Biomolecules

An organic molecule is **a complex molecule that is primarily made of carbon atoms bonded with other elements and/or other carbon atoms**. All living things on Earth are composed of organic molecules.

Biomolecules - Definition,types, structure, properties and its applications

Definition of Biomolecule: An organic compound normally present as an essential component of living organism.

IMPORTANT BIOMOLECULES

Characteristics of Biomolecules: -

1) Most of them are organic compounds.
2) They have specific shapes and dimensions
3) Functional group determines their chemical properties.
4) Many of them arc asymmetric
5) Macromolecules are large molecules and are constructed from small building block molecules.
6) Building block molecules have simple structure.
7) Biomolecules first gorse by chemical evolution.

Important Biomolecules of life

i) **Water -** Being the universal solvent and major constituents (60%) of any living body without which life is impossible. It acts as a media for the physiological and biochemical reactions in the body itself. Maintain the body in the required turgid condition.

2) **Carbohydrates -** It is very important for source of energy for any physical body function

3) **Proteins** - These are very important from body maintenance point of view, helps in tissue, cell formation.

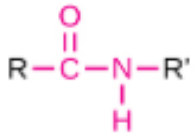
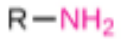
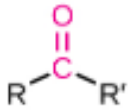
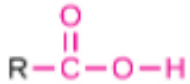
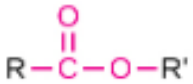
4) **Lipids:** These are very important from energy source as well as human nutrition point of view.

5) **Nucleic acids -** Nucleic acids are very important as DNA carries the hereditary information and RNA helps in protein formation for the body.

6) **Enzymes** - Enzymes are simple or combined proteins acting as specific catalysts and activate the various biochemical and metabolic processes within the body.

Table - Fundamental Biological molecules (Biomolecules)

Sr.	Small molecules	Atomic constituents	Derived macro-molecules
1.	Amino acid	C, H, O, N (S)	Proteins
2	Sugars	C, H,O	Starch, glycogen
3.	Fatty acids	C, H, O	Fats, oils
4.	Purines and pyrimidine	C, H, O, N	Nucleic acids
5.	Nucleotide	C, H, O, N, P	Nucleic acids (DNA and RNA)

Common Functional Groups Found in Biomolecules		
Name	**Functional Group**	**Compounds**
Aldehyde		Carbohydrates
Amide		Proteins
Amino		Amino acids, proteins
Carbonyl		Ketones, aldehydes, carboxylic acids, amides
Carboxylic acid		Amino acids, proteins, fatty acids
Ester		Lipids, nucleic acids
Ether		Disaccharides, polysaccharides, lipids
Hydroxyl		Alcohols, monosaccharides, amino acids, nucleic acids
Ketone		Carbohydrates
Methyl		Methylated compounds such as methyl alcohols and methyl esters
Phosphate		Nucleic acids, phospholipids, ATP
Sulfhydryl		Amino acids, proteins

*Functional groups are represented in pink. Ketone and aldehyde both contain a carbonyl group, highlighted in blue.

Figure 7.1.5: Functional groups.

Carbohydrates - Definition, functions, classifications, structure and Properties of Monosaccharide and Disaccharides.

Definition of carbohydrates :

Carbohydrates are defined as polyhydroxy aldehydes or polyhydroxy ketones and the substances which yield these derivatives on hydrolysis.

Functions of Carbohydrates

i) Supply energy
ii) Stored energy for future use
iii) Structural constituents
iv) Proteins sparing action
v) Necessary for oxidation of protein and fat
vi) Necessary for synthesis of non essential amino acids.
vii) Conserve water and electrolyte
viii) Beneficial effect on microflora.

Classification of carbohydrates

Carbohydrates are classified in to three major classes on the basis of complexity and behaviour on hydrolysis

1) Monosaccharides 2) Oligosaccharides 3) Polysaccharides

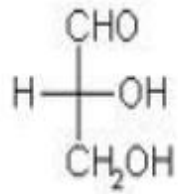
Monosaccharides :- Simple sugars and cannot be hydrolysed into smaller units. Depending upon no. of carbon in a unit, monosaccharides are subdivided into a dioses to decoses. More common subclasses of monosaccharides are:
Based on the functional group, they are classified as aldoses and ketoses

1) depending on whether they have aldehyde or ketone as functional group

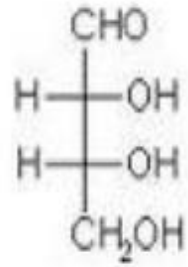
	Aldoses	**Ketoses**
Triose	Glyceraldehyde	Dihydroxy acetone
Tetrose	Erythrose	Erythrose
Pentose	Ribose, Xylose,Arabinose	Ribulose, Xylulose
Hexose	Glucose,Galactose, Mannose	Fructose
Heptose	-	Heptulose

