

Biochemistry

Biochemistry: Science concerned with the chemical basis of life in different phases of activity from the smallest micro- organism such as viruses to the most complex species like human.

IT is involved to know:

1. How do we grow?
2. Where do we get our energy?

There is a relationship between living and environment by exchange of chemicals take place between them through digestion, absorption, and excretion leading to growth and replenishment of tissues and multiplication of cell and the species.

Medical Biochemistry: It is sub branch of biochemistry, studied by doctors and nurses, It covered by the following aspects of chemistry.

1. tissues and foods
2. digestion and absorption.
3. tissue metabolism.
4. biochemistry disorders in disease. And others

Importance of biochemistry to nurses: (IT is the language of life)

1. essential to understand the basic functions of the human body.
2. to know how the food is digest, absorbed and used for body building.
3. to understand how the body gets energy every day.
4. interrelation between various metabolic processes.
5. study relationship between disease manifestations and changes in the composition of blood and other tissues to indicate the normal from the abnormal values of the body fluids.
6. the correct diagnosis , nursing care plans, treatment, prevention and control of infectious diseases depend on a sound knowledge of medical biochemistry.

Carbohydrates

Carbohydrates (CHO): include large group of compounds known as sugars and starches distributed in animals and plants.

Chemically: They are polyhydric alcohols having potentially active aldehyde or ketone groups.

General formula of CHO $C_n (H_2O)_n$

Ratio of hydrogen to oxygen = 2 / 1

In general CHO properties: 1. White solids 2. Soluble in water except polysaccharides

Sources of Carbohydrates

CHOs widely distributed in plants and animals.

In animal cells: CHOs serves as an important source of energy.

Ex: glycogen storage in muscle and liver, glucose present in body fluids.

in plants CHOs include:

1. **starches**: present in cereals, roots and tubers e.g: rice, wheat, potatoes, pulses etc.
2. **sugars**: disaccharides e.g: sucrose, lactose, maltose
3. **cellulose**: fibers found in vegetables, fruits, cereals . it is hard to digest and has no nutrition value.

Biological importance:

1. Main source of energy in the body, each gram of CHO gives 4kcal of energy when it oxidized.
2. The body prefer use of CHO as source of energy when it is supplied in diet and sparing proteins for tissues building.

Note: Brain and RBCs wholly depend on glucose as energy source

3. All CHOs digested into glucose before absorbed into blood.
4. Glucose is the sugar of blood and is excreted in urine as glycosuria.
5. Glucose is stored in liver and muscle as glycogen.

6. Lactose have several functions in GI tract , promotes growth of desirable bacteria. And help in synthesis if B – complex vitamins.

7. Cellulose is dietary fiber don't consider nutrients to the body.

Balanced diet:	CHOs rich in fiber constitute	60% of energy requirements
	Proteins give	15 – 20% of daily energy needs
	Fats give	20 – 30% of the energy needs

We must intake adequate amount of CHOs to meet a greater energy needs

Classification of Carbohydrates

Carbohydrates are also called saccharides, which comes from sakkron, a Greek word that means sugar.

The chemical classification includes monosaccharides, oligosaccharides and polysaccharides.

Monosaccharide		Oligosaccharide			Polysaccharide	
Functional group	Number of carbon atoms	Di-saccharide	Tri-saccharide	Tetra-saccharide	Homopoly-saccharide	Hetropoly-saccharide
Aldoses e.g Glucose	Trioses	Maltose	Raffinose	Stachyose	Starch	Hyaluronic acid
	Tetroses	Lactose			Dextrin	Heparin
Ketoses e.g Fructose	Pentoses	Sucrose			Glycogen	Chondroitin sulfate
	Hexoses				Cellulose	Dermatan Sulfate
	Heptoses				Inulin	Keratan Sulfate

1.Monosaccharides:

They are classify according :

1. number of carbon atom (tiroses, tertroses, pentoses, hexosis).
2. depending on functional group (aldehyde or ketone group)

The monosaccharides commonly found in humans are classified according to the number of carbons they contain in their backbone structures. The major monosaccharides contain four to six carbon atoms.

