

Carbohydrates

5th Sem

Lecture – 1

Paper – CC12

Kuheli Pramanik

Assistant Professor

Department of Chemistry

Kharagpur College

Carbohydrates

Carbohydrates

Carbohydrates are an important naturally occurring compounds. According to earlier concept carbohydrates may regarded as - hydrates of carbon as their general formula $C_x(H_2O)_y$. But each compounds does not

have the above general formula. e.g. 6-deoxy-L-mannose (L-rhamnose) having formula $C_6H_{12}O_5$

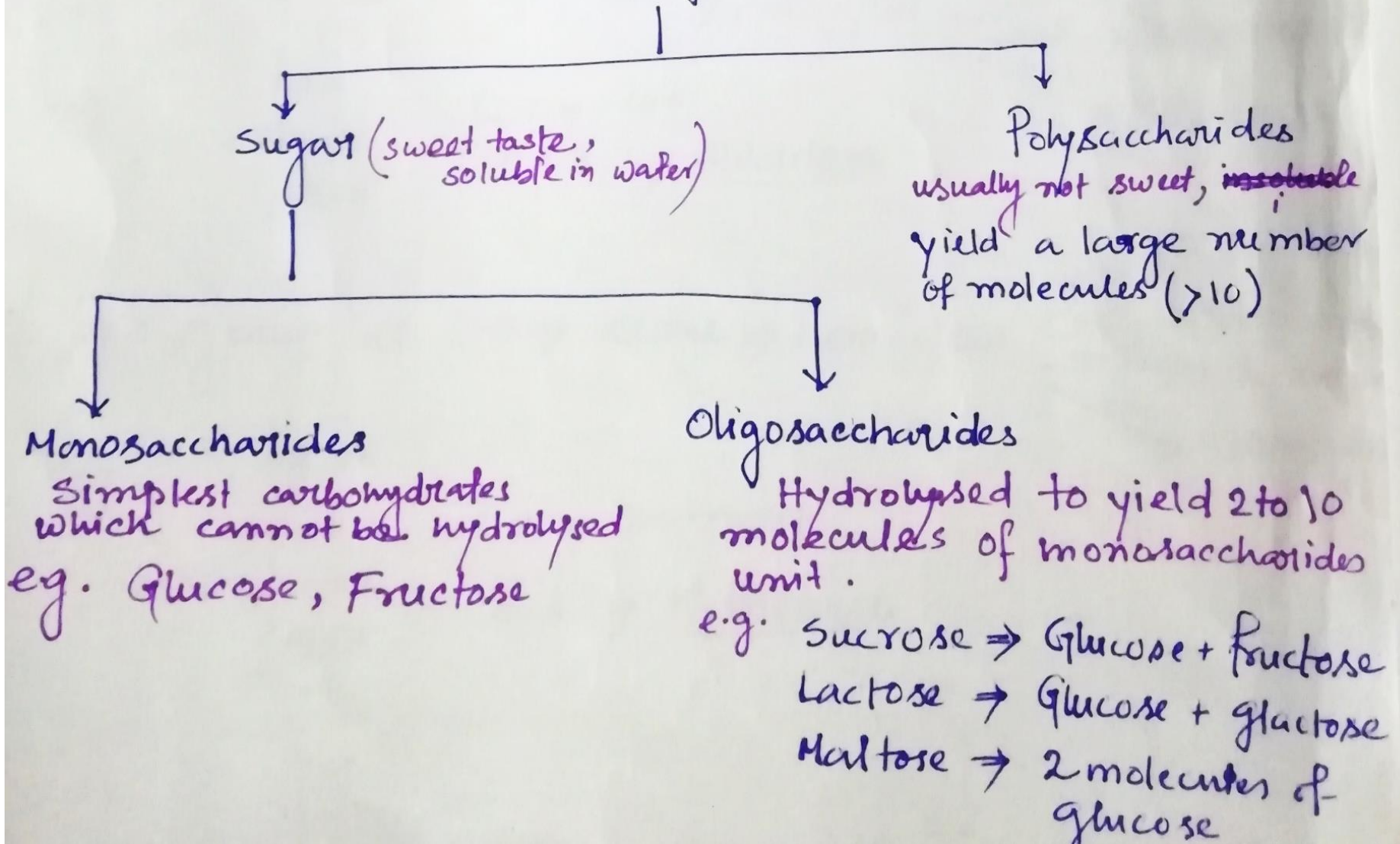
Therefore carbohydrates are usually defined as -
Optically active polyhydroxy aldehydes and ketones.

e.g. glucose \Rightarrow ~~H₂C~~ OHC-CH(OH)₄-CH₂OH

If 1,3-dihydroxy acetone ($HO-CH_2-\overset{O}{\parallel}C-CH_2-OH$) is a carbohydrate?
dates ?? \Rightarrow No, as it is optically inactive.

