HME103-Principles of Nutrition

Components in Foods and Their Relationships with Health: Carbohydrates, Energy Requirements, and Balance

Lesson Code-Name: HME103-Principles of Nutrition

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What is food (nutrient)? Food is any eatables and drinks that constitute the source of food components (protein, fat, carbohydrate, vitamin, mineral substance, etc.) necessary for human beings to survive, grow, reproduce and engage in economic activity.

Components Found in Foods

Main Components of Foods;

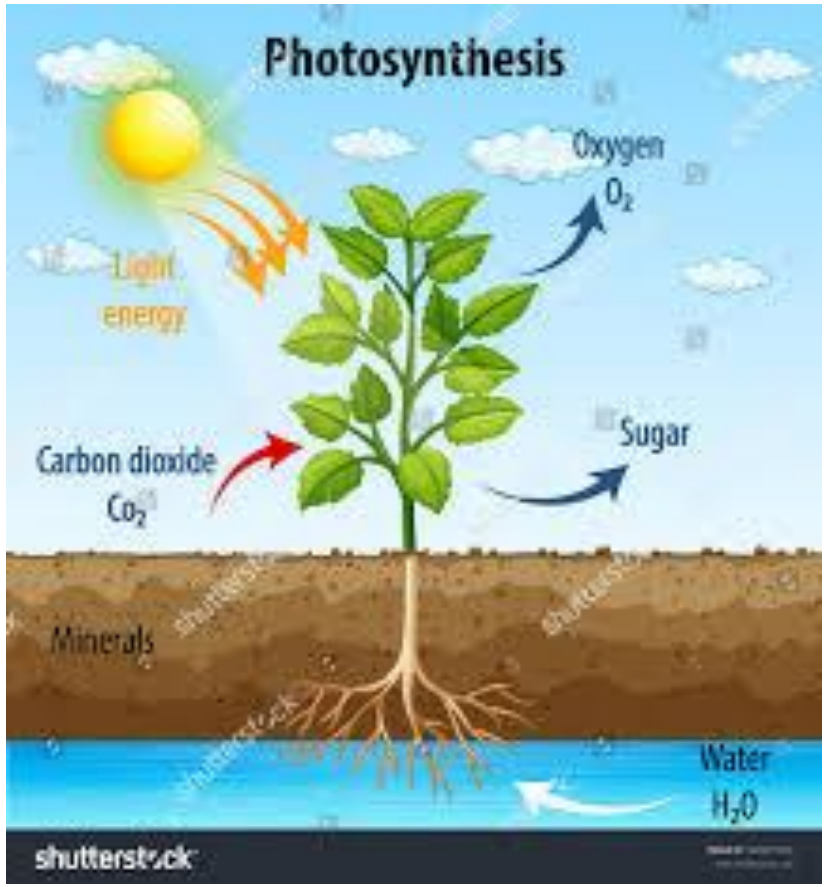
1.Water
2. Carbohydrates
3. Proteins
4. Fats
5. Minerals
6. Vitamins
7. Enzymes
8. Flavouring and colouring agents

CARBOHYDRATES

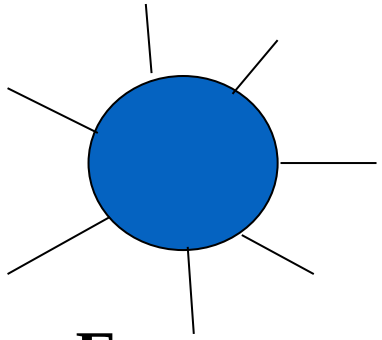
Carbohydrates are the most common organic compounds on earth.

Carbohydrates are generally organic compounds consisting of carbon, hydrogen, and oxygen elements (such as sugar, dextrin, starch, cellulose, pectin, plant gums, etc.).

Most of the carbohydrates are obtained through photosynthesis, which utilizes water, sunlight energy, and atmospheric CO_2



Photosynthesis



Enegy

CO_2
Water
Chlorophyll

GLUCOSE

$$6\,CO_2 + 6\,H_2o + \text{Sunlight} \longrightarrow C_6H_{12}O_6 + 6\,O_2$$

$$C_6H_{12}O_6 + 6\,O_2 \longrightarrow \text{Energy} + CO_2 + 6\,H_2o$$

Functions of Carbohydrates in the Body

Carbohydrates have many different functions in the body. These are;

- They provide 55-60 per cent of daily energy. Brain tissue uses only carbohydrates for energy. **1 g carbohydrate gives an average of 4 kcal energy.**

- They reduce the need for protein by preventing using protein for energy. If not enough carbohydrates are taken, proteins start to be used for energy. For this reason, carbohydrates taken into the body in the right amount prevent proteins from spending energy.

Functions of Carbohydrates in the Body

- Carbohydrates have an important place in daily nutrition because they are a source of dietary fiber (fiber, pulp). Dietary fiber increases intestinal movements and helps excrete the waste formed there as faeces (stool). They prevent constipation and reduce the amount of unwanted fat and sugar in the blood.

Dietary fiber (food fibre) is the edible parts of plants that are not digested in the human small intestine but are fully or partially fermented in the large intestine. Complex compounds such as cellulose, hemicellulose and lignin, which are found in plant foods and cannot be digested, form fiber.

Dietary fibre	Features	Sources
Soluble Fibres		
Pectin	It is been galacturonic acid, rhamnose, arabinose, the high content of galactose, intermediate laminate and on the primary wall	Whole grains, apple, legumes, cabbage, root vegetables
Gum	Generally are composed monomers of hexose and pentose	Oatmeal, haricot bean, legumes
Mucilages	Compounds which is synthesized in plants that it is contain of Glycoprotein	Food additives
Insoluble Fibres		
Cellulose	It is the main component of cell walls which consisting of glucose Monomers	Whole grains, bran, peas, root vegetables, beans family of cruciferous, apple
Hemicelluloses	Primary and secondary the cell walls	Bran, whole grains Guava pomace
Lignin	It is been consist of aromatic alcohols and the components of other cell wall	Vegetables, flour

Tablo 2. Çeşitli gıdaların diyet lifi içerikleri (Diyet lifi g/100 g yenilebilir kısım) [16]

Table 2. Dietary fiber contents of various foods (Dietary fiber g/100 g edible part) [16]

