PHARMACOGNOSY

3rd stage / 1st trem

Carbohydrates

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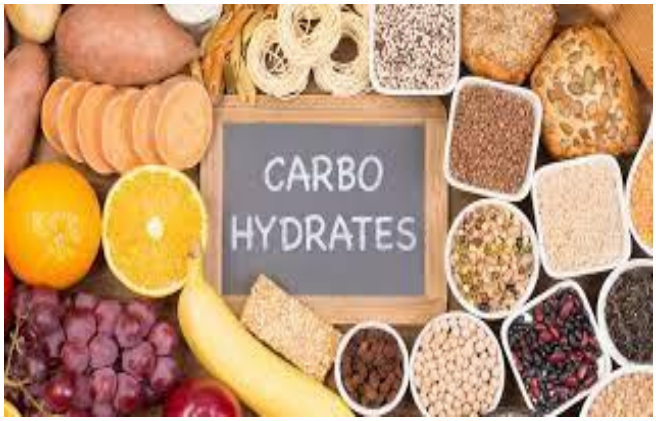
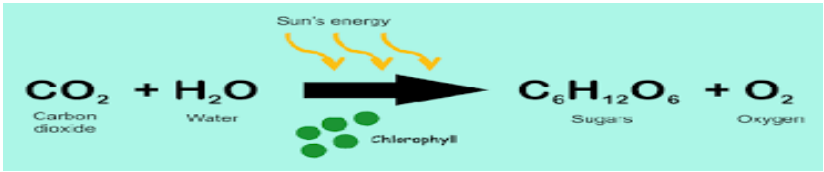


Carbohydrates

- Carbohydrates (CHO) are organic compounds (also called hydrated carbon) or polyhydroxy aldehydes or polyhydroxy ketones.
- containing **carbon**, **hydrogen**, and **oxygen**.
- Carbohydrates are widely distributed in plants and animals; they have important structural and metabolic roles.
- In plants, **glucose** is synthesized from carbon dioxide and water by photosynthesis.



Importance of Carbohydrates

1. Act as a main **source of energy** and **storage** form of energy.

2. Can **be** structural components of many organisms :

- ✓ Can be cell-membrane components mediating intercellular communication.
- ✓ Can be cell-surface antigens.
- ✓ Can be associated with proteins and lipids.
- ✓ Part of RNA, DNA, and several coenzymes (NAD+ , NADP+ , FAD, CoA).

Classification of Carbohydrates

1. **Monosaccharides** are those carbohydrates that cannot be hydrolyzed into simpler carbohydrates i.e. it composed from one unit.

2. **Disaccharides** are condensation products of two monosaccharide units.

3. **Oligosaccharides** are condensation products of two to ten monosaccharides. Example maltotriose (a trisaccharide of glucose).

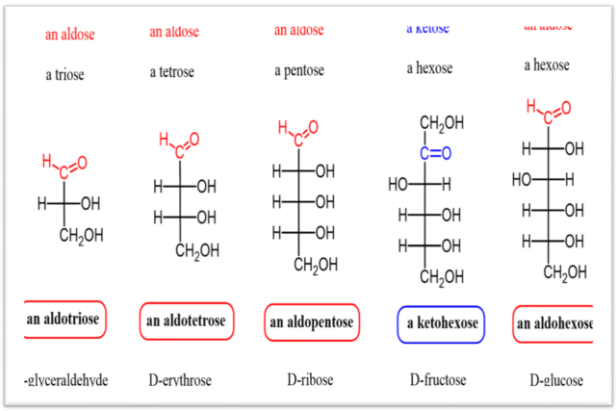
4. **Polysaccharides** are condensation products of more than ten monosaccharide units; example starches.

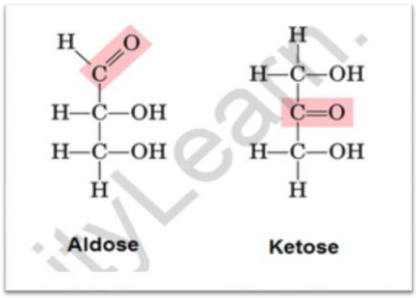
Monosaccharides

- **Monosaccharides** are those carbohydrates that cannot be hydrolyzed into simpler carbohydrates.

