

Biomolecules :

⇒ Carbohydrates

*) Classifications> 4

*) MOP of Glucose

→ from Sucrose> 6

→ from Starch> 6

*) Properties> 7

→ Rxn with $\frac{\text{HI}}{\text{red P}}$ n-hexane> 7

→ Rxn with NH_2OH Oxime> 8

→ Rxn with HCN cyanohydrin> 8

→ Rxn with $\text{Br}_2 (\text{H}_2\text{O})$ Gluconic acid> 8

→ Rxn with HNO_3 Saccharic acid> 9

→ Rxn with acetic anhydride Penta acetate> 9

*) Cyclic structure of

a) Glucose> 11

*) muta rotation

b) Fructose> 13

* Disaccharides

- 1) Sucrose (α -D-Glucose + β -D-fructose)
1-1> 14
- 2) Maltose (α -D-Glucose + α -D-Glucose)
1-4> 15
- 3) Lactose (α -D-Galactose + β -D-Glucose)
1-4> 17

* Polysaccharides

- 1) Starch (Amylose + Amylopectin)> 16
- 2) Cellulose (only β -D-glucose units)> 17
- 3) Glycogen> 18

* Configuration> 19
(α , β) ; (D, L)
(+, -) ; (cyclic vs linear)

* Tests

- 1) Molish test> 20
- 2) Seliwanoff's test> 20
- 3) Benedict's test> 21
- 4) Barford test> 21
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- 6) Fehling's test> 22
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III) Nuclei acids

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* DNA & RNA> 36

* Hormones> 37

Proteins> 30

* Peptide linkage> 30

* Types :

1) Fibrous> 31

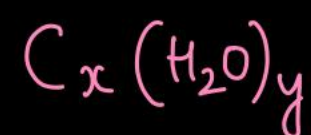
2) Globular> 32

* Denaturation of proteins> 33

Carbohydrates :

also called as Saccharides

* Hydrates of Carbon



E.g:- $x=y=6 \Rightarrow C_6H_{12}O_6$: Glucose
Fructose

Optically active Polyhydroxy
aldehydes / ketones.
(or)

the compounds which produce
such units on hydrolysis.

* Exception : $C_2(H_2O)_2$

↳ acetic acid CH_3COOH is not carbohydrate
↳ (Rhamnose) $C_6H_{12}O_5$ is also carb.

* classification -> Based on hydrolysis

i) Mono-Saccharides

→ doesn't hydrolyse
further

E.g:- Glucose
fructose
Galactose

ii) Oligo Saccharides

→ (2-10) mono sac

Disac → 2

E.g:- Sucrose, maltose
lactose

Trisac → 3

E.g:- Raffinose

iii) Poly saccharides

(non-sugars)

→ many mono sac

E.g:- Starch,
cellulose

* Classification - II > Reducing and Non-reducing Sugars

Reducing Sugars

→ +ve Tollen's test
+ve Fehling's test
+ve Benedict's test

Eg: Glucose, fructose ---
maltose, lactose ---

Non-reducing Sugars

→ -ve Tollen's test
-ve Fehling's test
-ve Benedict's test

Eg: Sucrose

* Classification - III > Based on No. of Carbon atoms

No. of Carbons :

Ald

Ket

③

Aldotriose

ketotriose

④

Aldotetrose

ketotetrose

⑤

Aldopentose

ketopentose

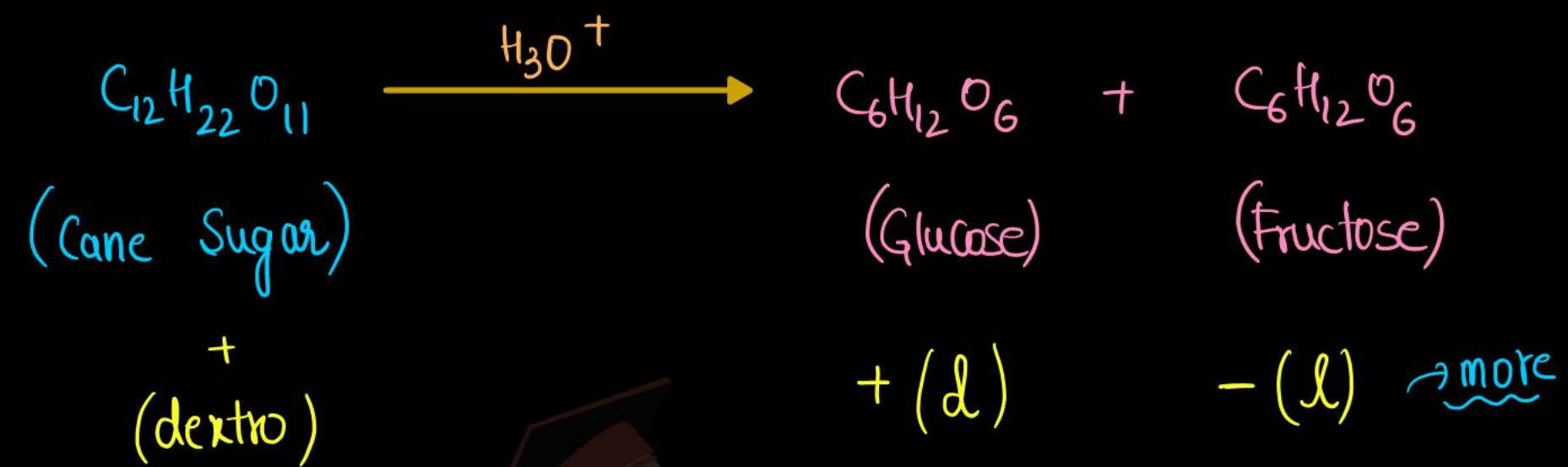
⑥

Aldohexose

ketohexose

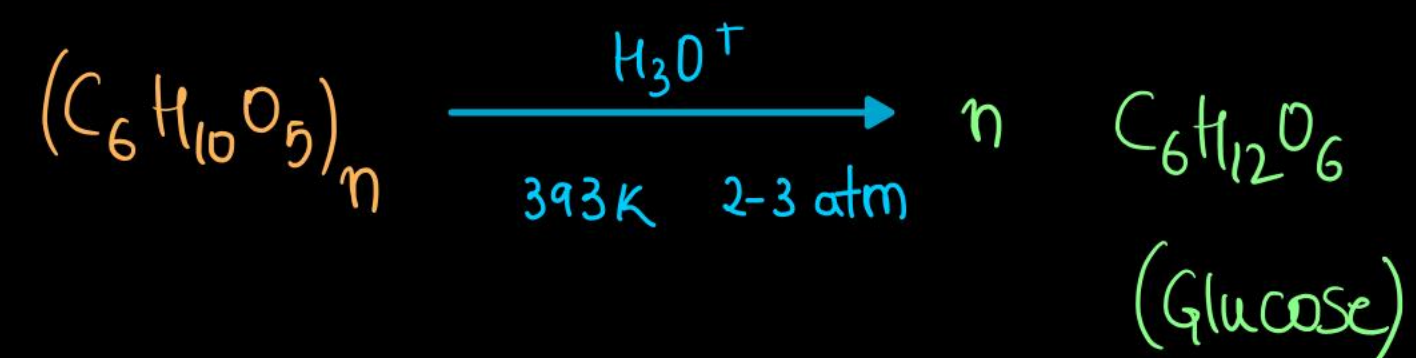
MOP of Glucose :

i) from Sucrose :



Inversion of
Cane Sugar

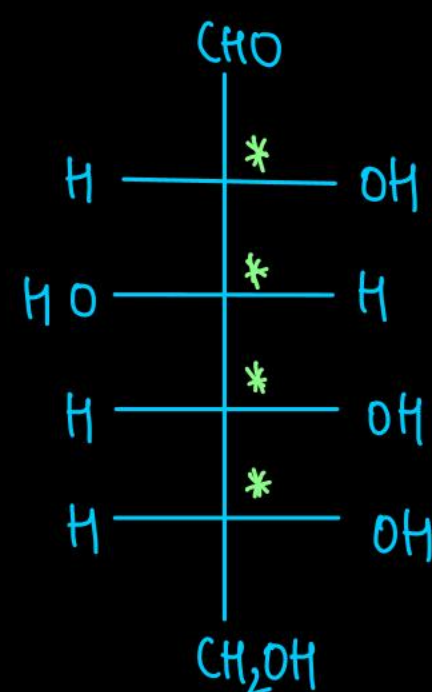
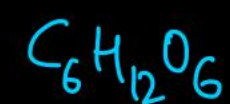
ii) from starch



Properties :

1) Glucose is also known as dextrose (+) & as well as (aldohexose)

2) Structure :