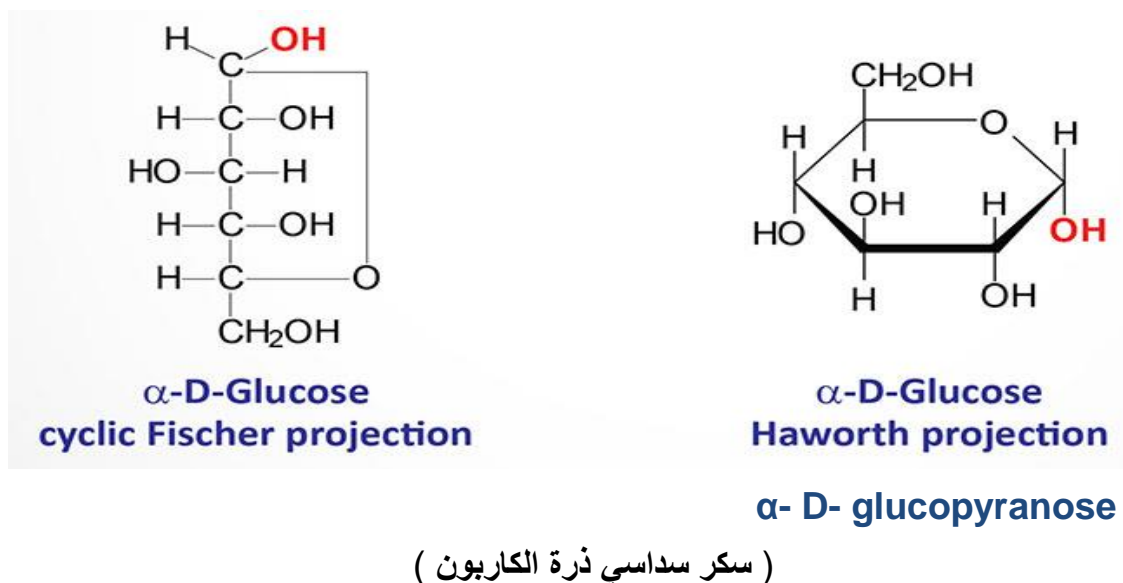
Carbohydrate Classifications

# Carbons	Category Name	Relevant examples
3	Triose	Glyceraldehyde, Dihydroxyacetone
4	Tetrose	Erythrose
5	Pentose	Ribose, Ribulose, Xylulose
6	Hexose	Glucose, Galactose, Mannose, Fructose
7	Heptose	Sedoheptulose
9	Nannose	Neuraminic acid, also called sialic acid