Gıda	Çözünen	Çözünmeyen	Genel toplam
Buğday kepeği	-	-	33.75
Buğday(ekmeklik)	2.92	9.75	12.66
Kuru fasulye	-	-	32.17
Mercimek	-	-	25.99
Bezelye	1.92	21.73	23.65
Barbunya	4.03	19.18	23.21
Nohut	-	-	23.03
Arpa	1.93	19.10	21.11
Yulaf	2.05	10.27	12.24
Pirinç	-	-	3.46
Bulgur	1.70	5.09	6.79
Badem	1.02	10.98	12.00
Fındık	-	-	11.54
Ceviz	2.03	9.49	11.50
İncir	-	-	10.06
Havuç	0.82	1.76	2.58
Erik	0.98	1.23	2.20
Dut	0.40	1.76	2.16
Elma	0.62	1.29	1.91
Portakal	0.72	1.17	1.89
Şeftali	0.54	1.28	1.82
Kiraz	0.28	1.61	1.89
Muz	0.45	1.24	1.69
Kavun	0.22	0.43	0.65
Karpuz	0.12	0.42	0.54
Kabak	0.73	0.90	1.63
Semizotu	0.49	1.10	1.59
Patates	0.41	1.13	1.54
Domates	0.17	0.94	1.10
Salatalık	0.19	0.32	0.52
Biber	0.67	1.19	1.86
Yeşil Fasulye	0.57	1.51	2.08
Ispanak	0.67	1.60	2.27
Bamya	1.35	2.00	3.36
Patlıcan	0.65	1.85	2.51
Keten tohumu	0.28	34.78	35.06
Çörek otu	-	-	37.14
Karamuk	-	-	43.60
Türk kahvesi	-	-	51.88
Keçiboynuzu	2.68	23.14	25.83
Hindistan cevizi(kuru)	-	-	18.91
Siyez buğdayı	-	-	11.30
Avokado	0.33	9.37	9.70
Pikan cevizi	1.32	6.93	8.25
Glutensiz ekmek	0.51	4.93	5.44

Functions of Carbohydrates in the Body

- Carbohydrates help keep water and electrolytes in balance in the body.
- They enable the proliferation of bifido bacteria, which prevent the proliferation of pathogenic bacteria in the intestines. In other words, they show prebiotic properties.
- In addition to being a source of energy, carbohydrates also function as structural and supporting elements in living things.

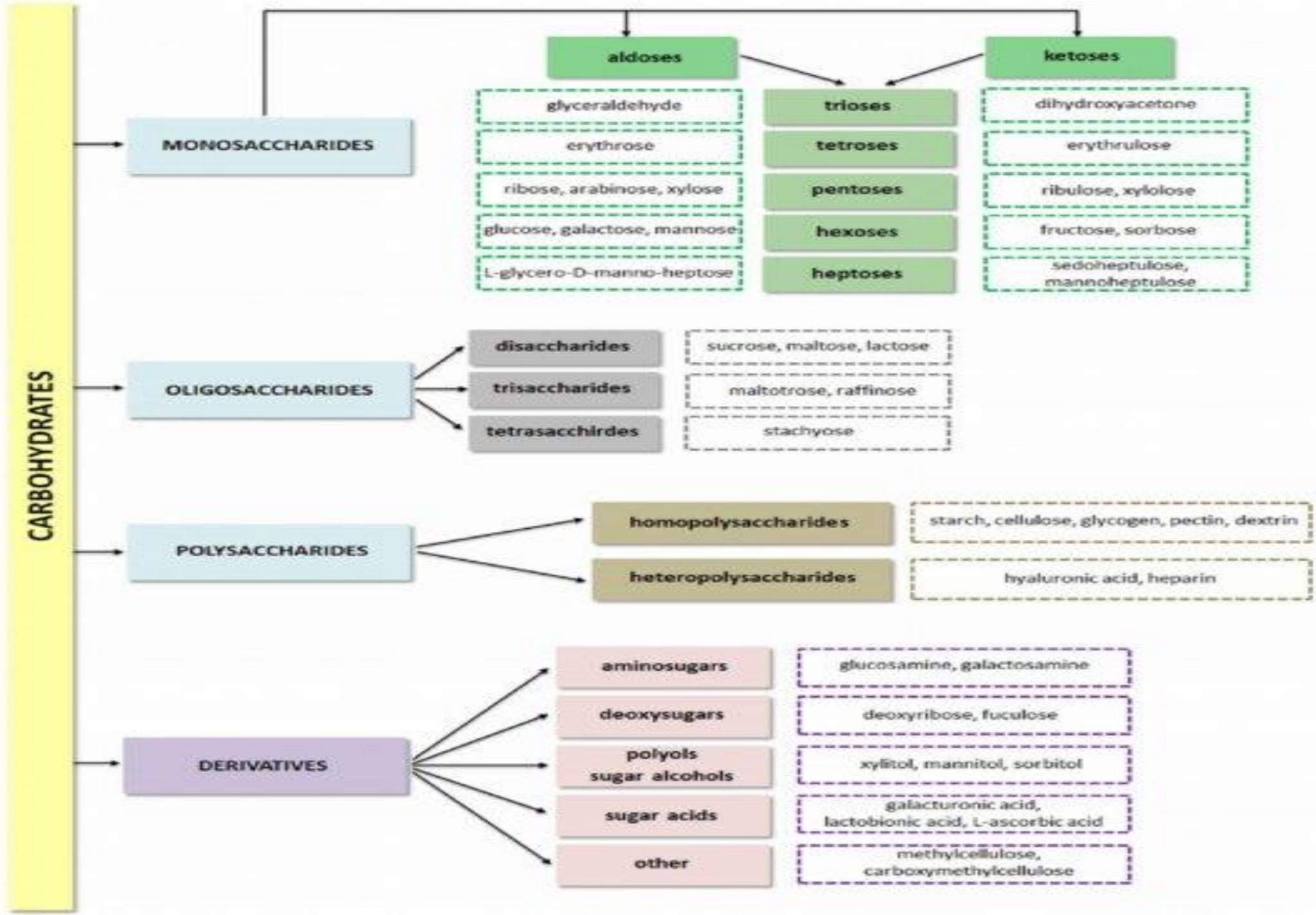
For example, water-insoluble carbohydrates serve as structural and supporting elements in animal cell envelopes and connective tissue. Some other carbohydrates lubricate joints, enable cells to adhere to each other, and provide biological specificity to the surface of animal cells.

