Republic of Iraq

Ministry of Higher Education for Sciences

Al- Zahra University for Women

Health and Medical Colleges

Department of Anesthesia Techniques

CHEMISTRY

Title of the lecture:

Carbohydrates classification reactions, main carbohydrates in human body.

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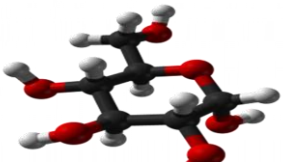


Carbohydrates

Are organic compounds primarily composed of carbon, hydrogen, and oxygen. They are classified into three main types based on the number of sugar units (monomers) they contain

Classification of Carbohydrates

The classification of carbohydrates is based on the number of sugar units in the molecule and their chemical structure.

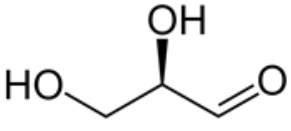
1 Monosaccharides

Definition: **These are the simplest form of carbohydrates, consisting of a single sugar unit. They serve as the building blocks for larger carbohydrates.**

Types based on the number of carbon atoms

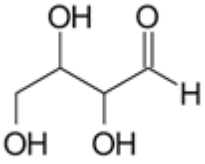
Trioses

(3 carbons) Example: Glyceraldehyde.



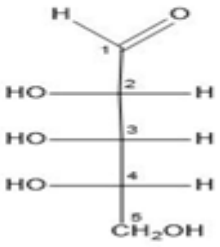
Tetroses

(4 carbons): Example: Erythrose



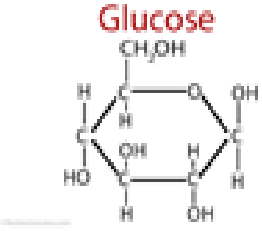
Pentoses

(5 carbons): Example: Ribose, which is a key component of DNA and RNA.



Hexoses

(6 carbons): Example: Glucose and fructose, which are the most common.



Properties

Soluble in water.

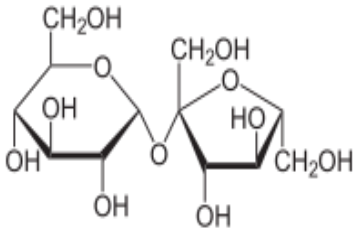
Sweet in taste.

Contain hydroxyl (-OH) groups, making them reactive.

2 Disaccharides

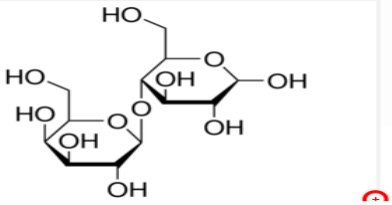
Definition: **Composed of two monosaccharides linked by a glycosidic bond**

1. Sucrose:



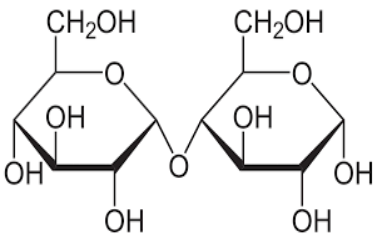
- Made of glucose and fructose.
- Known as table sugar and provides quick energy.

2. Lactose:



- Made of glucose and galactose.
- Found in milk and is a primary energy source for infants.

3. Maltose:

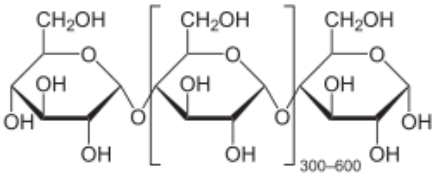


- Made of glucose + glucose.
- Produced during starch digestion in the digestive system.

3 Polysaccharides

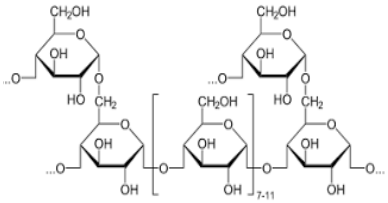
Definition: Large molecules consisting of multiple monosaccharide units linked by glycosidic bonds.

1. Starch



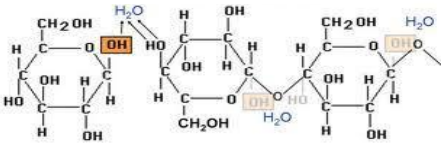
- **Found in plants as an energy reserve.**
- **Broken down into glucose in the body for energy.**

2. Glycogen



- **The primary storage form of glucose in the liver and muscles in humans.**
- **Provides quick energy when blood glucose levels drop.**

3. Cellulose



- **A major component of plant cell walls.**
- **Indigestible by humans but essential for digestive health as dietary fiber.**

Chemical Reactions of Carbohydrates

Carbohydrates undergo various chemical reactions.