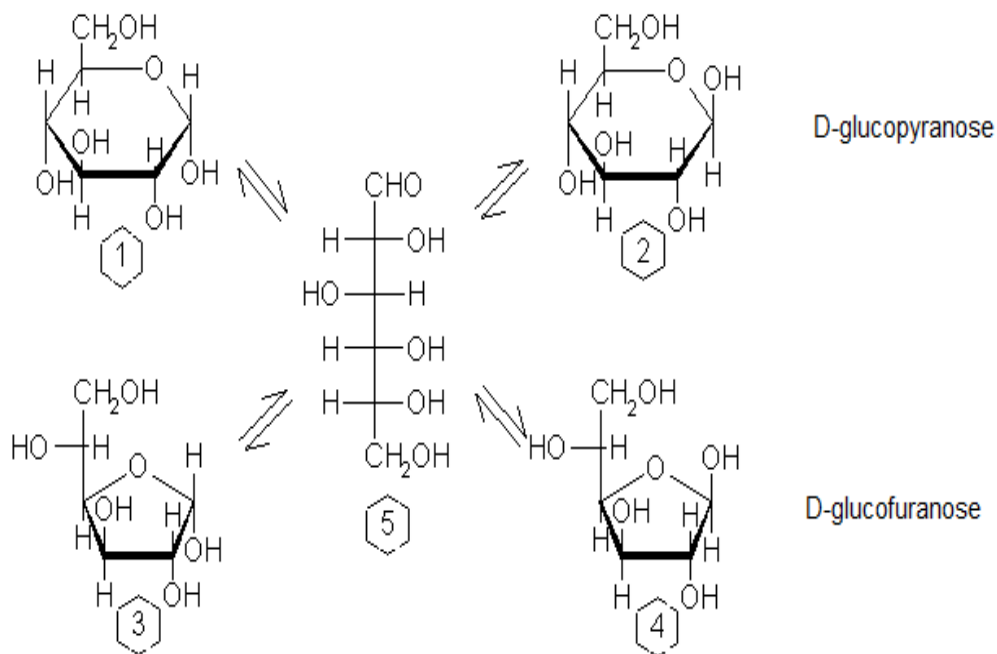
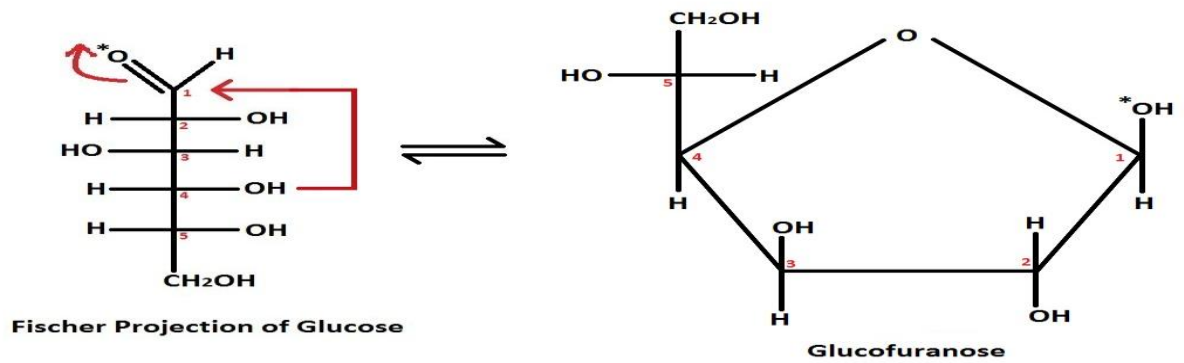
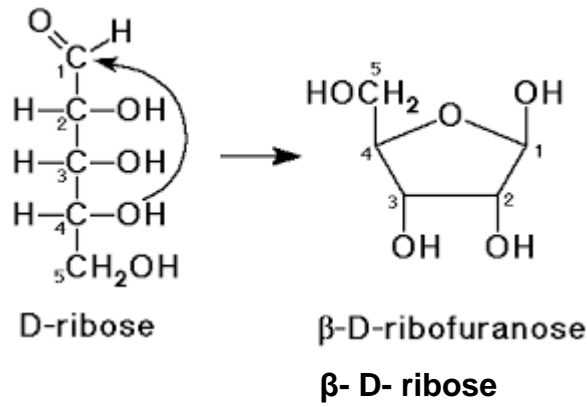
Furanoses: The five-membered ring structure resembles the organic molecule **furan**.

Pyranoses: Those with six-membered rings resemble the organic molecule **pyran** are termed.

Such structures can be depicted by either **Fischer** or **Haworth** style diagrams. The numbering of the carbons in carbohydrates proceeds from the carbonyl carbon, for aldoses, or ketosis.



(سكر خماسي ذرة الكربون)



Hexose sugars:

Glucose : known as dextrose presents in food and honey. **it is sugar of blood.**

Fructose: present in fruit juices and honey.

Galactose: found in milk sugar (**lactose**). Also it is found in brain and nerve tissue.

Note:

Foods that are high in simple sugars and low in fiber increase your blood sugar levels.

Although fruits and vegetables contain simple carbohydrates, they are healthier than processed foods like cookies and cakes because they contain fiber. This changes the way that your body processes the sugars because fiber slows down their absorption.

2.Oligosaccharides: on hydrolysis it gives (2-8) monosaccharides.

General formula: **$C_n (H_2O)_n - 1$** (n is the number of carbon atoms)

It is subdivided into:

1. Disaccharides:

On hydrolysis it gives two molecules of monosaccharides.