Aldoses - Aldotrioses – e.g. Glycerose, **Aldotertroses** – e.g. Erythrose, **Aldopentoses** – e.g. Ribose **Aldohexoscs** – e.g. glucose, galatose
Aldoheptose – glucoheptose.
Ketoses - Ketotrioses – e.g Dihydroxyacetone **ketotetroses** – e.g erythrulose, **ketopentoses** - e.g Ribulose, **Ketohexoses**, e.g. Fructose, **Ketoheptose** e.g. Scdoheptulose.
Explain structure of triose tetrose, pentose and hexoses only

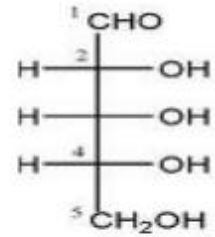
Aldoses



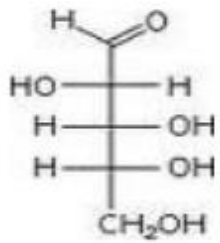
D-Glyceraldehyde



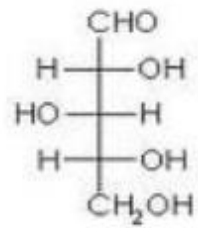
D- Erythrose



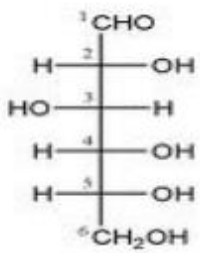
D-Ribose



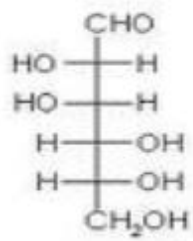
D-Xylose



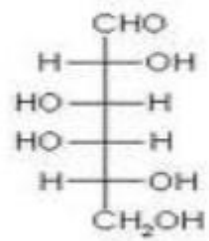
D-Arabinose



D-Glucose

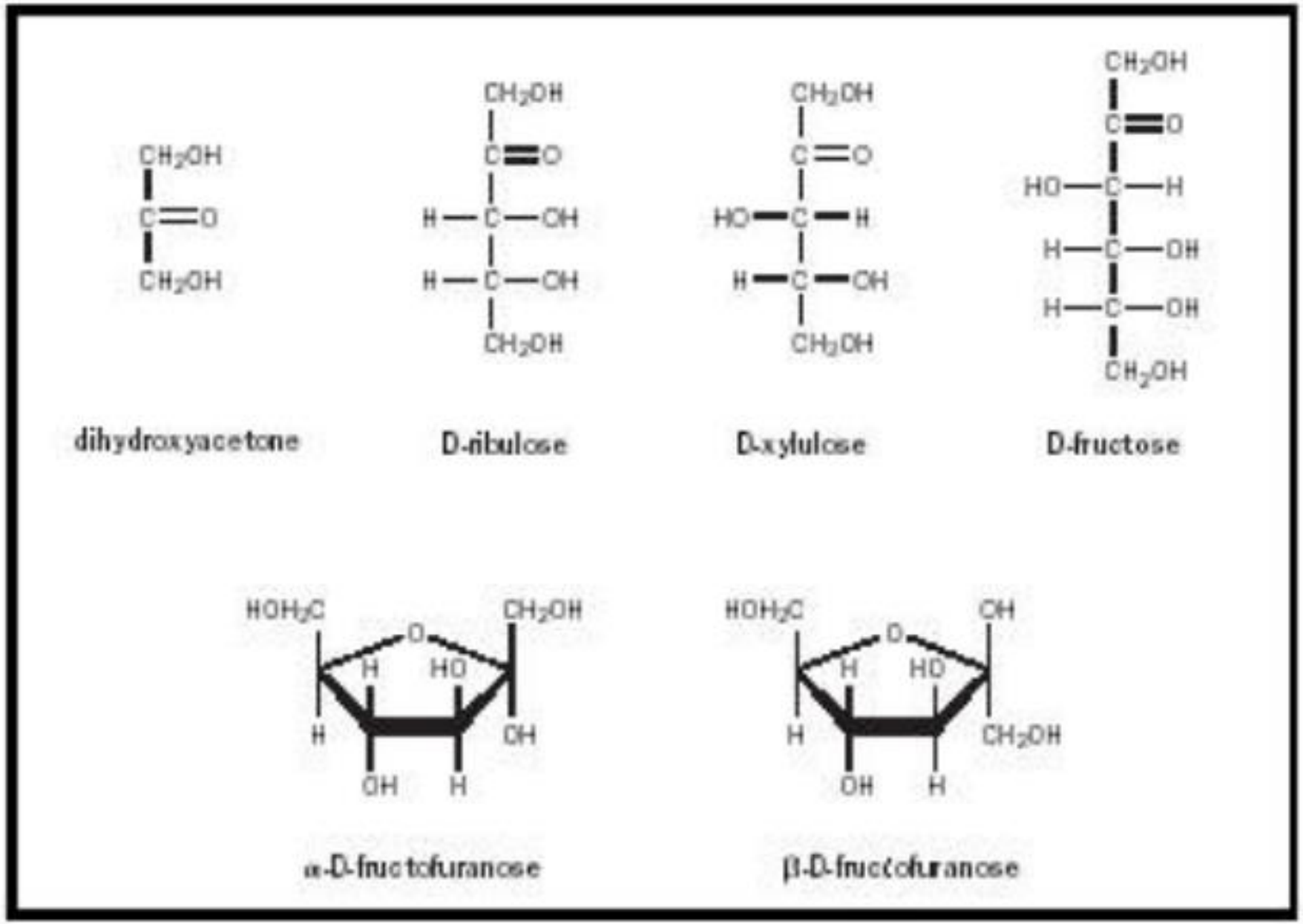


D-Mannose



D-Galactose

Ketoses


dihydroxyacetone
D-ribulose
D-xylulose
D-fructose
α-D-fructofuranose
β-D-fructofuranose

2.<u>Olignsaccharide:-</u> Definition - Oligosaccharides are polymers of monosaccharides containing two to ten residues accumulate in vacuole while polysaccharides in plastids, they are classified as

a) **Disaccharides** - yield two monosaccharides on hydrolysis.

i) **Reducing disaccharides** - e.g. Maltose (Glucose + glucose), Lactose (galactose + glucose), Other examples are Isomaltose, cellobiose.

ii) **Non reducing disaccharides** - Sucrose (glucose + Fructose)

b) **Trisaccharides** - e.g. Raffinose - (Glucose + Fructose + galactose) found in cotton seed and sugar beet. .

