JEE ASPIRANTS

MANZIL

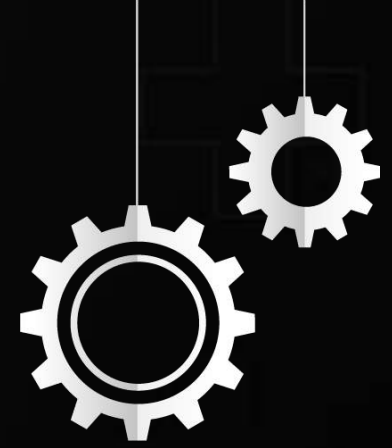
Organic Chemistry

BIOMOLECULES

ONE SHOT

Om Pandey, IIT Delhi

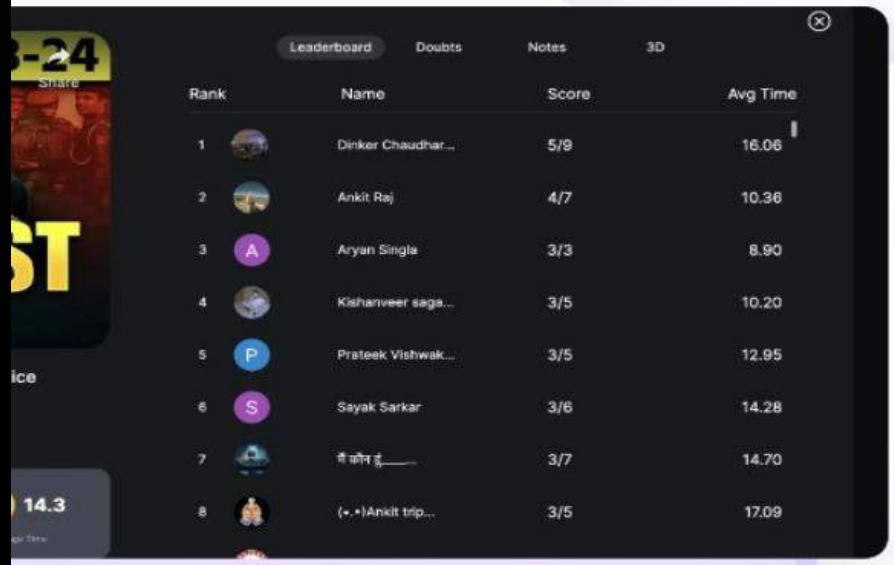
Topics to be covered



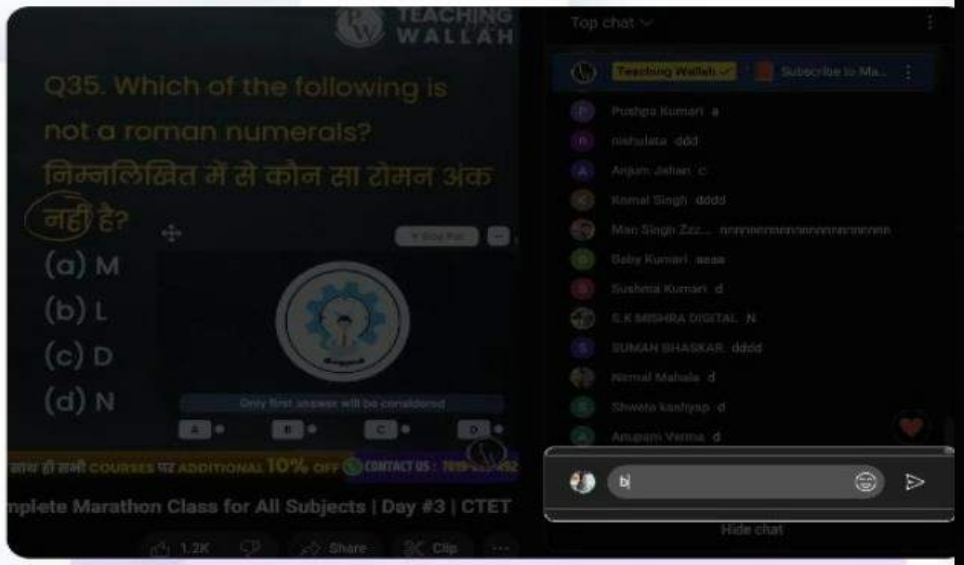
1) Carbohydrates
2) Amino Acids
3) Proteins
4) Vitamins
5) Nucleic Acid

Younity Features :

Things you should know



Check out your performance in class in the **leaderboard**



To attend **polls**, write a/b/c/d in youtube chat within time

What is Younity?

Interactive Polls
Elevate your learning experience through active participation in polls.

3D Models Library
Dynamic dashboard and competitive leaderboard for academic excellence.

Live Class Notes & Doubts
Access real-time class notes during live sessions and seamlessly address doubts with instant clarification.

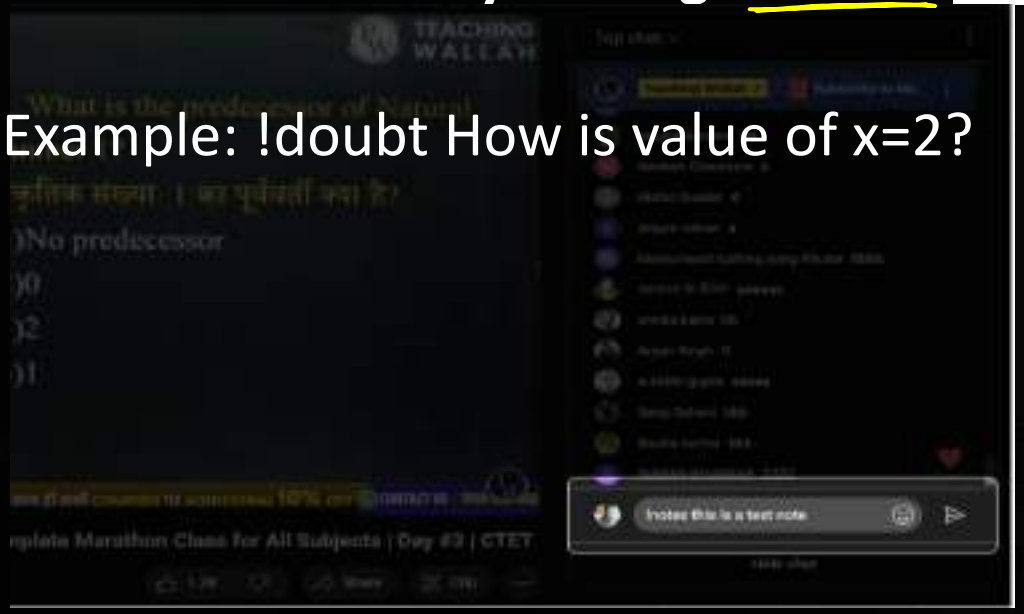
Youtube Notification
Stay informed and elevate your learning journey with timely YouTube notifications.

Dashboard & Leaderboard
Intuitive dashboard, while the leaderboard fuels friendly competition, inspiring better learning outcomes.

Video Call
Immersive video calls for personalized and effective education.

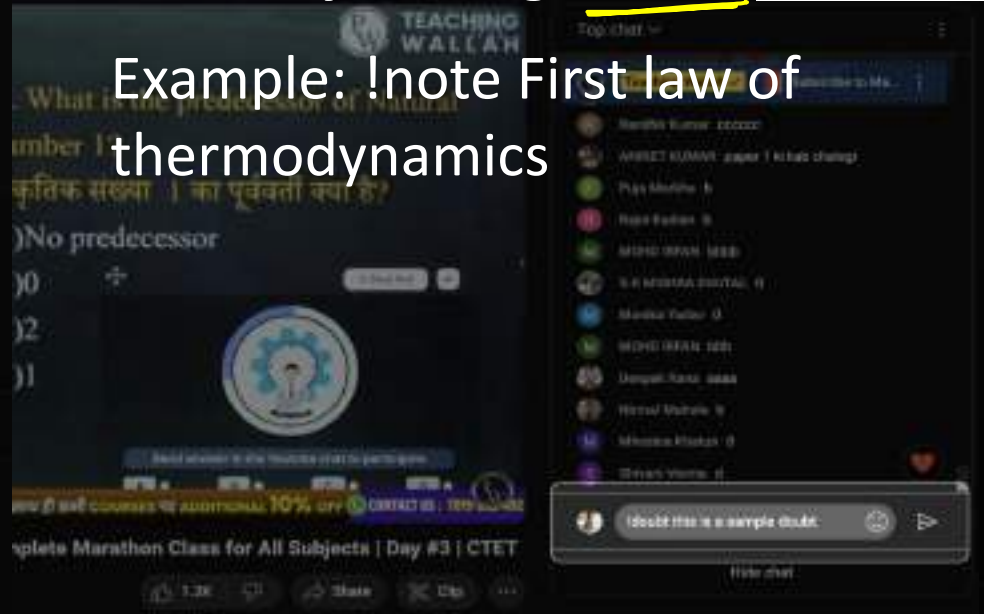
Ask Your Doubt by writing - !doubt *Your doubt*

Example: !doubt How is value of x=2?

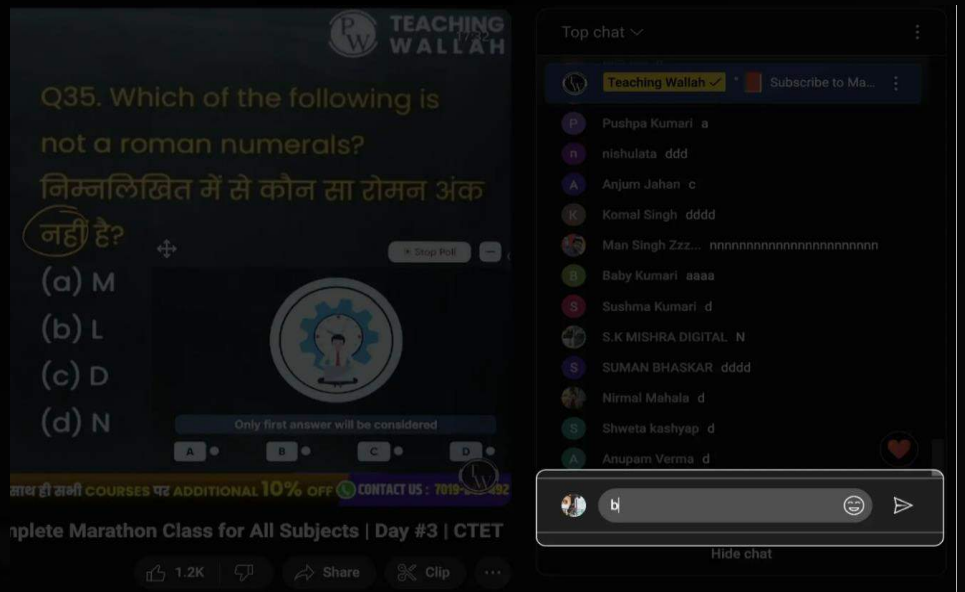


Write Your Notes by writing - !note *Your note*

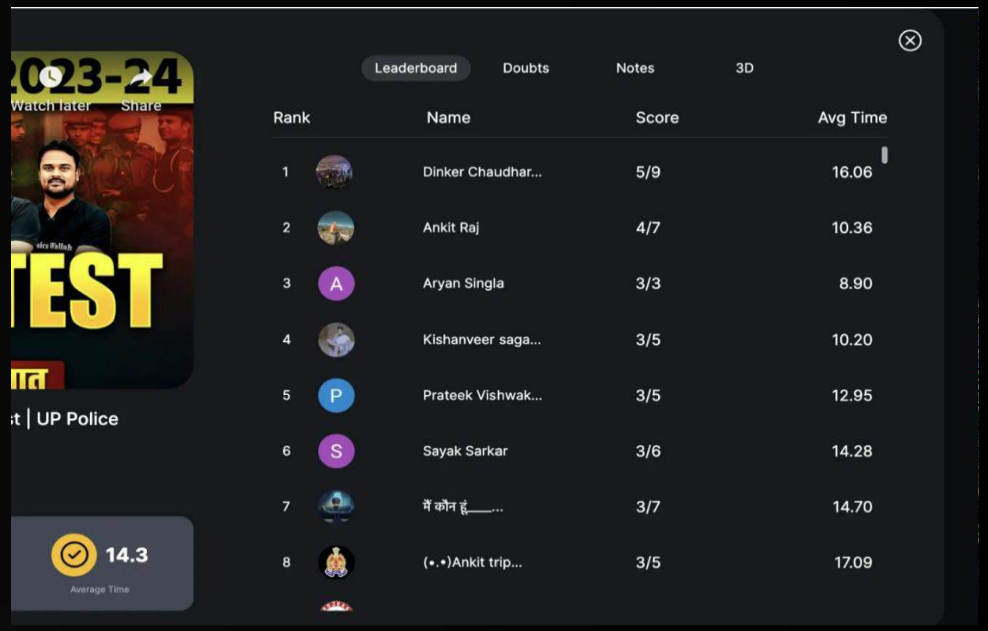
Example: !note First law of thermodynamics



Participate in polls through live chat



Check your leaderboard



Biomolecules

Carbohydrates Proteins Vitamins Nucleic Acids

Carbohydrates

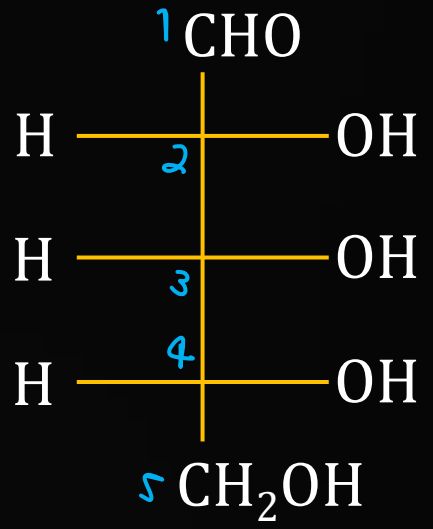
Optically active polyhydroxy aldehydes / ketones or substances that will yield these types of compounds on hydrolysis .