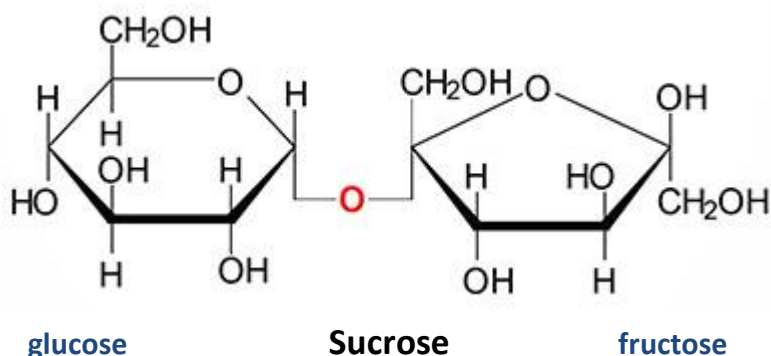
Ex: sucrose, lactose, mannose

General formula **$C_{12} H_{22} O_{11}$**

The linkage of two monosaccharides to form disaccharides involves a glycosidic bond. important disaccharides are sucrose, lactose and maltose.

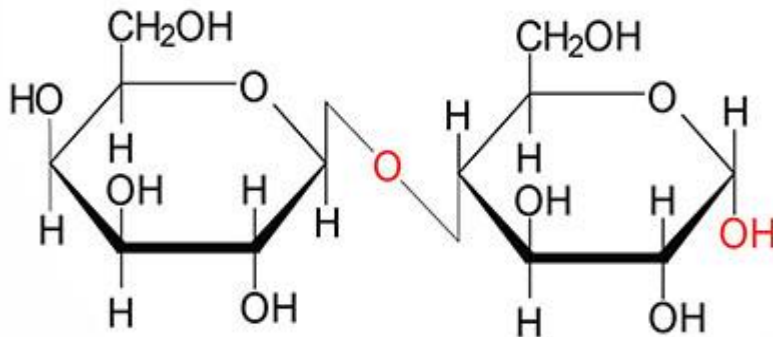
Sucrose: prevalent in sugar cane and sugar beets, is composed of glucose and fructose through an α -(1,2)- β -glycosidic bond.

sucrose → glucose + fructose



Lactose: is found exclusively in the milk of mammals and consists of galactose and glucose in a β -(1,4) glycosidic bond.

lactose \longrightarrow galactose + glucose



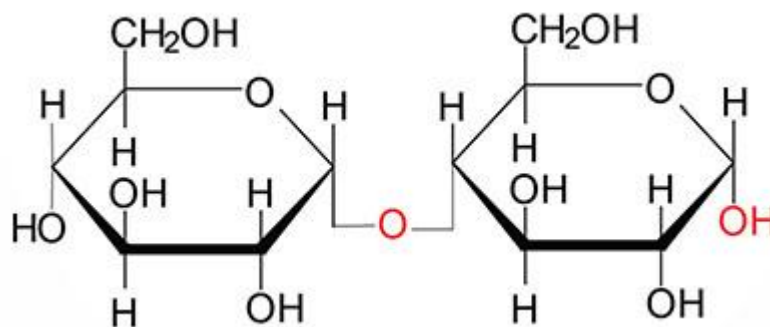
galactose

Lactse

glucose

Maltose: the major degradation product of starch, is composed of 2 glucose monomers in an α -(1,4) glycosidic bond.

maltose \longrightarrow glucose + glucose



glucose

Maltose

glucose

2.Trisaccharide: compound yield (3)units of monosaccharides on hydrolysis.

Ex: raffinose: (glucose + fructose + galactose)

3. Tetrasaccharide: compound yield (4) units of monosaccharides on hydrolysis.

Ex: stachyose: (glucose + fructose + galactose + galactose)

3.Polysaccharides

polysaccharides: on hydrolysis it yields (8) molecules.

Most of the carbohydrates found in nature occur in the form of high molecular weight polymers called **polysaccharides**. The monomeric building blocks used to generate polysaccharides can be varied; in all cases, however, the predominant monosaccharide found in polysaccharides is D-glucose.

When polysaccharides are composed of a **single monosaccharide** building block, they are termed **homopolysaccharides**.

Ex: glycogen (polymer of glucose)

starch (polymer of glucose)

cellulose (polymer of glucose)

Inulin (polymer of fructose)

dextrin (polymer of glucose)

Polysaccharides composed of **more than one type of monosaccharide** are termed **heteropolysaccharides**.