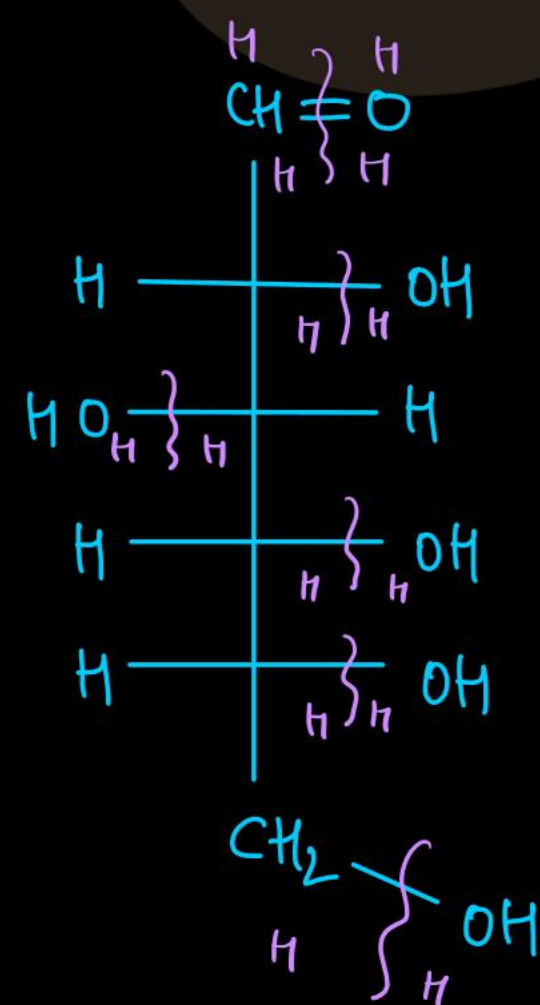


4-chiral Carbons

Chem Rxn's :-

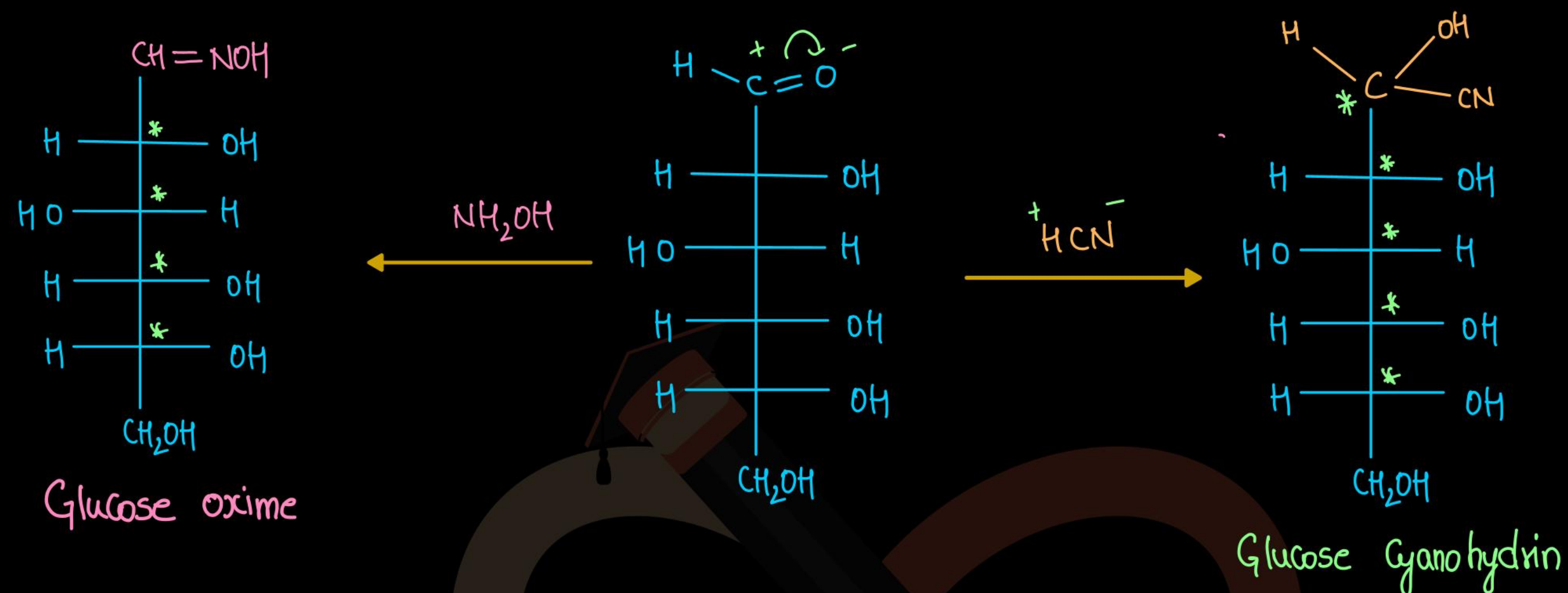
1) Rxn with HI / Red P

→ Indicates that all 6 Carbons are linked in straight chain

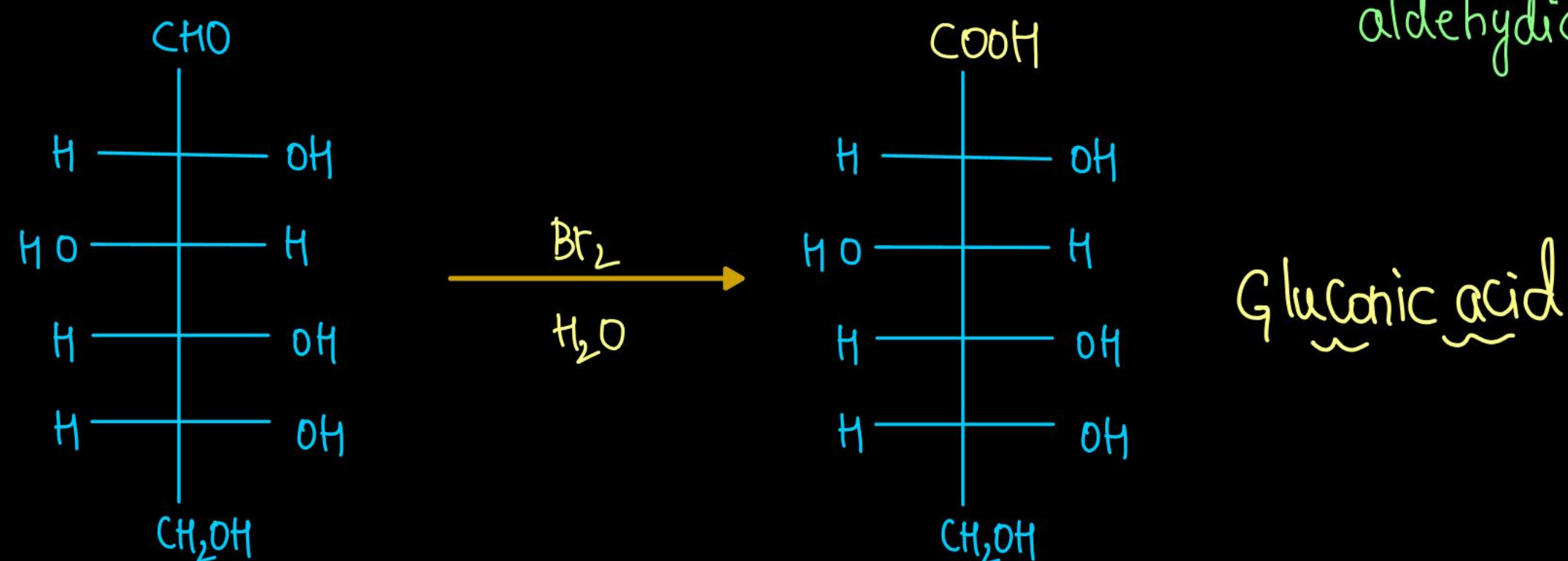


n-hexane

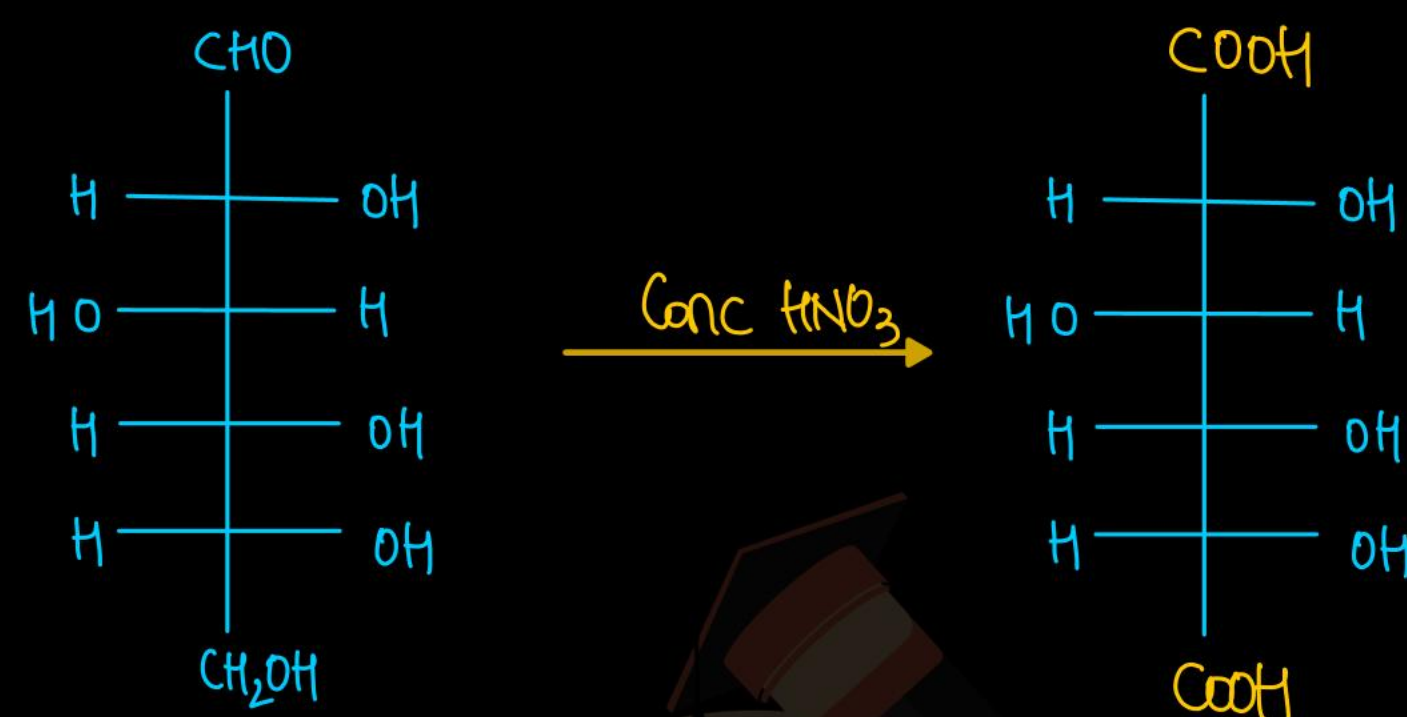
2) Rxn with NH₂OH & HCN $\longrightarrow$ Confirms presence of Carbonyl group ($\text{C}=\text{O}$)



4) Rxn with Br₂ + H₂O (mild OA) $\longrightarrow$ Indicates that carbonyl group is present in aldehydic grp.



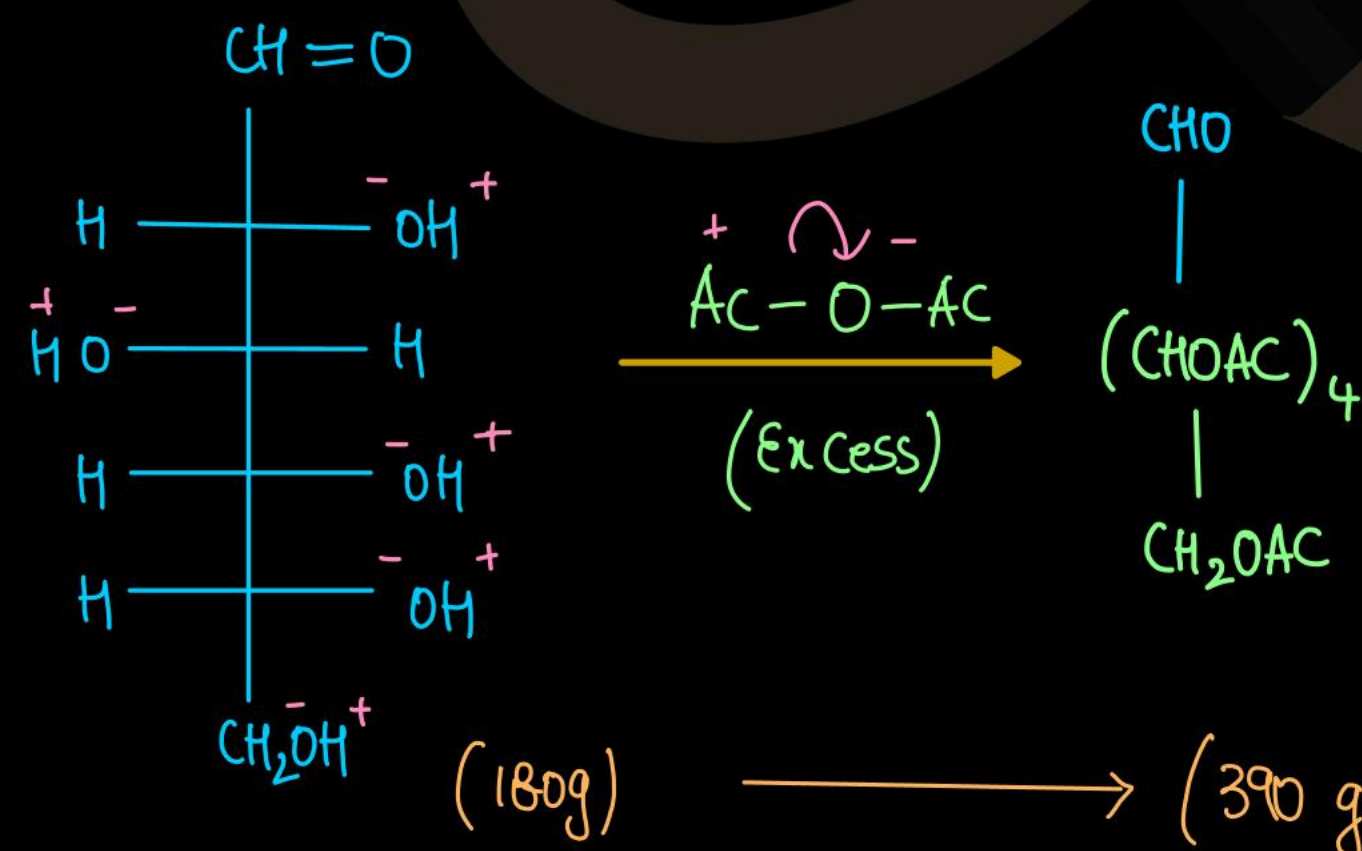
5) Rxn with Conc HNO_3 (strong o.A) $\rightarrow$ Indicates that carbonyl group is present in aldehydic grp.



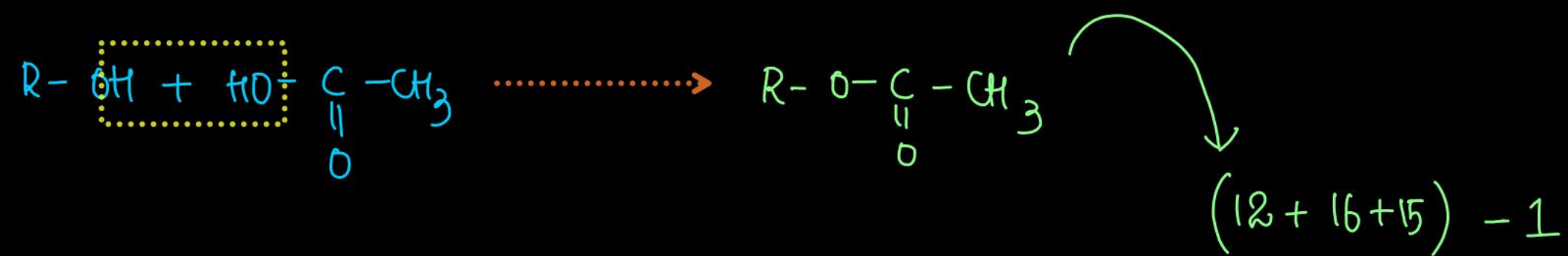
(Glucaric/Saccharic acid)

6) Rxn with acetic anhydride :

$\rightarrow$ Confirms presence of 5 OH groups



Glucose
penta acetate



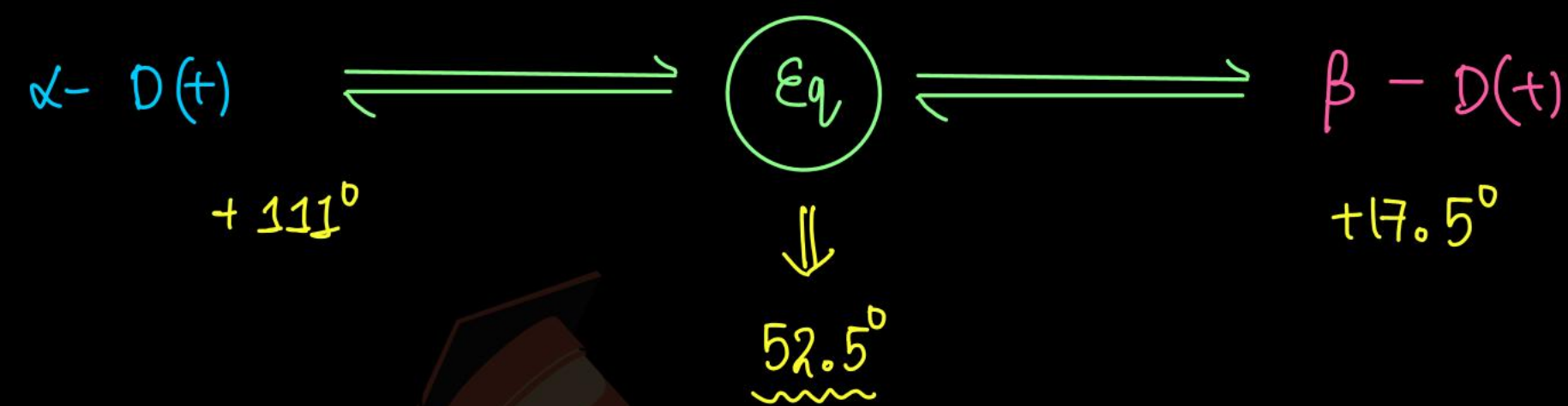
$$= 42g$$

⇒ for each OH group,

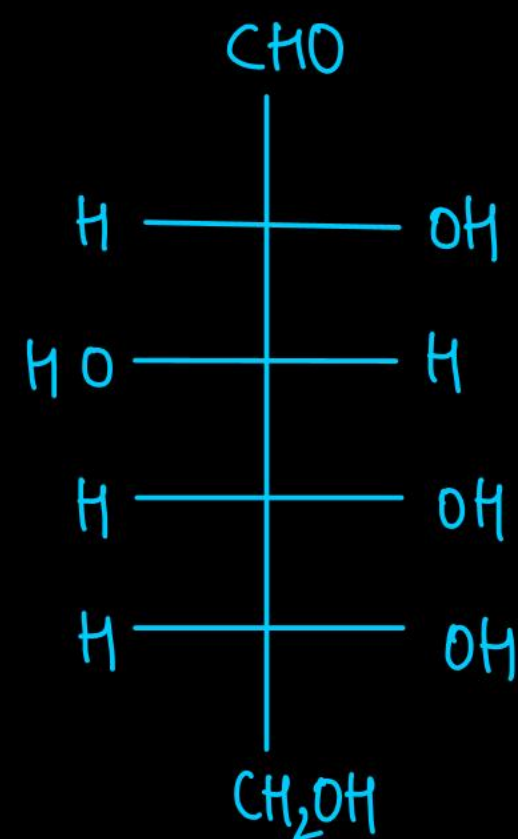
there is 42 g increase after each acylation

Muta Rotation :

Gradual change in Specific rotation to reach ϵ_g value is known as muta rotation.

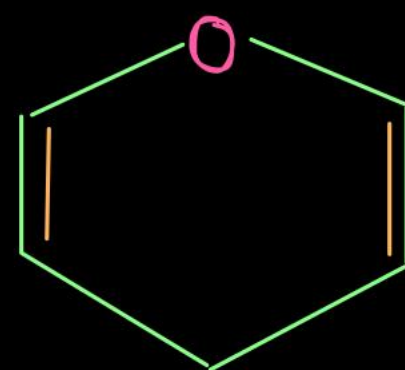
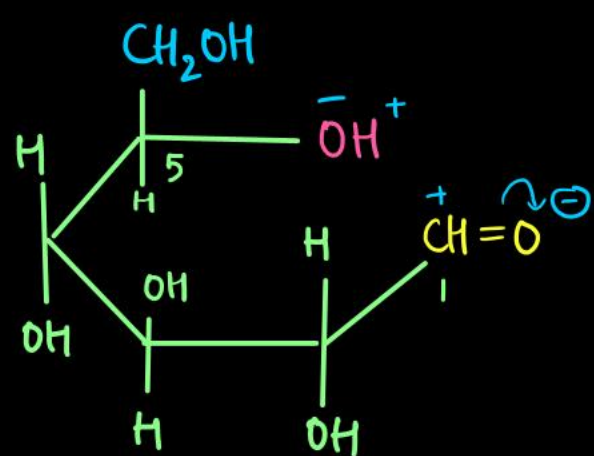
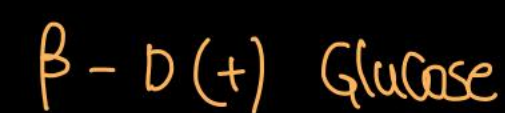
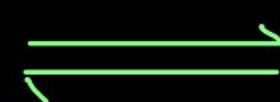


Cyclic structure of Glucose :

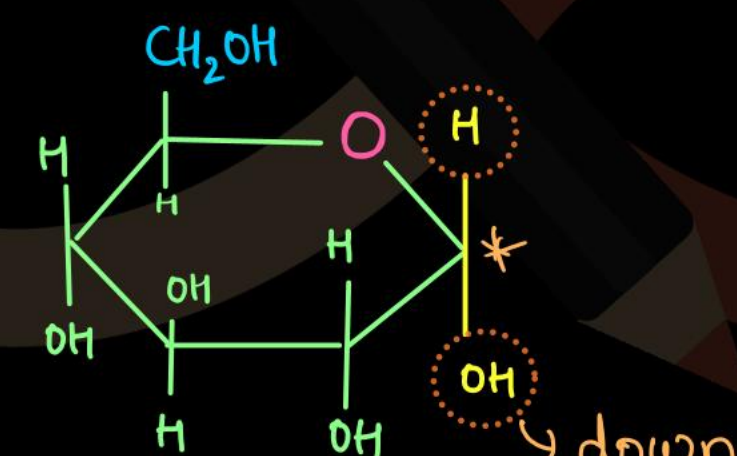


Although Glucose contains aldehyde grp, it could react with then.