Hydrates of carbon

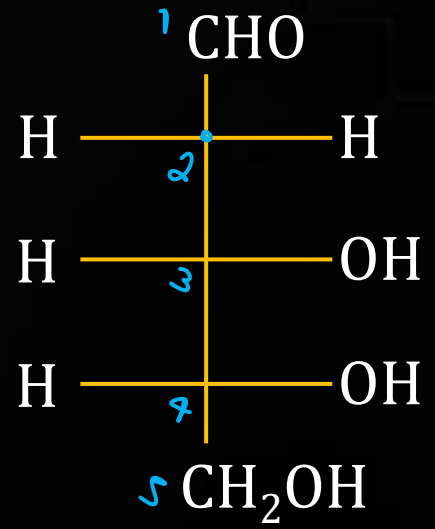
$C_x(H_2O)_y$

* Carbohydrates = Saccharides

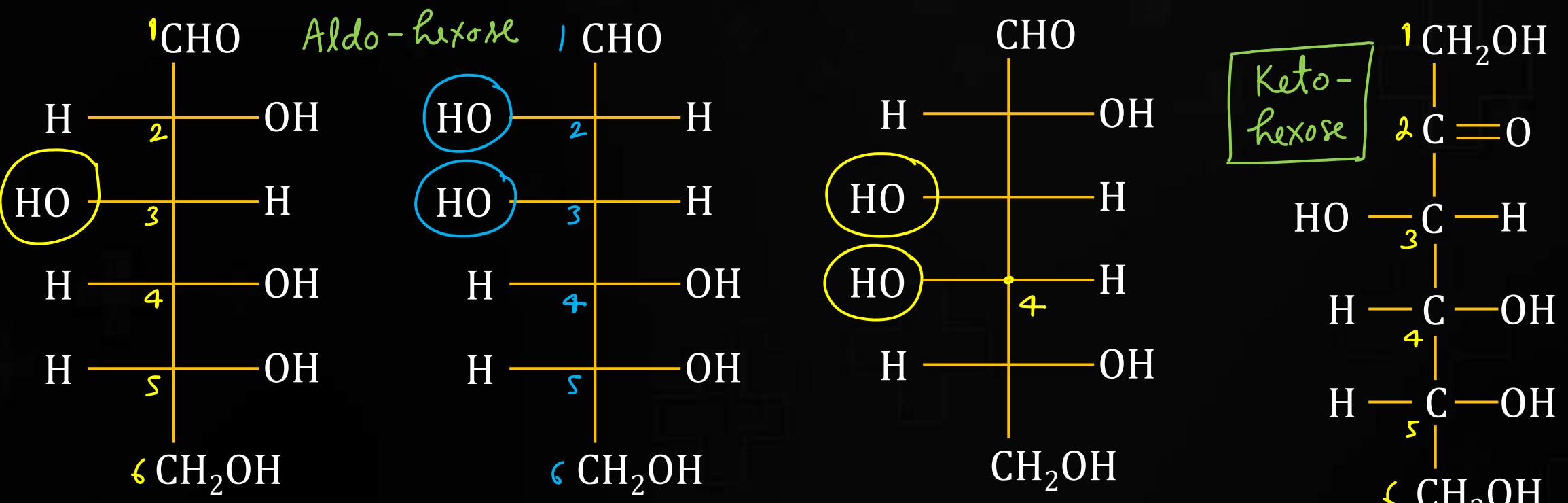
Some of the carbohydrates, which are sweet in taste, are also called sugars.



D-Ribose



D-2-deoxy Ribose



Glucose $\xrightarrow[\text{Epimer}]{\text{C-2}}$ **Mannose**

Galactose [C-4 epimer of glucose]

Fructose

Epimers : Diastereomers with more than one stereocentre that differ in the configuration about only one stereocentre .

Mono-saccharides : A carbohydrate that cannot be hydrolyzed further

2021/17 March/Shift-II

Fructose in an example of :