Ex: mucopolysaccharide : (hexose + hexosamine)

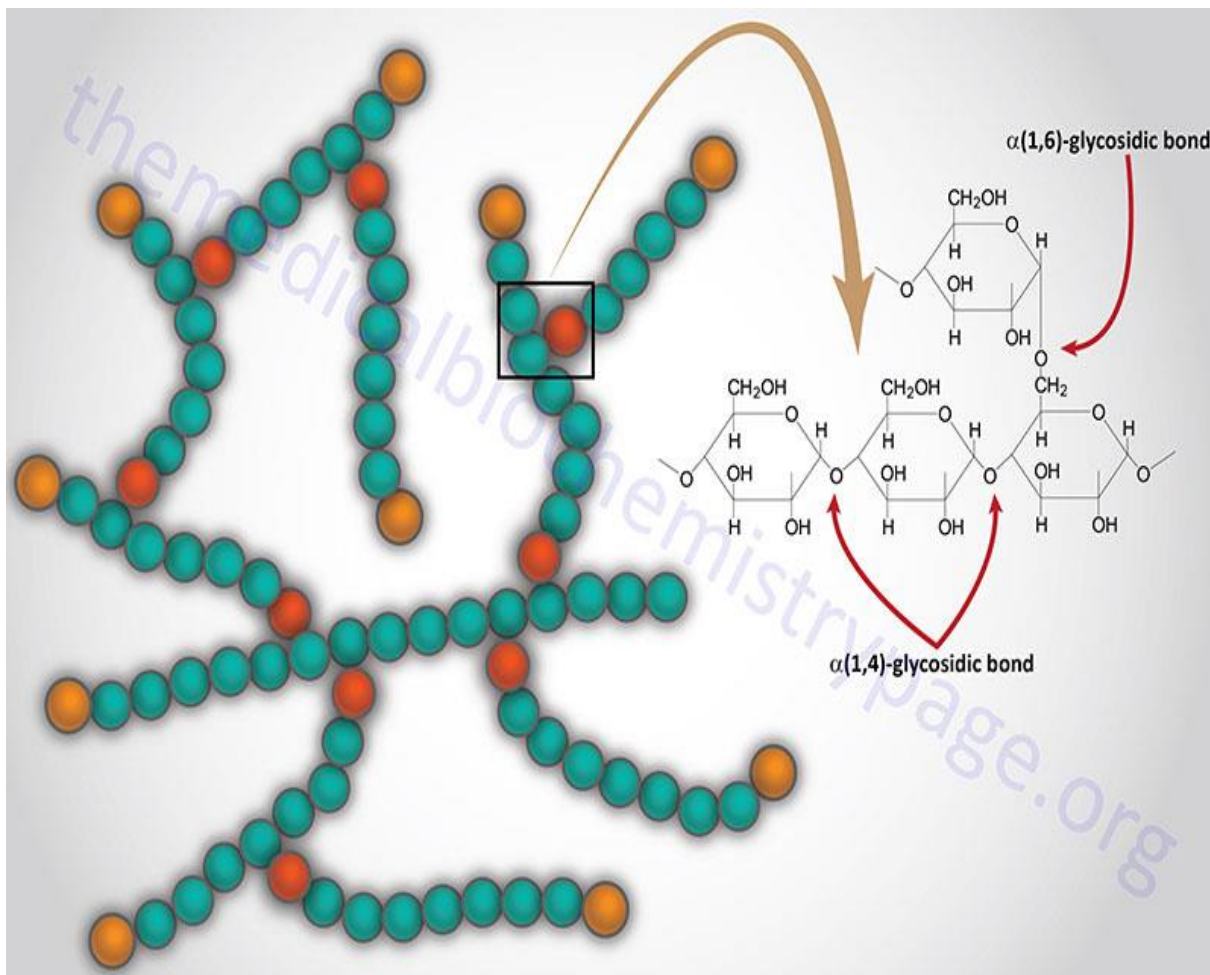
hyaluronic acid : (glucuronic acid + N- acetylhexosamine)

chondroitin : (glucuronic acid + N- acetylgalactosamine)

heparine : (glucuronic acid + glucosamine N- sulphate + sulphate ester)