c) Tetrasaccharides - yield 4 monosaccharides on hydrolysis e.g. stachyose (glucose + Fructose + galactose + galactose) (only tetrasaccharide known to exist in plant).

3. Polysaccharides :

Definition of Polysaccharides

Polysaccharides are polymeric anhydrides of monosaccharides. The long chain polymers are either straight chain or branched. They are also called glycanes.

Classification of Polysaccharides

1) On the basis of function
a) **Storage** e.g. Starch, glycogen
b) **Structural** - e.g.Cellulose, Pectins.

2) On the basis of composition
a) Homopolysaccharides
b) Heteropolysaccharides.

a) Homopolysaccharides - on hydrolysis gives single monosaccharide units
i) Pentosan - contains pentoses ($C_5 H_8 O_4$).
ii) Hexosans - Contains hexoses ($C_6 H_{10} O_5$) subdivided in to
A) Glucosans - Polymer or glucose e.g. starch, glycogen
B) Fructosans - Polymer or fructose e.g. inulin
C) Galactans - polymer of galactose e.g. Galactan
D) Mannans - Polymer of mannose e.g. Mananas.

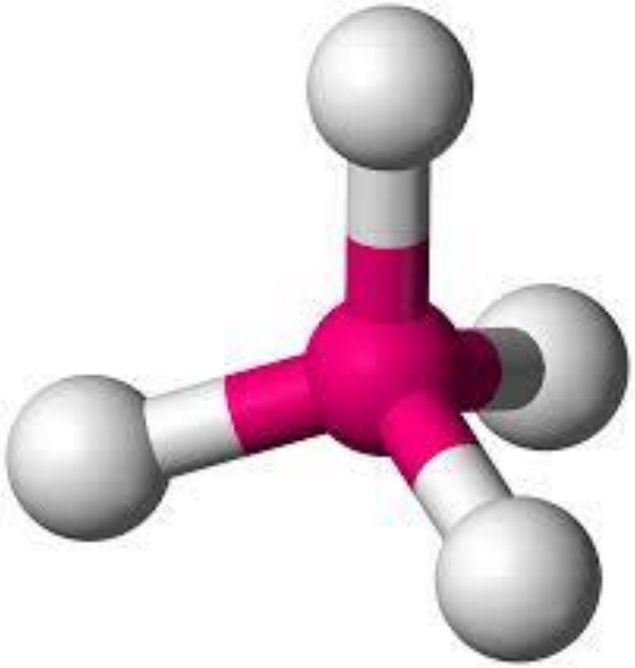
b) Heteropolysaccharide - e.g. Hyaluronic acid, Chondroitin sulphates.

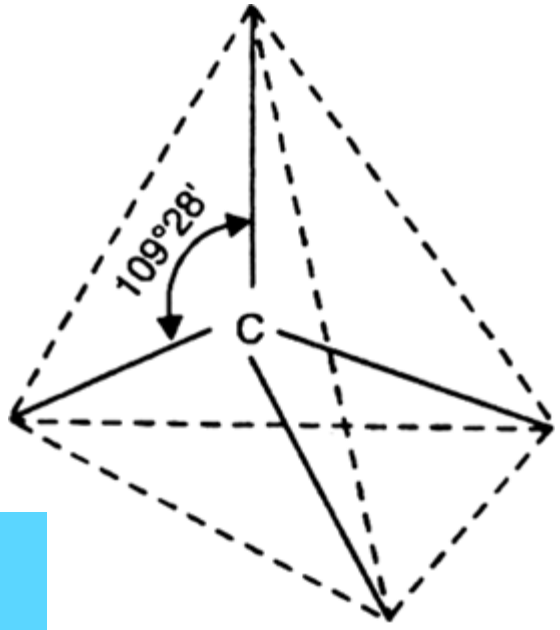
A) Gum - Consist of arabinose, rhamnose, galactose and glucoronic acid.
B) Agar - The sulphuric acid esters of galactans consists of galactose, galactouronic acid.
C) Pectins - Fundamental unit is pectic acid, consist of arabinosc,galactose, galactouronic acid.