A Pyranose

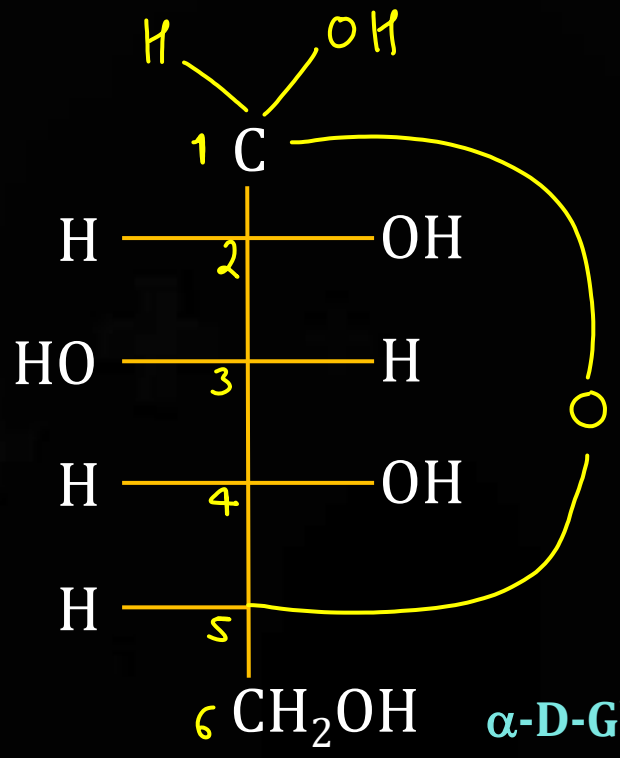
B Ketohexose

C Aldohexose

D Heptose

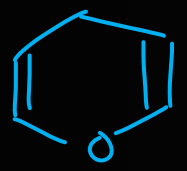
Cyclic Structure of glucose

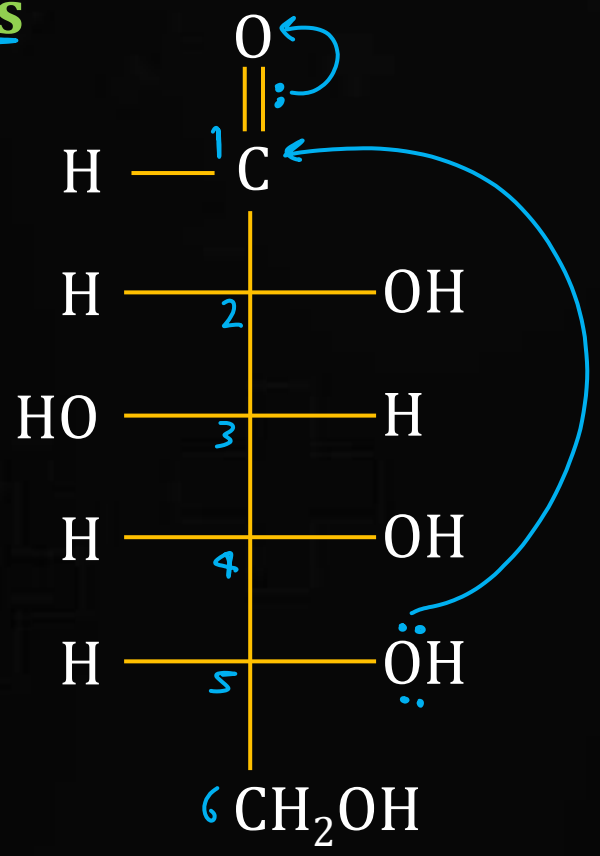
Anomers



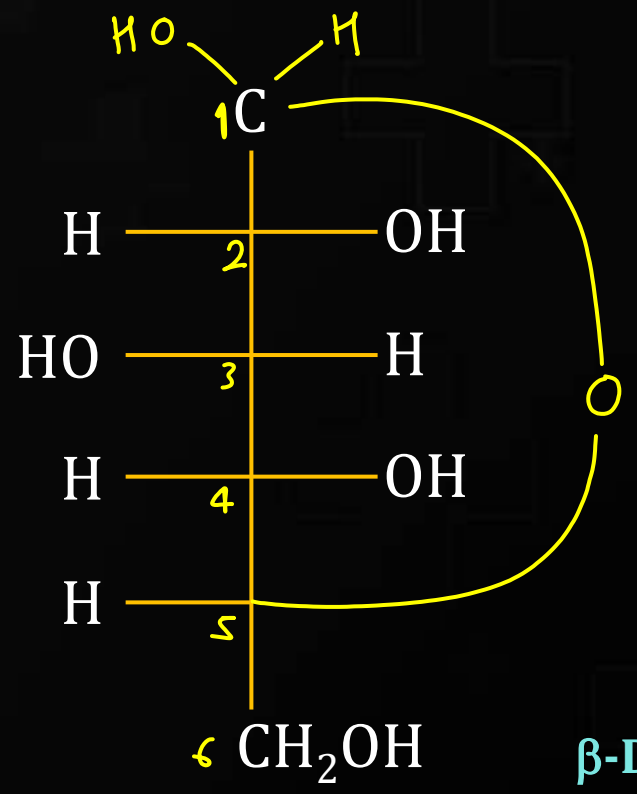
α-D-Glucose

α : Right
⇓
Below

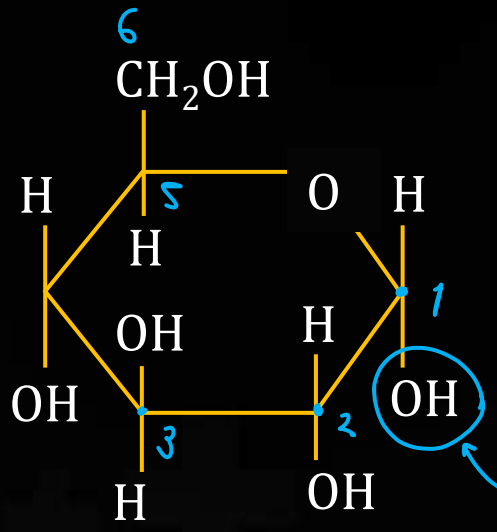




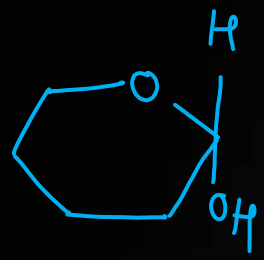
D-Glucose

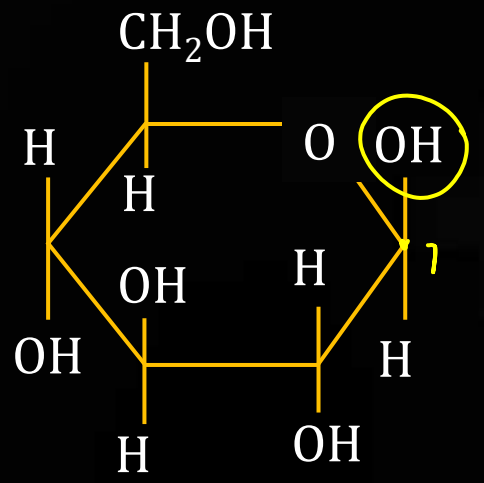


β-D-Glucose



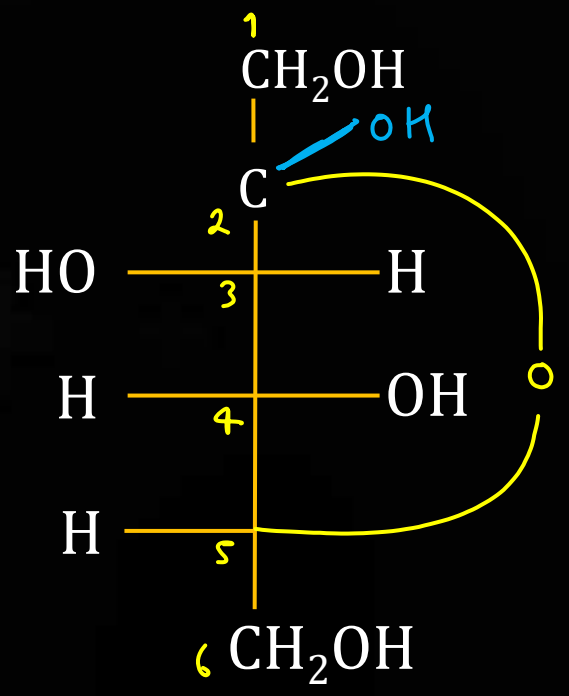
α-D-Glucopyranose



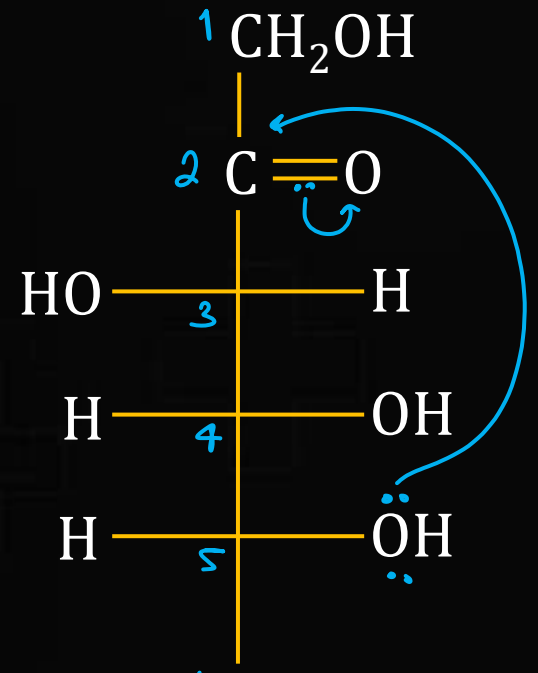


β-D-Glucopyranose

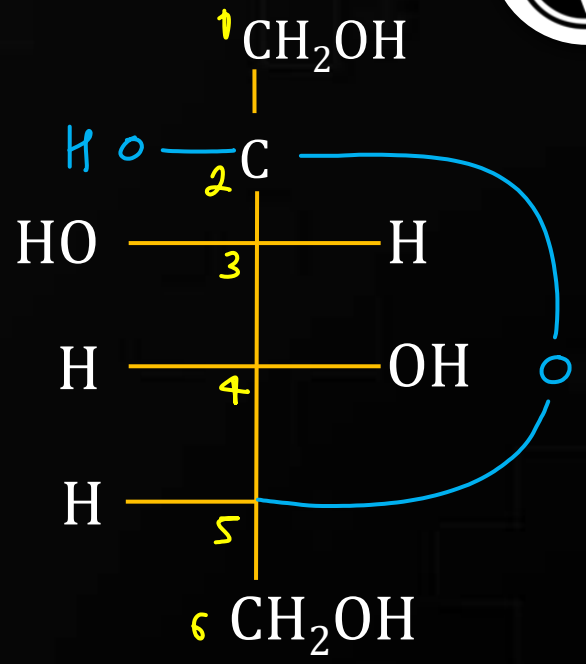
Structure of Fructose



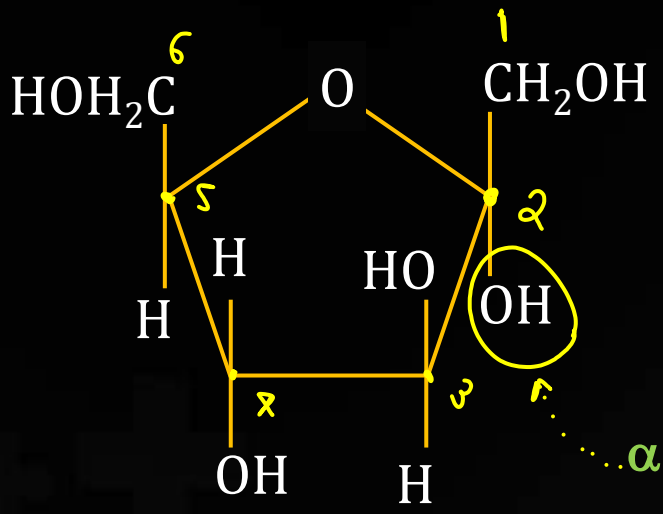
α-D-Fructose



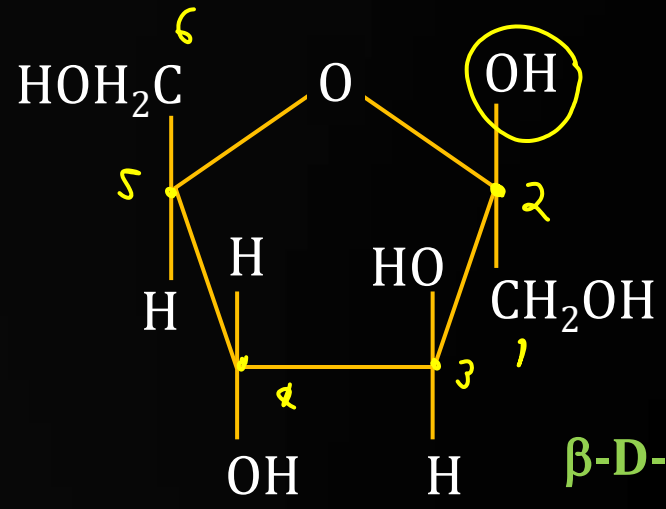
D-Fructose



β-D-Fructose



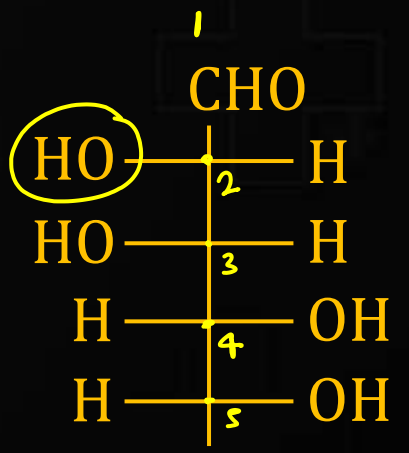
α-D-Fructofuranose



β-D-Fructofuranose

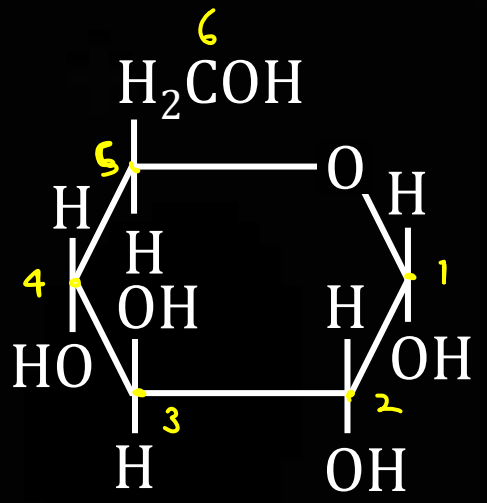
2023/01 Feb/Shift-I

The correct representation in six membered pyranose form for the following sugar [X] is



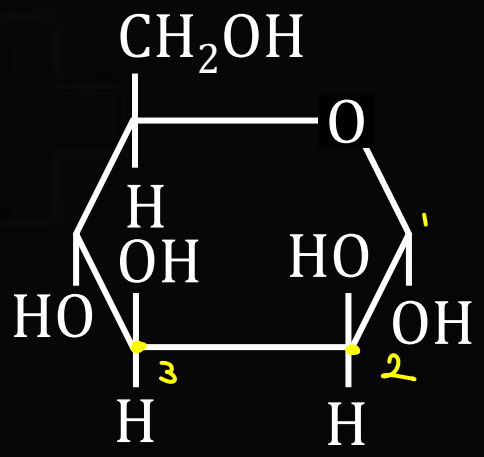
Sugar [X]

(A)

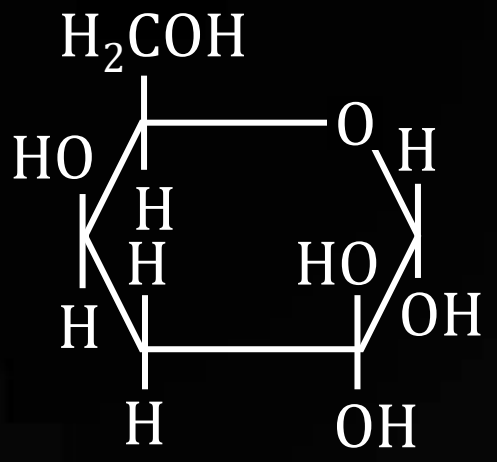


#

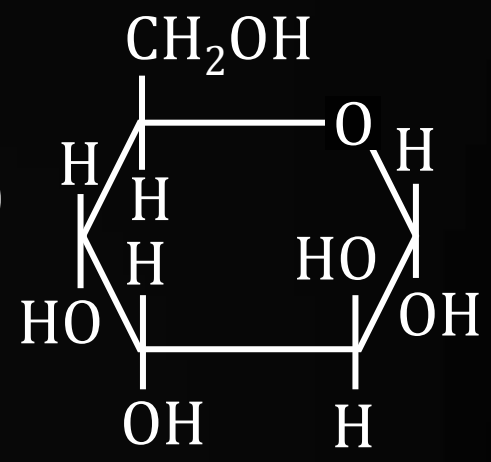
(B)



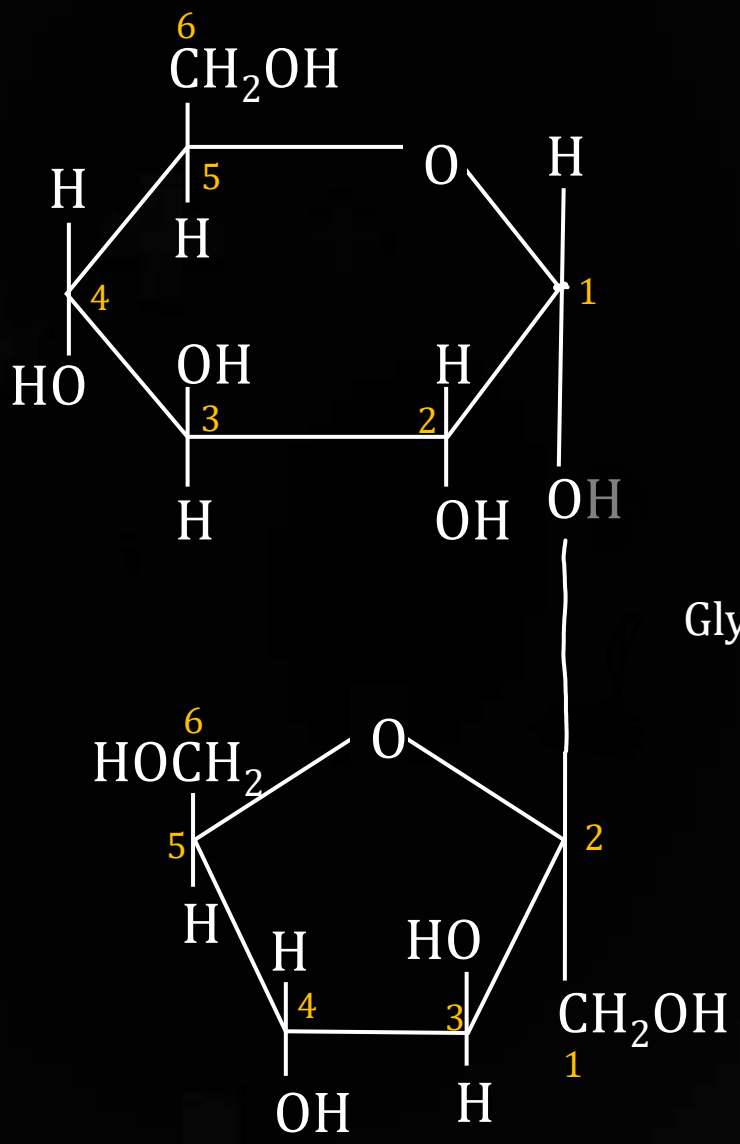
(C)



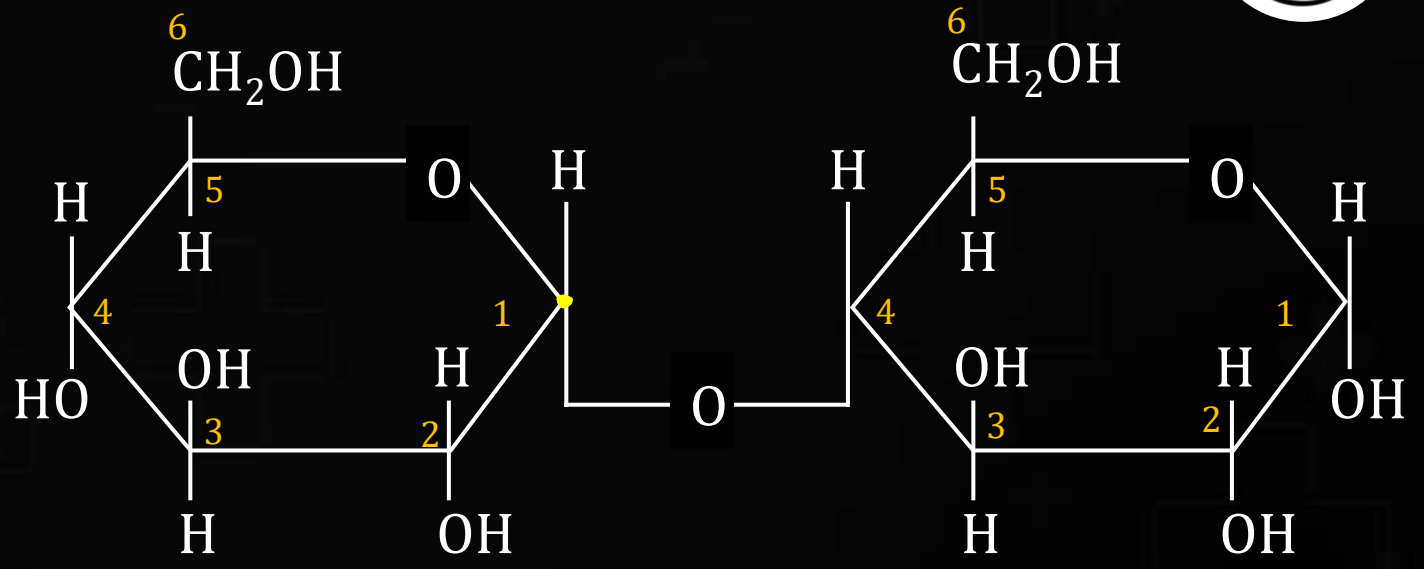
(D)



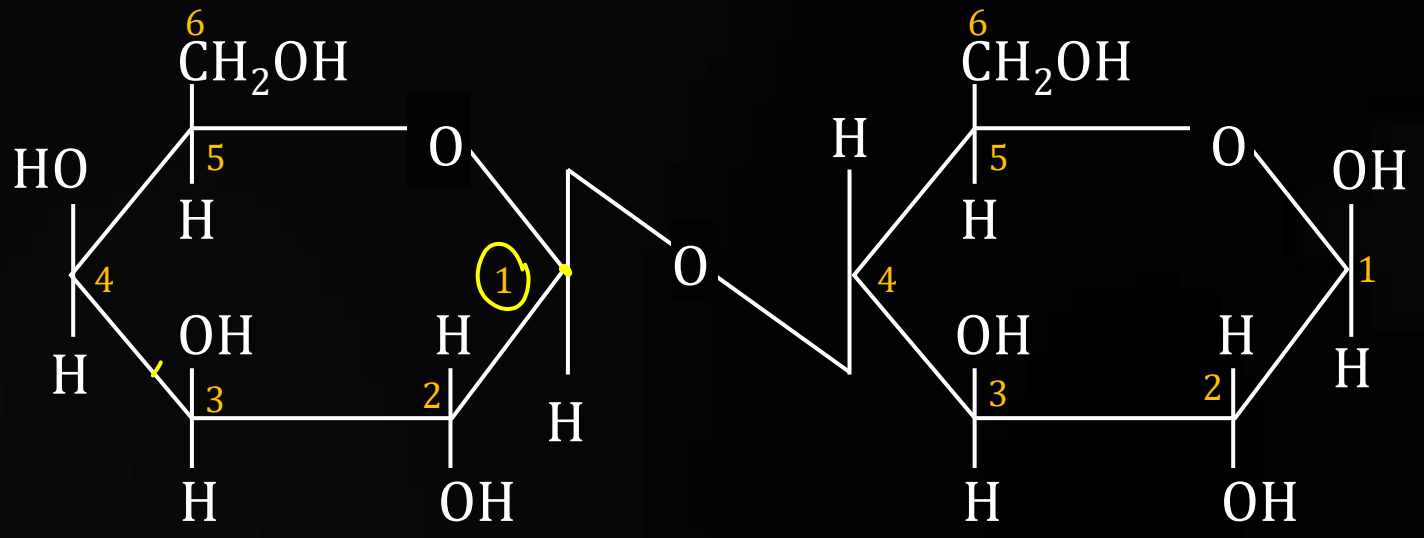
Sucrose : C_1 α-D-Glucose + C_2 β-D-Fructose



Maltose : C_1 α-D-Glucose + C_4 α-D-Glucose



Lactose : C_1 β-D-Galactose + C_4 β-D-Glucose



2021/20 July/Shift-I

Which of the glycosidic linkage between galactose and glucose is present in lactose ?