1- Oxidation

- **Monosaccharides like glucose can be oxidized by oxidizing agents.**
- **Example:**
- **Glucose is oxidized to glucuronic acid (important for detoxification in the liver).**
- **In cellular respiration, glucose is oxidized to produce energy.**

2- Reduction

- **Carbohydrates can be reduced to sugar alcohols.**
- **Example: Glucose is reduced to sorbitol, which is used in sugar-free products.**

3- Reduction

Hydrolysis:

- Disaccharides and polysaccharides break down into monosaccharides with the help of enzymes.
- **Examples:**
- Starch is hydrolyzed by amylase into maltose and then into glucose.
- Lactose is hydrolyzed by lactase into glucose and galactose.

4- Molisch Test

- A simple test to identify carbohydrates.
- When α-naphthol is added to carbohydrates, a violet ring appears.

5-Caramelization

- When carbohydrates like sucrose are heated, they decompose and form brown compounds used in food products.

Main Carbohydrates in the Human Body

A. Glucose

- Primary energy source:
- Absorbed into the blood after carbohydrate digestion.
- Used by cells to produce energy through glycolysis and the Krebs cycle.
- Blood glucose levels: Regulated by hormones like insulin and glucagon.

B. Glycogen

- Stored form of glucose:
- Found in the liver and muscles.
- Provides immediate energy during exercise or fasting.

C. Ribose

- A five-carbon sugar:
- Essential for the synthesis of nucleic acids (DNA and RNA) and ATP (the energy currency of the cell).

D. Lactose

- Milk sugar:
- Vital for growth in infants.
- Broken down by the enzyme lactase into glucose and galactose.

E. Sucrose

- **A dietary source of quick energy, widely used in daily life.**

F. Cellulose

- **Indigestible because humans lack the enzyme cellulase.**
- **Importance:**
- **Promotes bowel movement.**
- **Prevents constipation and improves digestive health.**

Importance of Carbohydrates in the Human Body

1

Primary energy source

• Glucose serves as the main fuel for all body cells, especially the brain.

2

Energy storage

• Excess carbohydrates are stored as glycogen.

3

Regulation of vital processes:

• Carbohydrates like ribose are part of essential molecules like ATP and DNA.

4

Digestive health:

Dietary fiber (e.g. Cellulose) enhances intestinal movement. •

5

Water balance regulation:

• Some carbohydrates bind water, helping maintain fluid balance in the body.

Carbohydrate Metabolism and Factors Controlling Blood Glucose Levels

Carbohydrate Metabolism

Carbohydrate metabolism refers to the biochemical processes by which carbohydrates are digested, absorbed, and utilized as the body's primary energy source. These processes include:

Digestion and Absorption

Carbohydrate digestion begins in the mouth through the action of salivary amylase, which breaks down starch into maltose.

• In the small intestine, disaccharides (e.g., sucrose and lactose) are further broken down into monosaccharides (glucose, fructose, and galactose) and absorbed into the bloodstream.

Utilization of Glucose in Cells

After absorption, glucose enters cells with the help of insulin and is utilized for energy production via the following pathways:

• Glycolysis: The breakdown of glucose into pyruvic acid to generate energy.

• Krebs Cycle: The oxidation of pyruvic acid in the mitochondria to produce ATP.

• Oxidative Phosphorylation: The production of large amounts of ATP using electrons from metabolic reactions.

Storage of Excess Glucose

When glucose levels are high, the body stores excess glucose as glycogen in the liver and muscles for later use. •

Glucose Production from Non-Carbohydrate Sources

During fasting or glucose shortage, the body produces glucose from amino acids or glycerol (from fats) through a process called gluconeogenesis.

Factors Affecting Blood Glucose Levels

A. Hormonal Regulation of Blood Glucose

Several hormones work together to maintain blood glucose levels within the normal range (70–110 mg/dL):

Insulin

1. • Secreted by beta cells of the pancreas in response to high glucose levels.
   • Promotes glucose uptake by cells and its storage as glycogen.

Glucagon

2. • Secreted by alpha cells of the pancreas when glucose levels are low.
   • Stimulates glycogen breakdown and glucose release into the blood.

Adrenaline

3. • Released during stress or physical exertion, enhancing glycogen breakdown and glucose production.

Growth Hormones and Thyroxine:

4. • Increase glucose utilization and metabolic activity.

Cortisol

5. • Increases glucose production from non-carbohydrate sources during stress.

B. Diet and Its Impact on Glucose Levels

- **Consuming carbohydrates raises glucose levels quickly, while fiber-rich foods slow down glucose absorption.**
- **Fasting lowers glucose levels, prompting the body to produce glucose from fats and proteins**.

C. Physical Activity

Exercise increases glucose uptake by muscles, lowering blood glucose levels.

D. Diseases and Disorders

• Diabetes Mellitus: Caused by insufficient insulin secretion or insulin resistance, leading to high glucose levels.

• Hypoglycemia: A significant drop in glucose levels, impairing brain function and causing symptoms like dizziness and fainting.