Carbohydrates

Classification of carbohydrates



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Sugars are further classified as :-

(i) **Reducing sugar** :- Sugars which reduces Fehling solⁿ, Tollen's reagent, Benedict's reagents
All monosaccharides (aldose or ketose), Most of disaccharides are reducing sugars (except - Sucrose)

(ii) **Non-reducing sugar** :- that can not reduce above reagents.
ex. Sucrose.

Carbohydrates

Nomenclature :- Carbohydrates usually have names end with 'ose'

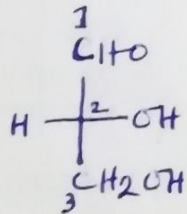
Carbohydrate $\xrightarrow{\text{with}}$ $-\text{CHO}$ group \longrightarrow Aldose

$\xrightarrow{\text{with}}$ $\text{C}=\text{O}$ group \longrightarrow Ketose

' $\text{C}=\text{O}$ '-group at C-1 \Rightarrow $-\text{CHO}$ \Rightarrow Aldo(n)ose

$n=3 \rightarrow$ Aldotriose
 $n=4 \rightarrow$ Aldotetrose
 $n=5 \rightarrow$ Aldopentose
 $n=6 \rightarrow$ Aldohexose

e.g.

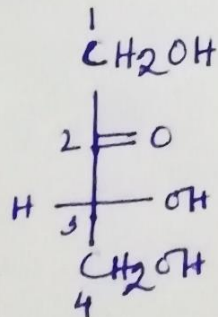


C-1 \Rightarrow $-\text{CHO}$
 $n=3 \Rightarrow$ Aldotriose

' $\text{C}=\text{O}$ '-group at C-2 \Rightarrow Ketone \Rightarrow Keto(n)ose

$n=3 \rightarrow$ Ketotriose
 $n=4 \rightarrow$ Ketotetrose
 $n=5 \rightarrow$ Ketopentose
 $n=6 \rightarrow$ Ketohexose

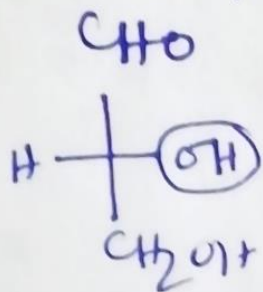
e.g.



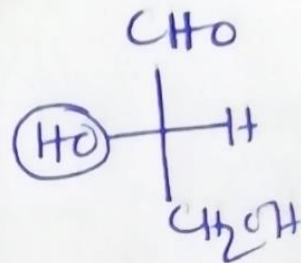
C-2 \Rightarrow $\text{C}=\text{O}$ group
 $n=4 \Rightarrow$ Ketotetrose

D and L Designation:

'D' and 'L' refers to relative configuration of the carbon atom farthest from the carbonyl group. First member of monosaccharides is glyceraldehyde whose 'D' and 'L' configuration is



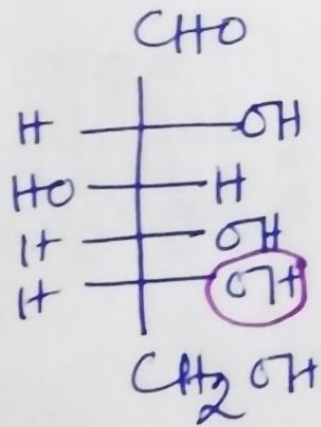
D-(+)-glyceraldehyde



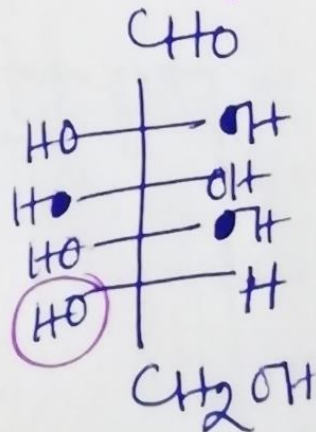
L-(-) glyceraldehyde

Carbohydrates

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The highest numbered stereocentre of a monosaccharide has same conf.ⁿ as D(+) glyceraldehyde named as
→ D-sugar. and same conf.ⁿ as L(-) glyceraldehyde named as → L-sugar.



D(+) glucose

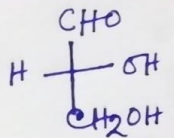


L(-) - glucose

Carbohydrates

The D-family of Aldose

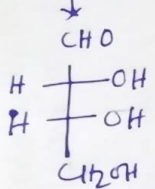
Aldotriose



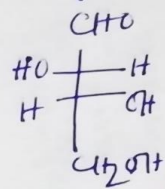
here $\left[\begin{array}{l} -\text{CHO} \Rightarrow \text{O} \\ -\text{OH} \Rightarrow - \\ -\text{H} \text{ and } -\text{CH}_2\text{OH} \text{ are not shown} \end{array} \right]$