Classification of Carbohydrates

Carbohydrates are generally divided into 3 large classes:

1.Monosaccharides
2.Oligosaccharides
3.Polysaccharides

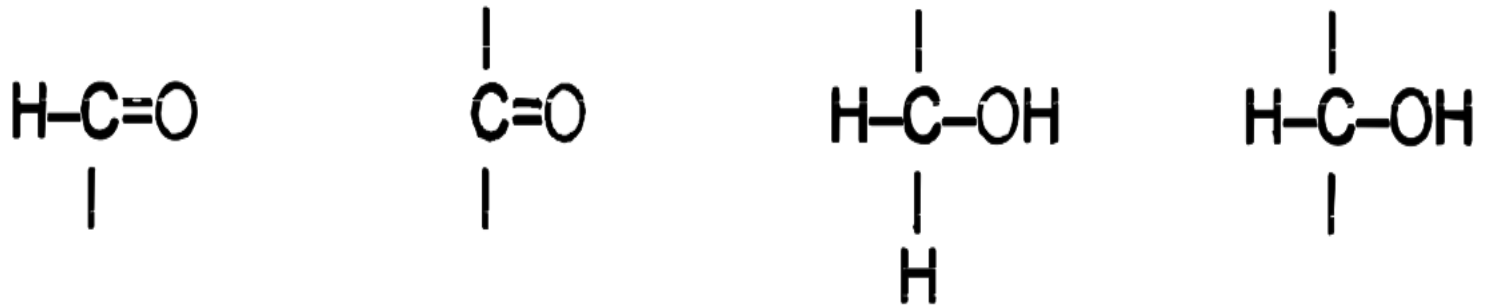
There are also some classifications in which carbohydrates are divided into 4 large classes: Monosaccharides,Disaccharides,Oligosaccharides, and Polysaccharides

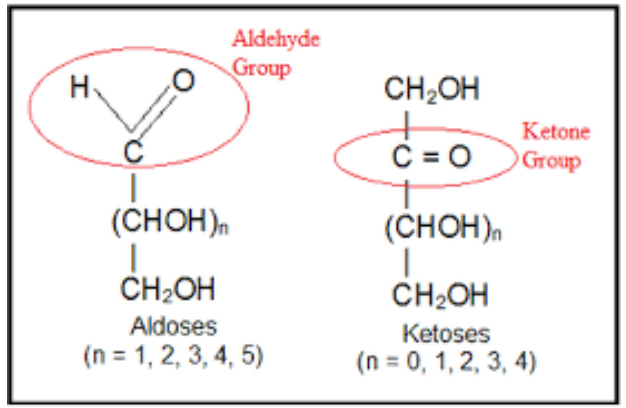

CARBOHYDRATES
MONOSACCHARIDES
aldoses
ketoses
glyceraldehyde
erythrose
ribose, arabinose, xylose
glucose, galactose, mannose
L-glycero-D-manno-heptose
trioses
tetroses
pentoses
hexoses
heptoses
dihydroxyacetone
erythrulose
ribulose, xylolose
fructose, sorbose
sedoheptulose, mannoheptulose
OLIGOSACCHARIDES
disaccharides
trisaccharides
tetrasacchirdes
sucrose, maltose, lactose
maltotrose, raffinose
stachyose
POLYSACCHARIDES
homopolysaccharides
heteropolysaccharides
starch, cellulose, glycogen, pectin, dextrin
hyaluronic acid, heparin
DERIVATIVES
aminosugars
deoxysugars
polyols sugar alcohols
sugar acids
other
glucosamine, galactosamine
deoxyribose, fuculose
xylitol, mannitol, sorbitol
galacturonic acid, lactobionic acid, L-ascorbic acid
methylcellulose, carboxymethylcellulose

1. Monosaccharides (Simple Sugars)

Monosaccharides are sugars consisting of a single polyhydroxy aldehyde or polyhydroxy ketone unit. They do not break down into simpler sugars by hydrolysis.

Carbohydrates have a carbonyl group consisting of either an aldehyde or a ketone, as well as two or more hydroxyl groups in both the primary alcohol structure and the secondary alcohol structure.

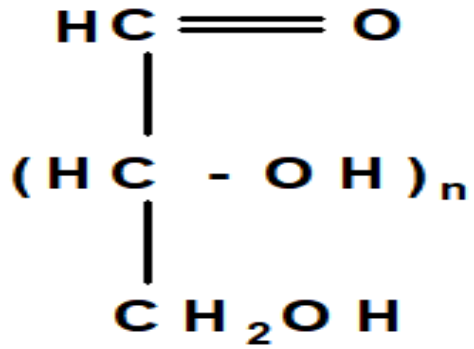




Aldehyde group **Ketone group** **Primary alcohol group** **Secondary alcohol group**