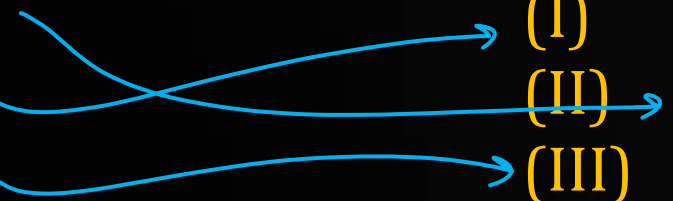
A C-1 of glucose and C-6 of galactose

B C-1 of galactose and C-4 of glucose

C C-1 of glucose and C-4 of galactose

D C-1 of galactose and C-6 of glucose

	Column-I		Column-II
(A)	Sucrose	(I)	β-D-Galactose and β-D-glucose
(B)	Lactose	(II)	α-D-Glucose and β-D-Fructose
(C)	Maltose	(III)	α-D-Glucose and α-D-Glucose



A (A)-(III), (B)-(II), (C)-(I)

B (A)-(III), (B)-(I), (C)-(II)

C (A)-(I), (B)-(III), (C)-(II)

D ✓ (A)-(II), (B)-(I), (C)-(III)

Disaccharide : It produces 2 unit of monosaccharide.

Sucrose : C_1 α-D-Glucose + C_2 β-D-Fructose $\xrightarrow{H_2O}$?

Maltose : C_1 α-D-Glucose + C_4 α-D-Glucose $\xrightarrow{H_2O}$ α-Glucose + α-Glucose

Lactose : C_1 β-D-Galactose + C_4 β-D-Glucose $\xrightarrow{H_2O}$ Gala + Glu

Cane sugar $C_{12}H_{22}O_{11}$ (sucrose) $\xrightarrow{H_2O}$ $C_6H_{12}O_6$ + $C_6H_{12}O_6$

α-Glucose β-Fructose

Oligosaccharides : Carbohydrates that produce 2 to 10 monosaccharide units on hydrolysis

2021/27 July/Shift-II

Compound A gives D-Galactose and D-Glucose on hydrolysis. The compound A is:

A Amylose

B Sucrose

C Maltose

D Lactose

POLYSACCHARIDES

Starch : Polymer of α-glucose

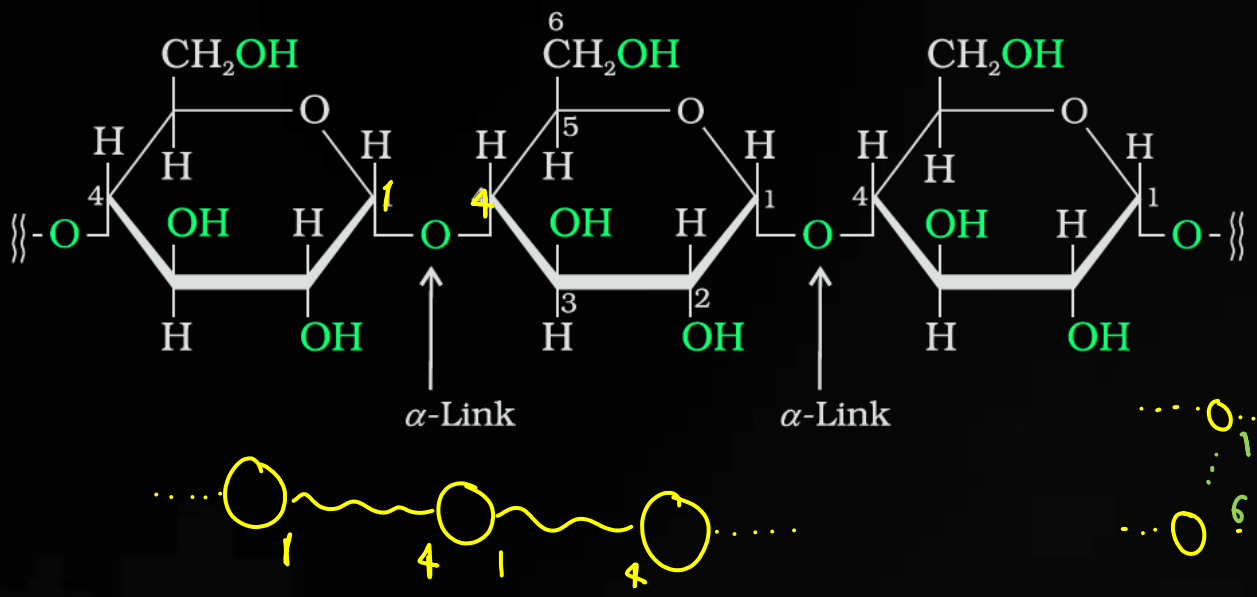
Amylose

Linear polymer

15-20% starch

Water soluble

Glycosidic linkage at C_1 & C_4



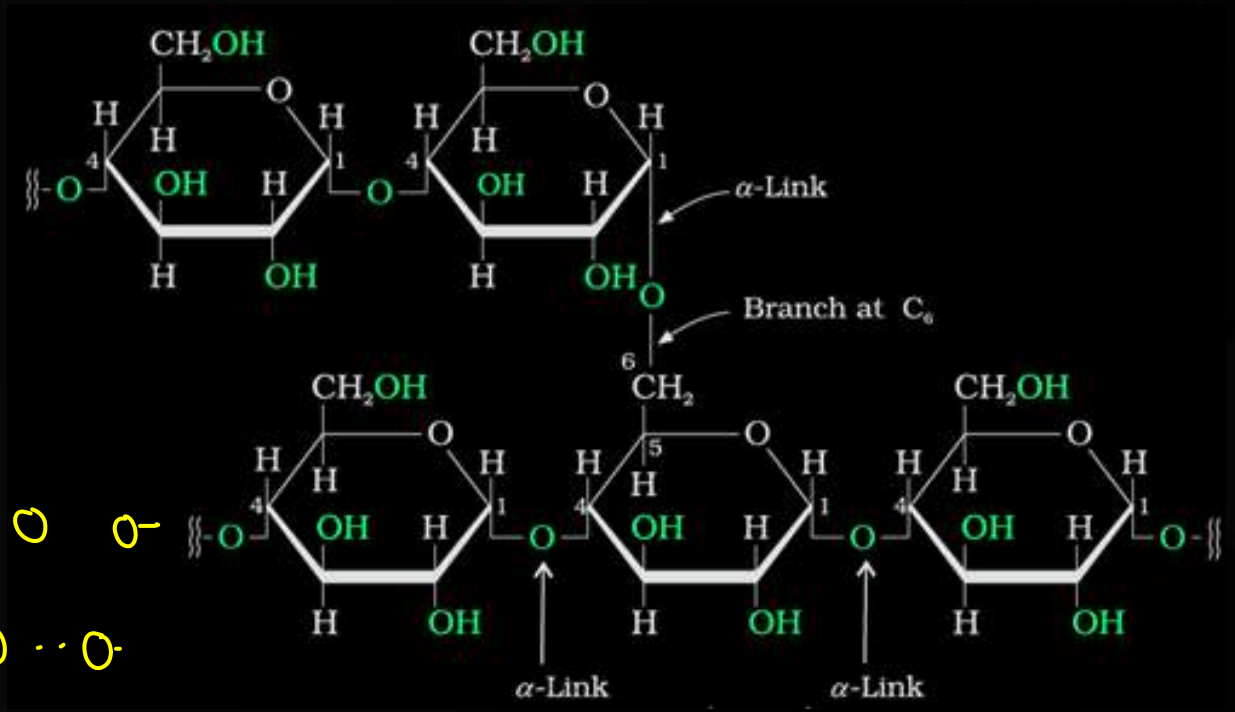
Amylopectin

Branched Polymer

80-85% starch

Water insoluble

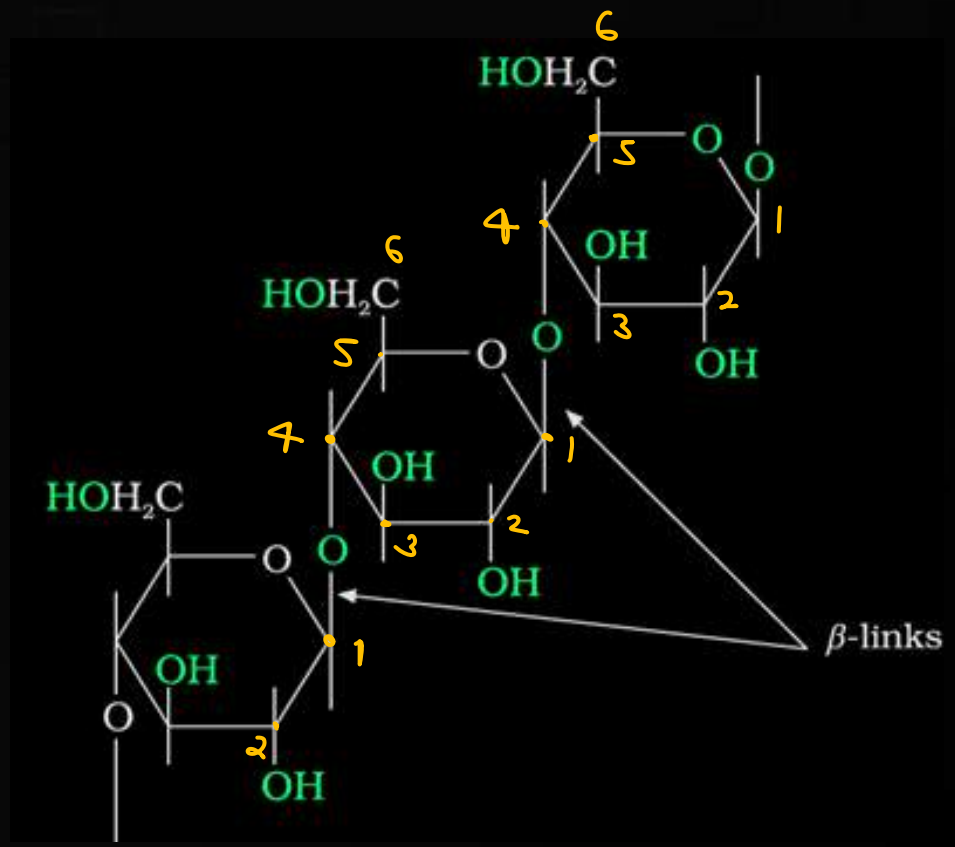
Glycosidic linkage at C_1 & C_4 and branch at C_6



Cellulose : Chain polymer of β-D-glucose units

Glycosidic linkage between C_1 and C_4

Most abundant organic substance in plant kingdom (plant cells)



Glycogen : The carbohydrates are stored in animal body as glycogen.

Animal starch because its structure is similar to amylopectin and is rather more highly branched.

- It is present in liver, muscles and brain. When the body needs glucose , enzymes break the glycogen down to glucose .

glycogen → glucose

Glycogen is also found in yeast and fungi.

Polysaccharide : Carbohydrates that produce a large no. of monosaccharide units on hydrolysis

Starch Cellulose Glycogen

$$\underset{\text{Starch}}{[C_6H_{10}O_5]_n} \xrightarrow{H_2O} x + y$$

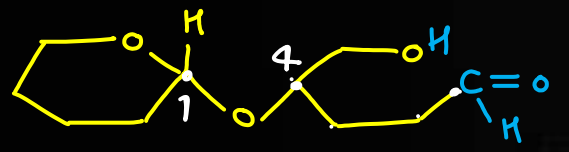
Polysaccharides are not sweet in taste. Hence they are also called non-sugars.

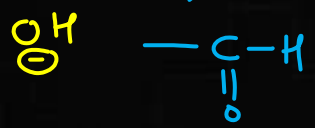
Reducing & Non-reducing Sugars

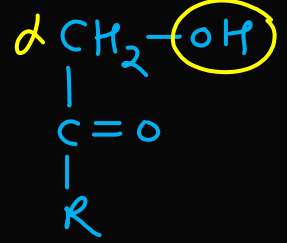
NH_4OH $NaOH$

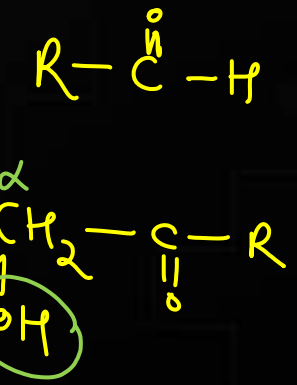
Reducing sugars : Carbohydrates which reduce Tollen's reagent and Fehling solution

All monosaccharides are reducing sugars. Glucose and Fructose.