- They may be **classified** as:
  - ✓ **trioses**, **tetroses**, **pentoses**, **hexoses**, and **heptoses**, **depending** upon the number of **carbon** atoms; and as **aldoses** or **ketoses** **depending** upon whether they have an **aldehyde** or **ketone** group.

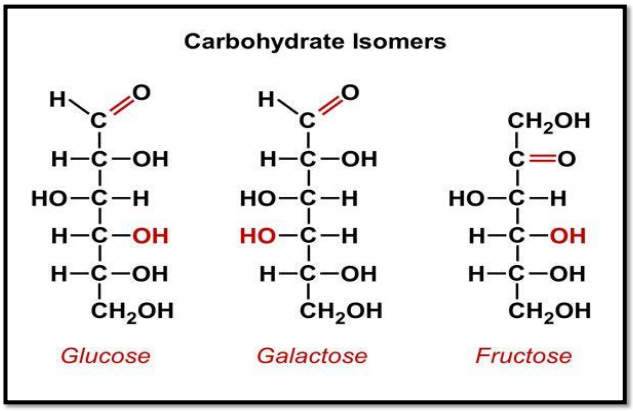
- **Hexoses are the most important monosaccharides found in plants**. They are the **first** detectable sugars synthesized by plants and form the units from which most of the polysaccharides are constructed such as glucose, fructose and galactose.





Isomers

- ✓Compounds that have the same chemical formula but have different structures are called isomers.
- ✓**For example**, **fructose**, **glucose**, **mannose**, and **galactose** are all isomers of each other, having the same chemical formula, **C6H12O6**.

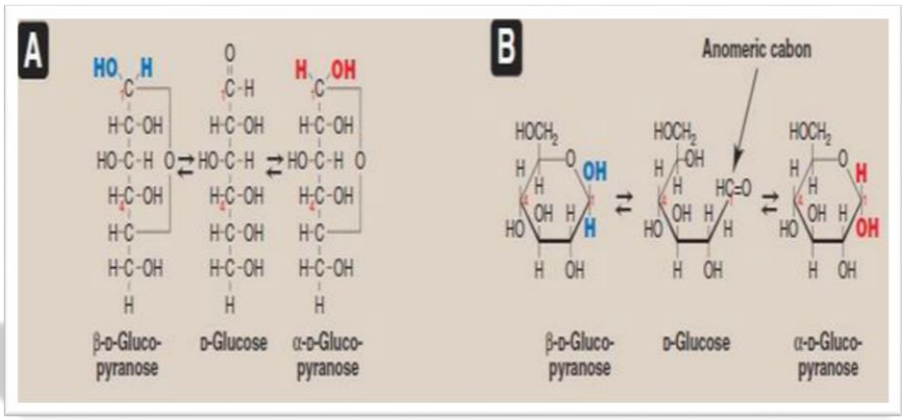


Cyclization of monosaccharides

- ➢**Less** than 1% of each of the monosaccharides with five or more carbons exists in the **open** chain (**acyclic**) form. Rather, they are predominantly found in a ring (**cyclic**) form, **in which the aldehyde (or keto) group has reacted with an alcohol group on the same sugar, making the carbonyl carbon (carbon 1 for an aldose or carbon 2 for a ketose) asymmetric.**

- ➢Monosachharides can exist in both cyclic structures i.e. either **pyrano** (six membered ring) or **furano** (five membered ring).

➢ ***Cyclization*** creates an **anomeric** carbon (the former carbonyl carbon), generating the α and β configurations of the sugar, for example, **α-Dglucopyranose** and **β- Dglucopryanose**. These two sugars are both glucose but are **anomers** of each other.



Reducing sugars

➢ If the hydroxyl group on the anomeric carbon of a cyclized sugar is **not linked to another compound by a glycosidic bond,** the ring can open.

