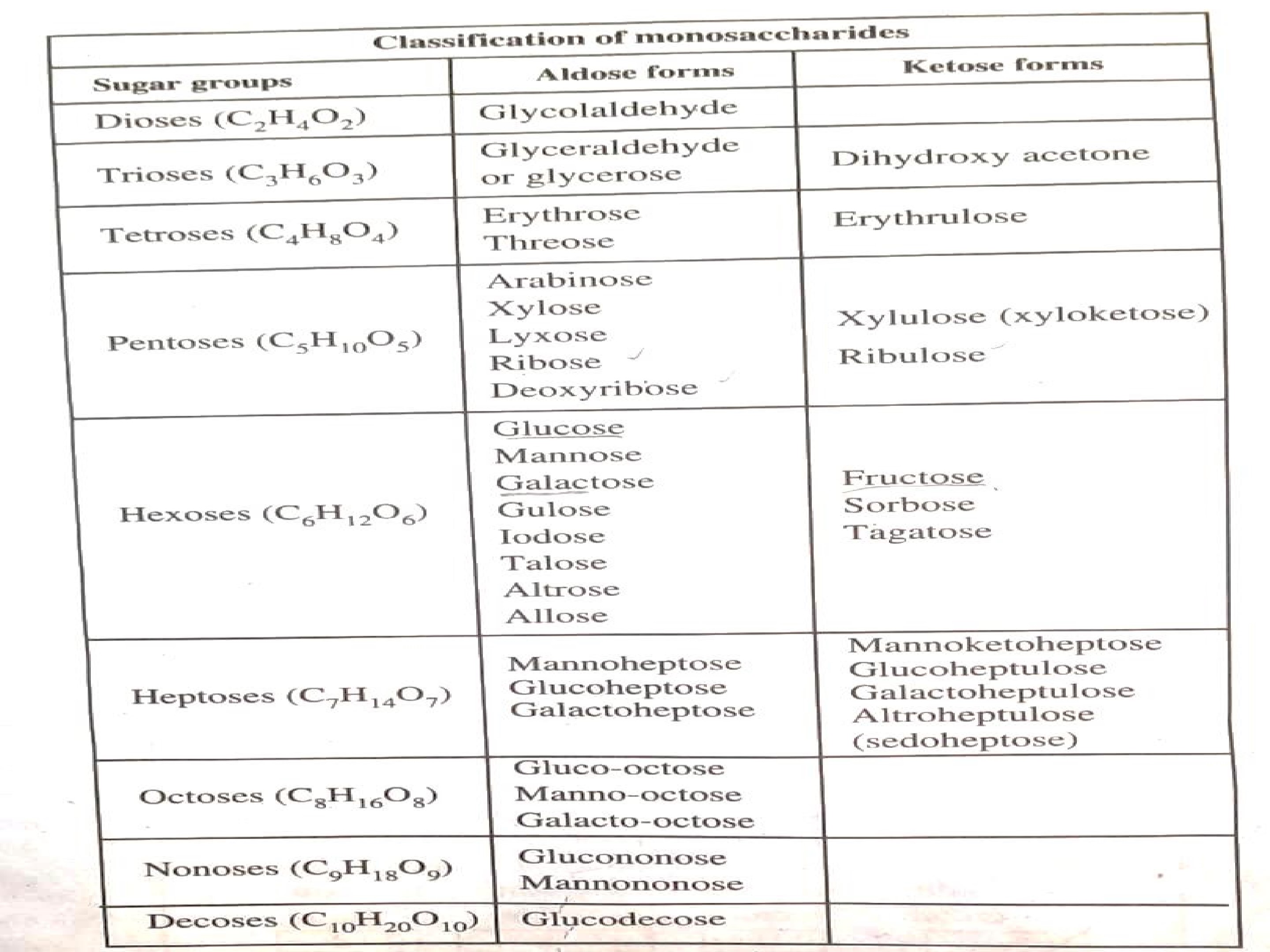
**BIOCHEMISTRY AND CYTOGENETICS**

**CARBOHYDRATES**