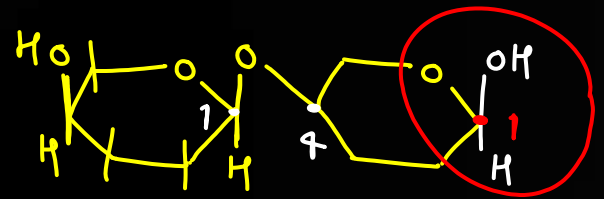


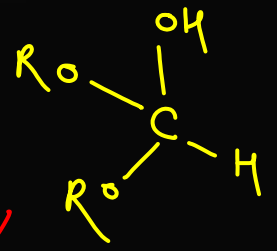






Maltose : C_1 α-D-Glucose + C_4 α-D-Glucose



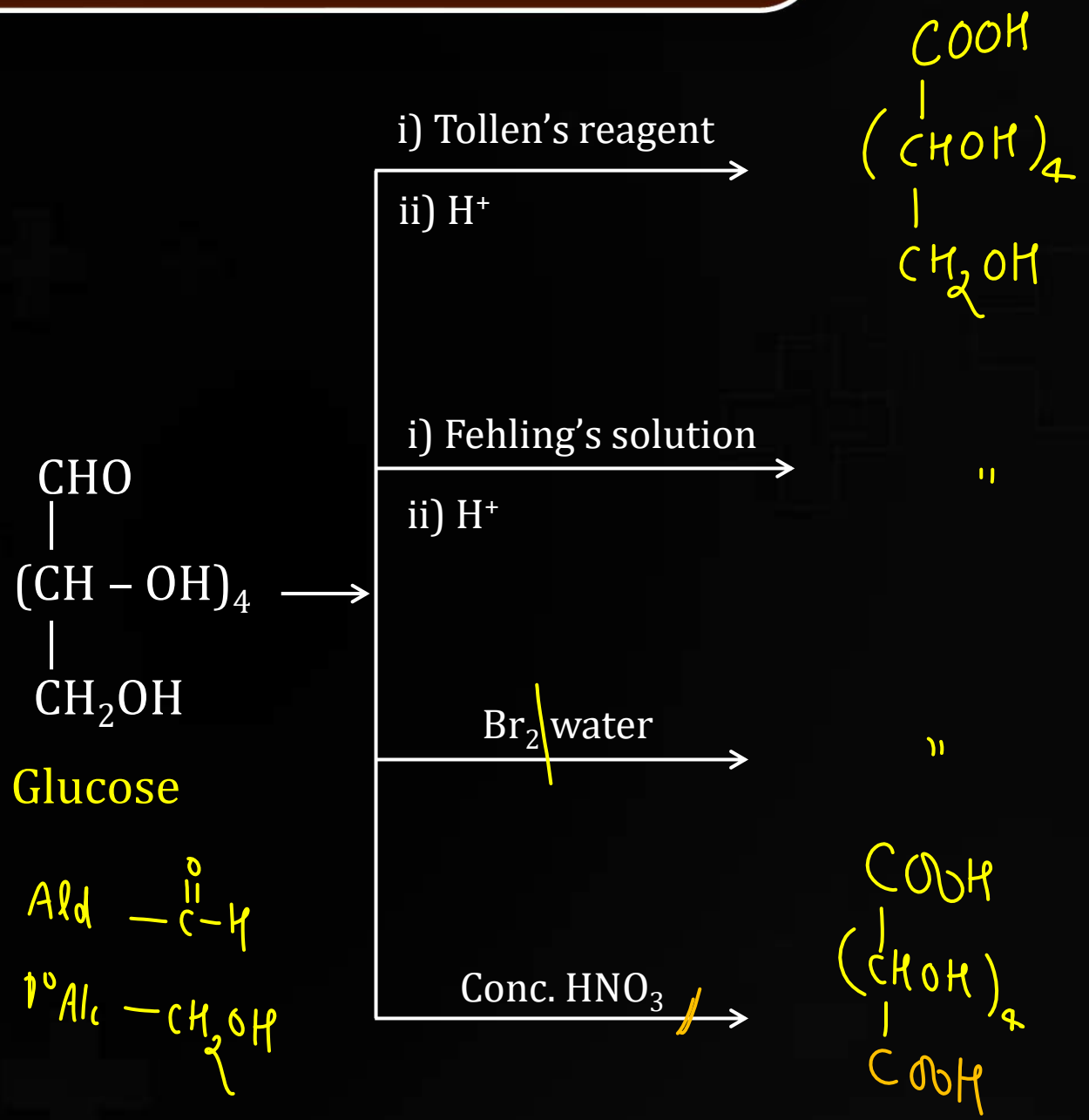


Lactose : C_1 β-D-Galactose + C_4 β-D-Glucose

Non-reducing sugars : Carbohydrates which cannot reduce Tollen's reagent and Fehling solution .

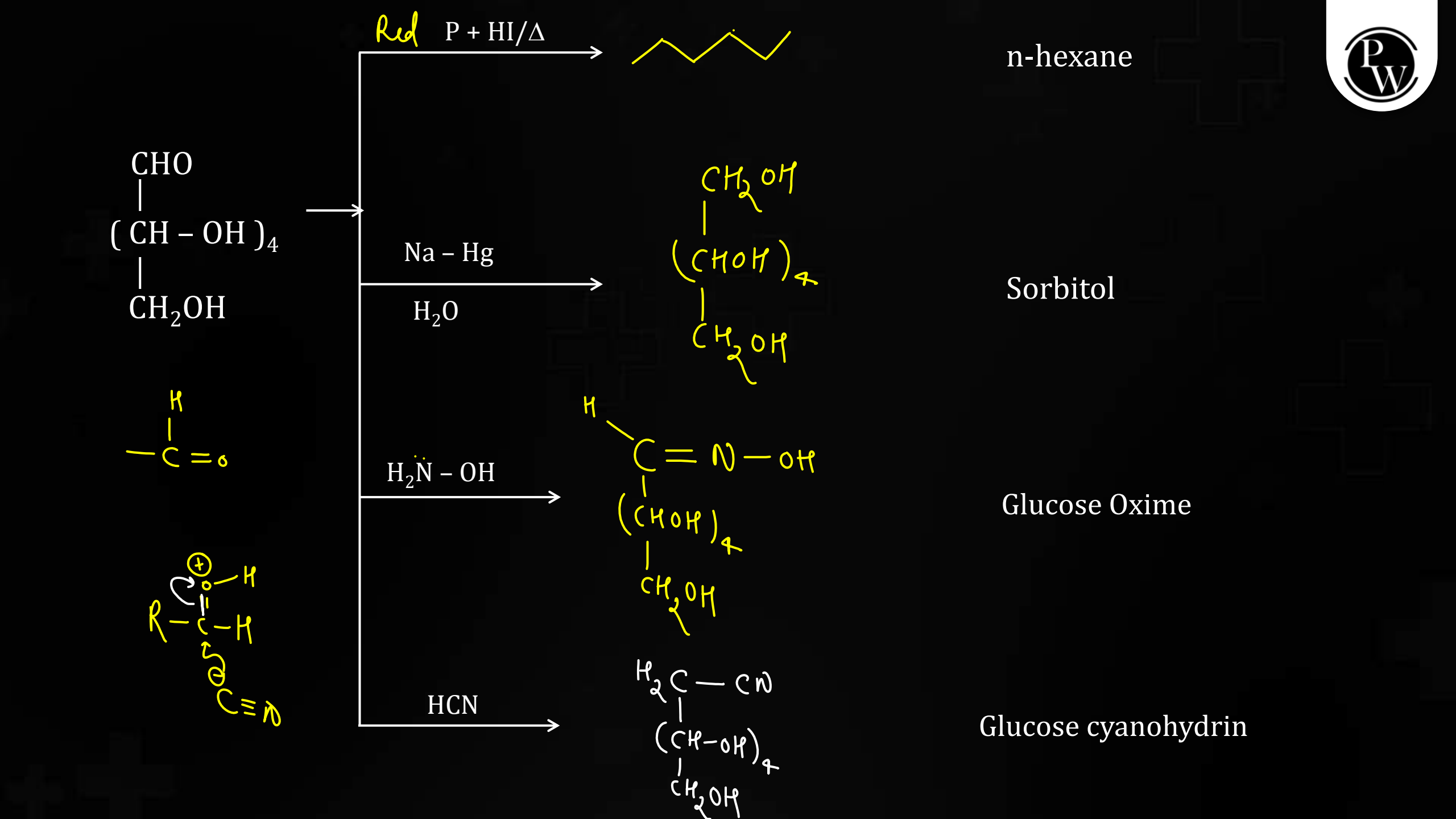
Sucrose : C_1 α-D-Glucose + C_2 β-D-Fructose

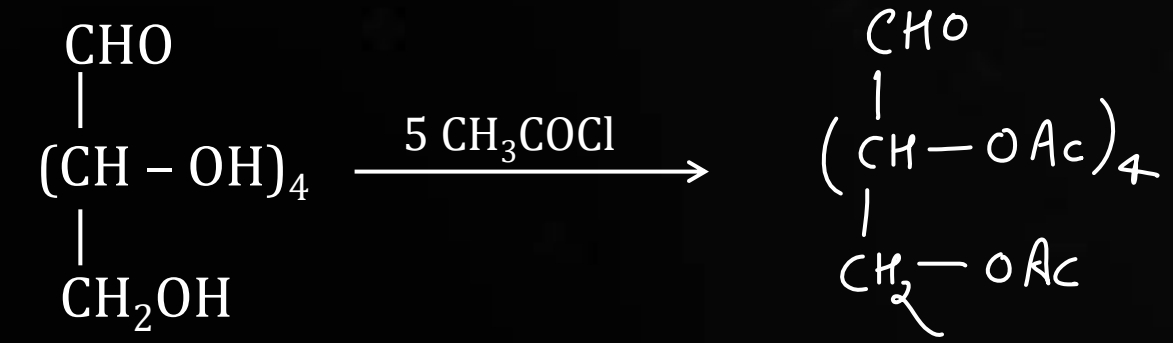
Chemical reactions of Glucose

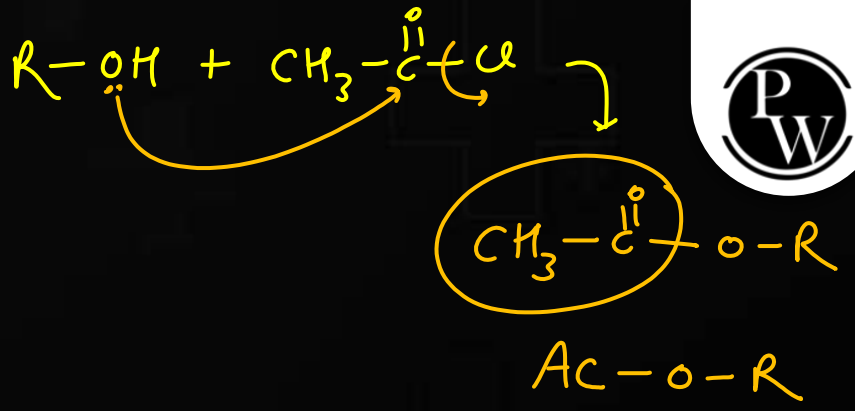


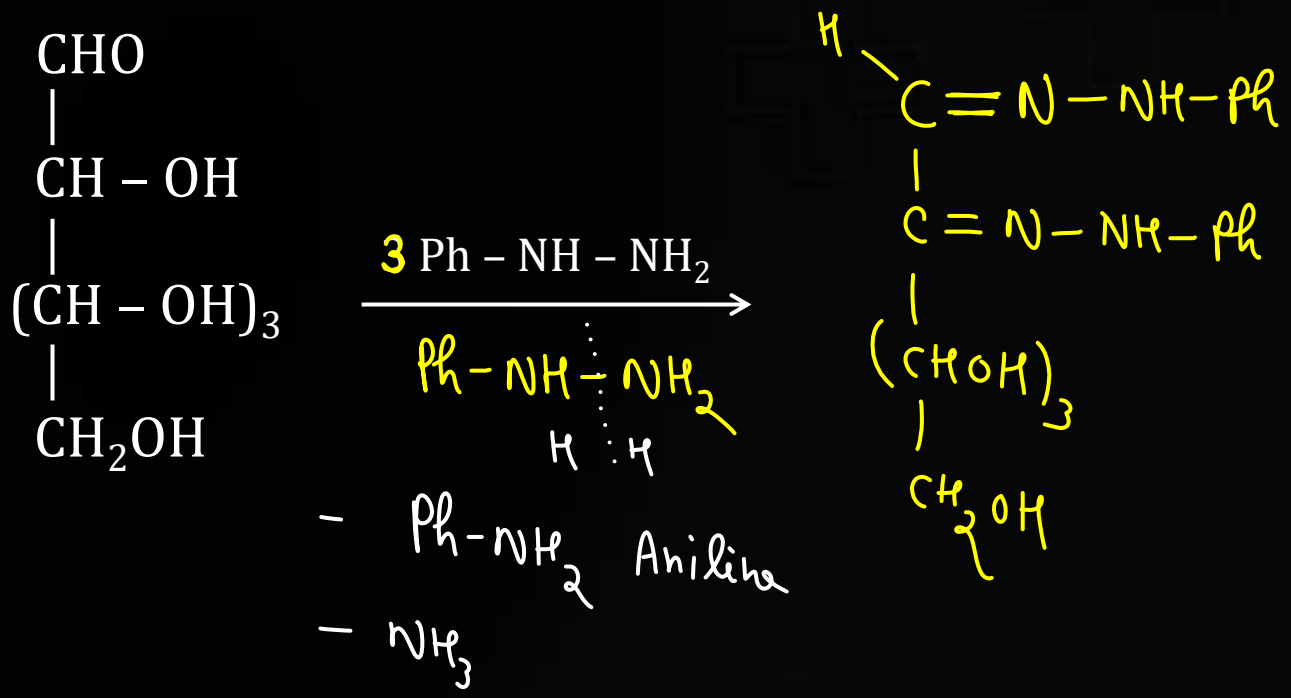
Gluconic acid

Saccharic acid


Red P + HI/Δ
n-hexane
CHO
(CH – OH)4
CH2OH
Na – Hg
H2O
Sorbitol
H2N – OH
Glucose Oxime
HCN
Glucose cyanohydrin

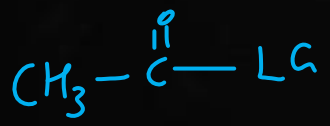






Glucosazone

2019/11 Jan/Shift-II



Column-I		Column-II	
(A)	Glucose + P/HI	(I)	Gluconic acid
(B)	Glucose + Br_2/water	(II)	Glucose pentaacetate
(C)	Glucose + acetic anhydride	(III)	Saccharic acid
(D)	Glucose + HNO_3	(IV)	Hexane

A (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

B (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

C (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

D (A)-(I), (B)-(III), (C)-(IV), (D)-(II)

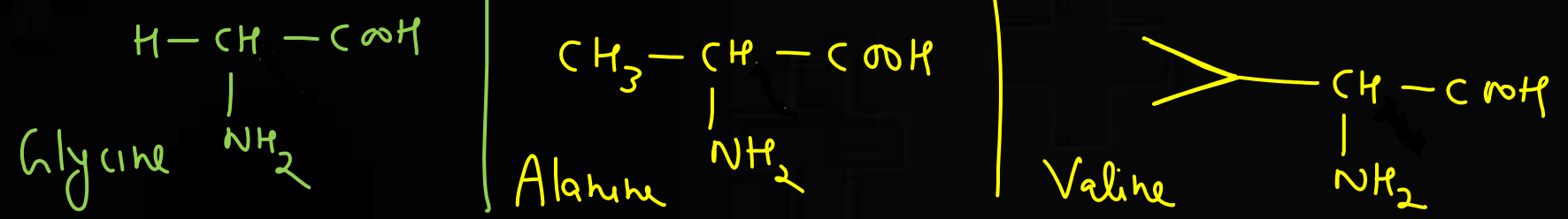
Amino acids

Amino group

$-NH_2$

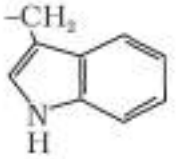
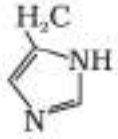
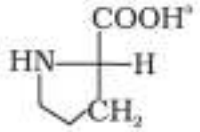
Carboxyl group

$-\overset{\overset{O}{\|}}{C}-OH$



α-Amino acids

Name of the amino acids	Characteristic feature of side chain, R	Three letter symbol	One letter code
1. Glycine	H	Gly	G
2. Alanine	$-CH_3$	Ala	A
3. Valine*	$(H_3C)_2CH-$	Val	V
4. Leucine*	$(H_3C)_2CH-CH_2-$	Leu	L