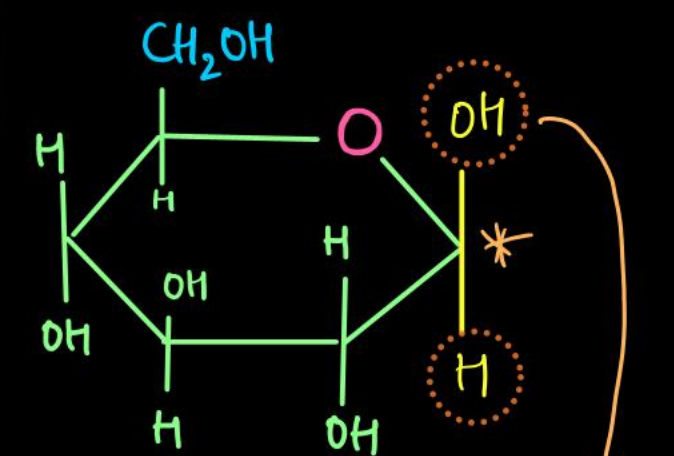
Thus, it indicates -CHO group is not free.



Pyran



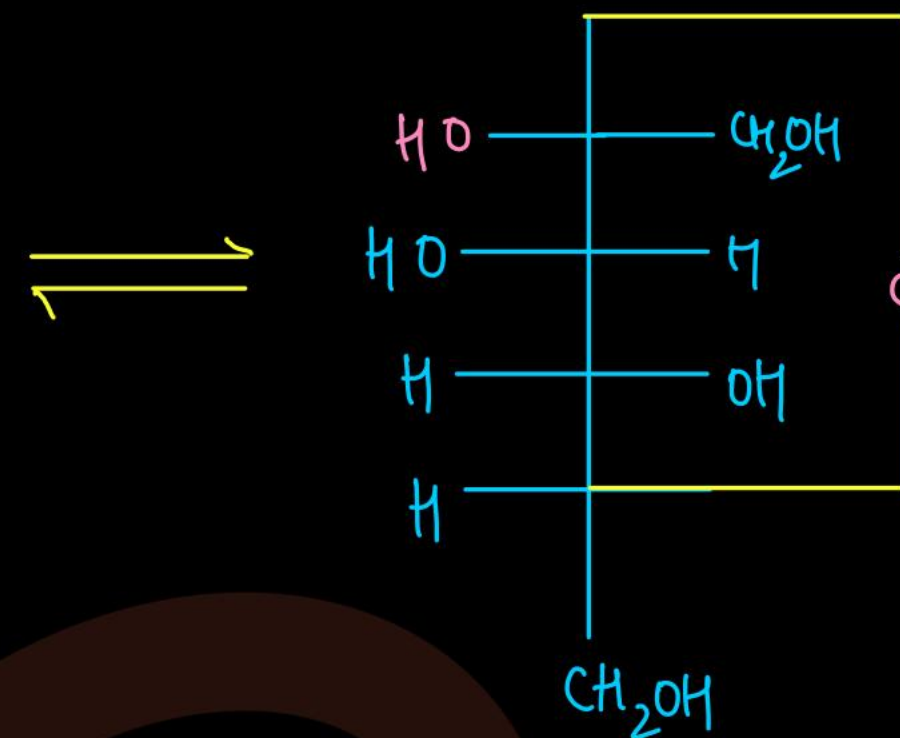
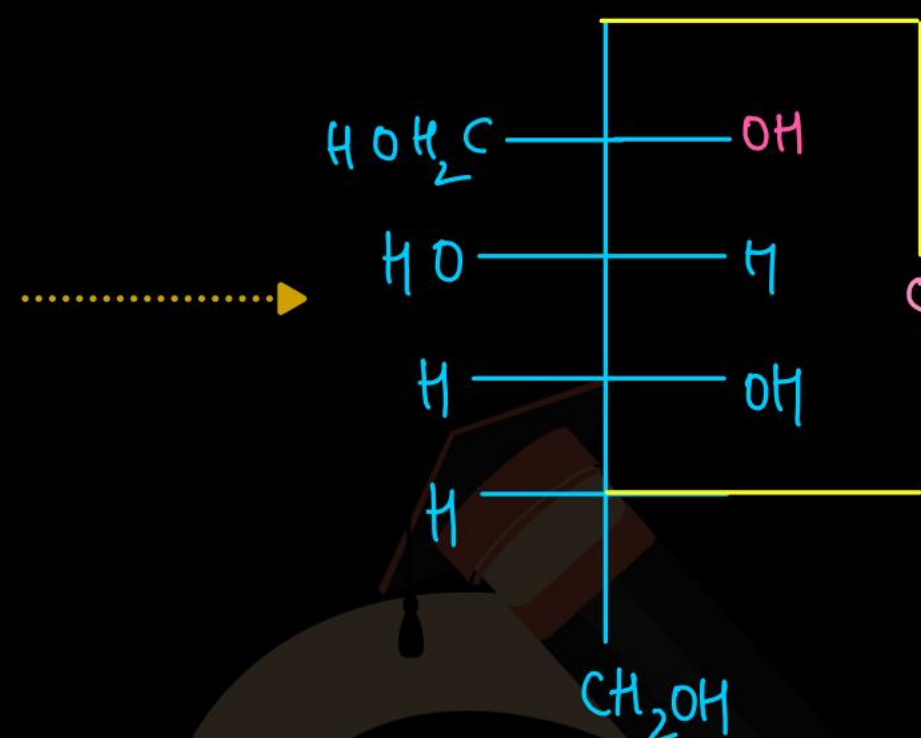
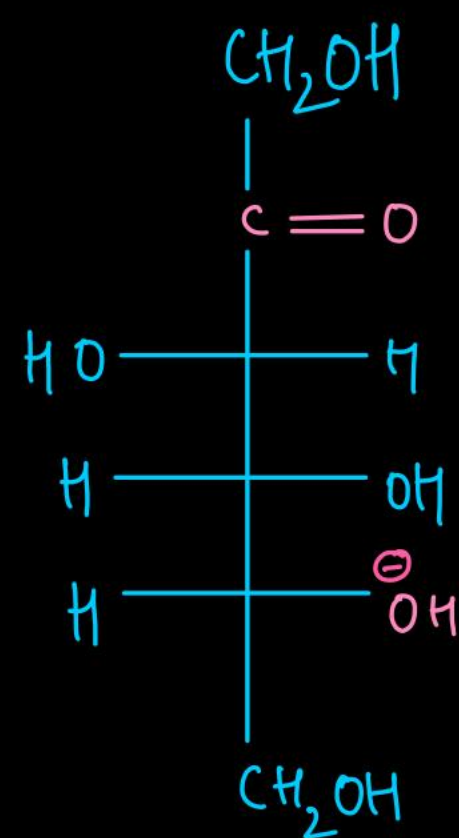
α -D-(+)-Glucopyranose



β -D-(+)-Glucopyranose

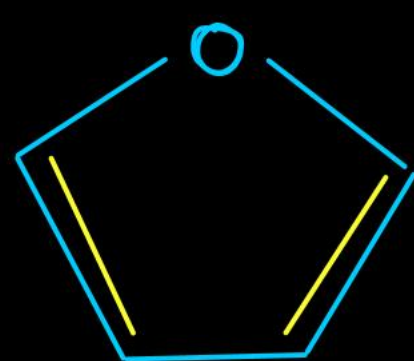
* The α , β forms differ only at C_1 (anomeric carbon) and hence called as anomers $\rightarrow$ diastereomers.

Structure of fructose :-

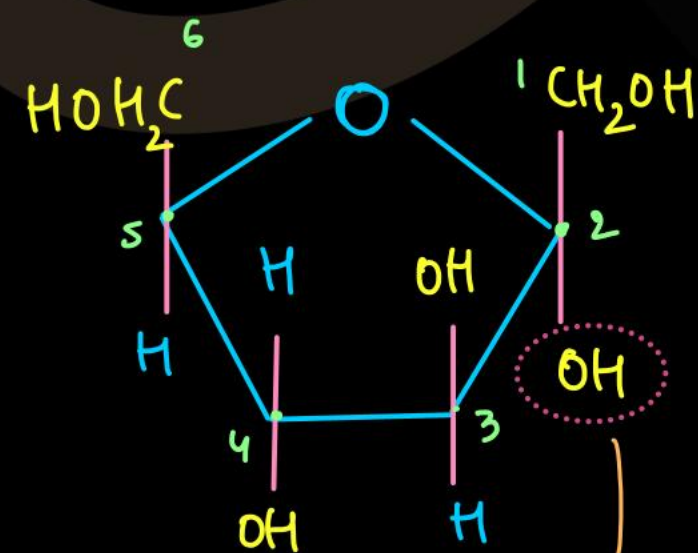


α -D(-)-fructose

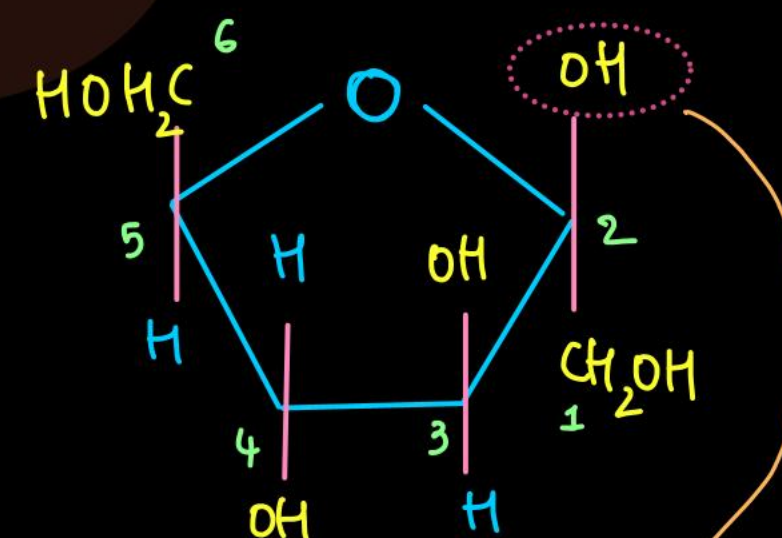
β -D(-)-fructose



furan



down
 α -D(-) fructofuranose

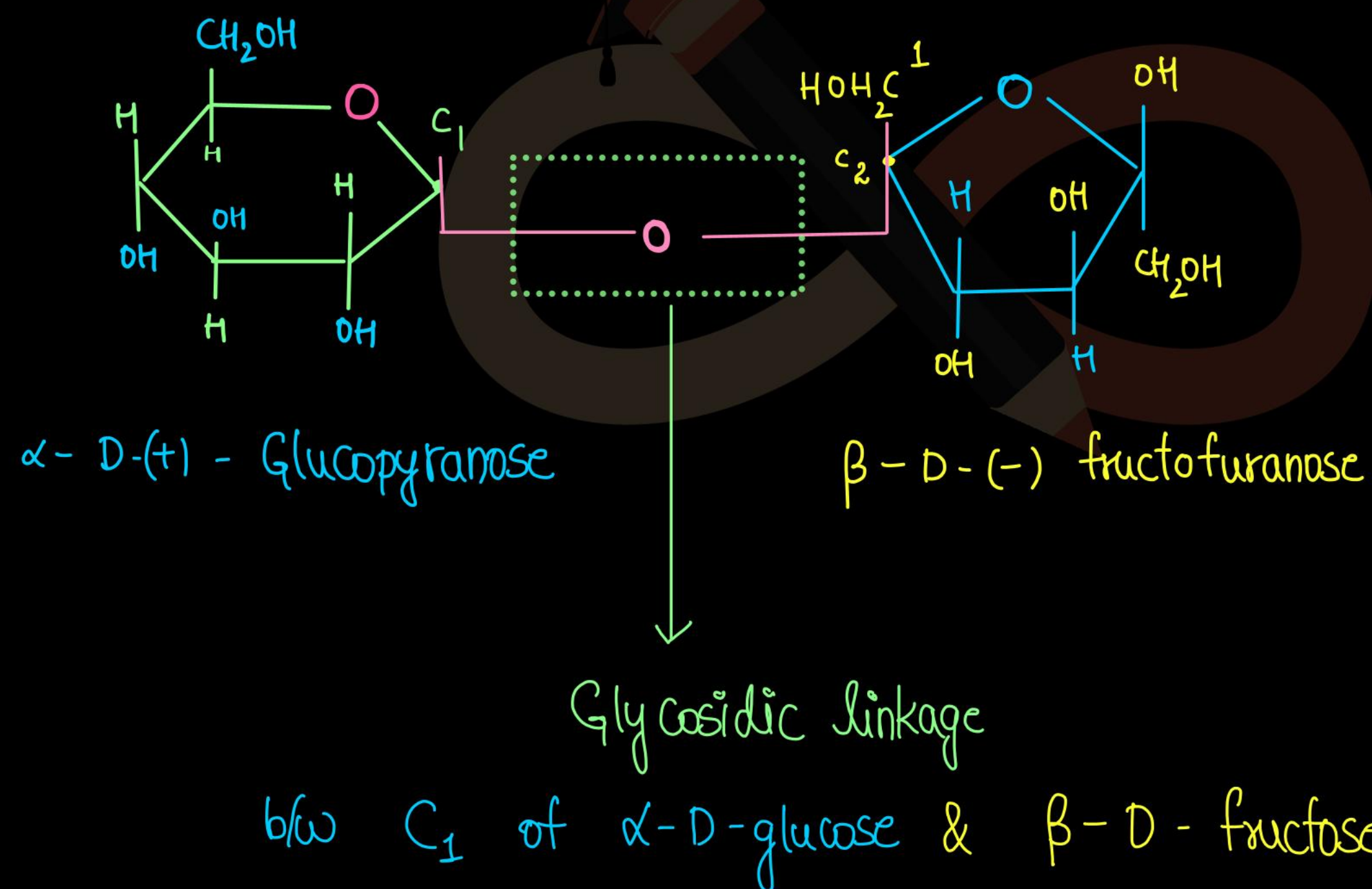


top
 β -D(-) fructofuranose

Disaccharides :-

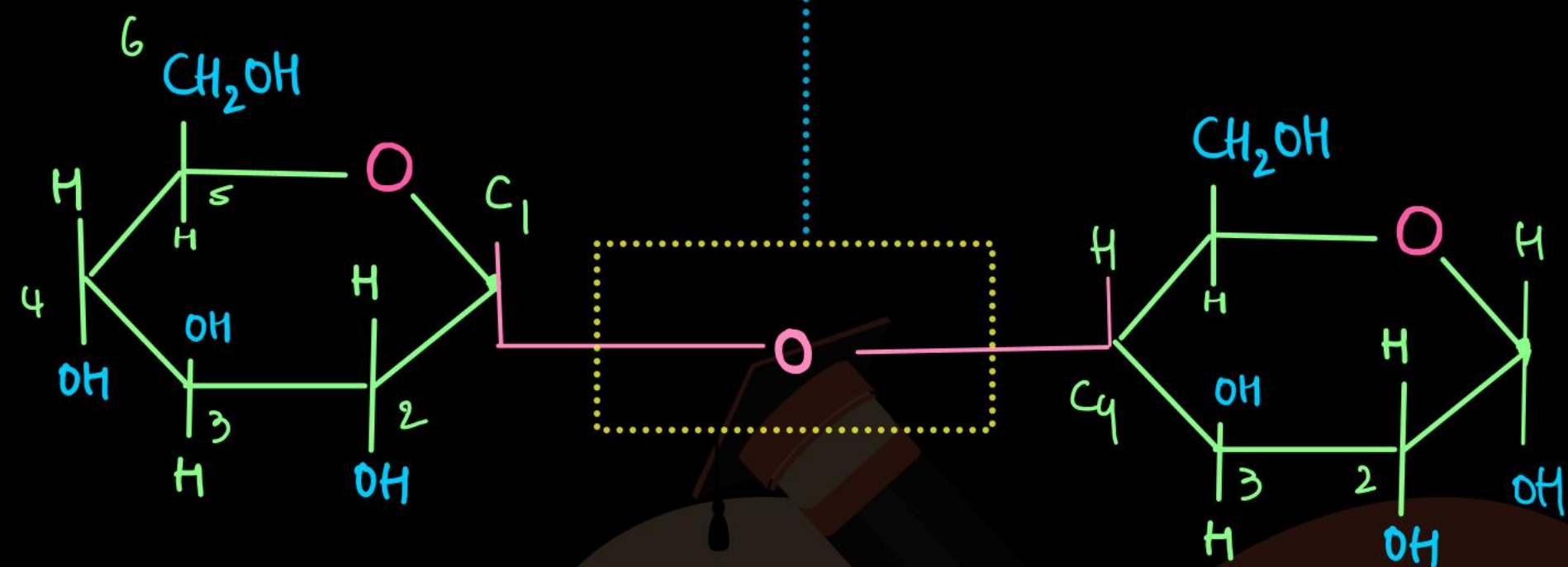
Two monosaccharides joined together by an Oxide linkage formed by loss of a water molecule is called Glycosidic linkage.