Glycogen

1. The major CHO **reserve** in animals especially **in liver and skeletal muscle**.
2. This molecule is a **homo polymer** of glucose in α -(1,4) linkage
3. It is **highly branched**, with α -(1,6) branch linkages occurring every 8-10 residues.
4. Glycogen is a very compact structure that results from the coiling of the polymer chains.
5. This compactness allows **large amounts of carbon energy to be stored** in a small volume, with little effect on cellular osmolarity.
6. It give red color with iodine.



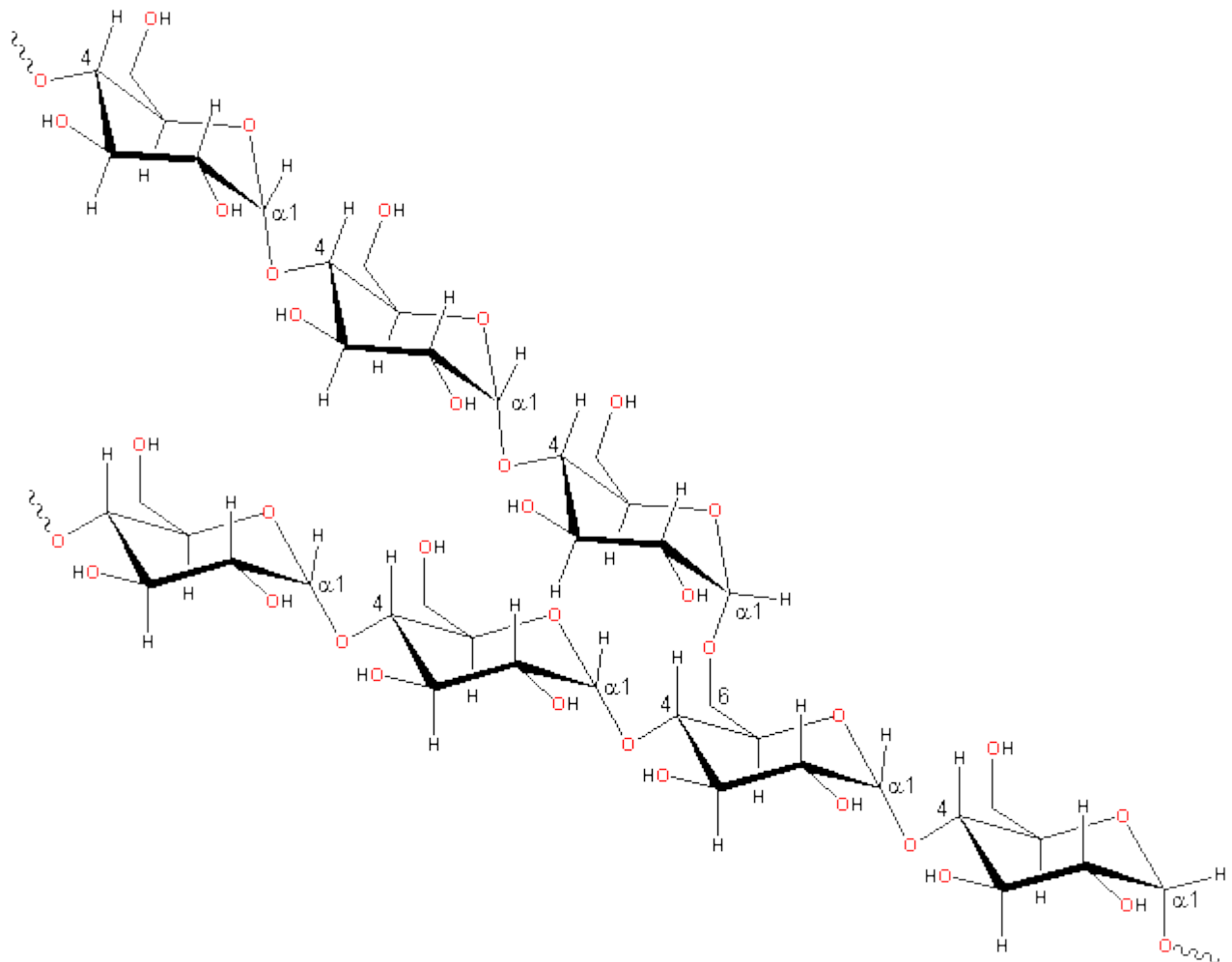
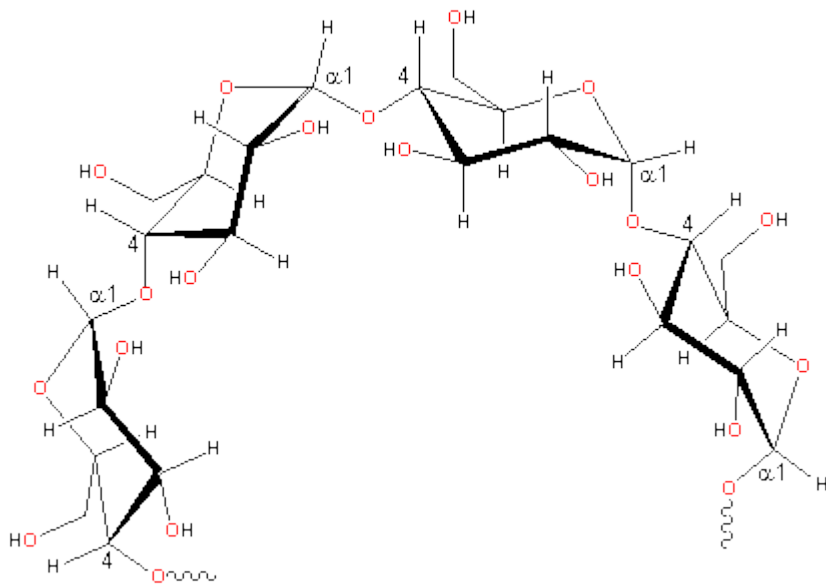
Starch