5. Isoleucine*	$H_3C\text{-}CH_2\text{-}CH(CH_3)\text{-}$	Ile	I
6. Arginine*	$HN{=}C(NH_2)\text{-}NH\text{-}(CH_2)_3\text{-}$	Arg	R
7. Lysine*	$H_2N\text{-}(CH_2)_4\text{-}$	Lys	K
8. Glutamic acid	$HOOC\text{-}CH_2\text{-}CH_2\text{-}$	Glu	E
9. Aspartic acid	$HOOC\text{-}CH_2\text{-}$	Asp	D
10. Glutamine	$H_2N\text{-}C(=O)\text{-}CH_2\text{-}CH_2\text{-}$	Gln	Q
11. Asparagine	$H_2N\text{-}C(=O)\text{-}CH_2\text{-}$	Asn	N
12. Threonine*	$H_3C\text{-}CHOH\text{-}$	Thr	T
13. Serine	$HO\text{-}CH_2\text{-}$	Ser	S
14. Cysteine	$HS\text{-}CH_2\text{-}$	Cys	C
15. Methionine*	$H_3C\text{-}S\text{-}CH_2\text{-}CH_2\text{-}$	Met	M
16. Phenylalanine*	$C_6H_5\text{-}CH_2\text{-}$	Phe	F
17. Tyrosine	$(p)HO\text{-}C_6H_4\text{-}CH_2\text{-}$	Tyr	Y
18. Tryptophan*		Trp	W
19. Histidine*		His	H
20. Proline		Pro	P

Classification of amino Acids

Depending on nature of synthesis

Essential Amino acids : Amino acids which cannot be synthesized in our body and must be obtained through diet

P V T — T I M H A L L Never Tired , Only Argue

Non-essential amino acids : Amino acids which can be synthesized in body

(i) Amino acids with aromatic chain :

Phenylalanine, Tyrosine, Tryptophan

(ii) Amino acids with sulphur :

Methionine , Cysteine

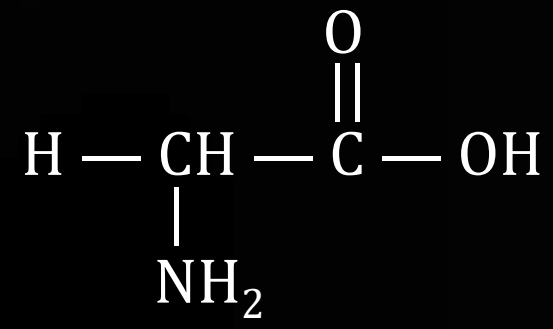
On the basis of functional group

Neutral amino acids

No. of amino group = carboxyl group

$-NH_2$ $-COOH$

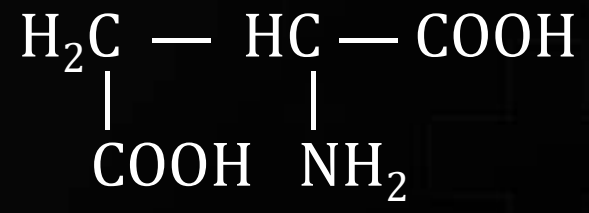
Glycine



Acidic amino acids

More no. of carboxyl group than amino group .

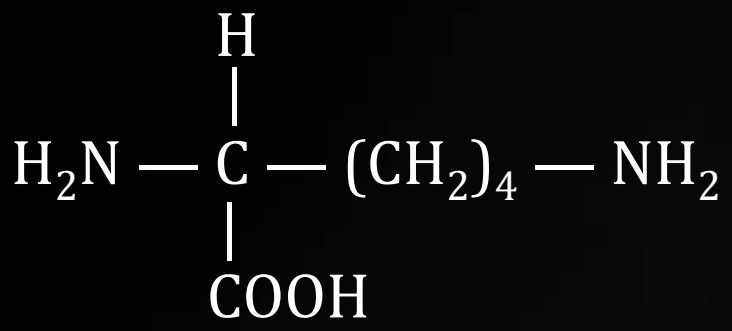
Aspartic acid



Basic amino acid

More no. of amino group than carboxyl group.

Lysine



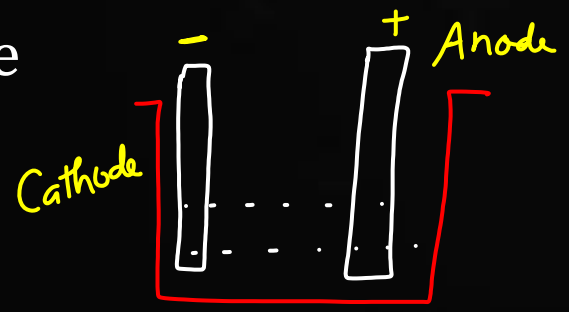
Zwitter Ion : Due to presence of both acidic and basic in the same molecule giving rise to a dipolar ion. This dipolar ion is known as Zwitter ion.

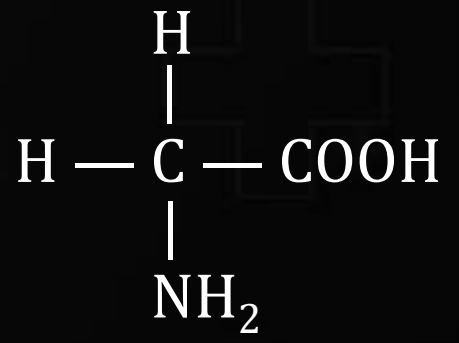
This can react with both acid and base. So it has amphoteric character.

Note : Amino acids are crystalline solids.

These are water soluble and behave like salts rather than simple amines or carboxylic acids.

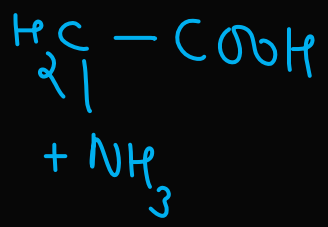
- All α-amino acids are optically active except Glycine. Because there is no chiral carbon in glycine





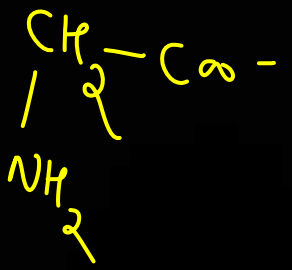
Isoelectric Point :

pH at which the amino acid shows no tendency to migrate when placed in an electric field

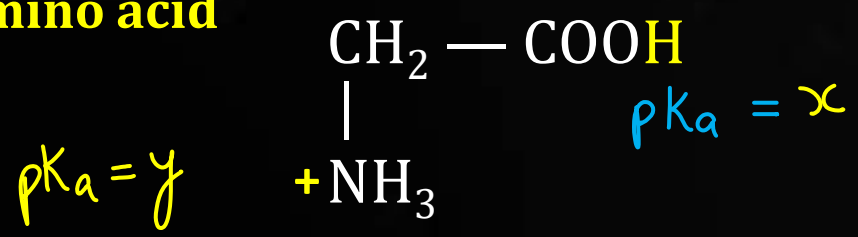


In acidic solution it exist as the +ve ion and migrate towards cathode.

In basic solution it exist as –ve ion and migrates towards anode.

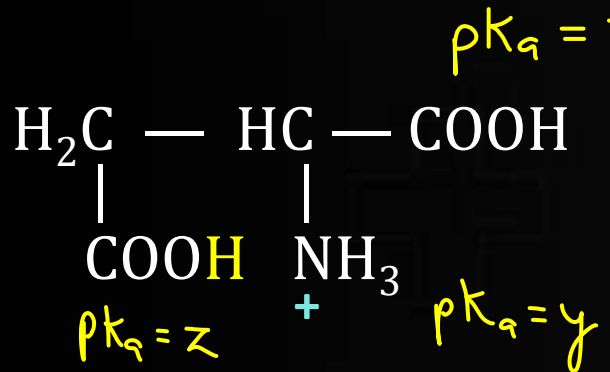


For Neutral amino acid



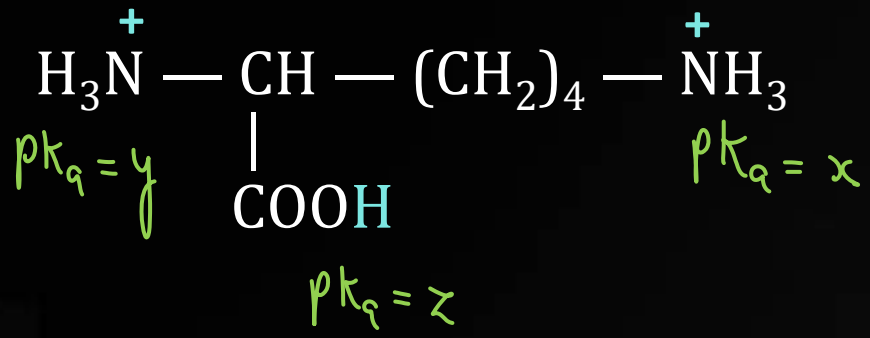
$$pI = \frac{x+y}{2}$$

For Acidic amino acid



$$IP = \frac{x+z}{2}$$

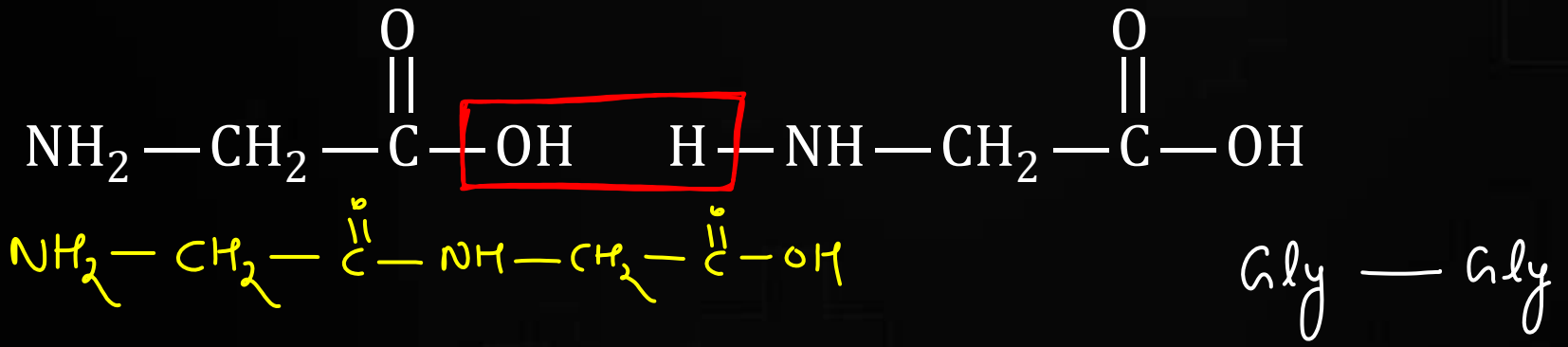
For Basic amino acid



$$IP = \frac{x+y}{2}$$

NOTE : Amino acid has minimum aqueous solubilities at their isoelectric points .

Dipeptide : Combination of 2 amino acids by ONE peptide bond $(-\overset{O}{\overset{\|}{C}}-NH-)$



- The amino acid unit having free $-NH_2$ groups is called N-terminal end whereas the amino acid unit with free $-COOH$ group is called C-terminal end.

Tripeptide : Combination of 3 amino acids linked by 2 peptide linkages.

Gly — Ala — Gly

Polypeptide : ..... Gly – Ala – Gly ....

Combination of 10 or more than 10 amino acids by peptide bonds, is known as polypeptide.

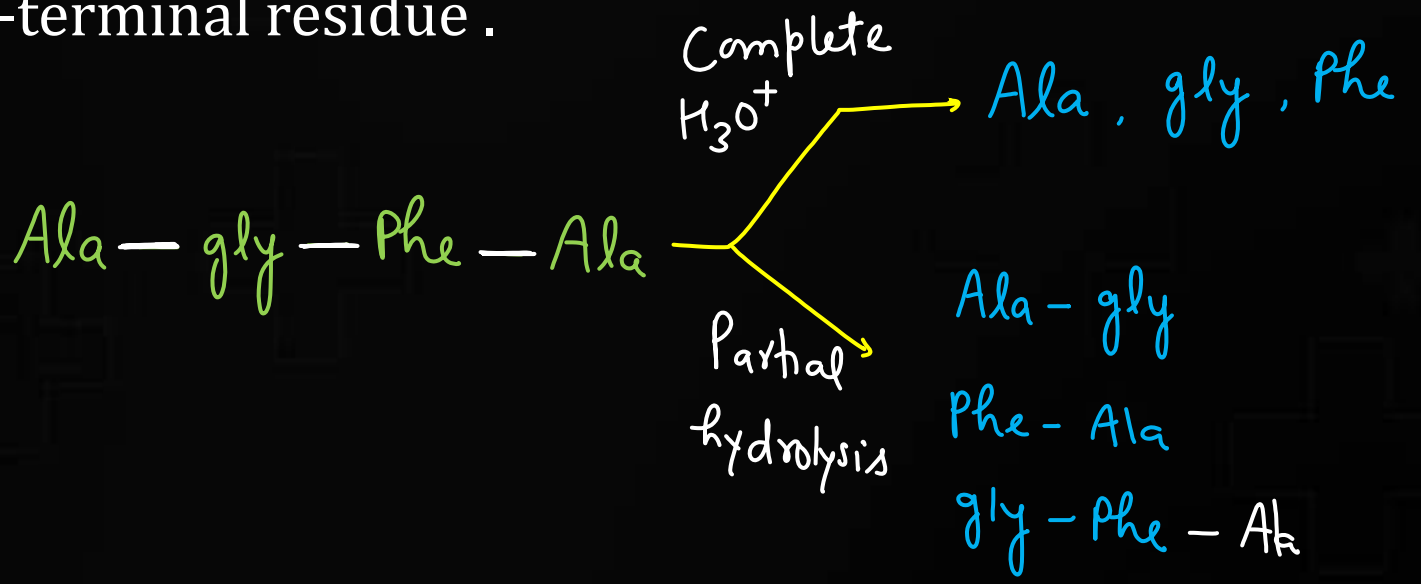
Naming of polypeptides :

Naming starts from –N– terminal residue & suffix - ine of amino acids is replaced by -yl for all except amino acid of C-terminal residue .

Alanylglycylphenylalanine

N-terminal

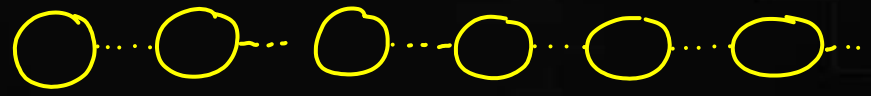
C-terminal



PROTEINS

Proteins are most abundant biomolecule of the living system.

Protein is a polypeptide.