Ex:-



X Non reducing sugar
(No free aldehyde grp)

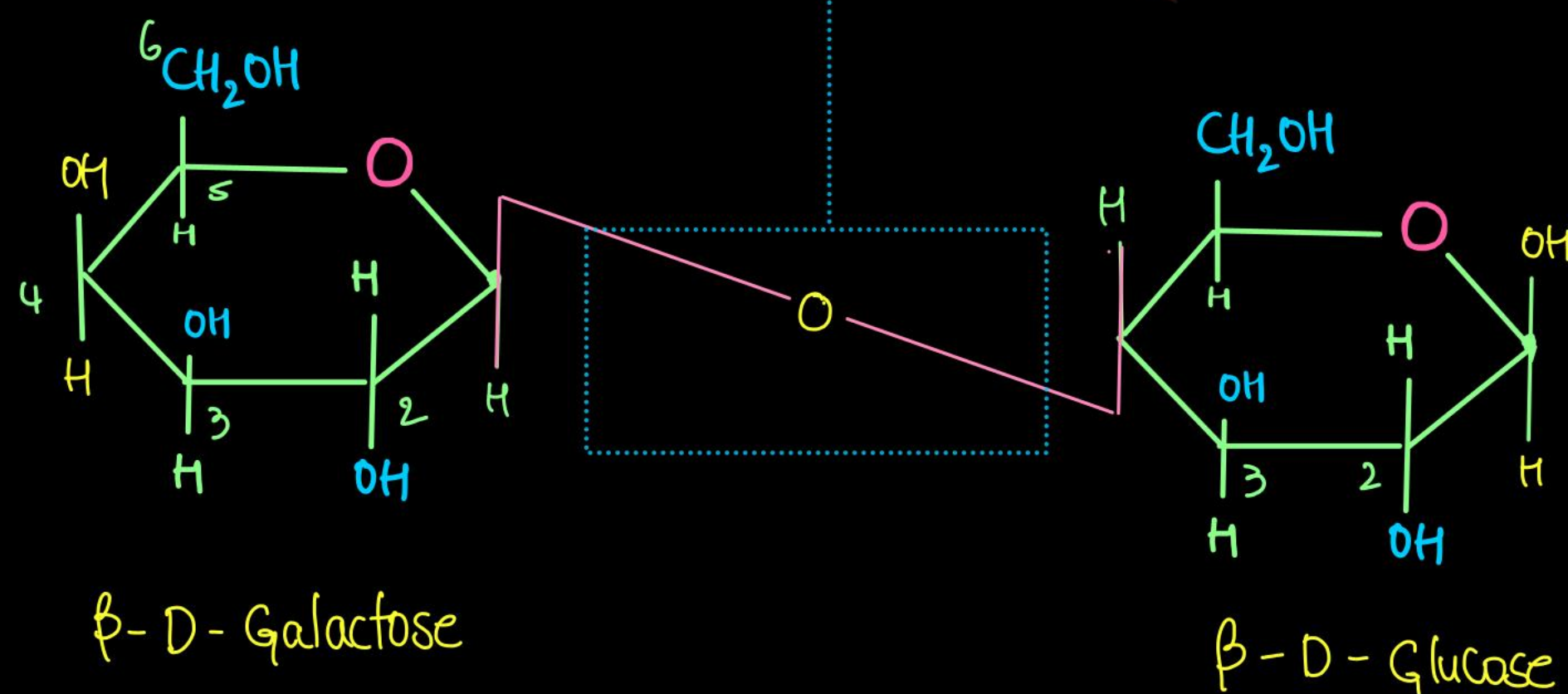
2) Maltose $\longrightarrow$ C_1 of α -D glucose + C_4 of α -D glucose



✓ Reducing Sugar
(free aldehyde group
at C_1)

3) Lactose $\longrightarrow$ C_1 of α -D-galactose + C_4 of β -D-glucose

milk sugar



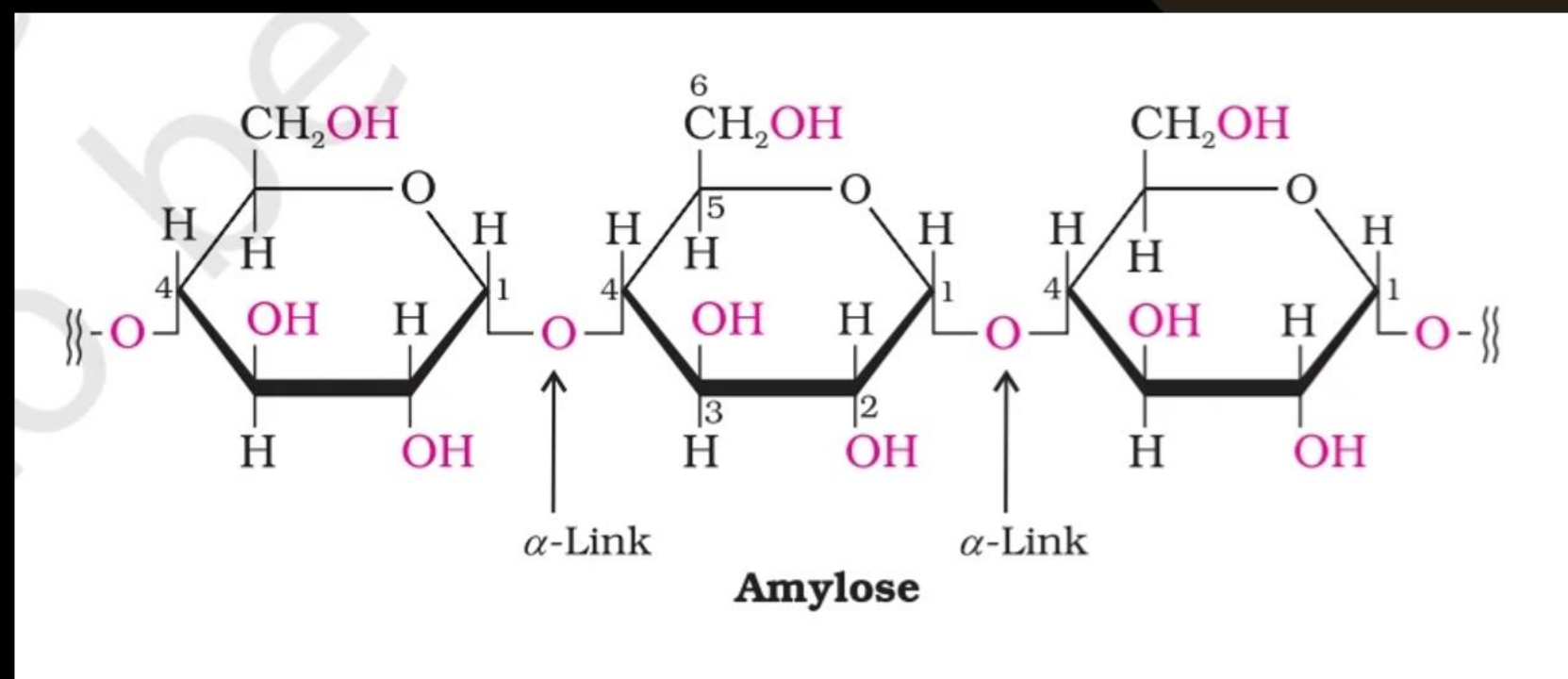
✓ Reducing Sugar
(free aldehyde group
at C_1)

Polysaccharides :-

i) Starch : Amylose (15-20%) + Amylopectin (80-85%)

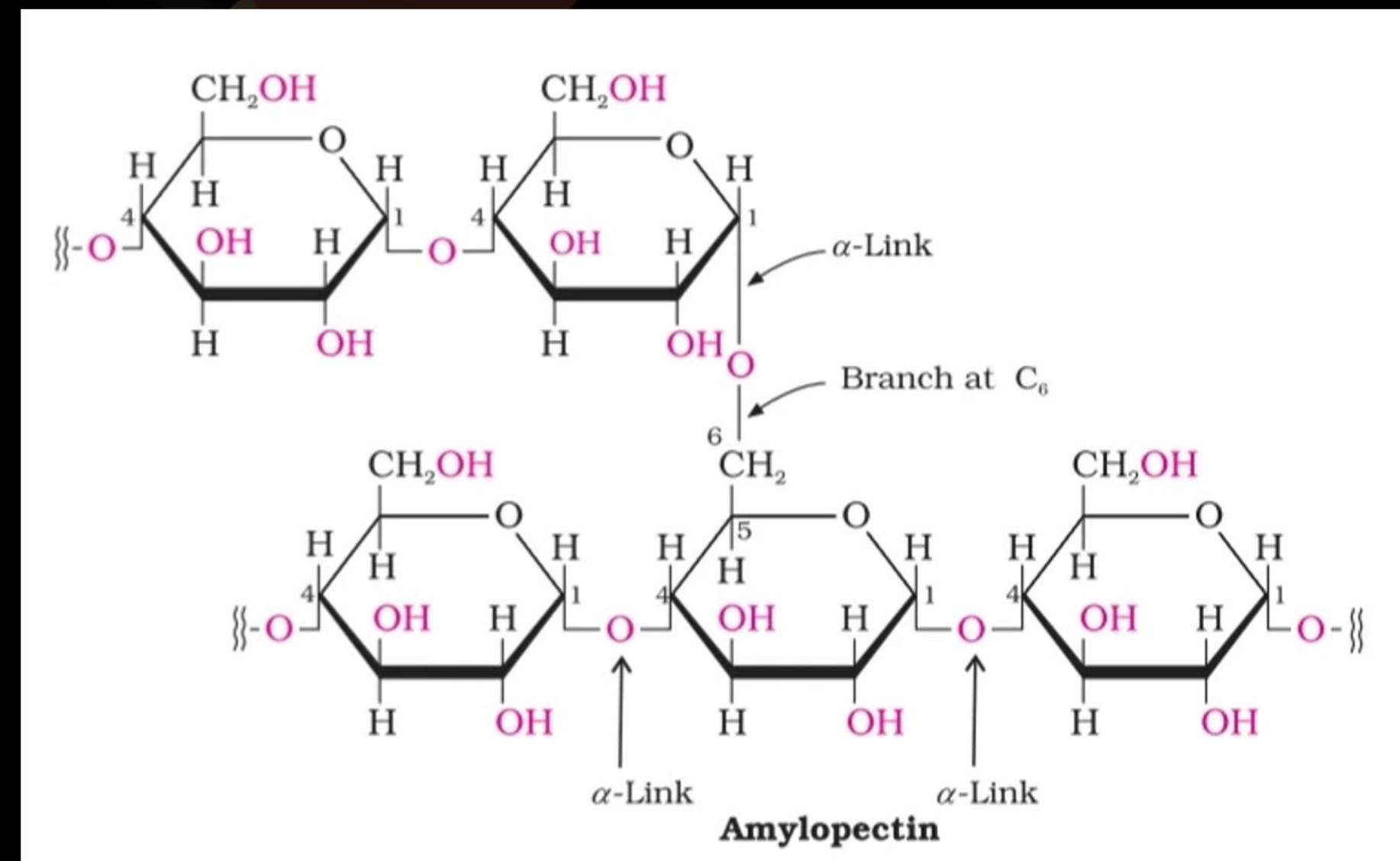
Amylose

- * water soluble
- * 200 - 1000 units of α -D (+) glucose.
- * C_1 - C_4 linkages

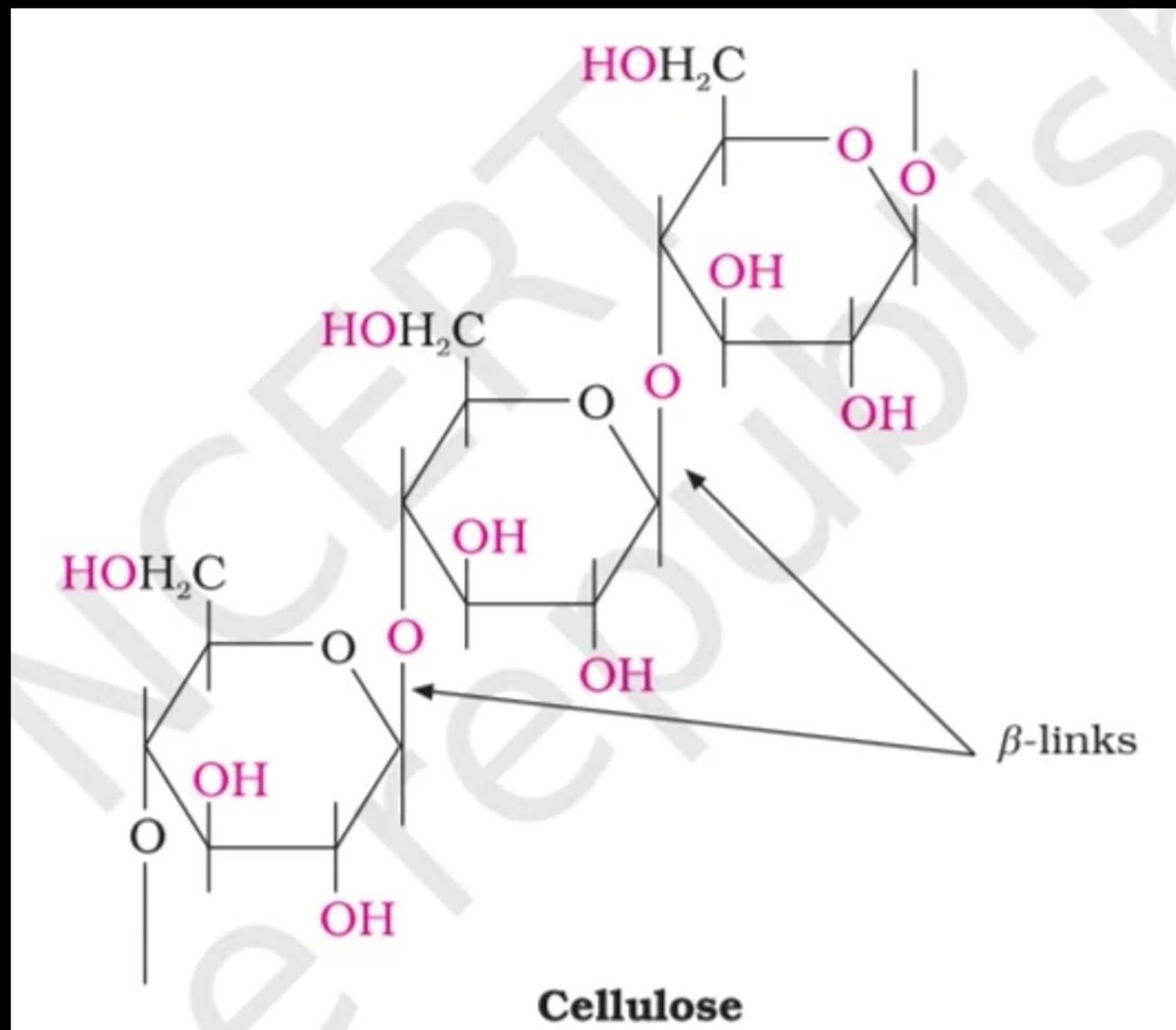


Amylopectin

- * Insoluble in water
- * chain polymer of α -D (+) glucose units by C_1 - C_4 linkages.
- * Branching occurs by C_1 - C_6



ii) Cellulose : Straight chain polysaccharide composed only of β -D-glucose units joined by glycosidic linkage b/w C_1 , C_4 .