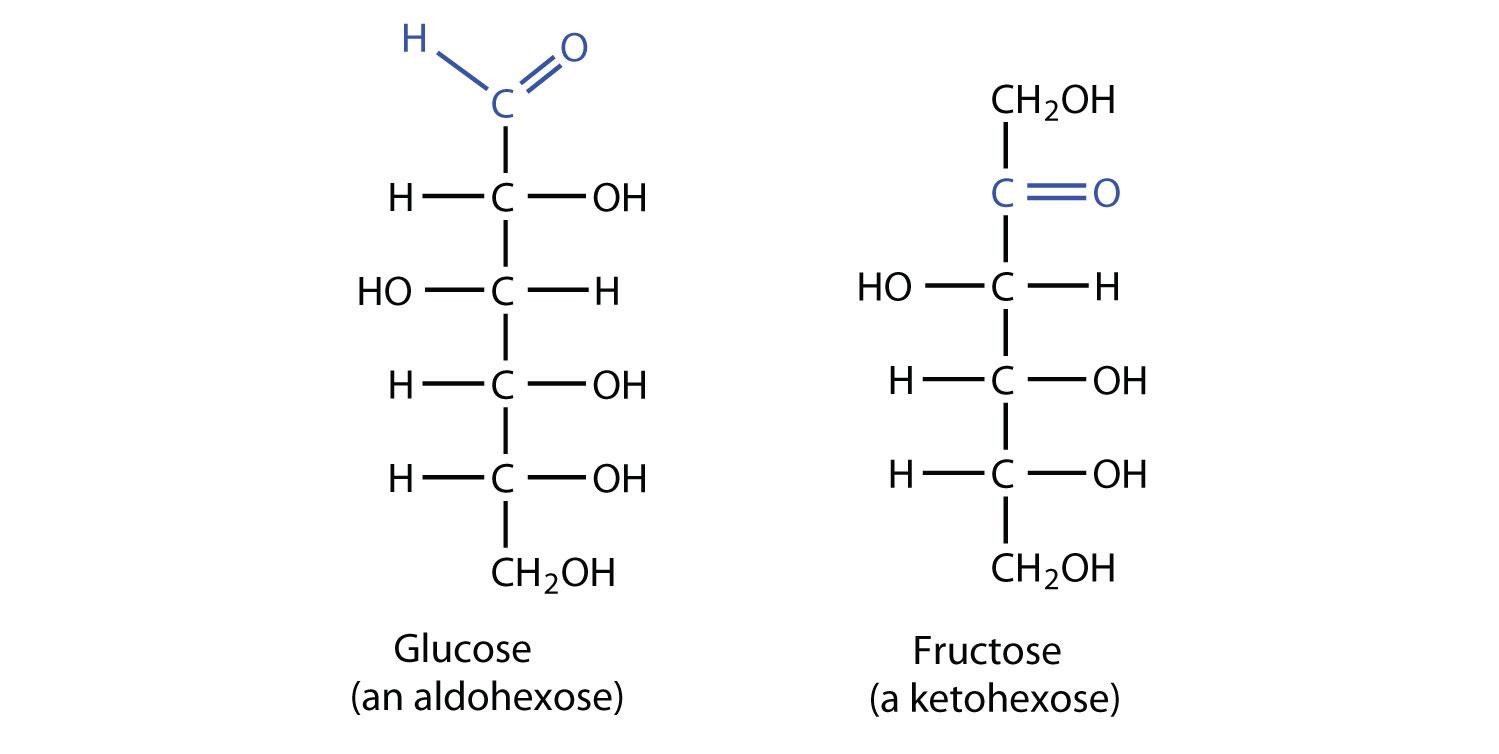
**Gincy C George (Assistant Professor On Contract)**