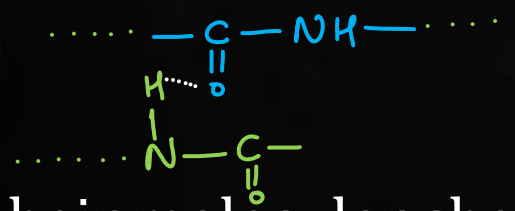


Polypeptide / Protein $\xrightarrow{\text{Hydrolysis}}$ Amino acids

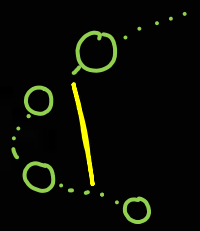
Proteins are the polymers of α-amino groups and they are connected to each other by peptide bond or peptide linkage.

- Peptide linkage is an amide linkage.

Classification of Proteins



Two types on the basis of their molecular shape.



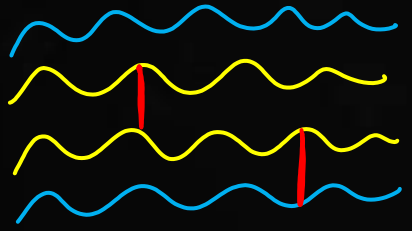
1. Globular Proteins
2. Fibrous proteins

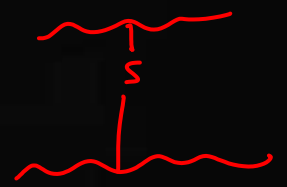
Globular Proteins :

The chains of polypeptides coil around to give a spherical shape. These are usually soluble in water.

Insulin and albumins

Fibrous Proteins





When polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre like structure is formed.

Such proteins are insoluble in water.

Keratin [hair/wool/silk] and myosin [present in muscles]

Structure and shape of proteins can be studied at **4** different levels.

Primary : Sequence of amino acids in polypetide chain

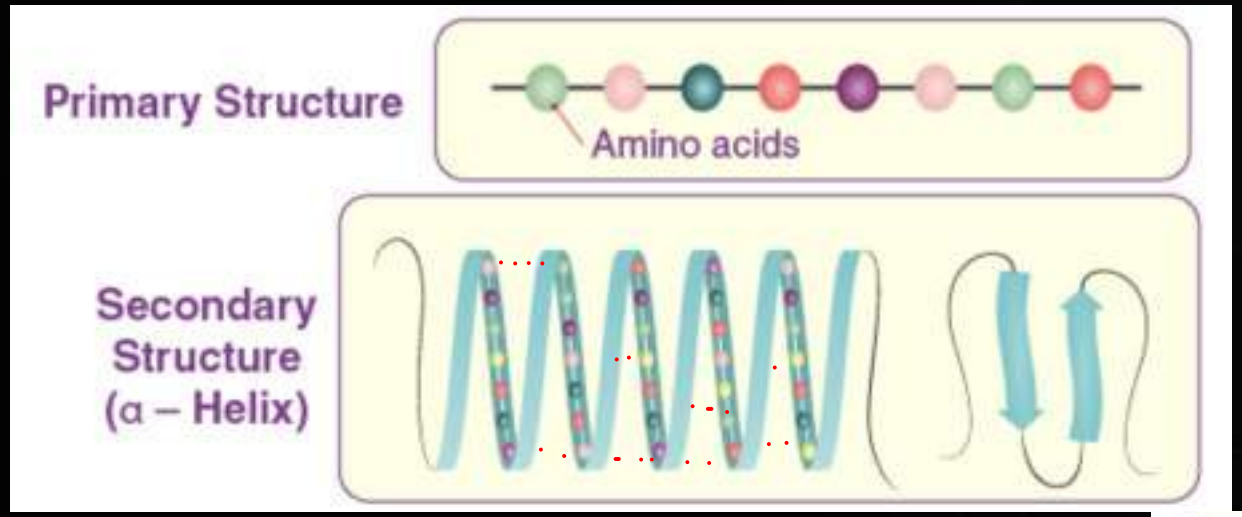
···· Ala – Gly – Ala ····

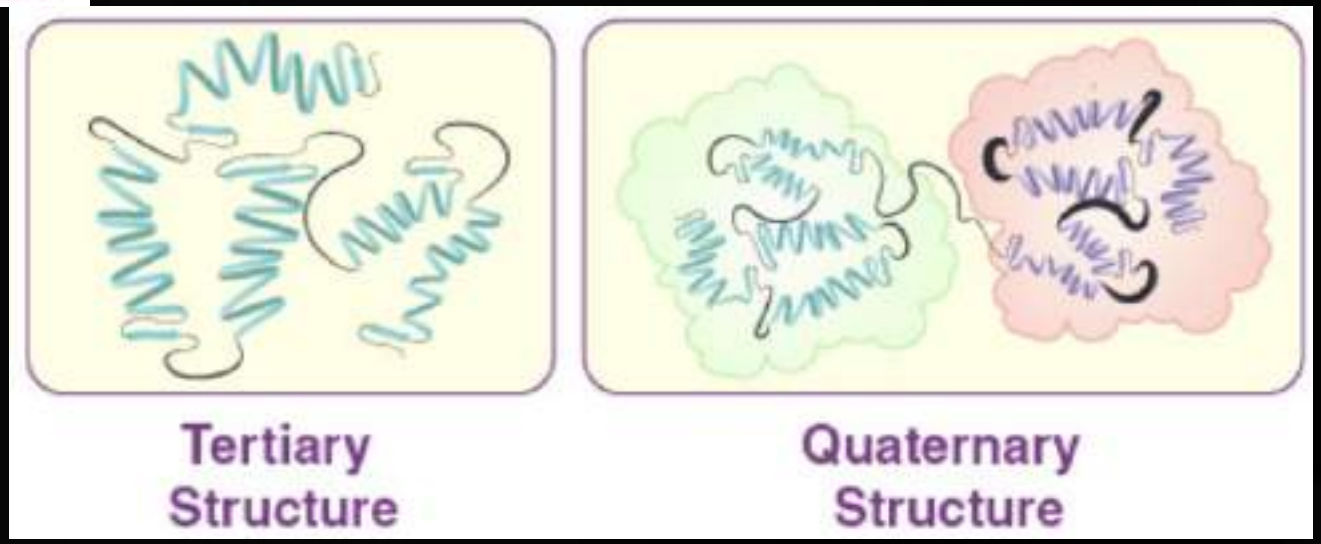
····· Gly – Gly – Ala – Ala ···

Secondary : Shape in which a long polypeptide chain exist

Tertiary : Folding of secondary structure.

Quaternary : Determination of the number of sub-units and their arrangement with respect to each other in an aggregate protein molecule.



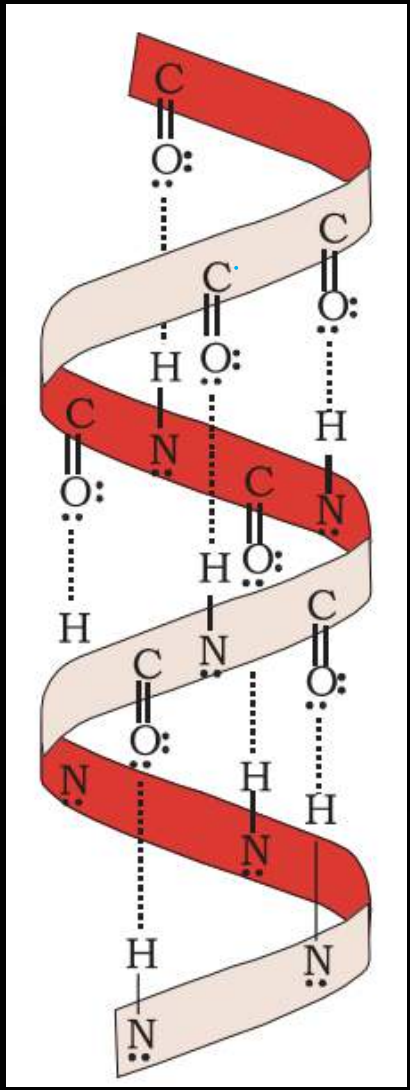


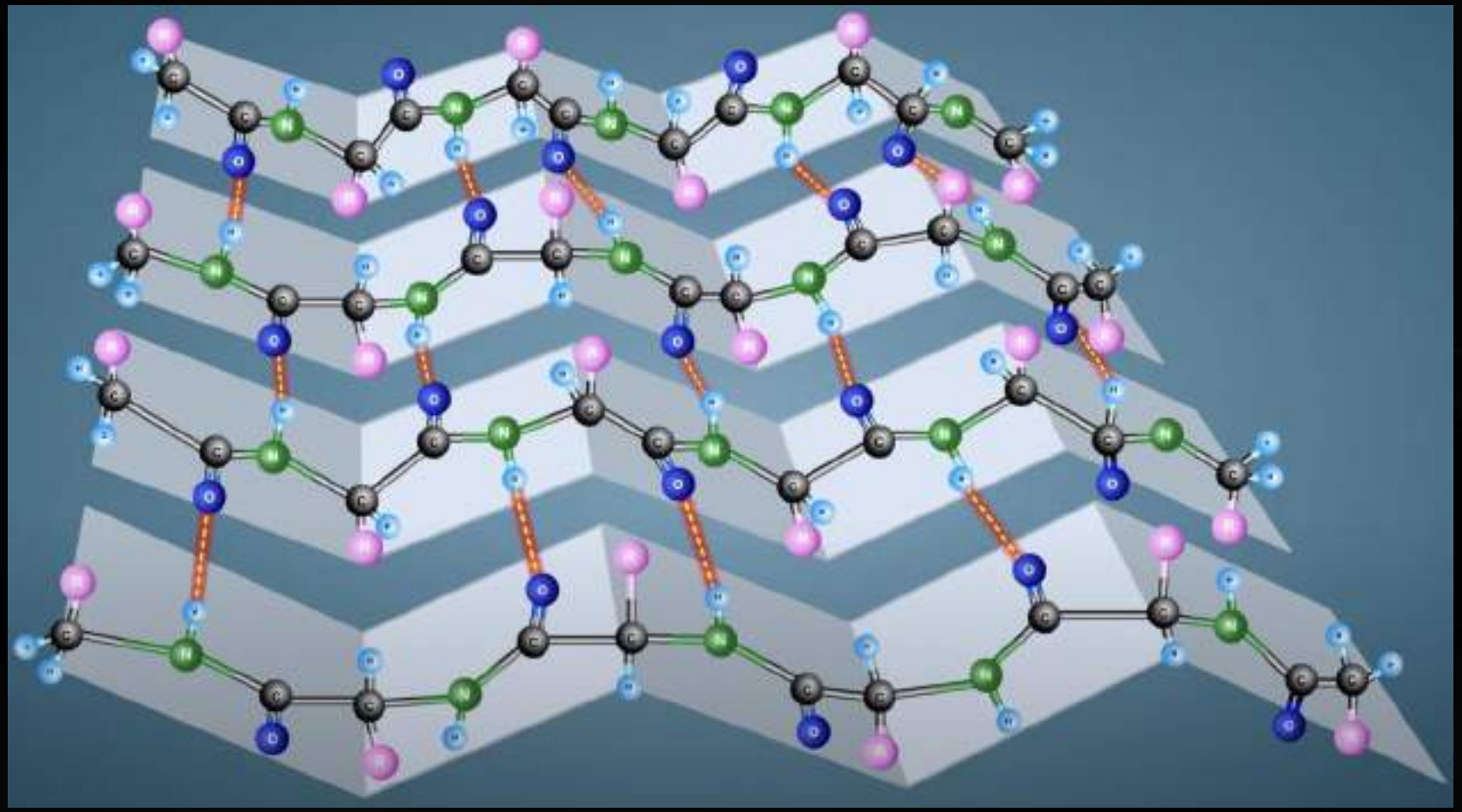
Primary structure of proteins :

Specific sequence of amino acids in polypetide chain is termed as primary structure of proteins.

2° structure of proteins : The shape in which a long polypeptide chain can exist.

2 different types of structures → α-helix & β-sheet.





These structures arise due to regular folding of backbone of polypeptide chain due to hydrogen bonding between — COOH and — NH — groups of peptide bond .

α-Helix : It is one of the most common ways in which polypeptide chain forms all possible hydrogen bonds by twisting into a right handed screw (helix). This hydrogen bond is in between —NH— group of each amino acid to the -COOH group of an adjacent turn of helix.

β-pleated Sheet: In β-structure, all peptide chains are stretched out to maximum extent and then laid side by side (which are held together by intermolecular hydrogen bonding).

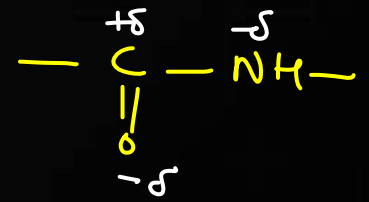
- The structure resembles the pleated folds of drapery and therefore is known as β-pleated sheet.

Tertiary structure of proteins :

It represents further folding of secondary structure.

It gives rise to two major molecular shape → fibre and globular.

- Stability of this structure depends on H-bonding, disulphide linkage, Vander Waals force of attraction and electrostatic forces of attraction.



Quaternary structure of proteins :

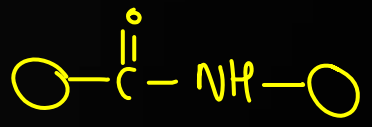
The spatial arrangement of sub unit of proteins with respect to each other is known as quaternary structure.