➢ The sugar can act as a reducing agent, and is termed a reducing sugar.

✓ *Joining of Monosaccharides*

➢ Monosaccharides can be joined to form disaccharides, oligosaccharides, and polysaccharides. Important disaccharides include **lactose (galactose + glucose**), **sucrose (glucose + fructose),** and **maltose (glucose + glucose)**.

Disaccharides

Those are compounds that can yield two monosaccharides molecules on hydrolysis. There are three common disaccharides, **sucrose, maltose and lactose**. All of which are isomers with the molecular formula C11H22O11.

➢ ***Sucrose*:** It is the only disaccharide that occurs **abundantly in free state in plants**.

✓Sucrose is used as sugar at home and occurs in fruit juices, sugar cane, sugar beet, the sap of certain maples, and in many other plants.

✓Upon hydrolysis; sucrose yields **equimolar quantities of glucose and fructose**.

✓ Sucrose is a non-reducing sugar.

➢***Maltose*:** Maltose although **seldomly occurring in the free state** in nature, is produced in large quantities by the hydrolysis of starch.

✓Upon hydrolysis, yields **2 molecules of glucose**. It is a reducing sugar.

➢***Lactose*:** Lactose possesses a free functional aldehyde group and is a reducing sugar.

✓Commercially known as milk sugar. Bacteria cause fermentation of lactose forming lactic acid. When these reactions occur, it changes the taste to a sour one. It is a reducing sugar.

➢ ***Oligosaccharides*** are condensation products of **two to ten monosaccharides**.

✓Example **maltotriose** (a trisaccharide of glucose).

➢Polysaccharides

✓Polysaccharides are formed from condensation products of **more than ten monosaccharide units.** If only one type of monosaccharide unit is present, the polysaccharide is a "**homoglycan**" but a "**heteroglycan**" if more than one kind on monosaccharide is involved.

➢Examples of Homoglycans:

1- Starch: composed of glucose.

2- Inulin: composed of fructose.

3- Dextran: polyglucagon formed from sucrose.

4- Cellulose: consist of several hundred of D-glucose.

➢*Examples of Heteroglycans*

1. **Gums:** They are **translucent**, **amorphous** substances that are frequently produced in higher plants as a protective after injury.

✓They are ingredients in **dental and other adhesives and in bulk laxatives.** They are also useful as **tablet binders, gelating agents, suspending agents, stabilizers, and thickeners.**

2. Tragacanth: is the **dried**, **gummy** exudate from Astragalus gummifer.

✓Tragacanth is employed pharmaceutically as a **suspending agent** for insoluble powders in mixtures, as an **emulsifying agent** for oils and resins, and as an adhesive. It is employed in **cosmetics (hand lotions) as a demulcent**.

3. Acacia: Acacia is the **dried**, **gummy** exudate from the sterns and branches of Acacia Senegal.

✓Acacia is used as a **suspending agent**. It possesses useful **demulcent** and **emollient** properties and finds applications an adhesive and **binder** in tablet granulations.

4. Agar: is the dried, **hydrophilic**, colloidal substance extracted from Gelidium cartilagineum is used as **a laxative, suspending agent, an emulsifier**, and as a **tablet excipient and disintegrant.**

5. Plantago seed (psyllium seed): is the cleaned, dried, ripe seed of Plantago psyllium. Plantago seed is **a cathartic.**

6. Pectin: Pectin is a purified **carbohydrate** product obtained from the dilute acid extract of the inner portion of the rind of citrus fruits or from apple. Pectin is classified as **a protectant and a suspending agent** and is an ingredient in many **antidiarrheal formulations**.