Carbonyl groups **Alcohol groups**

Aldoses

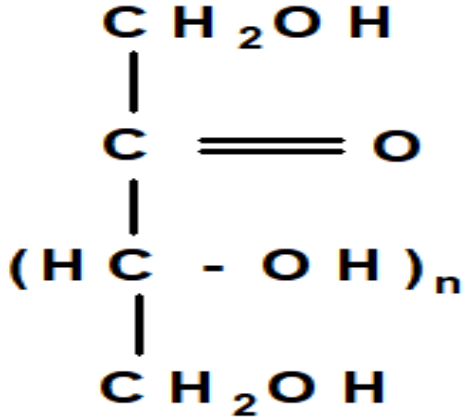


Aldehyde group

Secondary alcohol group

Primary alcohol group

Ketoses



Primary alcohol group

Ketone group

Secondary alcohol group

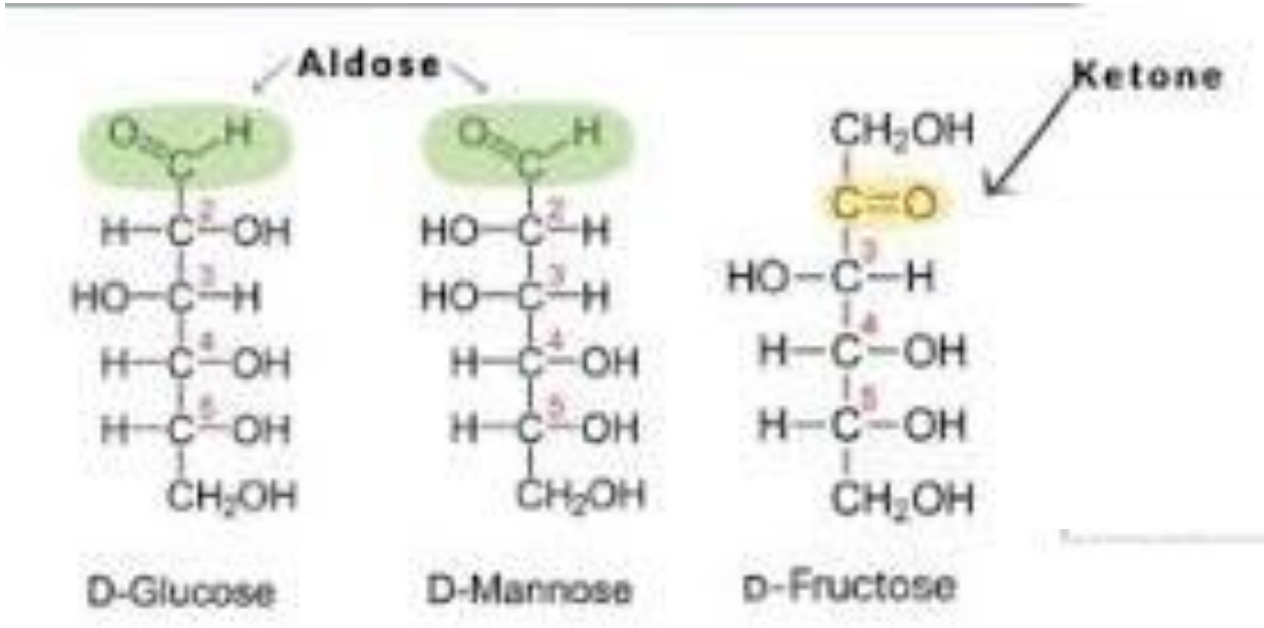
Primary alcohol group

Monosaccharides

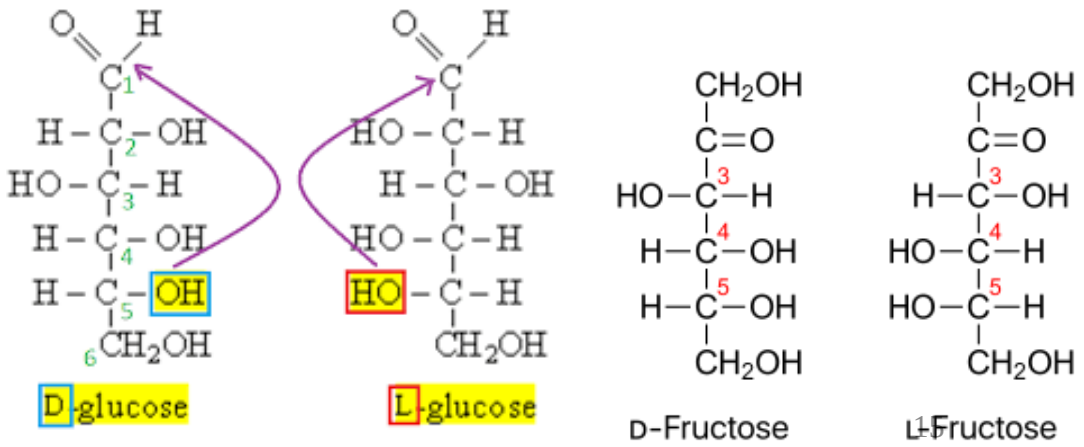
Aldoses contain aldehyde groups

Ketoses contain a keto group (generally at C2)

Isomers are molecules that have the same chemical composition but different connection structures between their atoms.



Isomers are named according to the -OH group of the asymmetric carbon atom furthest from the aldehyde/keto group. If the OH group is on the right, it is called D-, and if it is on the left, it is called L-.

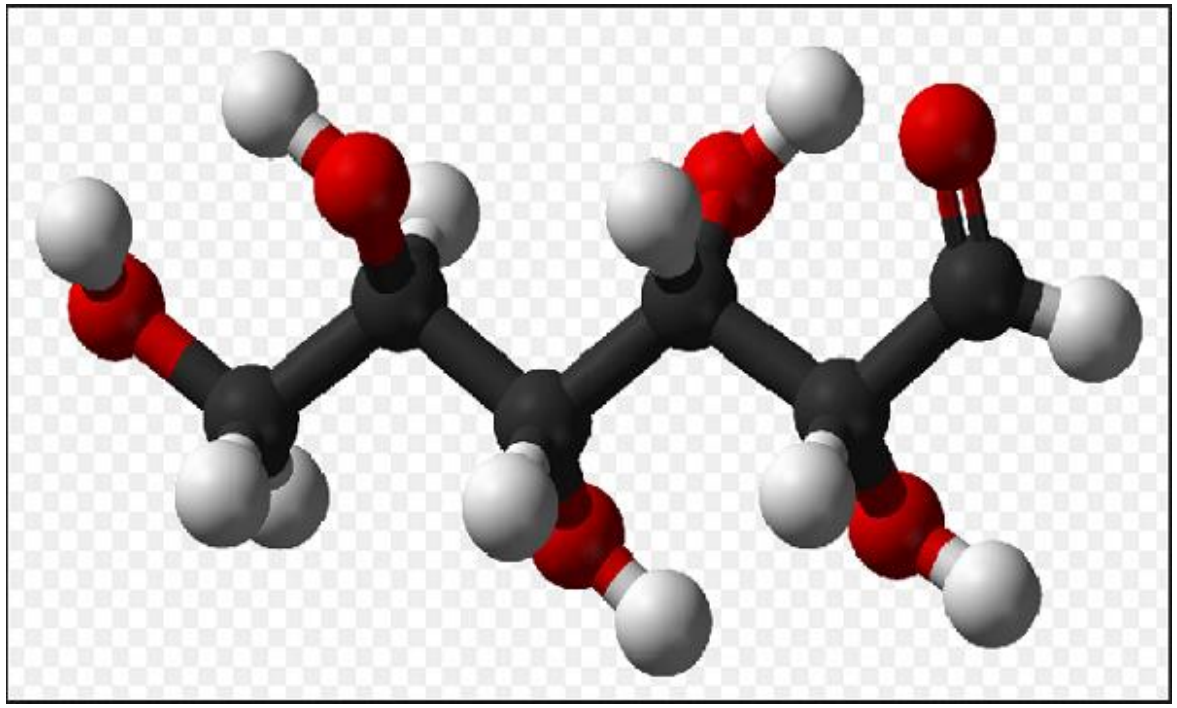


1. Monosaccharides (Simple Sugars)

Monosaccharides are also classified according to the total number of carbons in their molecules and are named by adding the suffix "**oz**" to the end of the Latin name of the carbon number;

Total number of carbons in the molecule of monosaccharides

Those with 3 are trioses,
.. 4 are tetroses,
.. 5 are pentoses,
.. 6 are hexoses,and
.. 7 are heptoses.

