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PAGE  
DATE:

M.Sc. (Sem - II).

Organic Chemistry - (Topic -  
Disaccharide-Lactose) Paper - VII.

Harendra Kumar

## Carbohydrates

Disaccharides :- When a hydroxy group of one monosaccharide molecule acts as the alcohol to form a glycosidic linkage with the hemiacetal group of a second monosaccharide, the resulting glycoside is called a disaccharide. Acetoh formed from two monosaccharides by the elimination of one molecule of water. Hydrolysis of a disaccharide either by water in presence of an acid or by enzymes yields two monosaccharides.



Monosaccharide Monosaccharide Disaccharide

Most common disaccharides are Lactose, Maltose, Sucrose, Cellulose etc.

Lactose (milk sugar),  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ .

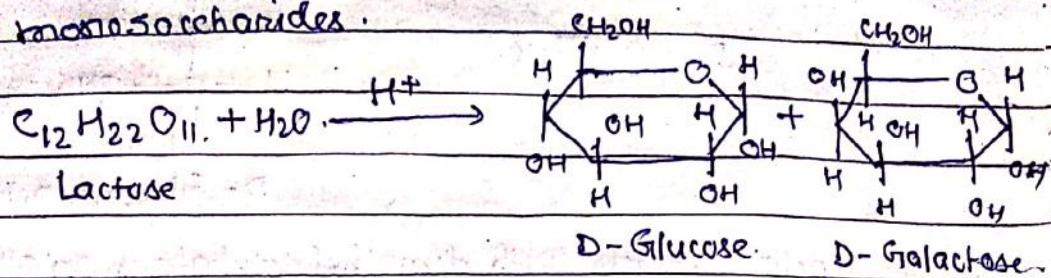
Occurrence - Lactose occurs in the milk of all animals. For example, cow's milk contains 4 to 6% and human milk contains 5 to 8% of this sugar. Unlike most other carbohydrates, it is found only in animals and not in plants.

Preparation - Lactose is obtained commercially from cows' milk after the removal of the emulsified fat and casein. The remaining whey is concentrated in vacuum pans and the raw lactose which separates is eventually decolorised with animal charcoal.

Structure of Lactose :- The structure of lactose has been derived as follows -

- Elemental analysis and molecular weight determination show that the molecular formula of lactose is  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ .
- Lactose reacts with acetic anhydride in the presence of sodium acetate to form lactose acetate. This reaction indicates the presence of eight hydroxyl groups in a lactose molecule. Lactose is a stable compound; the eight hydroxyl groups must be present on separate carbon atoms.

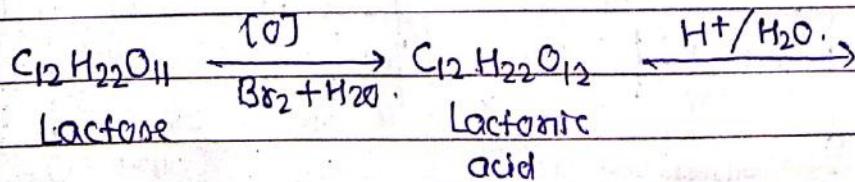
3. Hydrolysis of lactose with dilute acid yields an equimolecular mixture of D-glucose and D-galactose. This indicates that the lactose molecule is made up of one unit of each of these monosaccharides.

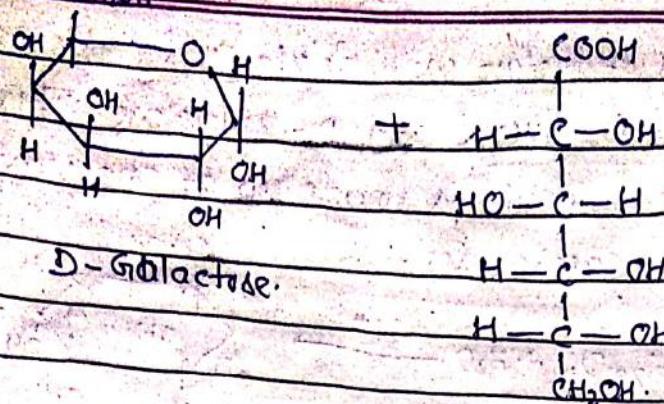


4. Lactose reduces Tollen's reagent and Fehling's solution, reacts with hydrogen cyanide, and forms an osazone. All these reactions indicate that one free hemiacetal group must be present and this is in equilibrium with some of the free aldehyde form.

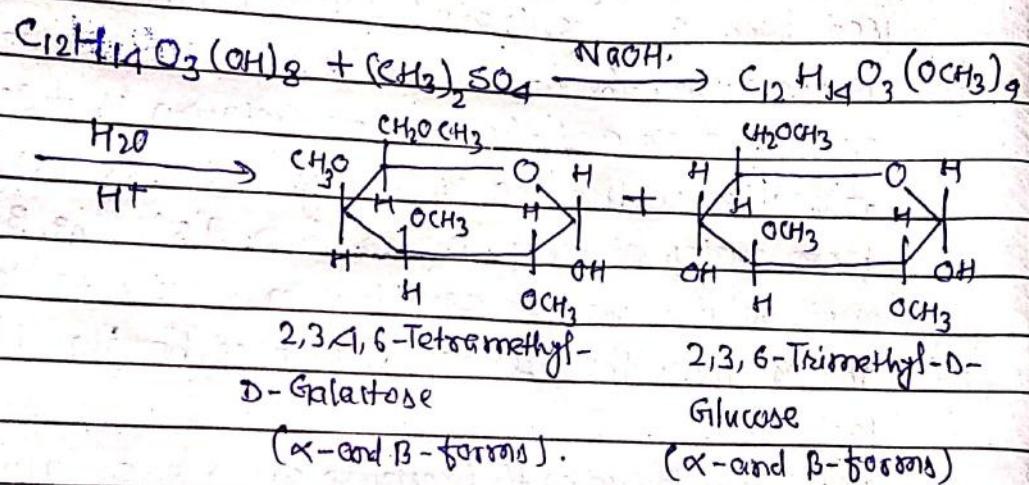
5. Lactose can be isolated in two crystalline forms depending on how one recrystallises ordinary lactose. If it is recrystallised from a concentrated aqueous solution at ordinary temperature, the  $\alpha$ -form of the sugar is obtained. The melting point is  $223^\circ\text{C}$  and the specific rotation is  $+90^\circ$ . However, if another portion of the ordinary lactose is recrystallised from water at temp. higher than  $95^\circ\text{C}$  the  $\beta$ -forms exhibit mutarotation until an equilibrium value of  $+55^\circ$  is reached. This confirms the presence of a free hemiacetal group in lactose.

6. Oxidation of lactose with bromine water gives lactonic acid, which on hydrolysis yields a mixture of D-galactose and D-glucuronic acid. This indicates that it is the glucose unit that contains the free hemiacetal-aldehyde group.



CH<sub>2</sub>OH.

7. Lactose reacts with dimethyl sulphate in an alkaline solution to form acetomethyl lactose, which on hydrolysis yields a mixture of 2,3,4,6-tetramethyl D-galactose and 2,3,6-trimethyl-D-glucose. The formation of these compounds indicates that both units exist in 6-membered pyranose forms, and the glycosidic linkage involves the hydroxyl group at C1 in glucose.



8. Lactose also hydrolysed by emulsin, an enzyme that hydrolyses  $\beta$ -Glycosides rather than  $\alpha$ -glycosides. This indicates that lactose is a  $\beta$ -galactoside.