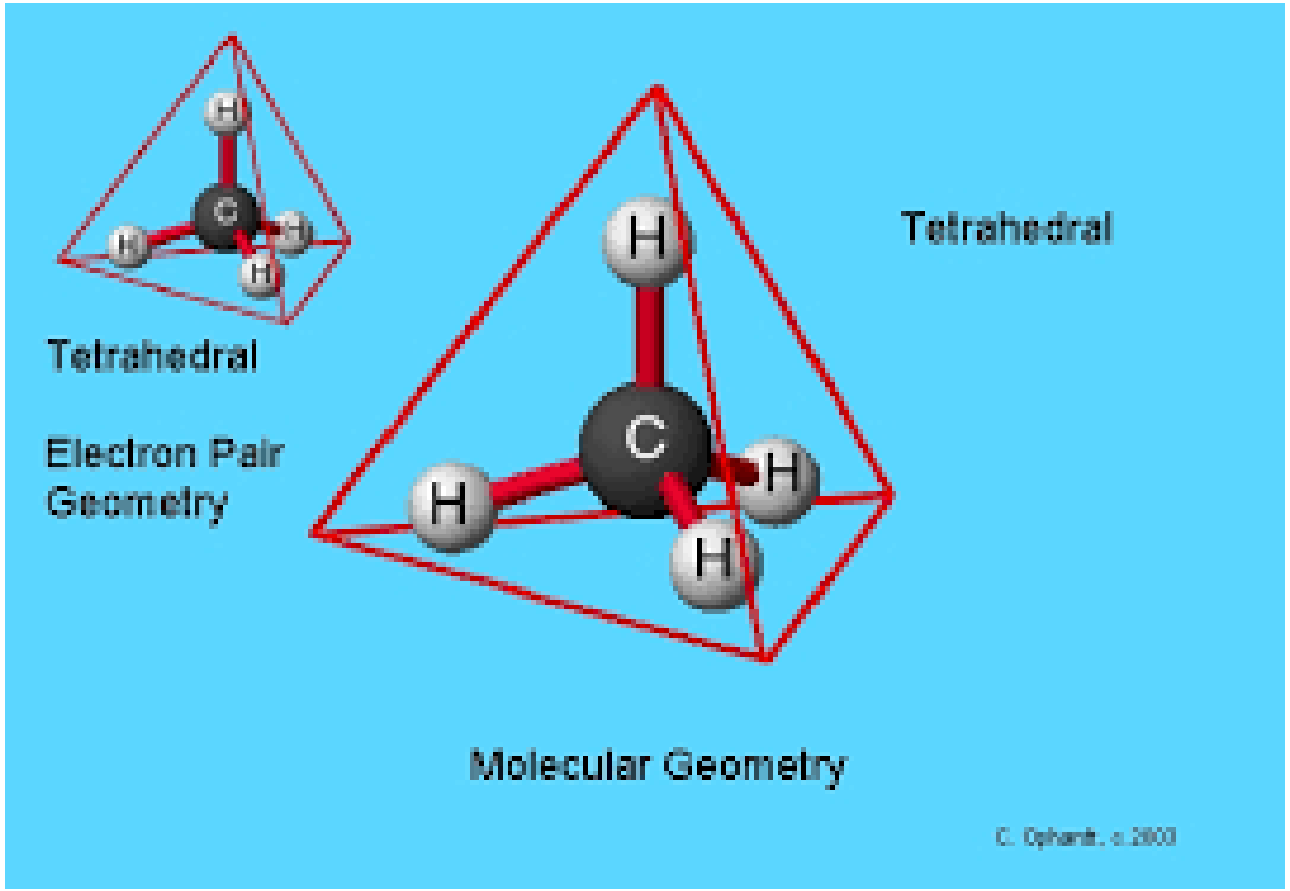
Functions of Polysaccharides

1) They serve as structural components of the cells
2) They serve as stored form of energy
3) They serve as nutrient.