- * Occurs exclusively in plants
- * Most abundant organic substance
- * Present in cell wall of plants.

iii) Glycogen : * Carbohydrates are stored in animals as glycogens.

* Also known as Animal starch

* Similar to amylopectin & is more highly branched

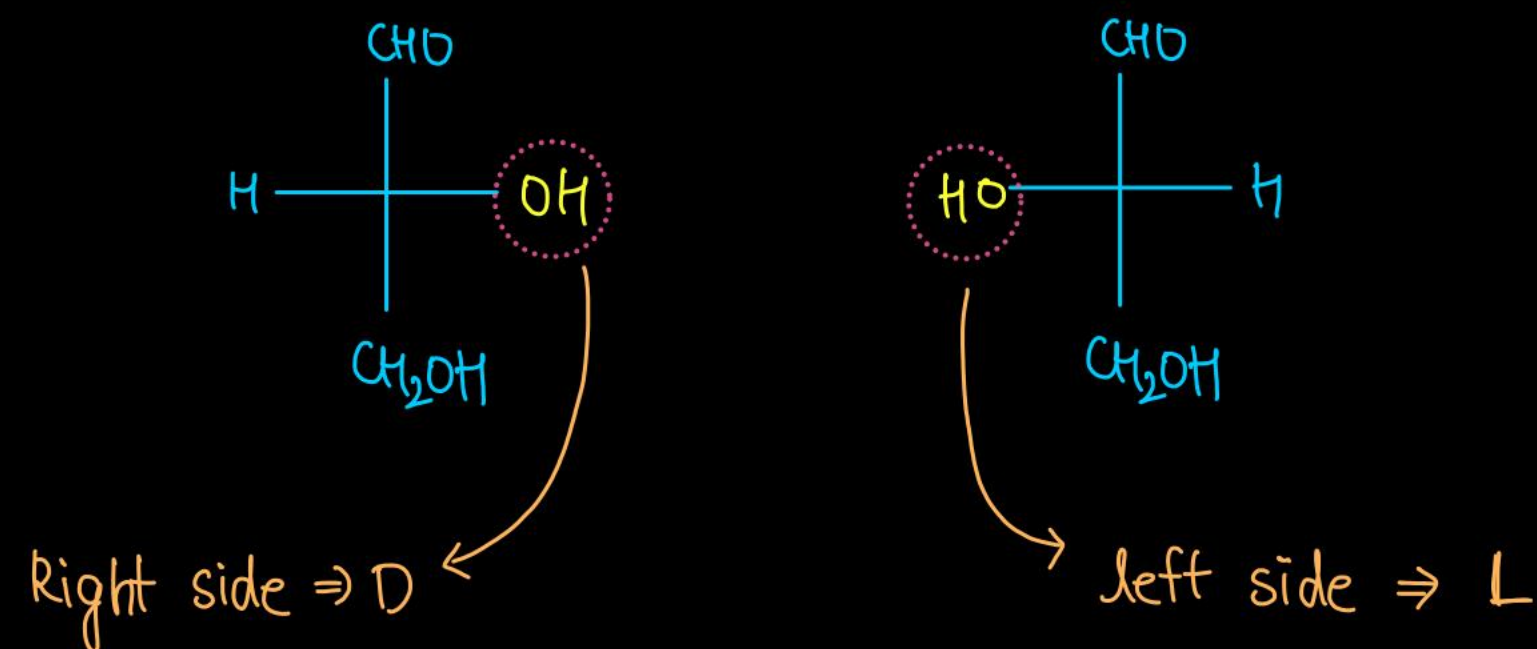
* Present in liver, muscles, brain.

* Also found in yeast & fungi

* When body needs glucose, enzymes break Glycogen $\longrightarrow$ Glucose.

Configuration of Aldoses.

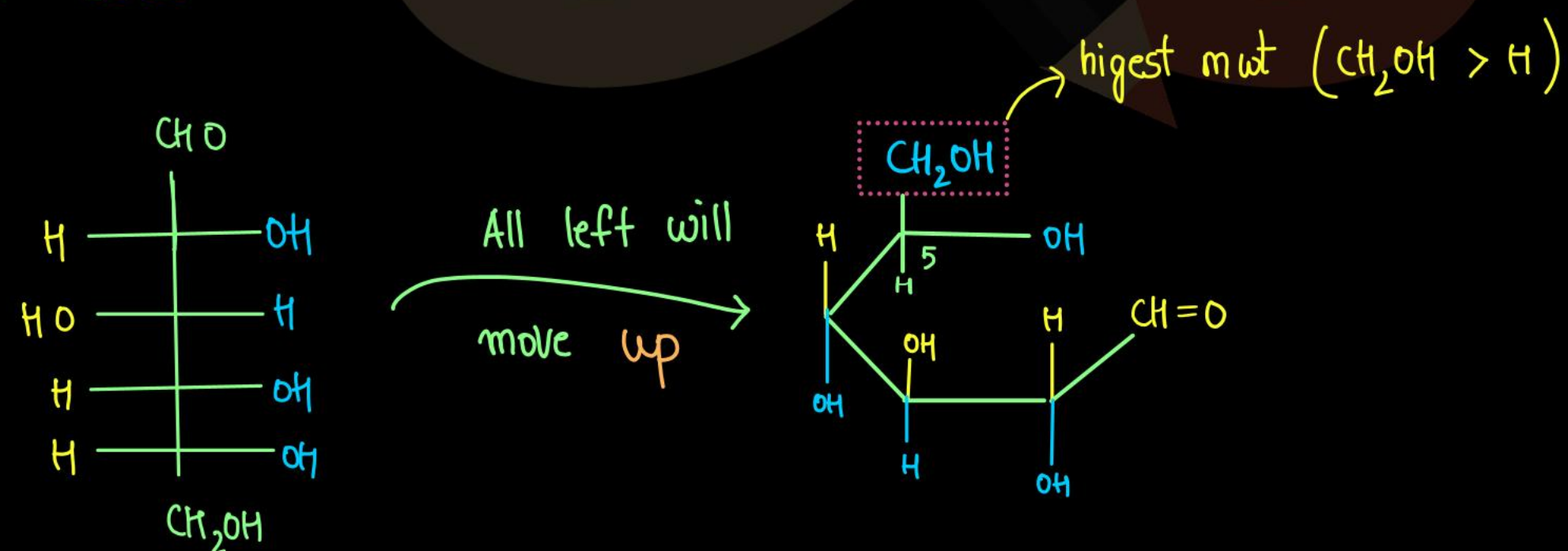
i) D vs L



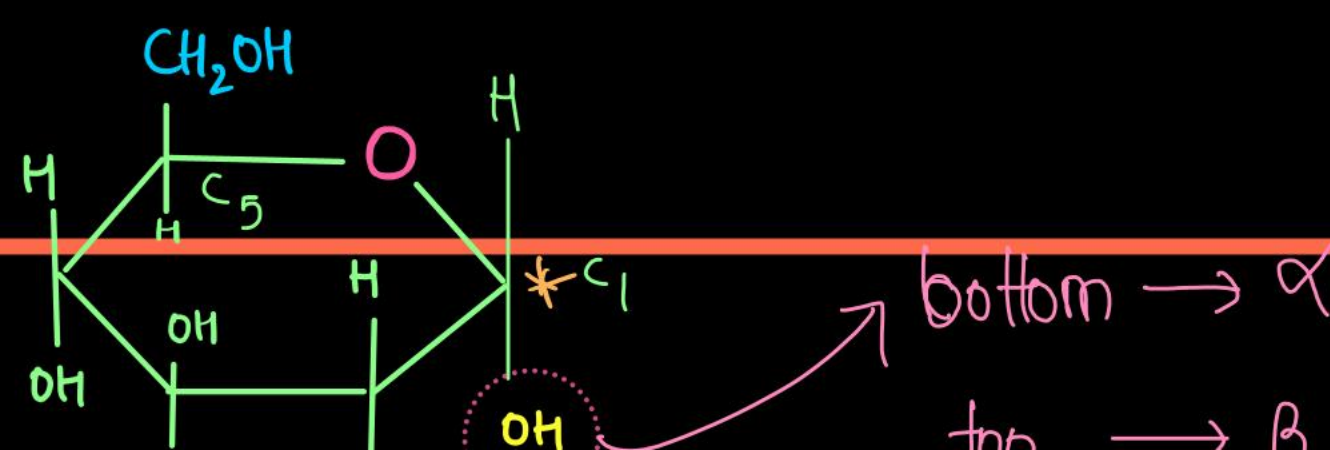
ii) (+) vs (-)

$\hookrightarrow$ they stand for dextrorotatory (d) and levorotatory (l) in optical activity.

iii) Cycle vs Linear:



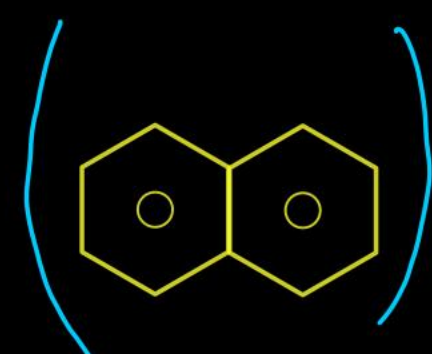
iv) α (vs) β



Tests

1) Molish test : (for carbohydrates)

α -naphthanol + EtOH



Carbohydrates

H_2SO_4

* mono sacc $\rightarrow$ fast

* di, poly sacc $\rightarrow$ slow

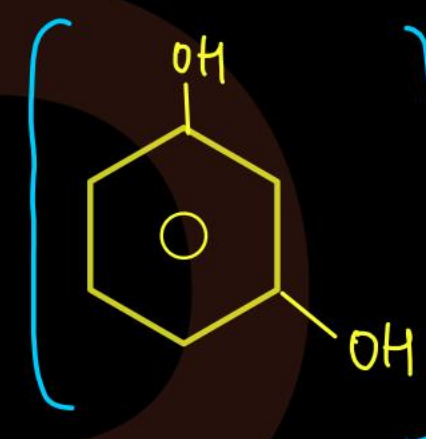


Purple ring at junction

2) Seliwanoff's test

(to diff aldose & ketose)

Resorcinol + HCl

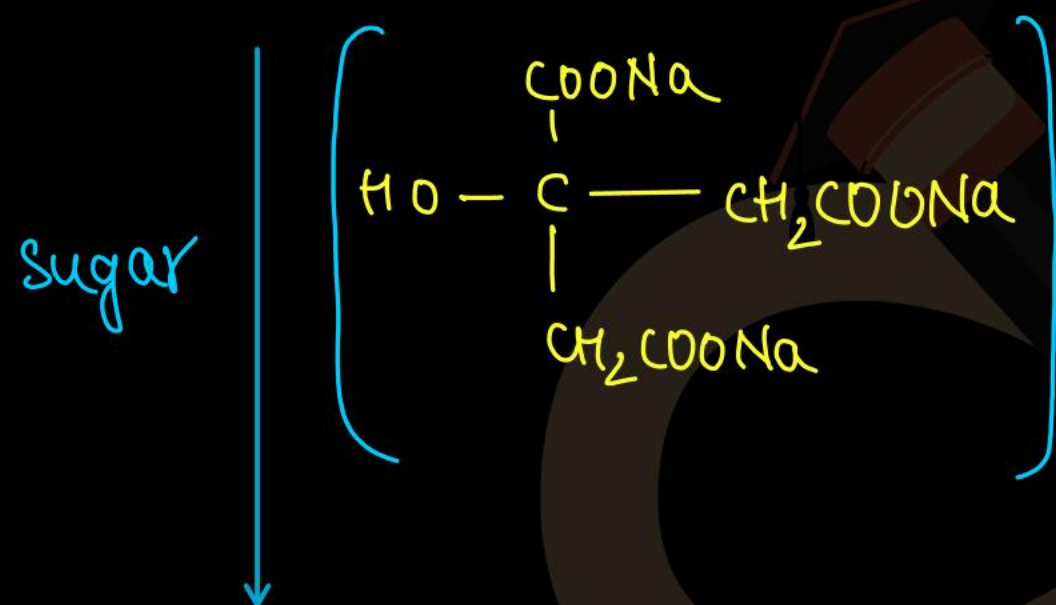


ketose like
fructose

Cherry Red ppt $\downarrow$

③ Benedict's test (for reducing sugar)

aq CuSO_4 + Sodium citrate



Blue	Green	Orange	Brick Red
No sugar	small sugar	moderate sugar	Large sugar

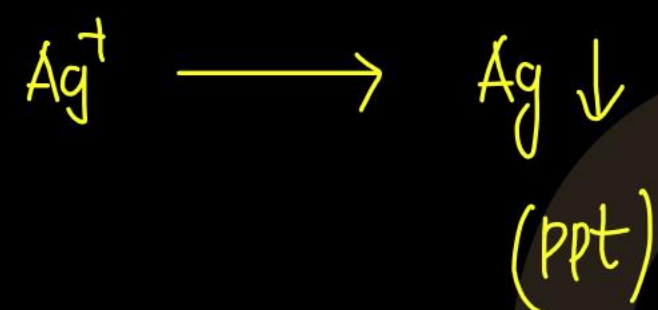
④ Barfoed test (for monosacc)

CuSO_4 + CH_3COOH

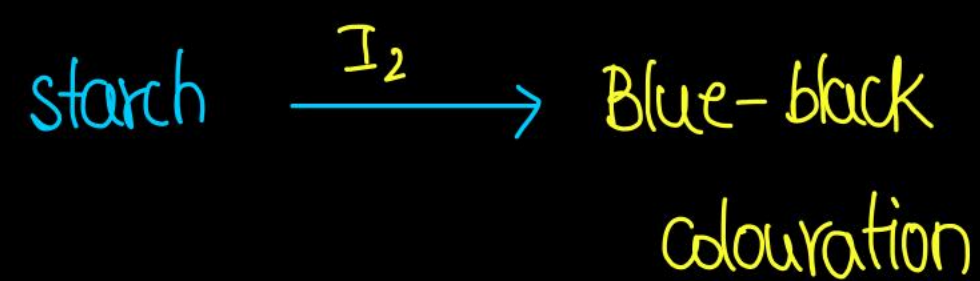
mono
sacc.

Red/Brown ppt
↓
due to Cu_2O ↓

⑤ Tollen's Test : (for reducing Sugar)

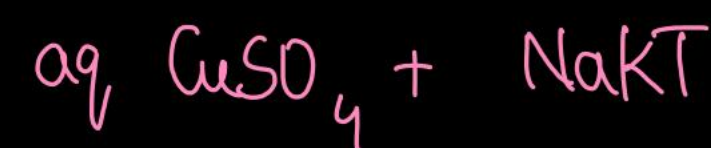


⑦ Iodine test (for starch)



due to absorption of Iodine.

