starch, cellulose).
- In pharmaceutical science, understanding carbohydrates is critical for their functional, pharmacological, and industrial applications.
- They also play a role in diagnostic tests, immunology (as antigens), and biotechnology.

### Classification of Carbohydrates




#### A. Based on Structure and Complexity

## 1. Monosaccharides (Simple Sugars)

- **Definition**: The simplest carbohydrates that cannot be hydrolyzed into smaller units.
- **Number of Carbon Atoms**:
  - Trioses – 3 carbon atoms (e.g., Glyceraldehyde)
  - Tetroses – 4 carbon atoms
  - Pentoses – 5 carbon atoms (e.g., Ribose, Arabinose)
  - Hexoses – 6 carbon atoms (e.g., Glucose, Fructose, Galactose)
  - Heptoses – 7 carbon atoms
- **Types Based on Functional Group**:
  - Aldoses – Contain an aldehyde group (e.g., Glucose)
  - Ketoses – Contain a ketone group (e.g., Fructose)

## 2. Disaccharides

- **Definition**: Composed of two monosaccharide units linked via glycosidic bond.
- **Based on Reducing Property**
  - **Reducing sugars:** Possess free aldehyde or ketone groups (e.g., glucose, lactose, maltose)
  - **Non-reducing sugars:** Do not have free aldehyde/ketone groups (e.g., sucrose)
- **Examples**:
  - Sucrose (Glucose + Fructose)
  - Lactose (Glucose + Galactose)
  - Maltose (Glucose + Glucose)

## 3. Oligosaccharides

- **Definition**: Composed of 3–10 monosaccharide units.
- **Example**: Raffinose (Glucose + Fructose + Galactose)

## 4. Polysaccharides

- **Definition**: Large molecules composed of more than 10 monosaccharide units.
- **Types**:
  - **Homopolysaccharides** – Composed of only one type of monosaccharide.
    - Starch (Glucose polymer)
    - Cellulose
    - Inulin (Fructose polymer)

- **Heteropolysaccharides** – Composed of more than one kind of monosaccharide.
  - Pectin
  - Hyaluronic acid
  - Mucopolysaccharides

### B. Based on Source

#### A. Plant-derived Carbohydrates

- Starch, Cellulose, Inulin, Pectin, Gums, Mucilages

#### B. Animal-derived Carbohydrates

- Glycogen (animal starch)
- Chitin (in arthropods)

### C. Based on Functionality

1. **Nutrients:** Glucose, Fructose, Sucrose
2. **Binders and Fillers:** Starch, Cellulose derivatives
3. **Suspending and Emulsifying Agents:** Mucilages, Gums
4. **Laxatives:** Cellulose, Agar, Psyllium
5. **Plasma Expanders:** Dextran
6. **Diagnostic Agents:** Inulin (glomerular filtration marker)

## Functions and Applications of Carbohydrates in Pharmacy

### Pharmaceutical Applications

#### 1. Excipients in Formulations

- **Binders**: Starch and cellulose are used to hold tablets together.
- **Diluents**: Lactose is a common diluent in tablet formulations.
- **Thickeners**: Gums and mucilages help increase viscosity in liquid preparations.

#### 2. Drug Delivery Systems

- Polysaccharides like alginates and cellulose derivatives are used in controlled-release formulations.
- Carbohydrate-based hydrogels are being researched for targeted drug delivery.

#### 3. Sweeteners and Flavoring Agents

- Sucrose, glucose, fructose are used in syrups and oral solutions.

### 4. Bioadhesive and Mucoadhesive Agents

- Natural gums like xanthan gum, guar gum, and tragacanth are used to enhance drug adhesion to mucosal membranes.

### 5. Laxatives

- Bulk-forming laxatives like cellulose, psyllium, and agar are used in constipation management.

### 6. Plasma Expanders

- Dextrans (polysaccharides derived from sucrose) are used as plasma volume expanders in hypovolemic conditions.

## Therapeutic and Diagnostic Applications

### A. Glucose Tolerance Test

- Utilizes glucose solutions to test insulin response in diabetes diagnosis.

### B. Inulin Clearance Test

- Inulin is used to assess renal glomerular filtration rate (GFR).

### C. Antioxidant and Immunomodulatory Activities

- Some complex polysaccharides exhibit immunostimulant effects (e.g., beta-glucans).

### D. Antibacterial and Antiviral Agents

- Modified carbohydrates are used to interfere with pathogen adhesion and biofilm formation.

# Chemical Tests for Carbohydrates

- Several qualitative and quantitative chemical tests are available to identify the presence and type of carbohydrates in crude drug samples.
- These are fundamental in pharmacognostic evaluation.

## General Tests

### 1. Molisch's Test

- **Principle**: Carbohydrates are dehydrated by concentrated sulfuric acid to form furfural derivatives, which condense with α-naphthol to form a violet ring.
- **Procedure**: Add Molisch reagent (α-naphthol in alcohol) to sample and carefully layer conc. $H_2SO_4$.
- **Positive Test**: Appearance of violet ring at the junction.

### 2. Fehling's Test

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