Carbon tetrahedron

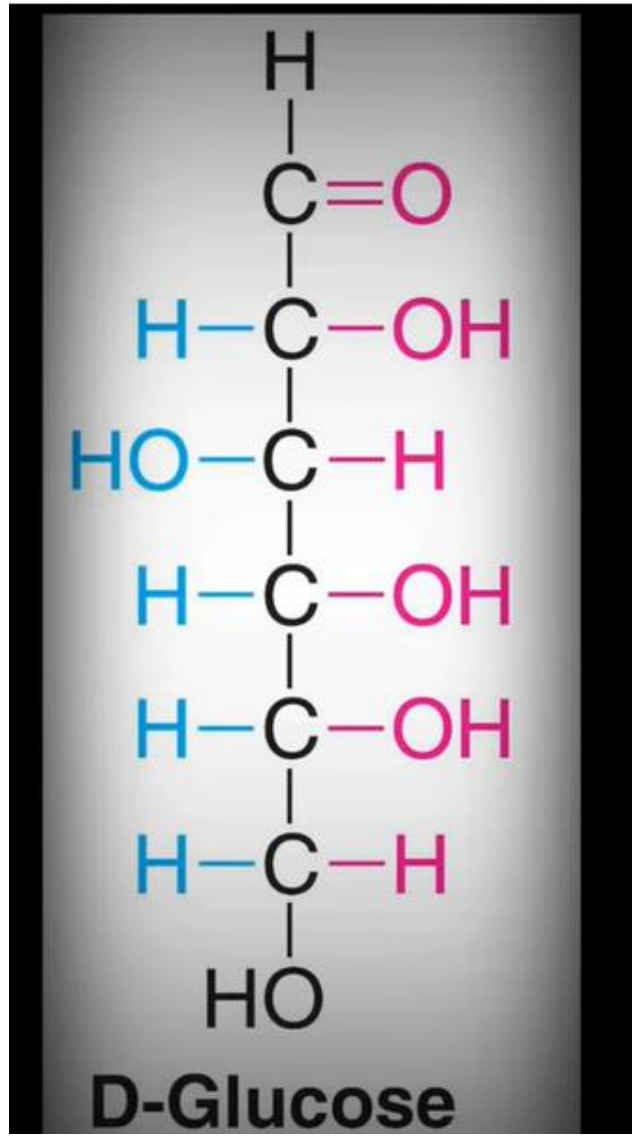


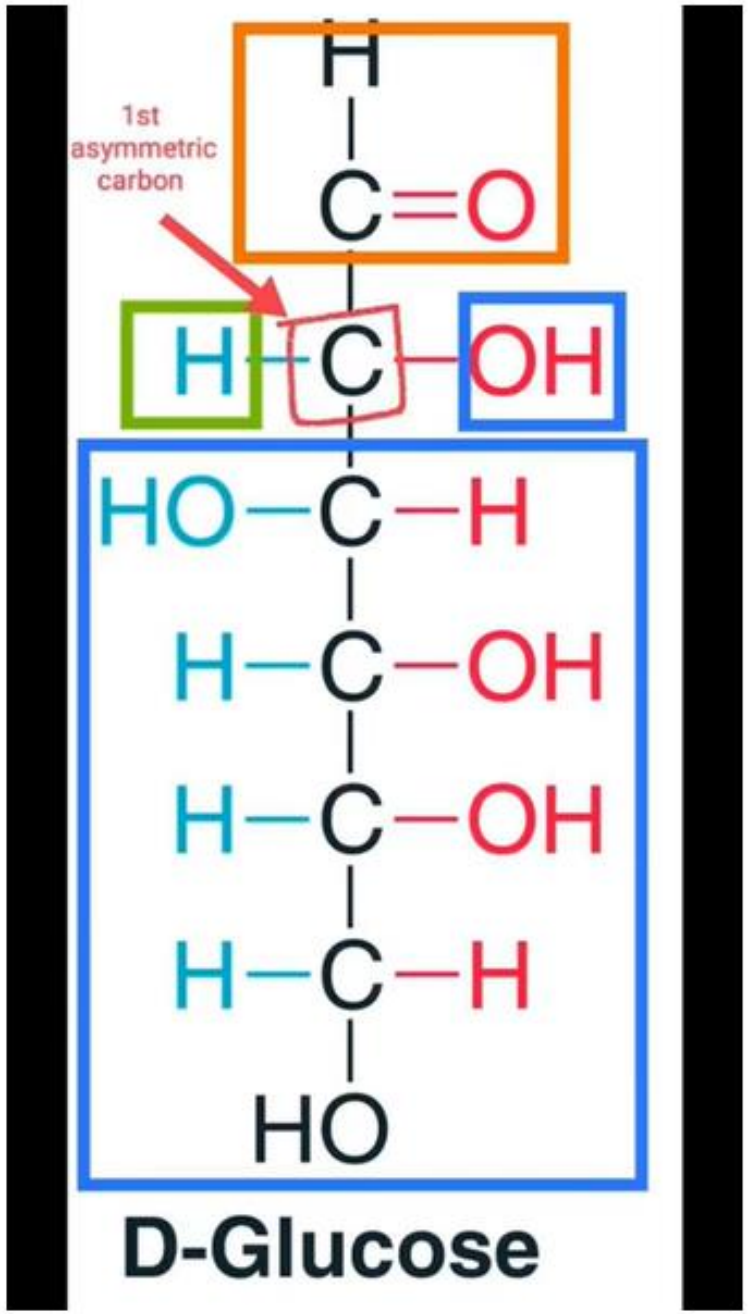