⑥ Fehling's test :- (for reducing Sugar)



Red / Brown ppt

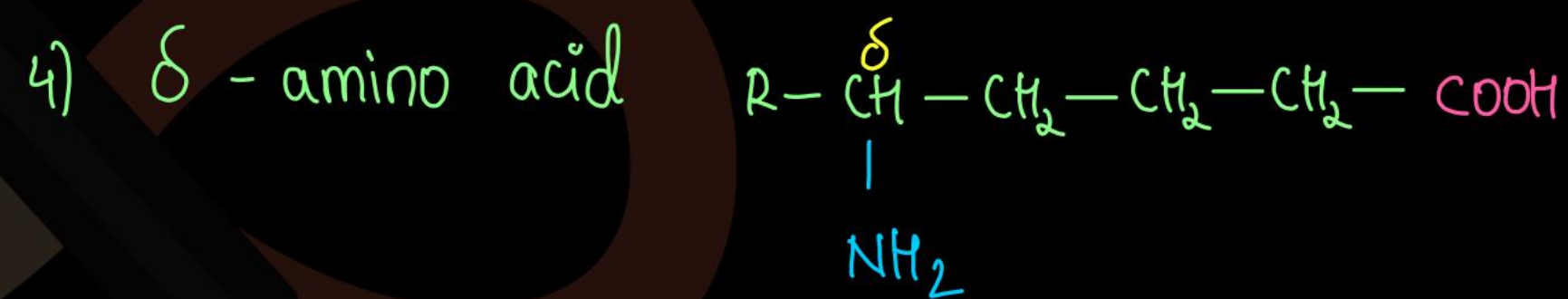
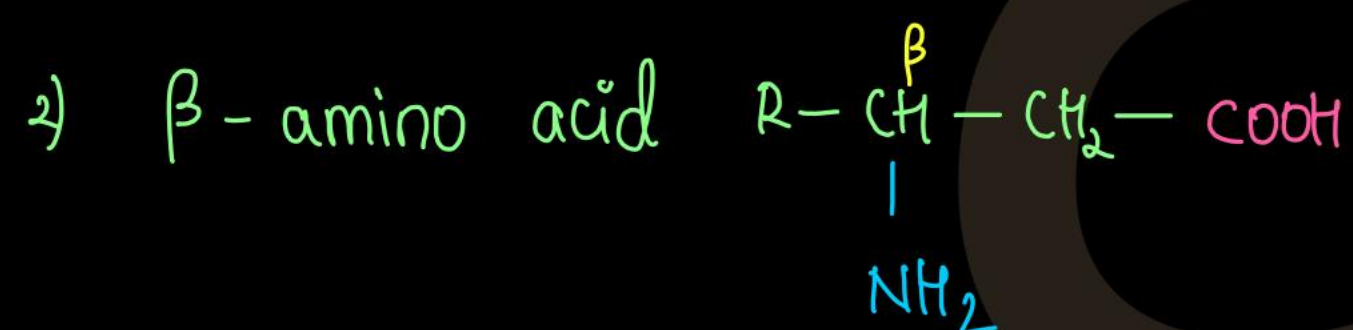
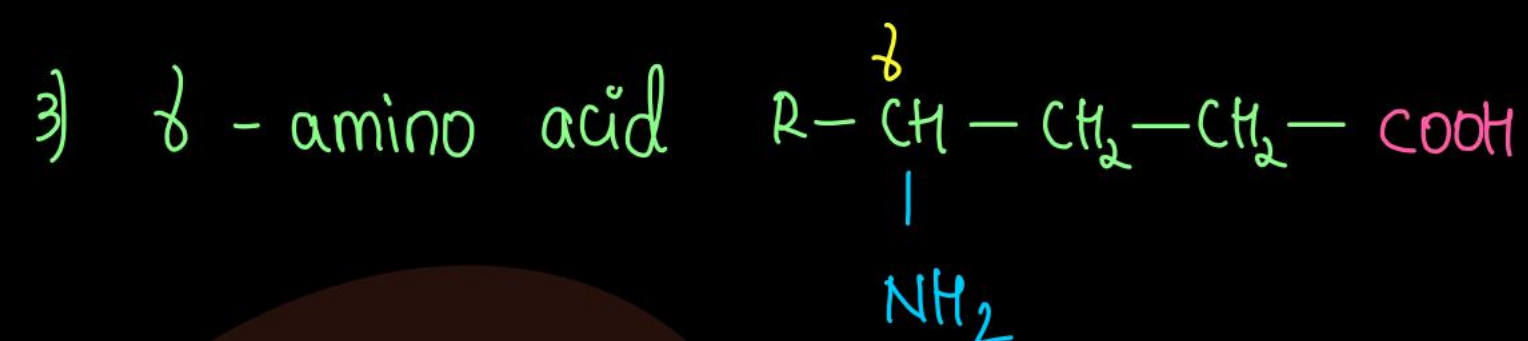
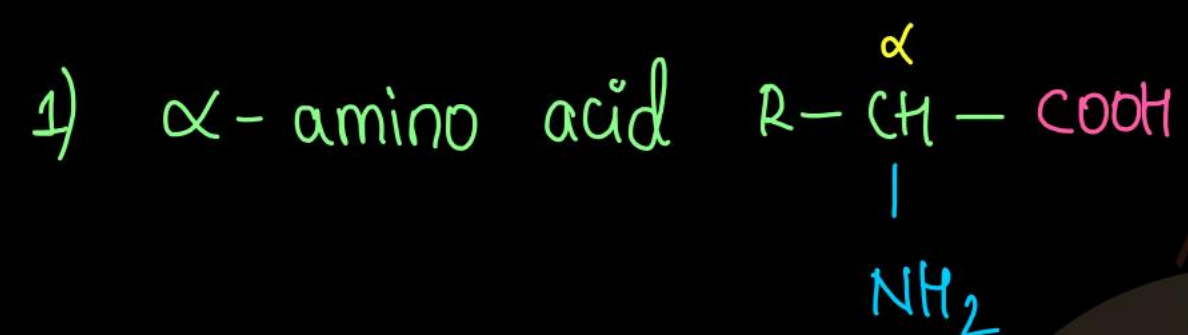


[Sodium Potassium]
tartrate

Amino Acids

*) Contains $(-\text{NH}_2)$ & (COOH) groups

⇒ Classification based on relative position of COOH & NH_2



Proteins $\xrightarrow{\text{hydrolysis}}$ Only α -amino acids are obtained

↓

Polymers of α -amino acids

Properties :-

* Usually colourless,
Crystalline solids
Water Soluble

this is due to
presence of both
groups in same molecule

* Behaves like salts rather than simple amines (or) Carboxylic acids.

* Most of the amino acids have L-Configuration

represented by writing
-NH₂ group on left side

* Glycine → Only optically inactive natural occurring amino acid

* High MP & BP due to Zwitter ion.

* Amino acids are classified as

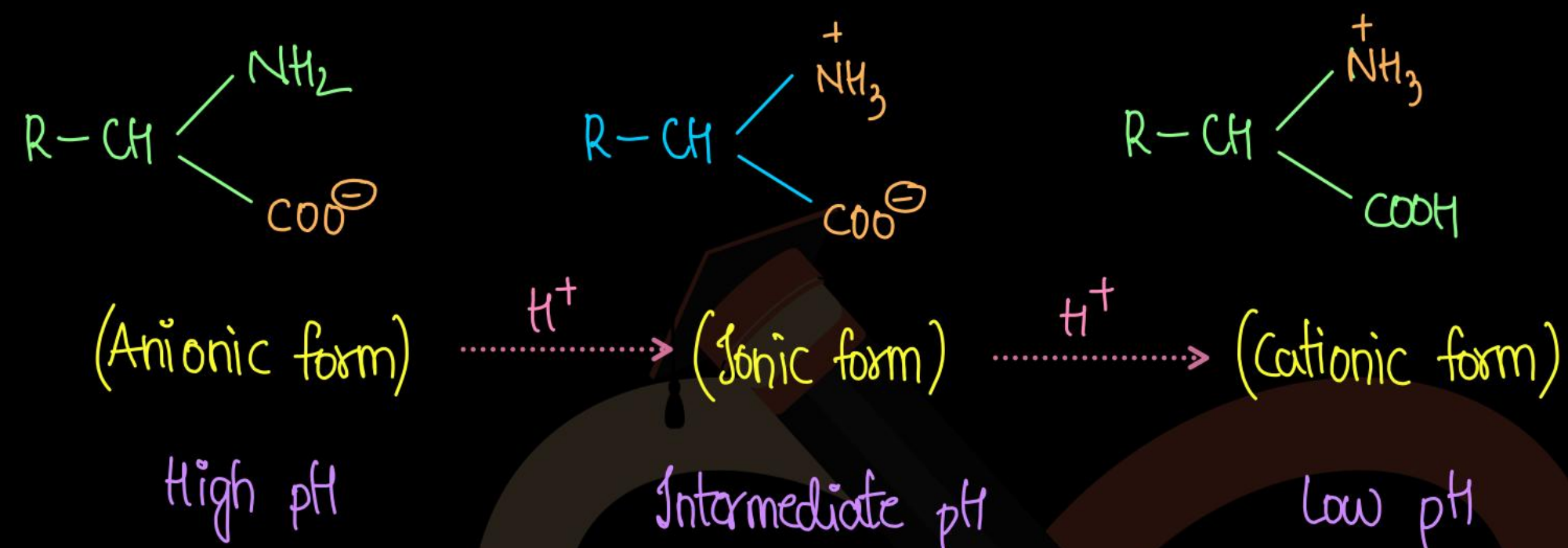
i) acidic no. of (NH₂) < no. of (-COOH)

ii) basic no. of (NH₂) > no. of (-COOH)

iii) Neutral no. of (NH₂) = no. of (-COOH)

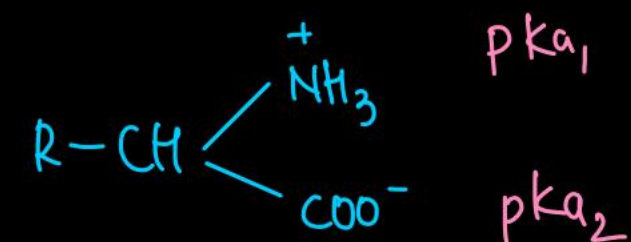
Zwitter ion : (dipolar ion)

→ depending on pH, zwitter ion exists in 3 diff forms



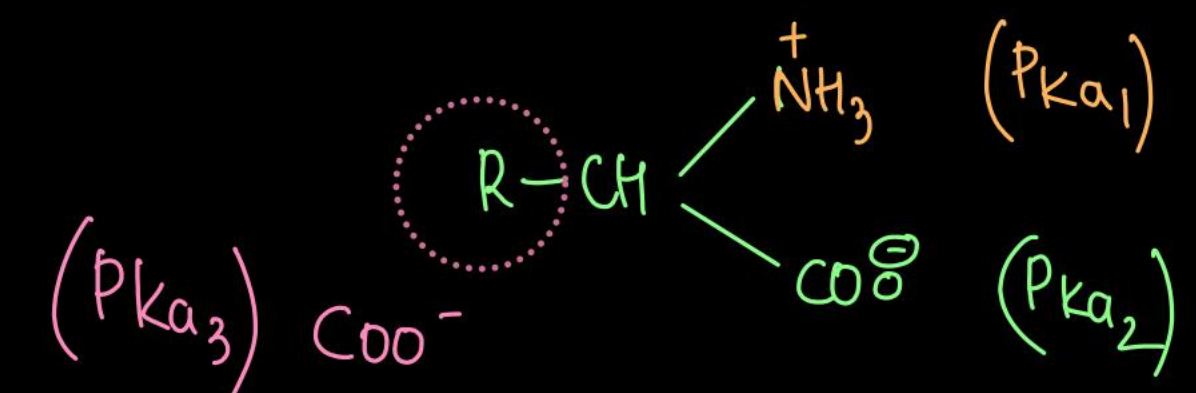
Calculation of pH of zwitter ion :

Case 1) Neutral amino acid



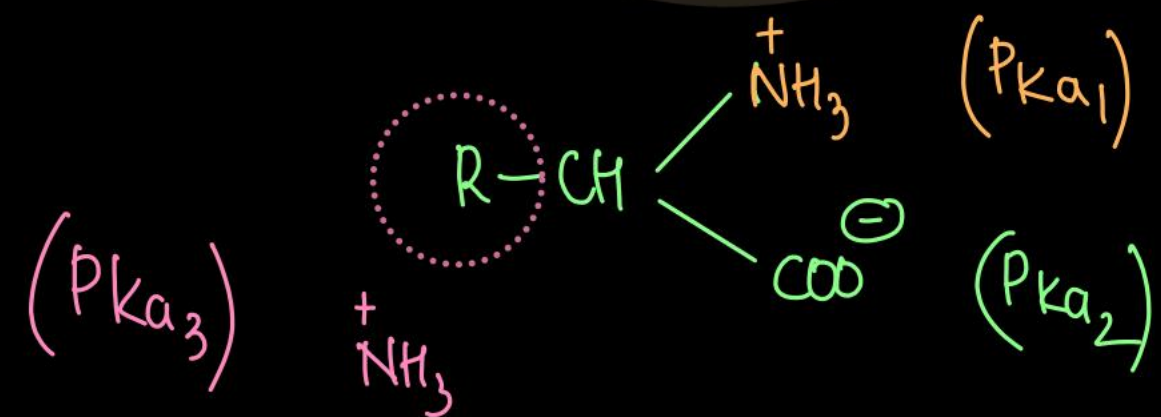
$$\text{pH} = \frac{(\text{pKa}_1 + \text{pKa}_2)}{2}$$

Case 2> Acidic Amino acid



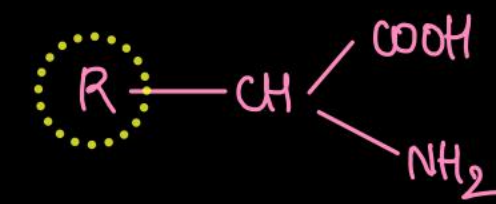
$$\text{pH} = \frac{(\text{pK}_{\text{a}2} + \text{pK}_{\text{a}3})}{2} \rightarrow \text{only acidic}$$

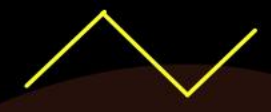
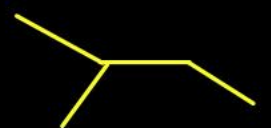
Case 3> Basic Amino acid



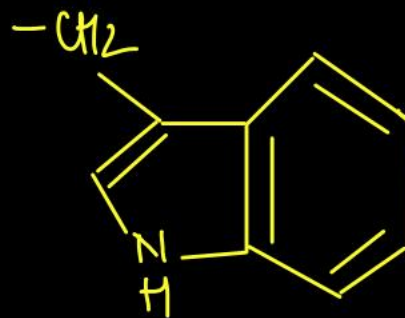
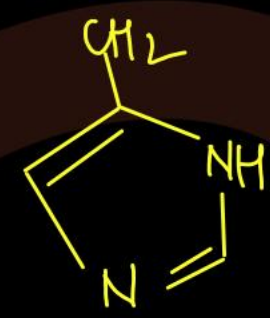
$$\text{pH} = \frac{(\text{pK}_{\text{a}1} + \text{pK}_{\text{a}3})}{2} \rightarrow \text{only Basic}$$

Natural amino acids



1)	Glycine	Gly	G	H -
2)	Alanine	Ala	A	CH ₃ -
3)	Valine	Val	V	
4)	Leucine	Leu	L	
5)	Isoleucine	Ile	I	
6)	Arginine	Arg	R	$\text{HN} = \underset{\text{NH}_2}{\text{C}} - \text{NH} - (\text{CH}_2)_3 -$
7)	Lysine	Lys	K	$\text{H}_2\text{N} - (\text{CH}_2)_4 -$