# CARBOHYDRATES

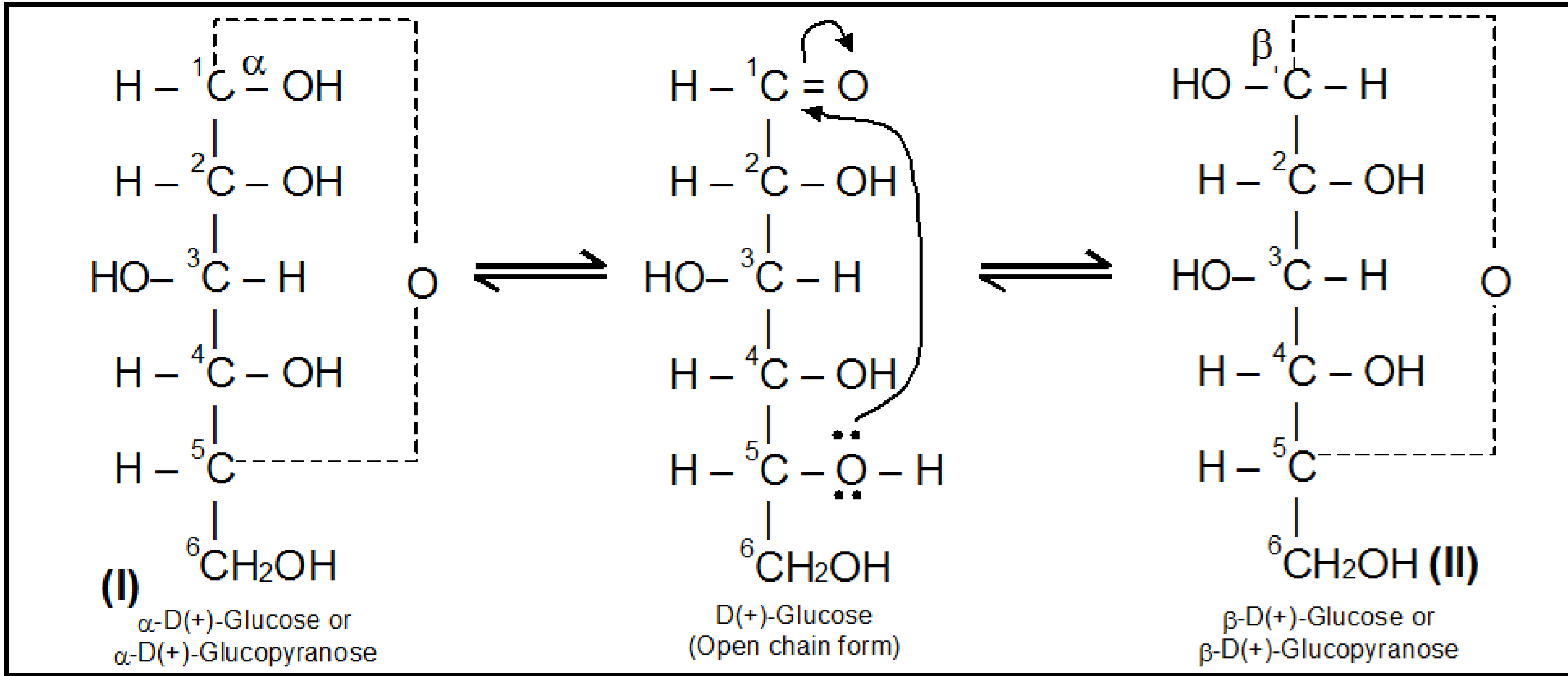
* Carbohydrates are commonly called saccharides and it comes from a Greek word *sakcharon, which means “sugar”.*
* Compounds containing carbon, hydrogen and oxygen in which hydrogen and oxygen are present in the ratio 2:1 even some contain nitrogen*,* phosphorus, or sulfur.
* General formula of carbohydrate is (CH₂O)*n*
* But all compounds with H & O in the ratio 2:1 may not be carbohydrates, like acetic acid (CH₃COOH), lactic acid(CH₃-CH-OH-COOH)
* Even all carbohydrates may not contain H & O in the ratio 2:1, eg: rhamose C₆H₁₂O₅
* There are three major classes of carbohydrates: monosaccharides, oligosaccharides, and polysaccharides
* **Monosaccharides,** or simple sugars, consist of a single polyhydroxy aldehyde or ketone unit.
* Most abundant monosaccharide is the 6C sugar D-glucose, sometimes referred to as dextrose
* Monosaccharides are colorless, crystalline solids that are freely soluble in water but insoluble in non-polar solvents.
* Most have a sweet taste. The backbones of common monosaccharide molecules are unbranched carbon chains in which all the carbon atoms are linked by single bonds.



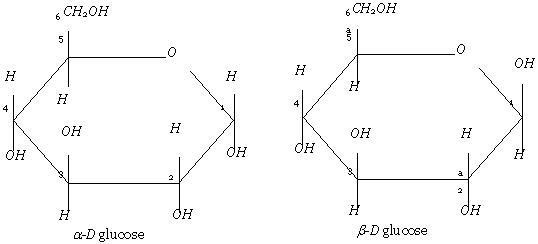
* In the open-chain form, one of the carbon atom is double-bonded to an oxygen atom to form a carbonyl group (reducing group); each of the other carbon atoms has a hydroxyl group.
* If the carbonyl group is at an end of the carbon chain (that is,the aldehyde group) the monosaccharide is an **aldose;** if the carbonyl group is at any other position (ketone group) the monosaccharide is a **ketose.**
* Carbohydrates are hydroxy aldehydes or ketones i.e they are polyhydroxy aldehydes or polyhydroxy ketones
* The simplest monosaccharides are threecarbon trioses: glyceraldehyde, which is an aldotriose, and dihydroxyacetone, a ketotriose
* They are called reference molecules
* Most common monosaccharides in nature are glucose and fructose