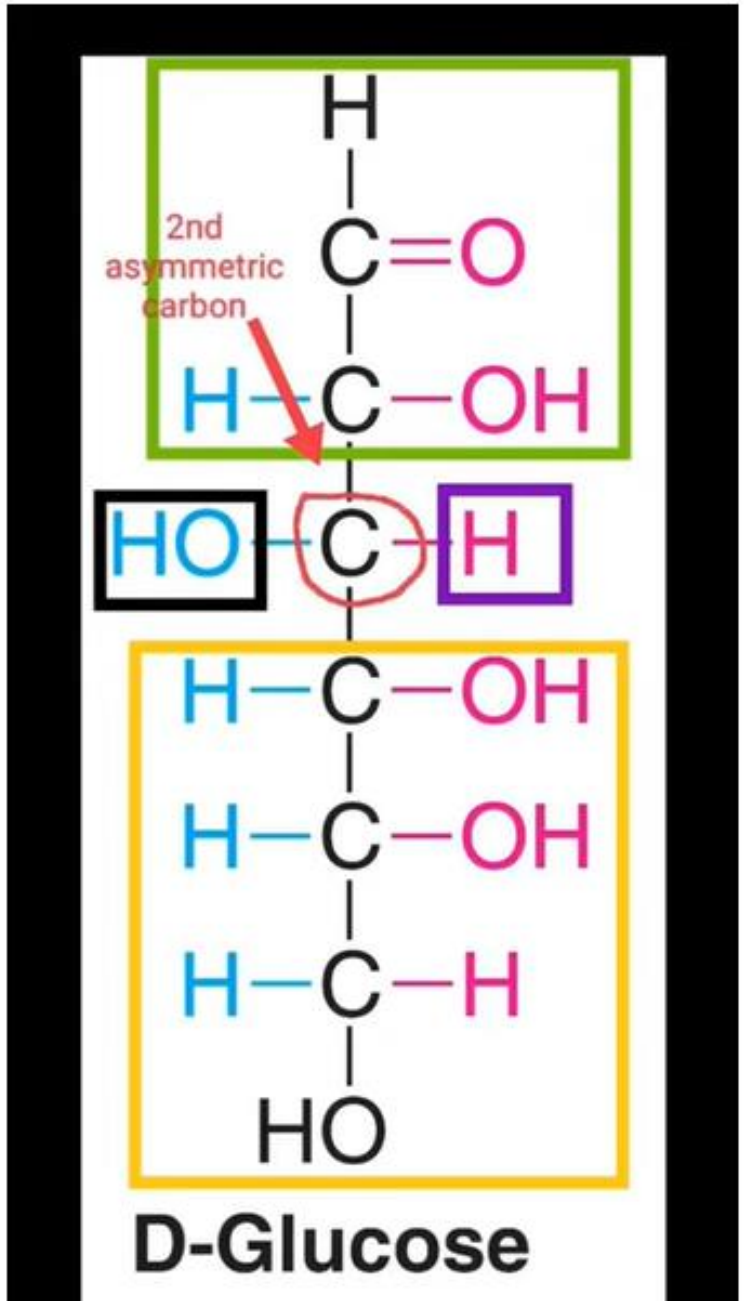


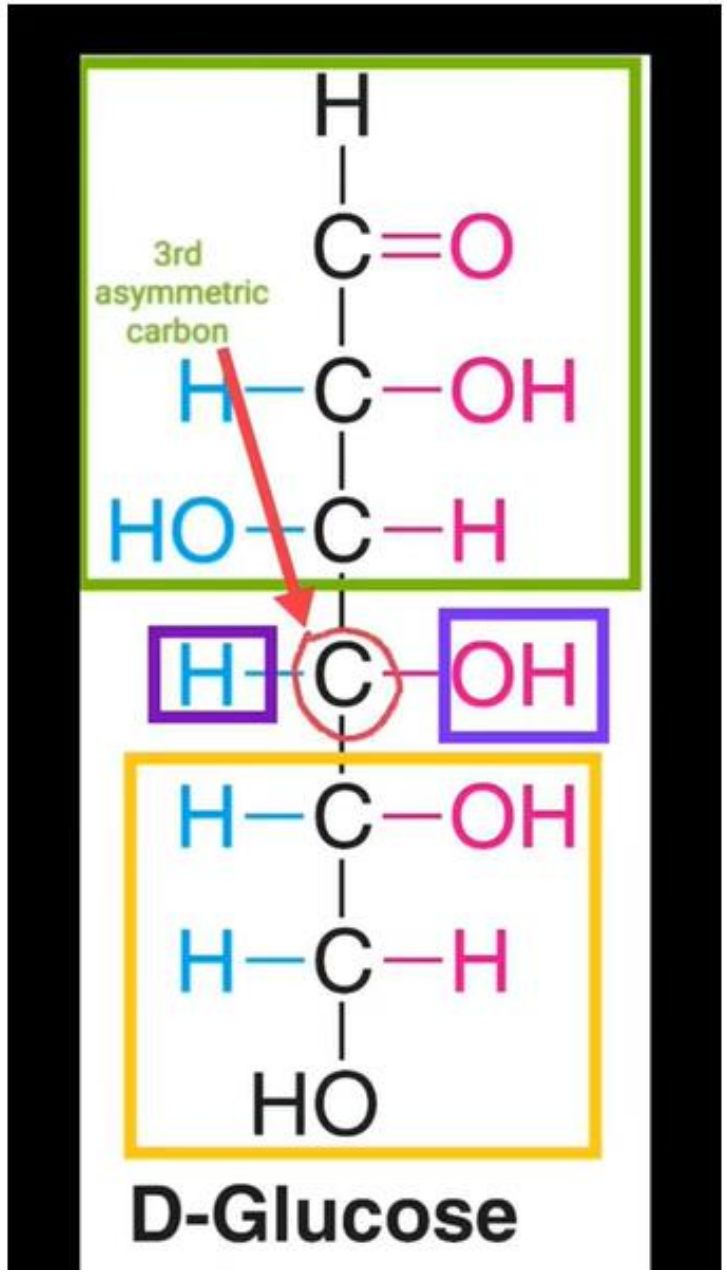
ASYMMETRY

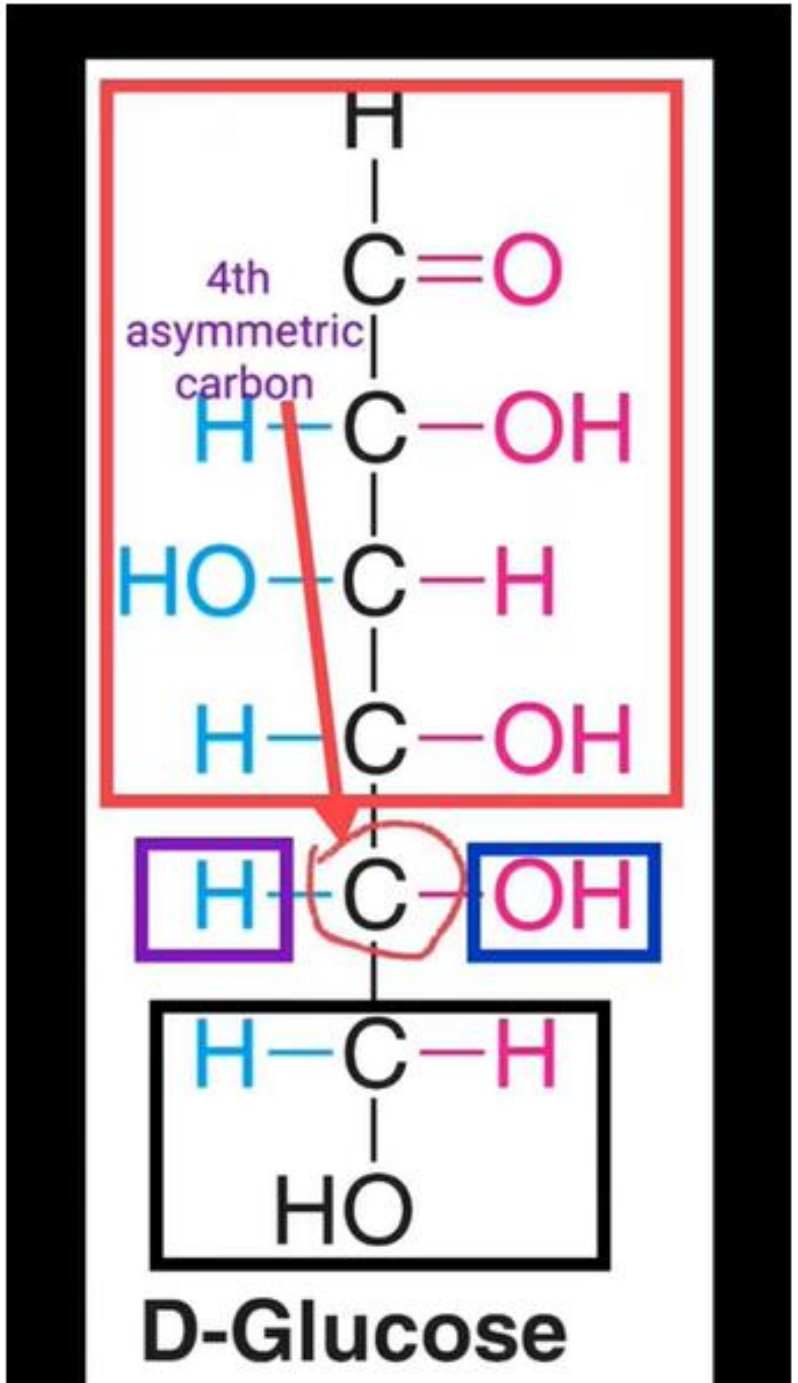
A carbon atom to which 4 different atoms or groups of atoms are attached is called asymmetric