Carbohydrate utilization

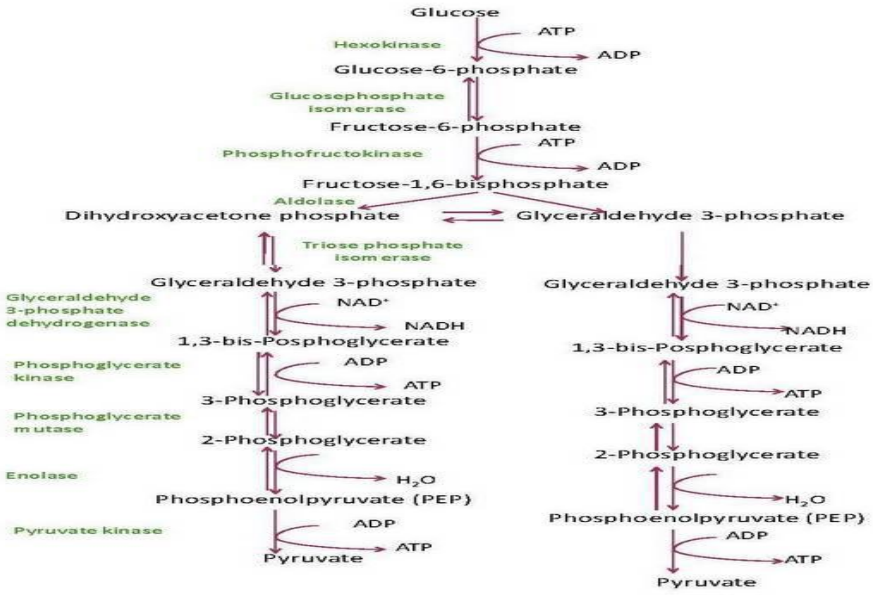
- **Storage** carbohydrate such as the **starch of plants or glycogen of animals** is made available for energy production by a process which involves conversion of **glucose to pyruvate** by **glycolysis** and then the **pyruvate converted to acetylcoenzyme A**, then will pass to **the tricarboxylic acid cycle** (TCA).

- As a result of this, the energy rich **carbohydrate is oxidized to CO2 and H2O.**

- Coenzymes in TCA will carry the liberated hydrogen atoms to the cytochrome system in which the energy is liberated in stages, with the formation of ATP from ADP.

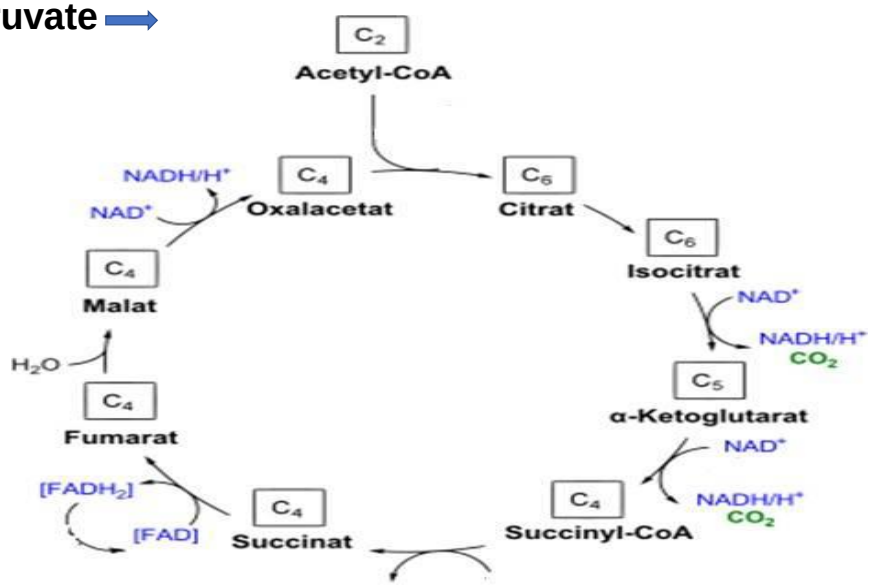
- The hydrogen combines with oxygen to form water.