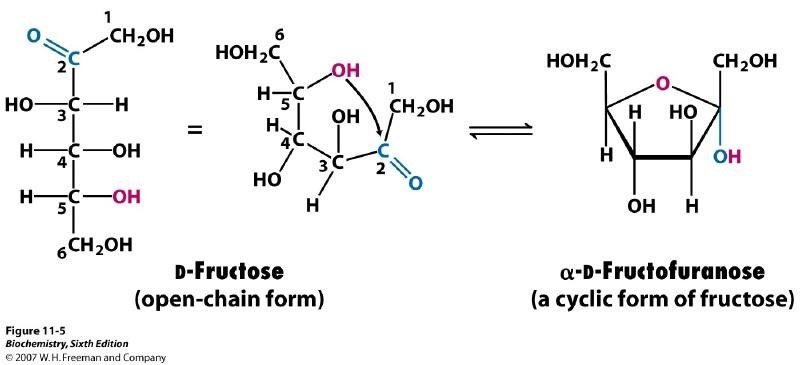
Open chain structure of glucose & fructose 

* Monosaccharides with more than 4 C atoms can exist in the form of a ring structure in aquous solution
* H E Fischer proposed the existance of monosaccharides in the form of a cyclic structure in aquous solution such that carbonyl group has forms a covalent bond with the oxygen of a hydroxyl group
* The formation of these ring structures is the result of a general reaction between alcohols (hydroxyl group)and aldehydes or ketones (carbonyl group) to form derivatives called **hemiacetals or hemiketals**
* This leads to formation of asymmetric carbon atom with formation of 2 stereoisomers
* Here, OH of the 5th C atom make a bridge with O of 1st C atom, OH is transferred to 1st C atom making it asymmetric
* As a result 2 stereoisomers of glucose are formed- **α- glucose** and **β- glucose**
* These are called **anomers** of glucose
* If OH is on the right side, it is called α-glucose and if OH is on the left side, it is called β- glucose
* In case of fructose, only α anomer is possible
* It is because, the carbonyl group is present in the 2nd C atom, and 1st C is not vacant, so rotation is not possible
* In case of glucose, carbonyl group is present in 1st C atom, so rotation possible, and 2 anomers present



* Walter Haworth also showed the existance of monosaccharides in the form of a ring structure when dissolved in water, it can be in the form of pyran ring or furan ring
* Sugar forming pyran ring- pyranoses
* Sugar forming furan ring- furanoses
* Glucose and fructose can exist in both pyranose and furanose form
* Stable form of glucose is pyran ring form and that of fructose is furan ring form





PROPERTIES OF MONOSACCHARIDES

## ISOMERISM

* Phenomenon in which compounds have same emperical formula and elemental

composition, but different structures is called isomerism

* 2 types of isomerism; structural isomerism and stereo isomerism

## • Structural isomerism

* Phenomenon in which molecular formula of the compounds are same but have different structures
* Eg: glucose and fructose
* Ethyl alcohol (CH₃ CH₂ OH)and dimethyl ether (CH₃-O-CH₃)

## • Stereo isomerism

* Phenomenon in which molecular formula as well as the groups are same, but spacial arrangement of the group are different
* Stereo isomerism are of 2 types:
* Geometrical isomerism
* Optical isomerism
* **Geometrical isomerism/ cis-trans isomerism**
* This type of isomerism arise due to restricted rotation about the double bond
* Eg: maleic acid and fumaric acid
* In maleic acid, H and COOH are on the same side, but in fumaric acid COOH group is arranged on opposite side
* 2 C atoms are linked by double bond, so free rotation is not possible
* Maleic acid is called cis- isomer and fumaric acid is called trans- isomer
* **Optical isomerism**
* It arises due to chirality of the C atom
* The presence of asymmetrical C atom causes optical activity
* Asymmetrical C atom or chiral C atom- Catom attached to different groups
* Eg: D- glyceraldehyde and L- glyceraldehyde
* They are mirror images of each other, each compound is called **enantiomer** of the other
* **Epimerisation**
* Epimer- variation in the H and OH in any one of the asymmetric C atom other than carbonyl carbon is called epimers
* Eg: mannose is the 2nd epimer of glucose, Galactose is the 4th epimer of glucose
* Process by which one epimer is converted to other in presence of the enzyme epimerase, is called epimerisation
* Eg: conversion of glucose into galactose and viceversa takes place in liver tissue

## • Mutarotation

* **Mutarotation** is the change in the optical rotation
* *A*nomers of D-glucose (α- D glucose and β- D glucose) interconvert in aqueous solution by a process called mutarotation.
* Mutarotation was discovered by French chemist Dubrunfaut in 1846