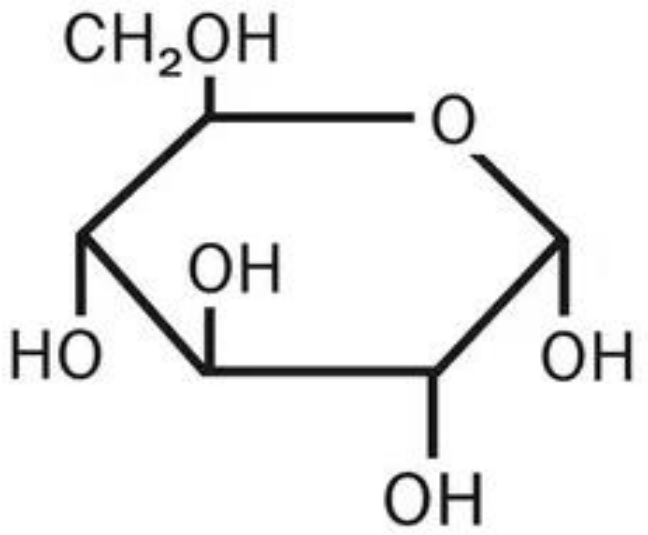


1. Monosaccharides (Simple Sugars)

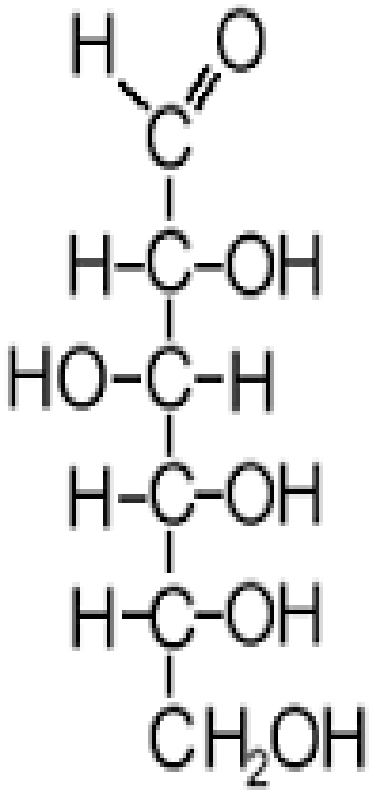
The most important monosaccharides are glucose, fructose and galactose. They form subunits of oligosaccharides and polysaccharides.

Glucose is found free in nature and mostly together with fructose in fruits, honey and plant juices. It is also formed as a result of the hydrolysis of starch, sucrose, maltose and lactose. It is the body's basic sugar. It is found in the blood at a rate of 0.1%. Since it is abundant in grapes, it is also called **grape sugar**.

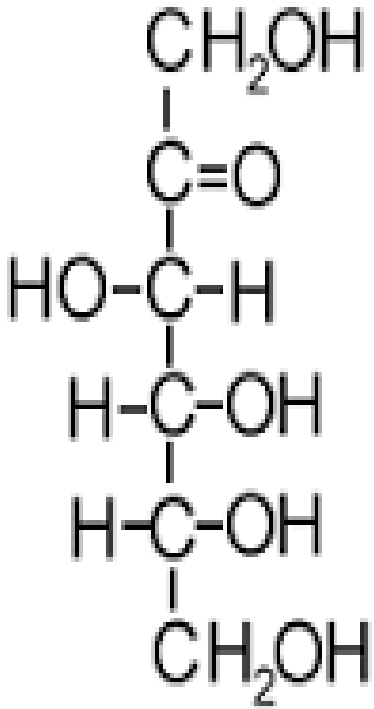
Glucose



D-Fructose is found in fruits and honey. They are the sweetest candies. It is also called fruit sugar. It is found in tea sugar in half along with glucose.

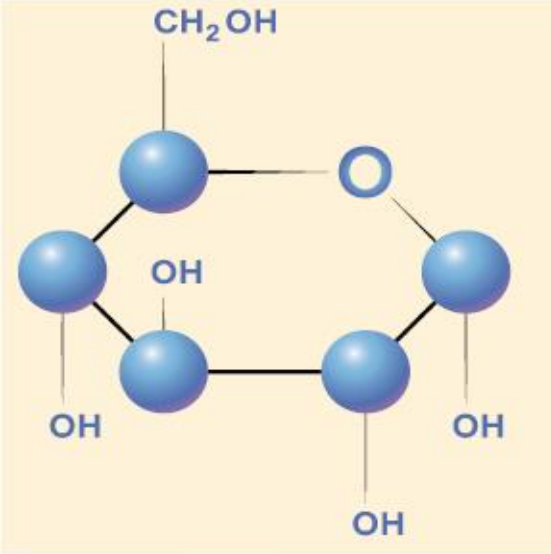


Glucose

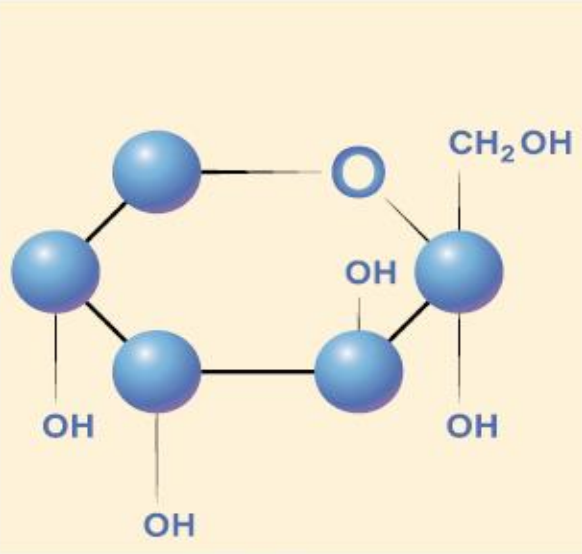


Fructose

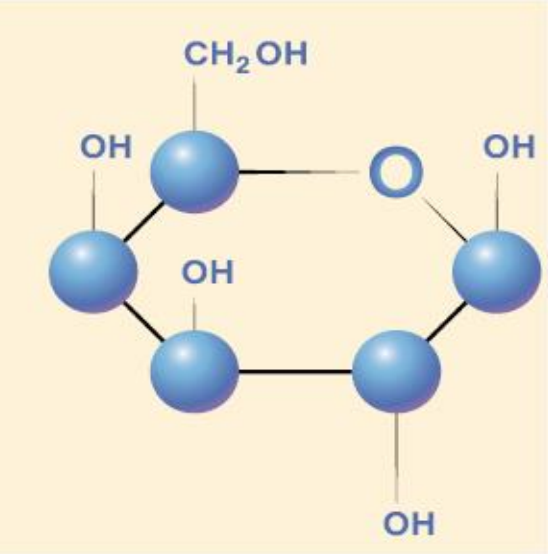
D-Galactose is a sugar that is not found free in nature, resulting from the hydrolysis of lactose (milk sugar).