Embden-Meyerhof scheme (pathway) of glycolysis:



Tricyclic acid cycle:

Pyruvate ⟶



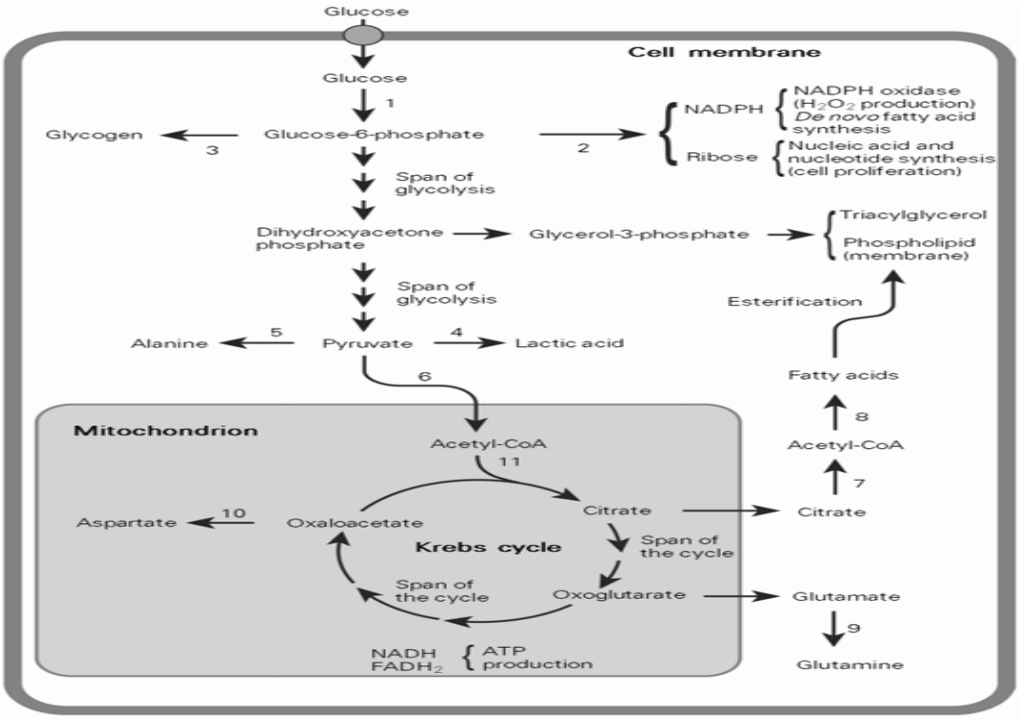
- The overall reaction for the metabolism of one molecule of glucose in terms of ADP and ATP is:

$$C_6H_{12}O_6 + 6O_2 + 38ADP + 38\ P\ (inorganic) \longrightarrow 6H_2O + 6CO_2 + 38ATP$$

Glucose

In the cytoplasm

Glycolysis:	2 ATP	⟶ 2 ATP
In the mitochondria		
From glycolysis:	2 NADH ⟶ 6 ATP	⟶ 6 ATP*
From respiration:		
Pyruvic acid ⟶ acetyl CoA:	1 NADH ⟶ 3 ATP	(× 2) ⟶ 6 ATP
Krebs cycle:	3 NADH ⟶ 9 ATP 1 FADH₂ ⟶ 2 ATP	(× 2) ⟶ 24 ATP
Total:		38 ATP


Glucose
Cell membrane
Glucose
1
Glycogen
3
Glucose-6-phosphate
2
NADPH
NADPH oxidase
(H_2O_2 production)
De novo fatty acid synthesis
Ribose
Nucleic acid and nucleotide synthesis
(cell proliferation)
Span of glycolysis
Dihydroxyacetone phosphate
Glycerol-3-phosphate
Triacylglycerol
Phospholipid (membrane)
Esterification
Span of glycolysis
Alanine
5
Pyruvate
4
Lactic acid
6
Fatty acids
8
Mitochondrion
Acetyl-CoA
11
Acetyl-CoA
7
Aspartate
10
Oxaloacetate
Citrate
Citrate
Krebs cycle
Span of the cycle
Span of the cycle
Oxoglutarate
Glutamate
9
Glutamine
NADH
$FADH_2$
ATP production


Thank you for your attention