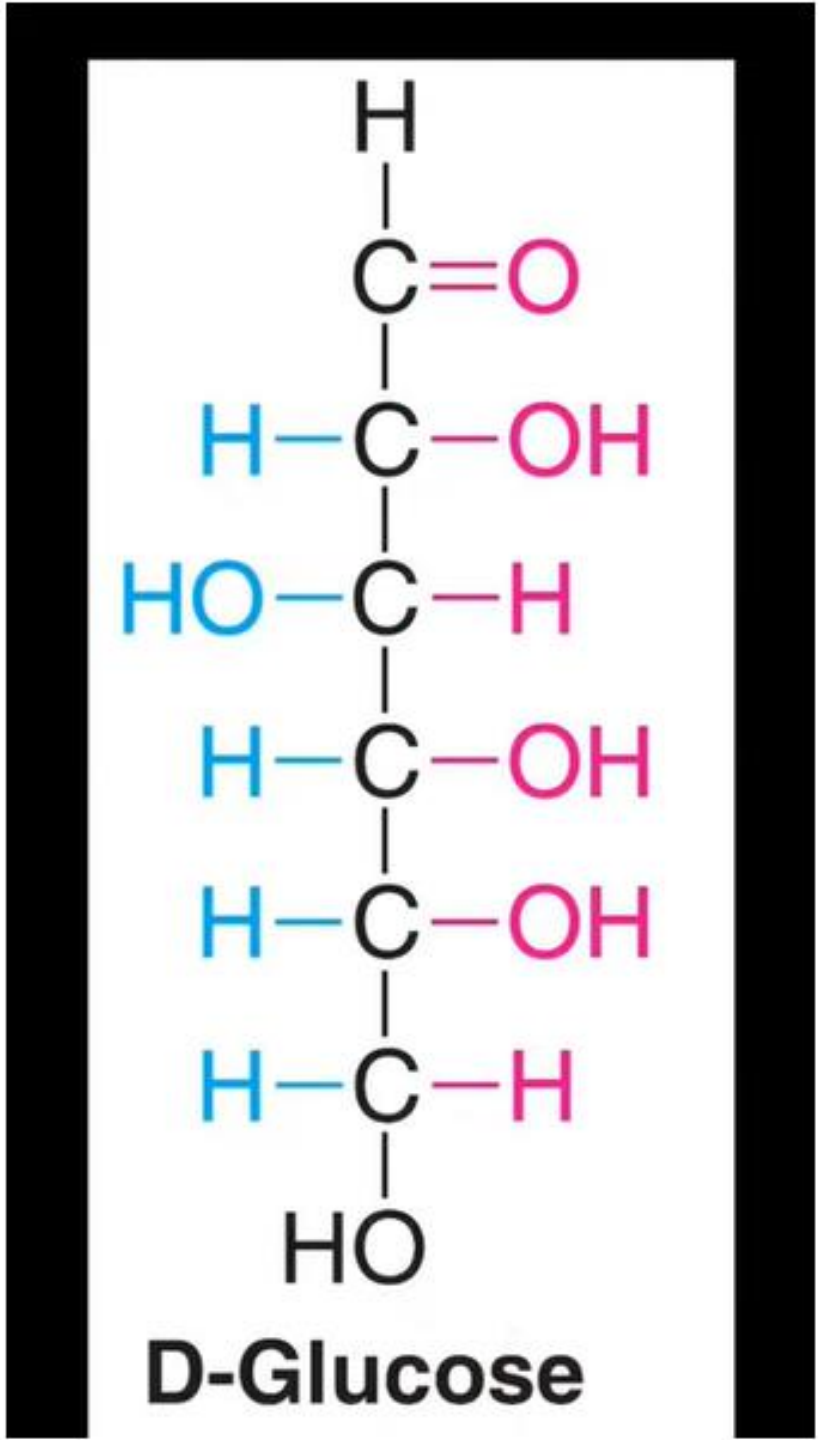

H
C=O
H–C–OH
HO–C–H
H–C–OH
H–C–OH
H–C–H
HO
D-Glucose


1st asymmetric carbon
H
C=O
H–C–OH
HO–C–H
H–C–OH
H–C–OH
H–C–H
HO
D-Glucose


2nd asymmetric carbon
H
C=O
H–C–OH
HO–C–H
H–C–OH
H–C–OH
H–C–H
HO
D-Glucose


3rd asymmetric carbon
H
C=O
H–C–OH
HO–C–H
H–C–OH
H–C–OH
H–C–H
HO
D-Glucose





In glucose 2-5 carbon atoms are asymmetric

THANK YOU