Glucose



Fructose

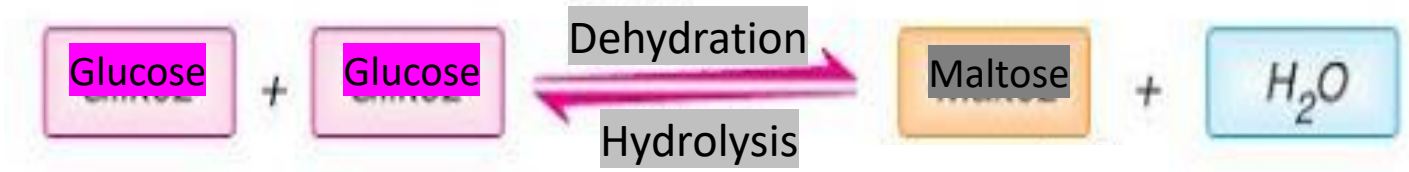


Galactose

2.Oligosaccharides

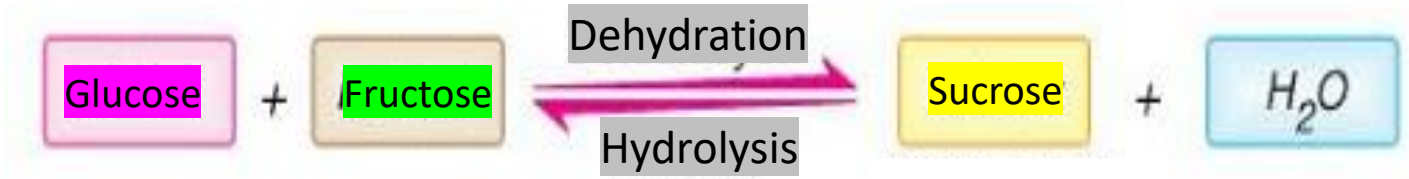
Disaccharides

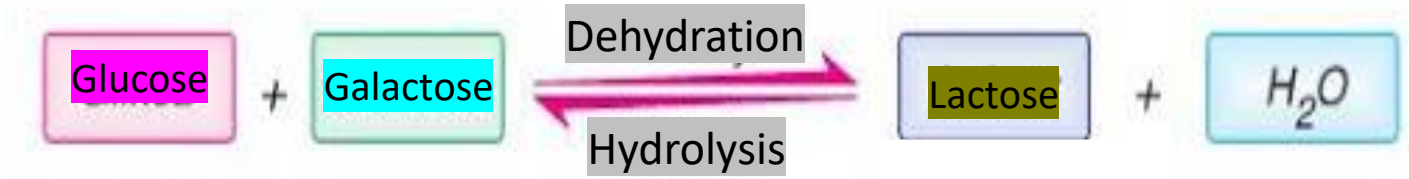
They are formed as a result of two monosaccharides bonded together.



The most common disaccharides are;

- maltose (barley sugar),
- sucrose (tea sugar) and
- Lactose (milk sugar)





Important disaccharides

1.Sucrose

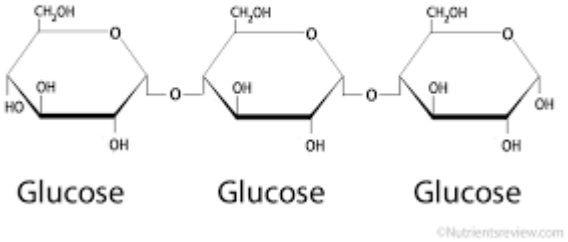
Sucrose is the sugar known as tea sugar obtained from sugar beet and sugar cane. It is formed by combining glucose and fructose monosaccharides. There is 16-20% sucrose in sugar beet and 14-28% in sugar cane.

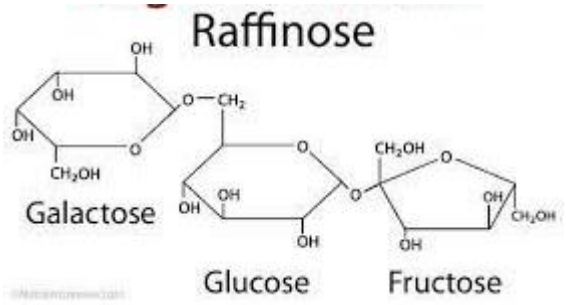
2. Lactose

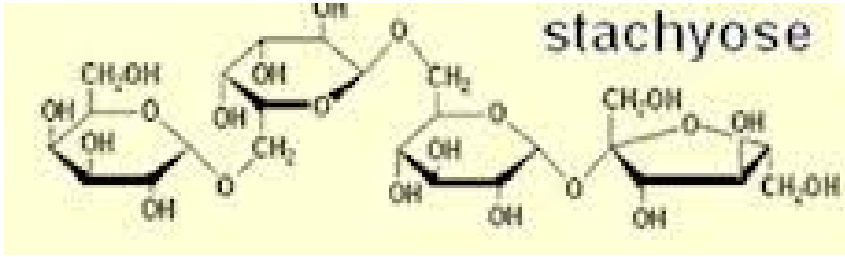
Lactose, known as milk sugar, is a disaccharide formed by the formation of glycosidic bonds between molecules of glucose and galactose. It is found in nature only in milk. That's why it is called milk sugar.

Other Oligosaccharides

They are low molecular weight carbohydrates consisting of 3 to 10 saccharides such as maltotriose, raffinose, and stachyosis.