Starch is the major form of stored carbohydrate in plant cells. The largest source of starch is corn (maize) with other commonly used sources being wheat, potato, tapioca and rice.

Its structure is identical to glycogen, except for a much lower degree of branching (about every 20–30 residues). Unbranched starch is called **amylose**; branched starch is called **amylopectin**.

Amylose : A linear molecule comprising of 1,4 linked α -D-glucopyranosyl units

1. (20- 30%) amylose.
2. helical structure.
3. give blue color with iodine.



Amylopectine: 1. (70 - 80 %) 2. Branching 3. Give red color with iodine

Inuline

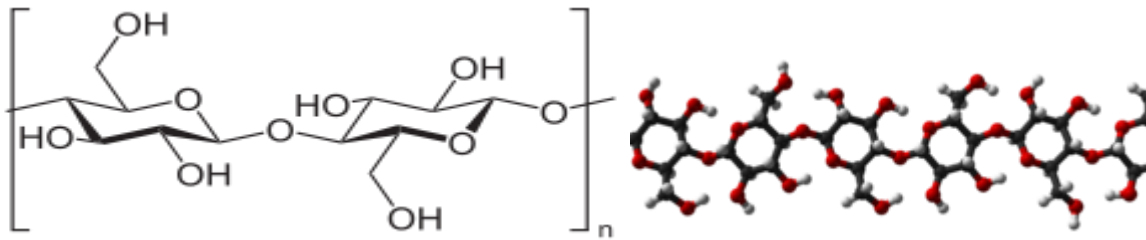
Found in tubers, their hydrolysis will give fructose, colorless with iodine.

Cellulose

Cellulose: is an organic compound with the general formula $(C_6H_{10}O_5)_n$

IT is a polysaccharide consisting of:

1. A linear chain of several hundred to many thousands of $\beta(1-4)$ linked glucose units.
2. Cellulose is an important structural component of the primary cell wall of **green plants**, many forms of **algae** and the **oomycetes**. Some species of **bacteria** secrete it to form biofilms.
3. **In humans**, cellulose acts as a hydrophilic bulking agent for feces and is often referred to as a "dietary fiber". It is not digested.



β 1- 4- glucose units