8)	Glutamic	Glu	E	$\text{HOOC}-\text{CH}_2-\text{CH}_2$
9)	Aspartic	Asp	D	$\text{HOOC}-\text{CH}_2$
10)	Glutamine	Gln	Q	$\text{H}_2\text{N}-\underset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{CH}_2-\text{CH}_2$
11)	Asparagine	Asn	N	$\text{H}_2\text{N}-\underset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{CH}_2$
12)	Threonine	Thr	Th	$\text{CH}_3-\text{CH}(\text{OH})-$
13)	Serine	Ser	S	$\text{HO}-\text{CH}_2$
14)	Cysteine	Cys	C	$\text{HS}-\text{CH}_2$
15)	Methionine	Met	M	$\text{CH}_3-\text{S}-\text{CH}_2-\text{CH}_2$

16)	Phenylamine	Phe	F	$C_6H_5-CH_2-$
17)	Tyrosine	Tyr	Y	$HO-C_6H_4-CH_2-$
18)	Tryptophan	Trp	W	
19)	Histidine	His	H	

* Sulphur Containing : Cysteine (Cys)
Methionine (Met)

* Non-essential amino acids $\longrightarrow$ Can be synthesised in the body

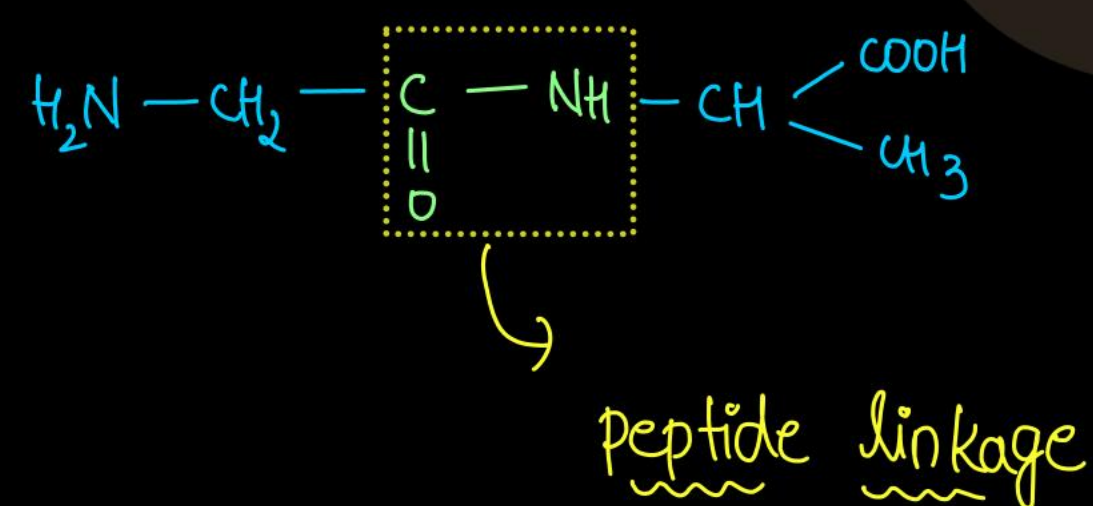
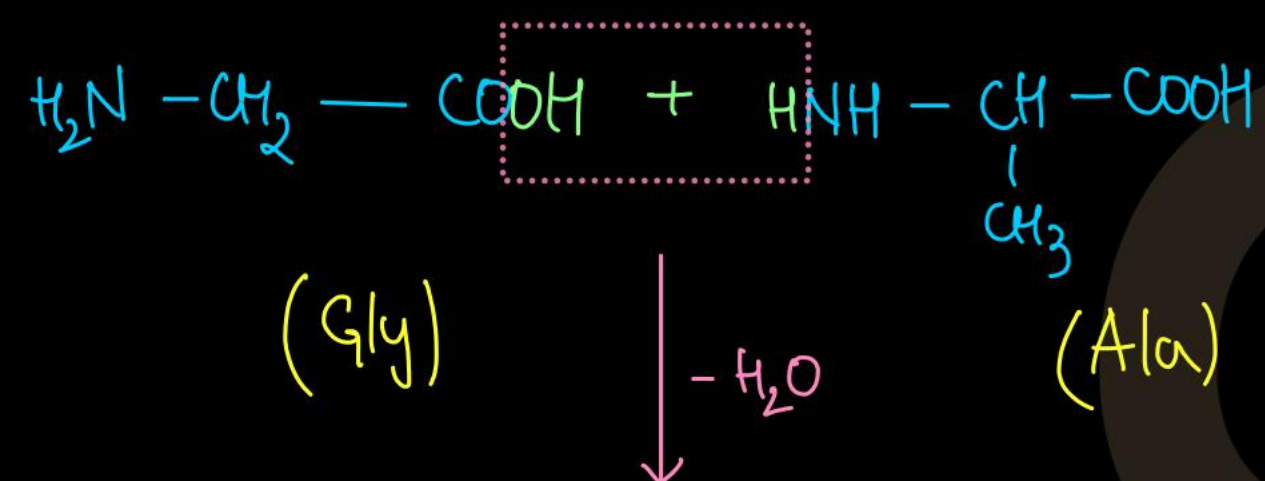
* Essential amino acids $\times$ (must be obtained through diet)

Proteins

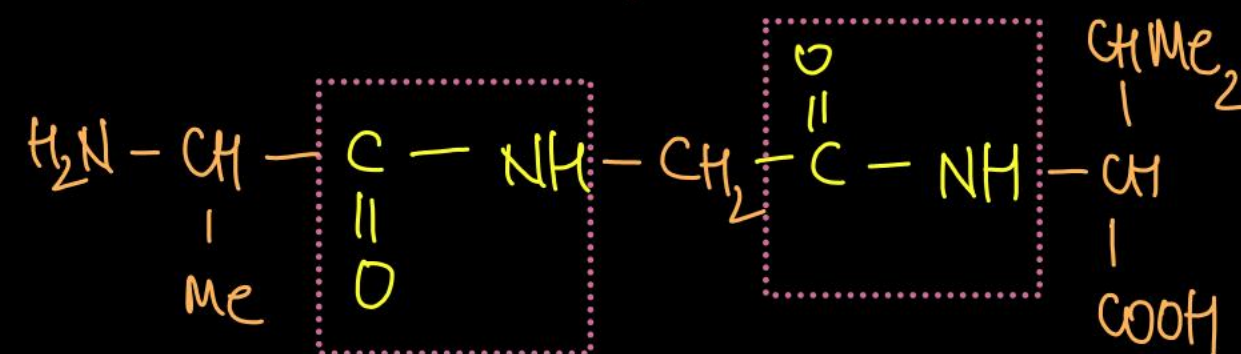
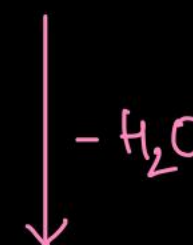
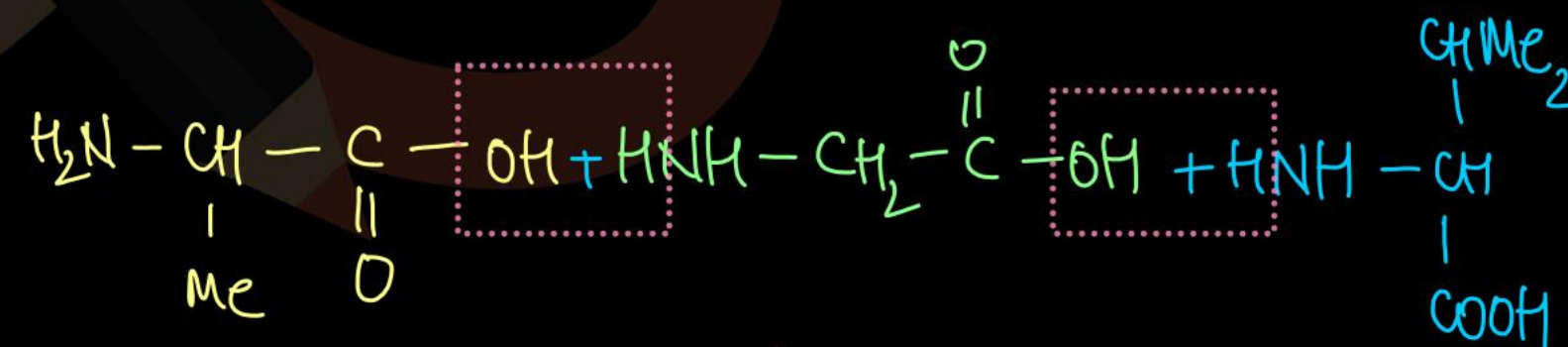
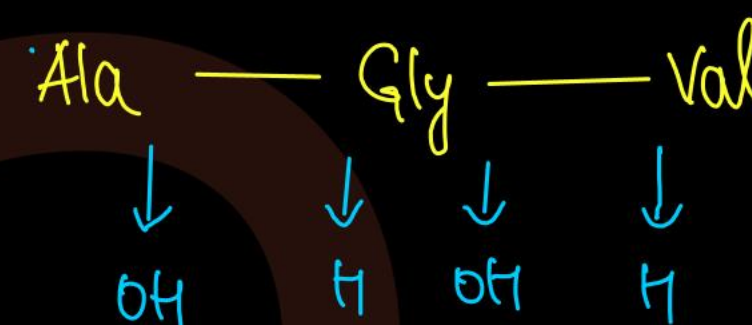
* Proteins are the polymers of α -amino acids connected by peptide linkage

dipeptide $\rightarrow$ 2 amino acids
 $\rightarrow$ 1 linkage b/w them

tri peptide $\rightarrow$ 3 amino acids
 $\rightarrow$ 2 linkages b/w them



(Gly-Ala)



Types of proteins

I> Fibrous proteins :

↳ Parallel bonds

↳ held by Hydrogen & disulphide bonds

*) Insoluble in water

Eg:- keratin (hair, wool, silk)

myosin (muscles)

II> Globular proteins :- (4 levels)

↳ coil around & form spherical shape

*) Soluble in water

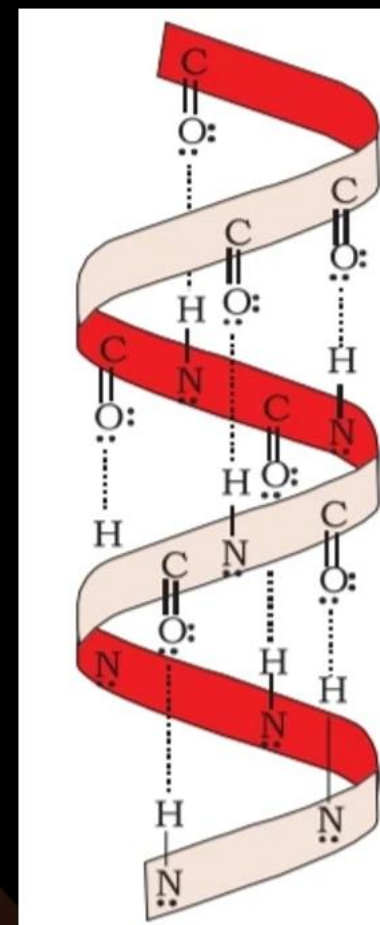
Eg:- Insulin (51 amino acids)

Albumins

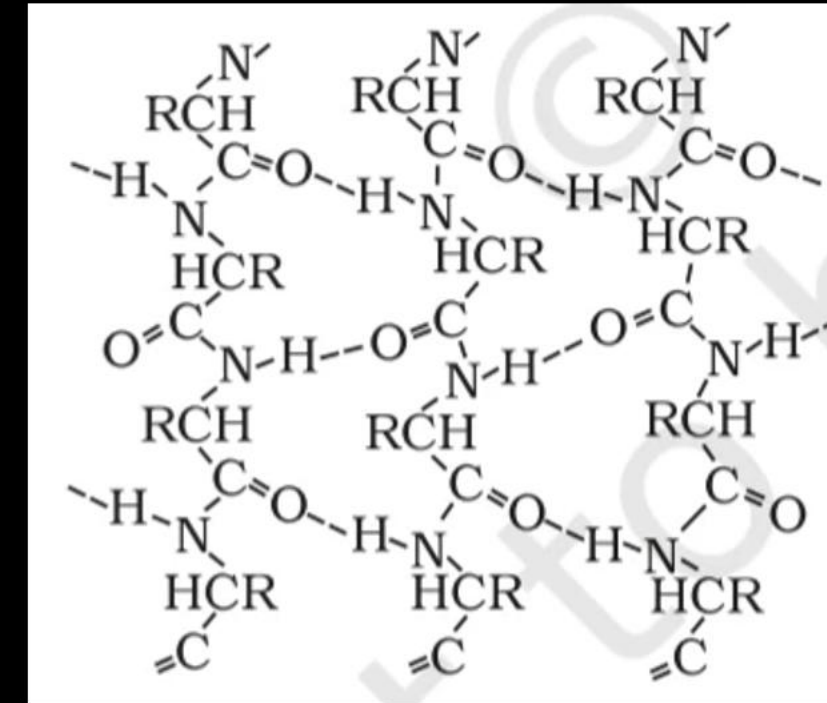
i) Primary structure :
→ Specific Sequence

ii) Secondary structure

* H bond b/w



α -Helix struc.



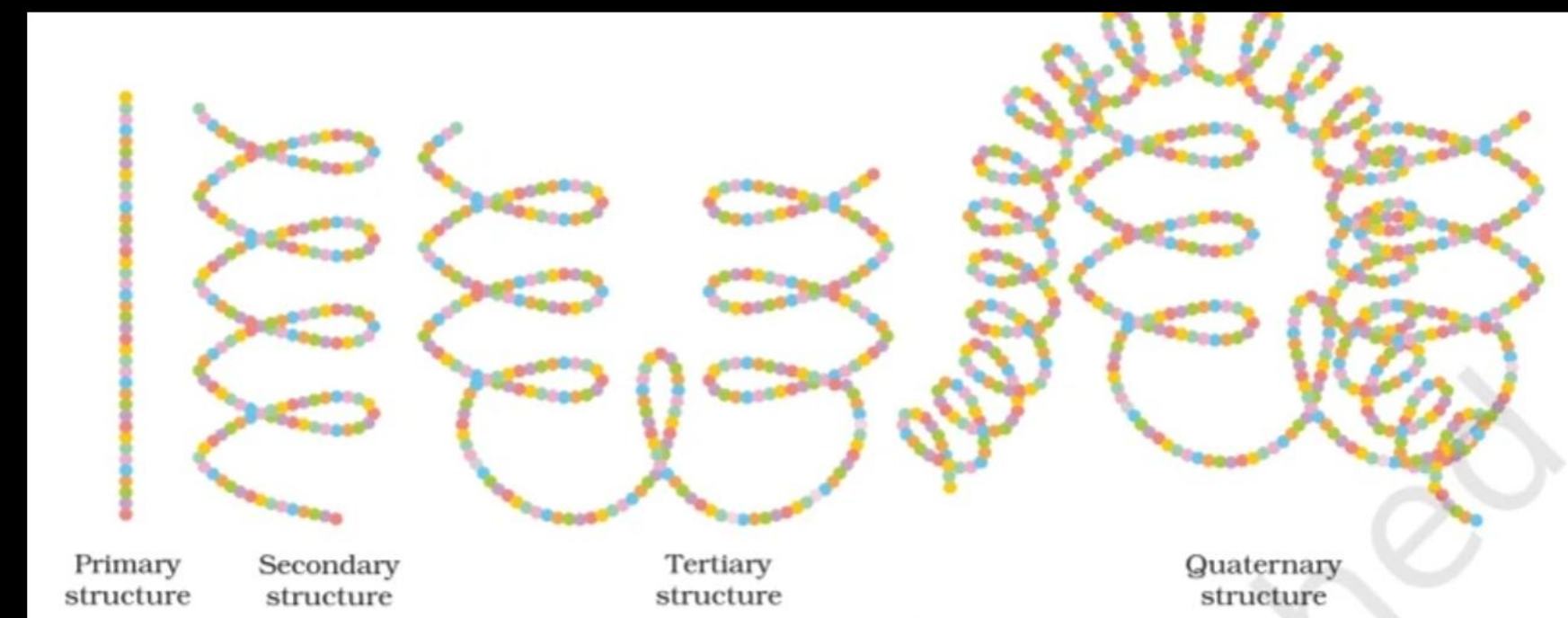
β -pleated sheet

iii) 3° structure of proteins :-

* Folding of 2° & 3° by
Hydrogen bonds
disulphide linkages
vander waal & Electrostatic forces

iv) Quaternary structure :

* Composed of two (or) more polypeptide chains
referred to as Sub-Units.