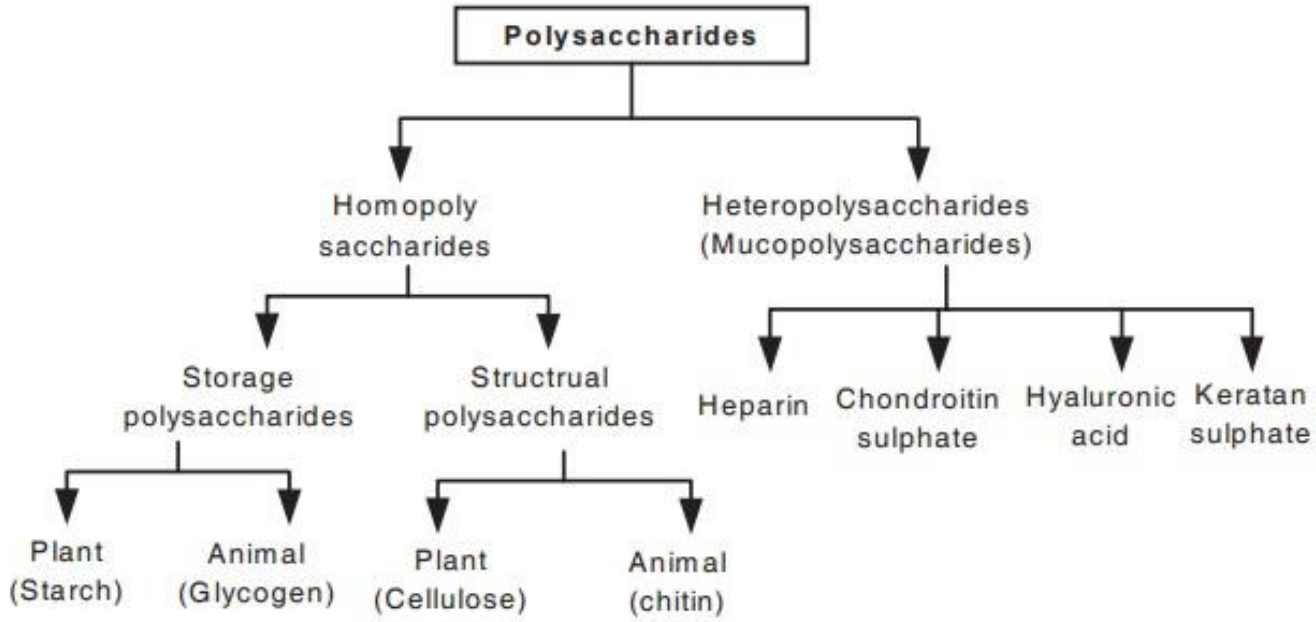






3.Polysaccharides

Polysaccharides are carbohydrates formed by connecting many monosaccharides through glycoside bonds. Most carbohydrates found in nature are polysaccharides, which are high molecular weight polymers. They are broken down into monosaccharides in their structure by the action of enzymes or acids.



Polysaccharides are generally divided into two groups.

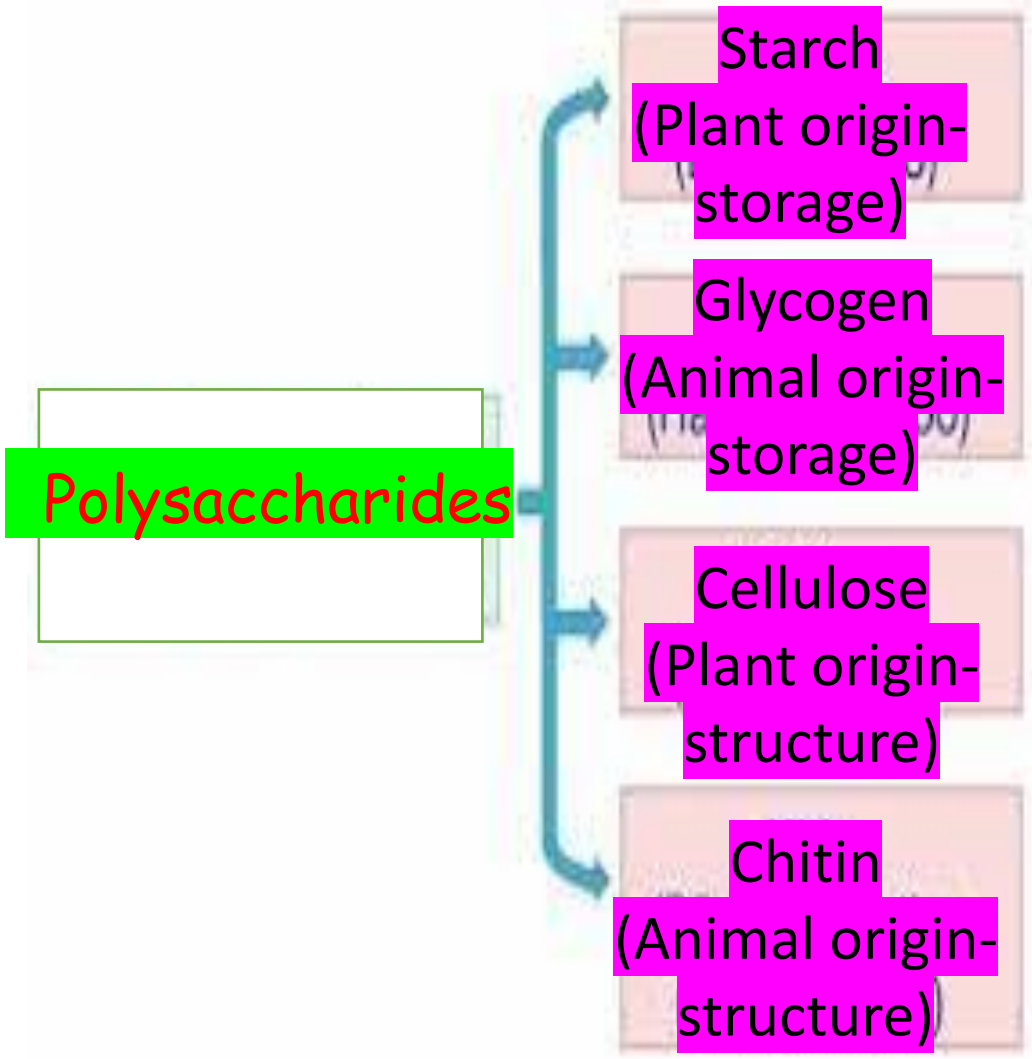
1. Homopolysaccharides: These contain a single type of monosaccharide or its derivatives (such as starch, cellulose).
2. Heteropolysaccharides: These are polysaccharides that form more than one monosaccharide derivative when hydrolyzed (Pectic compounds, plant gums).

Important Polysaccharides

•Starch: It is found in plant foods as a storage carbohydrate. It is a large molecule polysaccharide formed by combining a large number of glucose. It can also be obtained pure. It does not dissolve in water.

•Glycogen: It is a polysaccharide of animal origin that is stored in the muscles and liver and used for energy in the cell.

•Cellulose, Hemicellulose, Lignin etc. (Fibre): They are located in the vegetal structure. They are the indigestible parts of food. It is called fiber, it increases intestine movements and ensures regular functioning of the intestine. It is recommended to prevent constipation and in weight loss regimes as it provides a feeling of fullness in the stomach and intestines.



Carbohydrate metabolism

Digestion in the mouth

Digestion of carbohydrates begins in the mouth, thanks to the amylase enzyme (ptyalin) in saliva. As chewing time increases, carbohydrate digestion in the mouth increases.

Digestion in the stomach

When nutrients reach the stomach, carbohydrate digestion stops due to the acid pH of the stomach. Thus, the function of saliva ends at the pH of the stomach. But the carbohydrate molecule digested by saliva is not fully usable.

Digestion in the small intestine

Starch, glycogen and dextrin are broken down into disaccharides (maltose) by amylase in the pancreatic juice secreted into the duodenum.