D-glyceraldehyde

Aldotetrose

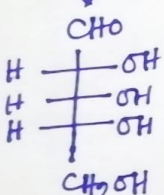


D-erythrose

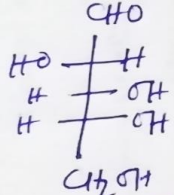


D-threose

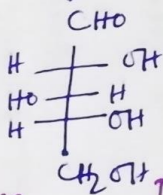
Aldopentose



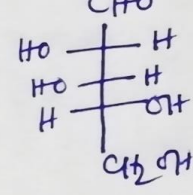
D-ribose



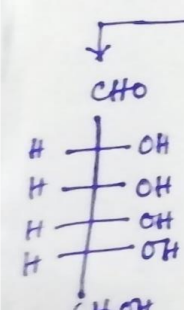
D-arabinose



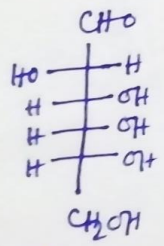
D-xylose



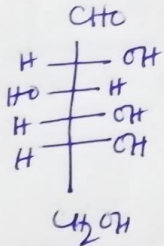
D-lyxose



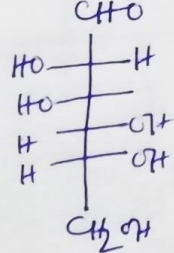
D-Allose



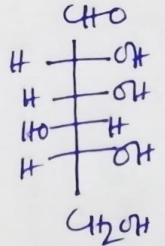
D-altrose



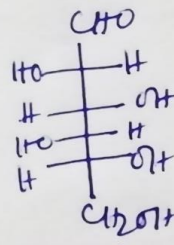
D-glucose



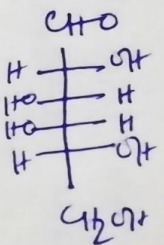
D-mannose



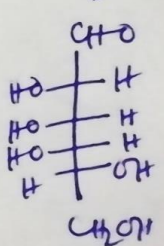
D-gulose



D-idose



D-galactose



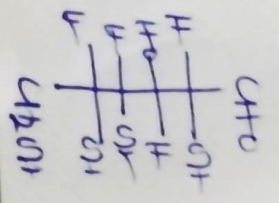
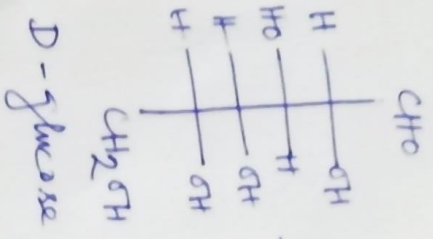
D-talose

Aldohexose

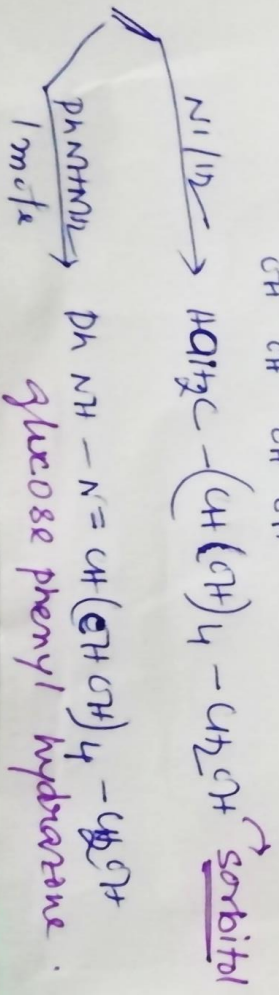
Carbohydrates

Establishment of open chain structure of glucose

↓ On the basis of elemental analysis and M.W., the molecular formula of glucose is $C_6H_{12}O_6$



— On the basis of above evidence, the structure of glucose is $\text{HOOC}-\text{CH}(\text{OH})-\text{CH}(\text{OH})-\text{CH}(\text{OH})-\text{CH}_2\text{OH}$



- (i) $\text{red P}_4/\text{HI} \rightarrow C_6H_{14}$ (n-hexane) \rightarrow indicates the presence of 6-C in straight chain
- (ii) $\text{Ac}_2\text{O}/\text{PX} \rightarrow \text{HOAc}(\text{HAc})_4\text{CH}_2\text{OAc} \rightarrow$ indicates presence of five free-OH gr. pentaacetyl derivative
- (iii) $\text{NH}_2\text{OH} \rightarrow \text{HON}=\text{C}(\text{CHOH})_4\text{CH}_2\text{OH}$ glucose monooxime
- (iv) $\text{HCN} \rightarrow \text{Ne}(\text{SH}(\text{OH}))(\text{CHOH})_4\text{C}_6\text{H}_5\text{OH}$ glucose cyanohydrin
- (v) $\text{Br}_2/\text{H}_2\text{O} \rightarrow \text{HOOC}-(\text{CH}(\text{OH}))_4-\text{CH}_2\text{OH} \rightarrow$ gluconic acid \rightarrow Presence of γ -OH group
- (vi) $\text{HNO}_3 \rightarrow \text{HOOC}-(\text{CH}(\text{OH}))_4-\text{COOH}$ glucaric acid \rightarrow indicates beside -OH group, there must have one primary alcohol group (-OH) group
- (vii) $\text{stable comp} \rightarrow$ does not dehydrate easily \rightarrow indicating not more than one -OH gr. are present in diff. carbon atom.

Carbohydrates