Denaturation of proteins:

Native protein $\xrightarrow[\Rightarrow \text{H \& B disturbed}]{\text{change in T/pH ...}}$ denaturated

$2^{\circ}, 3^{\circ}$ $\xrightarrow{\hspace{2cm}}$ ✓ denaturates

1° $\xrightarrow[\text{X}]{\hspace{2cm}}$ No damage

Ex:-

- * Coagulation of egg white on boiling
- * Curdling of milk

Nucleic acids

* Nucleic acids are long chain polymers of nucleotides.
Hence they are also called Polynucleotides

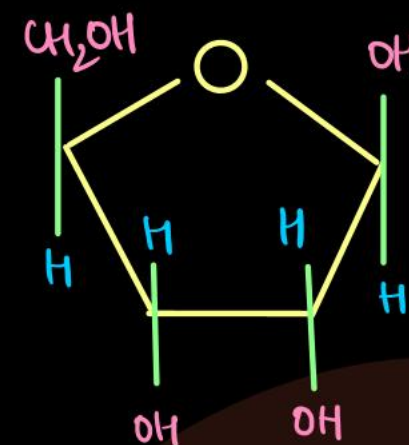
Structure of Nucleic acid:

Nucleotides

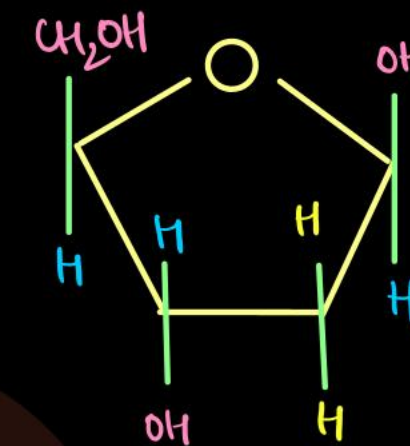
Pentose sugar

Nitrogenous bases

Phosphate ester



(β -D-ribose)



(β -D-2-deoxyribose)

1) Adenine (A)

2) Guanine (G)

3) Cytosine (C)

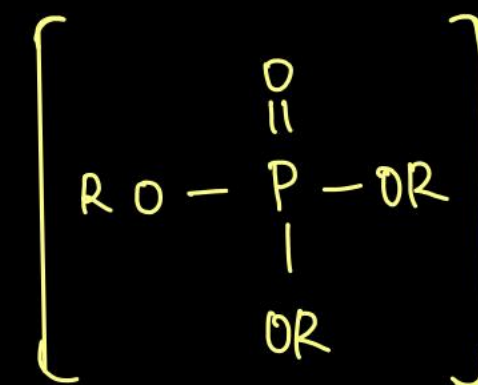
4) Uracil (U)

1) Adenine (A)

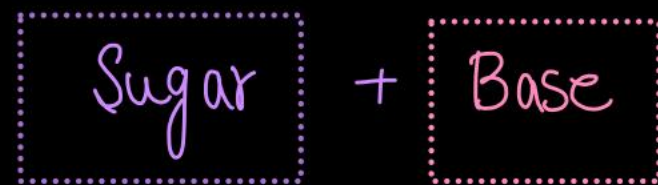
2) Guanine (G)

3) Cytosine (C)

4) Thymine (T)



Nucleosides



v/s

Nucleotides

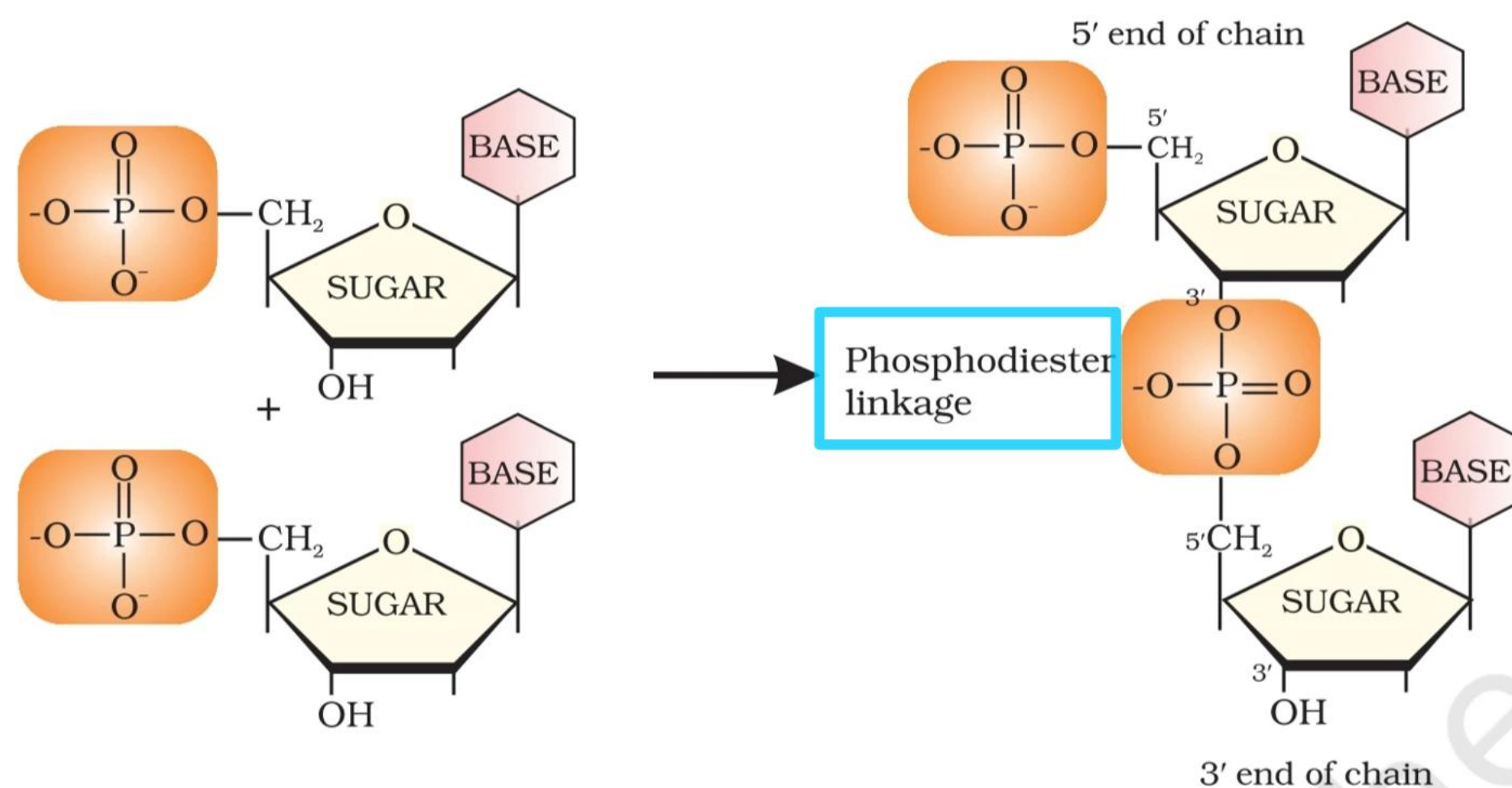
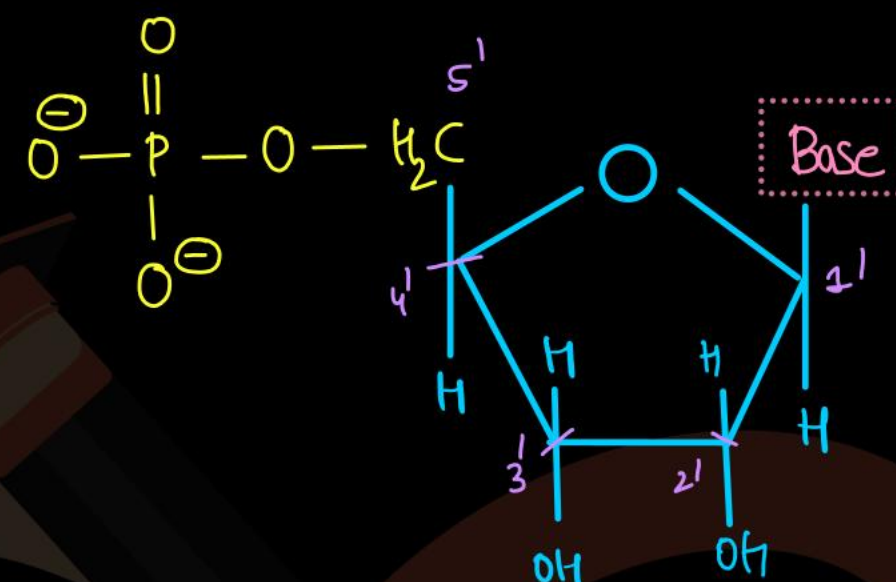
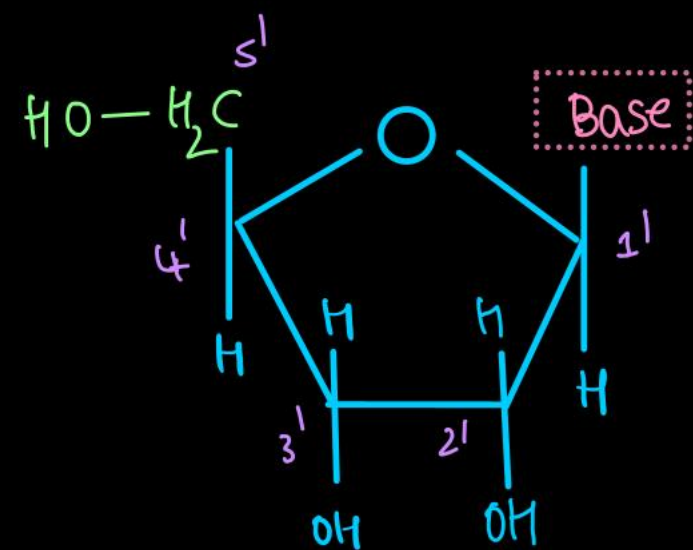
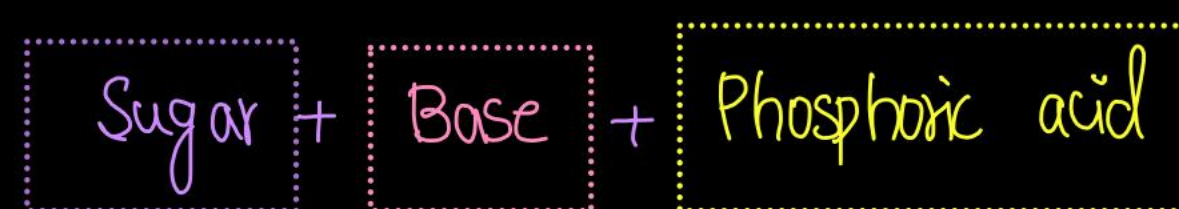
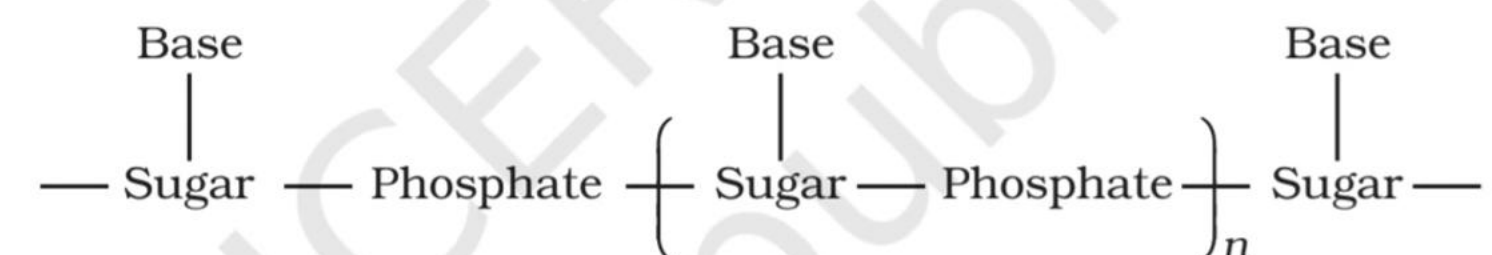


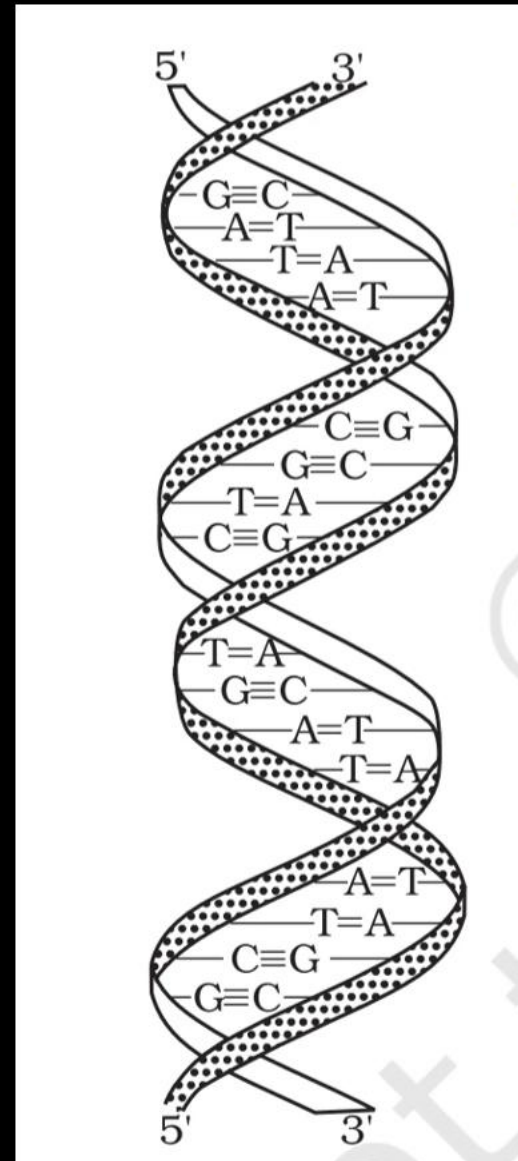
Fig. 10.6: Formation of a dinucleotide

*) Nucleotides are joined together by phosphodiester linkage b/w 5' and 3' Carbons.

A simplified version of nucleic acid chain is as shown below.



DNA :-



→ Double stranded helix structure of DNA is held by Hydrogen bonds.

* The two strands are complementary to each other

Adenine  Thymine (A - T)

Cytosine  Guanine (C - G)

* Proteins are synthesised by RNA but message for synthesis is present in DNA (not RNA)

RNA :-

*)

→ messenger (m-RNA)

→ ribosomal (r-RNA)

→ transfer (t-RNA)

Hormones :-

- 1) Steroids :- estrogen, androgen
 - 2) Poly peptides :- insulin, endorphins
 - 3) Amino acid :- epinephrine & norepinephrine
derivates
- 