Starch/ Glycogen + Amylase enzyme + Water --------> Maltose + Dextrin

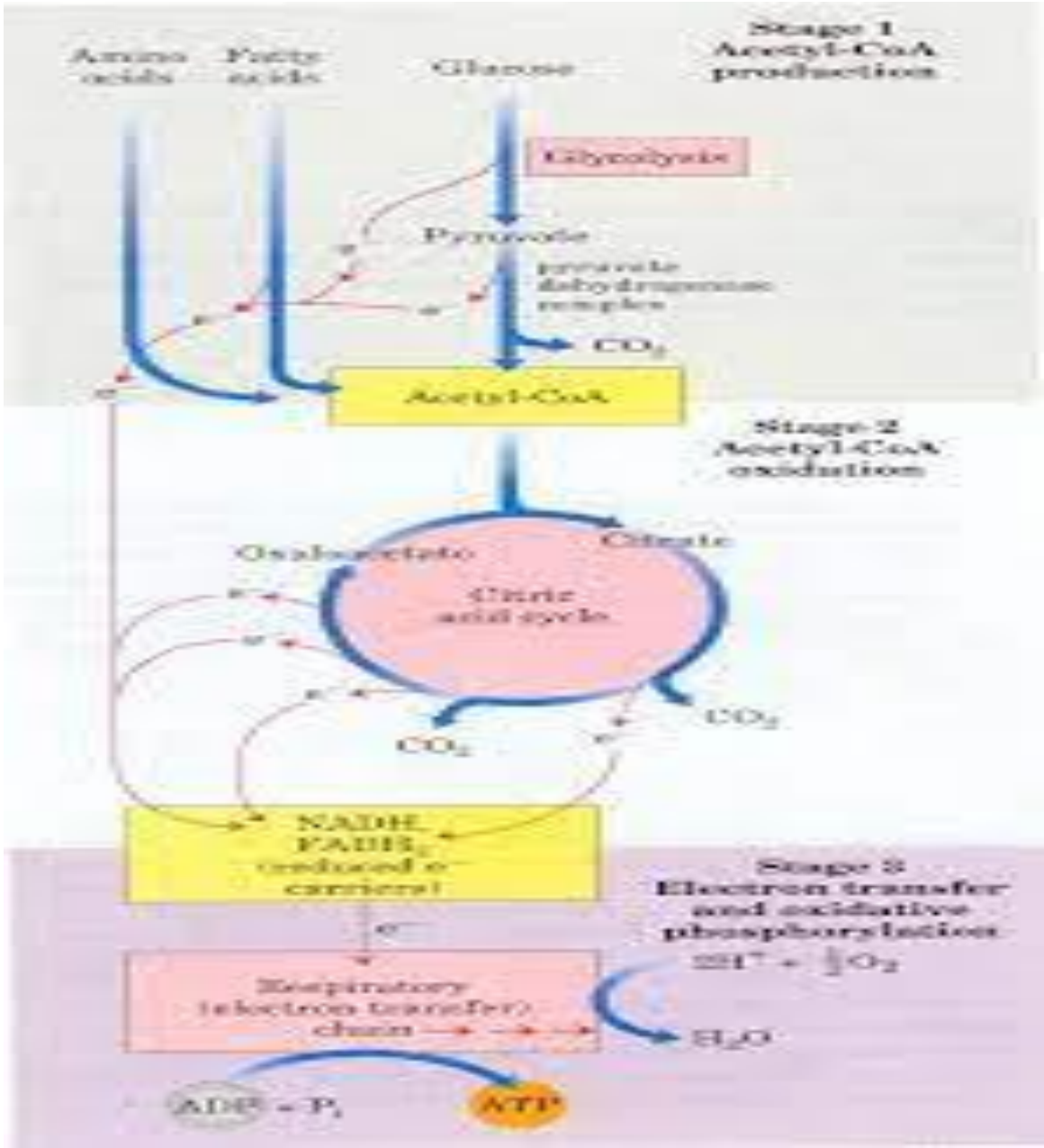
Disaccharides are broken down into monosaccharides by maltase (breaks down maltose), lactase (breaks down lactose), and sucrase (breaks down sucrose) enzymes secreted from the small intestine glands.

The digestion products of carbohydrates are glucose, fructose and galactose.

Carbohydrate metabolism

Digestion occurs step by step, and the final place is the small intestine mucosa. From here, monomers pass into the blood. The monomers that pass into the blood are taken to the relevant places, where they are mostly converted into D-glucose to be used in metabolism. In tissues, glucose turns into energy, water and carbon dioxide as a result of oxidation with the help of enzymes in the presence of oxygen.

Glucose is used primarily for energy needs.If there is no need for energy, glucose turns into glycogen and is stored in the liver.



Carbohydrate requirement

Daily energy requirement varies depending on;

- ✓ age,
- ✓ gender,
- ✓ physical activity level,
- ✓ physiological state (pregnancy and lactation),
- ✓ being/not being sick,
- ✓ genetic structure and environmental conditions.

1 g carbohydrate=4 kcal

When the energy taken in and the energy spent are equal, energy balance is achieved in the body. Too much energy intake causes body weight to increase, while too little energy intake causes body weight loss.

Excess carbohydrates are stored as glycogen in the liver and muscles. Carbohydrates are the most economical and fast source of energy for the body. Muscle and liver glycogen is used as an energy source in heavy working conditions and endurance exercises.

After the daily excess carbohydrate is stored as glycogen, the rest turns into fat and is stored. For this reason, it is recommended that 45-60% of daily dietary energy comes from carbohydrates.

Carbohydrate-containing foods

In general, the leading carbohydrate-based foods are plant-based foods. Plant foods store more or less carbohydrates depending on their type. 60-90% of dry grains consist of carbohydrates. Fruits and vegetables contain 10-20% carbohydrates.

Simple carbohydrates; They contain a single or at most two molecules of sugar. Single-molecule sugars are glucose (grape sugar), fructose (fruit sugar) and galactose (milk sugar). Those containing two molecules of sugar are sucrose (tea sugar), lactose (milk and its products) and maltose (some vegetables and malt). Simple sugars give food its sweet taste. It is naturally found in fruits, milk, and as added sugar in sodas, iced tea drinks, fruit drinks, candy and desserts.

Complex carbohydrates; This group includes starch and dietary fiber. Starch is found in many plant foods. Cereals (wheat, rye, oats, rice, barley and millet), legumes (dry beans, lentils, chickpeas) and root vegetables (potatoes) contain starch. Vegetables and fruits, whole grains and legumes contain fiber.

Question: How much carbohydrate should be included in the diet of an adult with a daily energy requirement of 2000 kcal?

Anwer: 225-300 g.