Denaturation of proteins

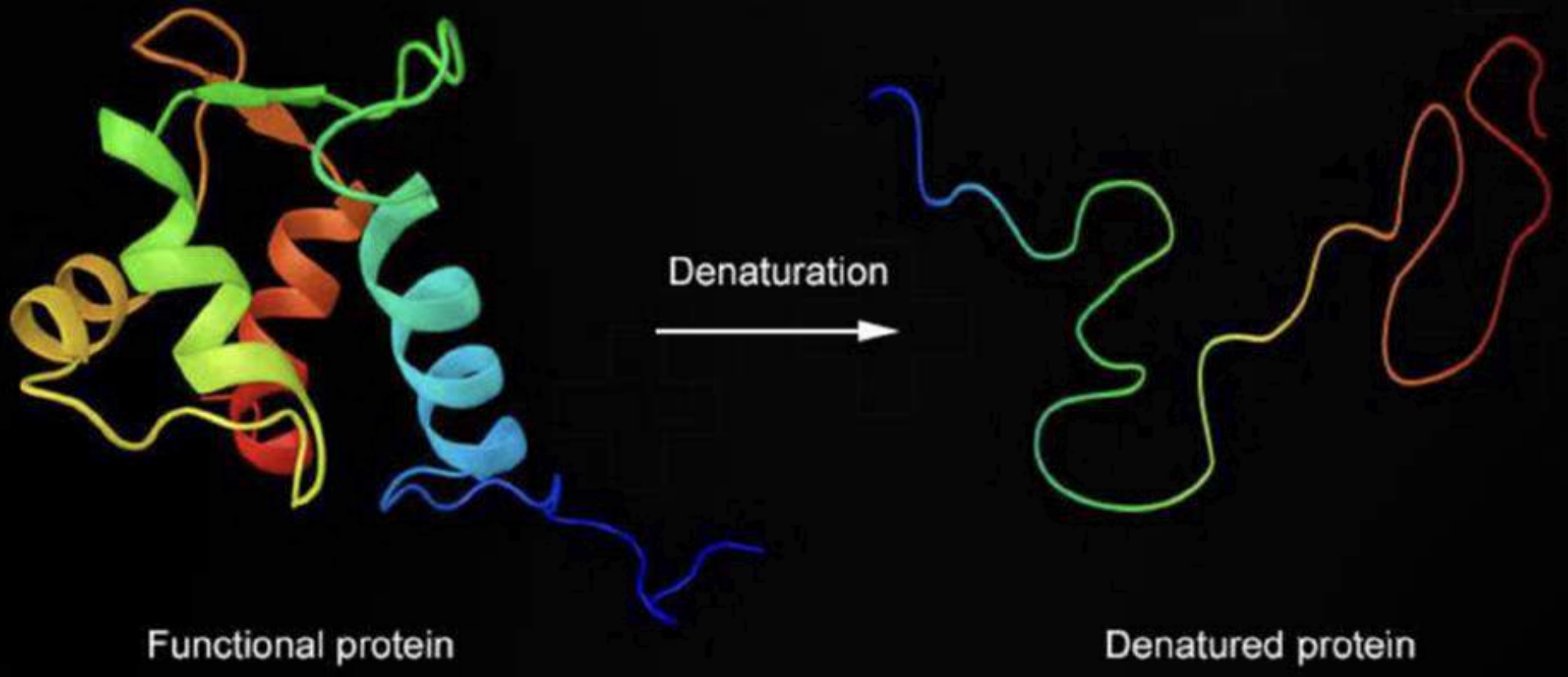
Native proteins : Protein found in a biological system with a unique 3D structure and biological activity is called native protein.

When a native form of protein is subjected to a physical change (change in temperature) or chemical change (change in pH) hydrogen bonds are disturbed.

Due to this unfolding of proteins or uncoiling of helix happens and protein loses its biological activity. This is called Denaturation of protein.



- During denaturation 2°/3° structures are destroyed but 1° structure remains intact.


Denaturation
Functional protein
Denatured protein

Nucleic Acids

Nucleus of a living cell is responsible for the transmission of inherent character.

- The particles in nucleus of cell (responsible for heredity), are called chromosomes.
- Chromosomes are made up of proteins and nucleic acids.

DNA
Deoxyribonucleic acid

RNA
Ribonucleic acid

Nucleic acid ⟶ Pentose sugar + phosphoric acid + Base

DNA ⇒ β-D-2-deoxyribose + phosphoric acid + [AGCT]

RNA ⇒ β-D-ribose + phosphoric acid + [AGCU]

2022/29 June/Shift-I

Sugar moiety in DNA and RNA molecules respectively are

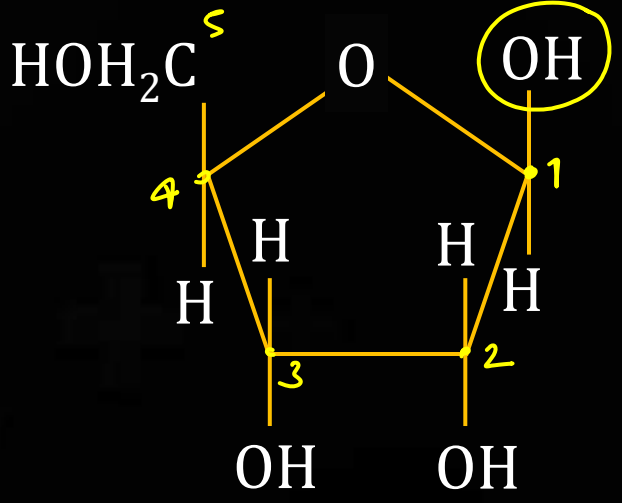
A β-D-2-deoxyribose, β-D-deoxyribose

B β-D-2-deoxyribose, β-D-ribose

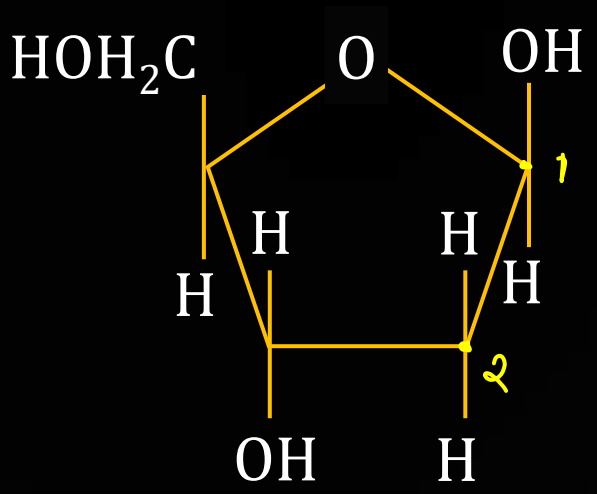
C β-D-ribose, β-D-2-deoxyribose

D β-D-deoxyribose, β-D-2-deoxyribose

Pentose sugar



β-D-ribose



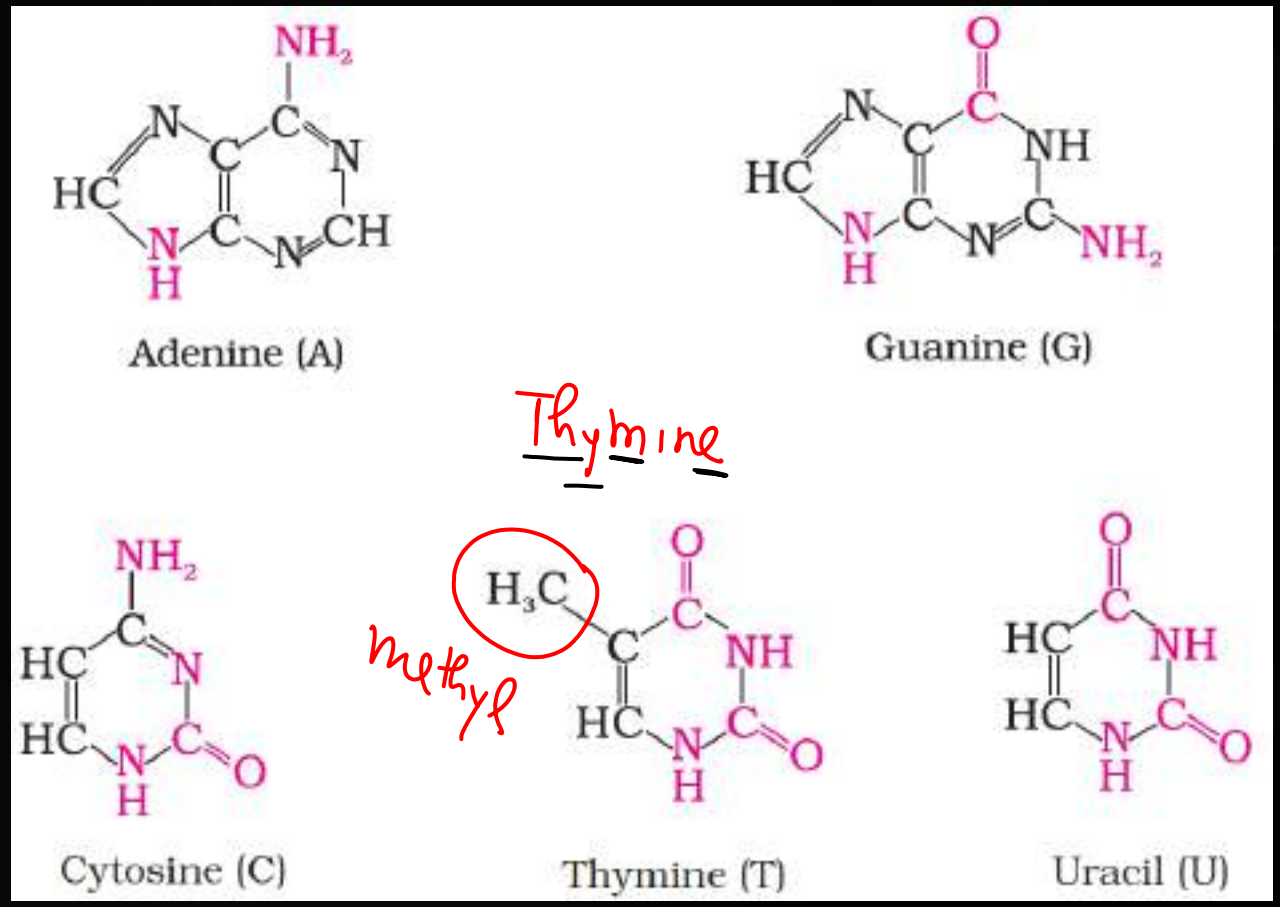
β-D- 2 - deoxy ribose

AG - Purine

CUT - Pyrimidine

A = T , G ≡ C

Hydrogen bond



2021/25 July/Shift-II

Which one of the following is correct structure for cytosine?

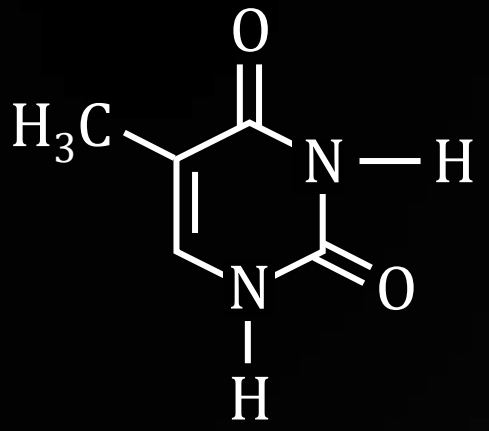
CUT

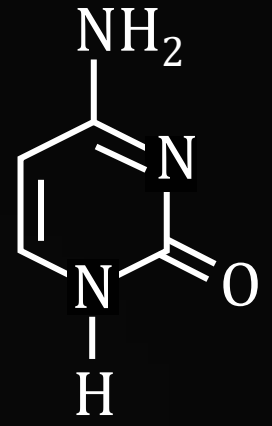
$-NH_2$ $[2C=O]$

$-C=O$

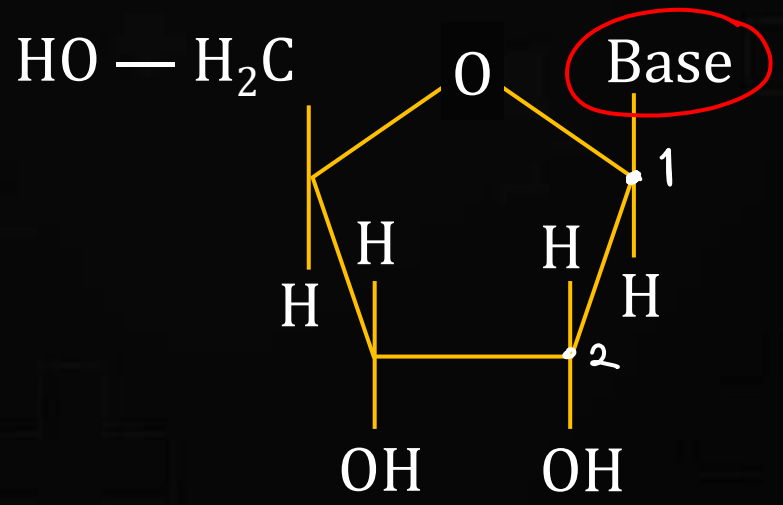
(A) 

(B) 

(C) 

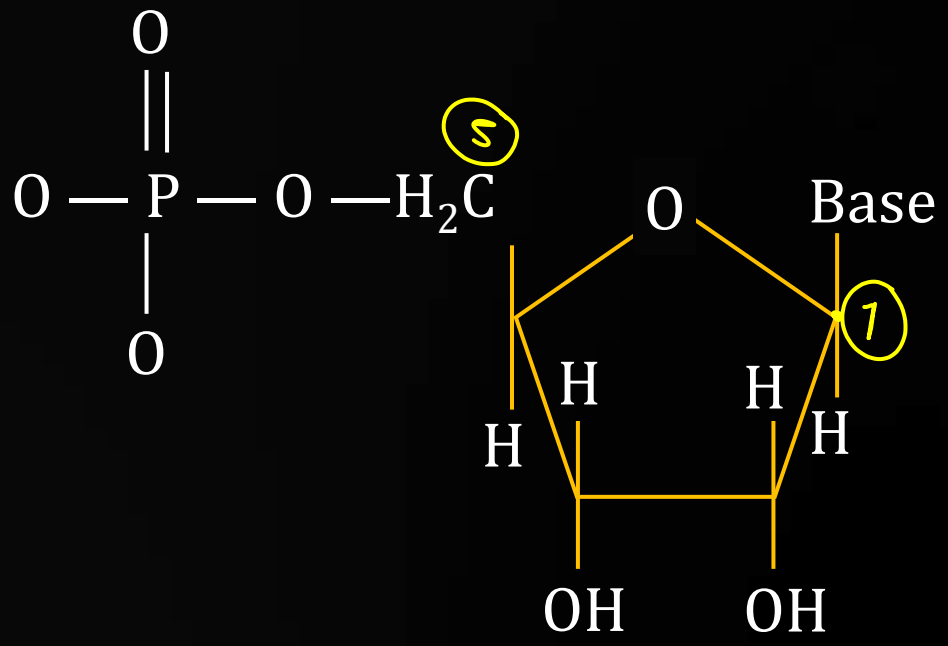
(D) 

Nucleoside = Sugar + base



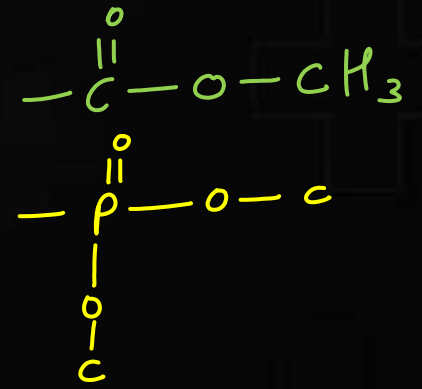
Nucleotide = Phosphate + sugar + base

3



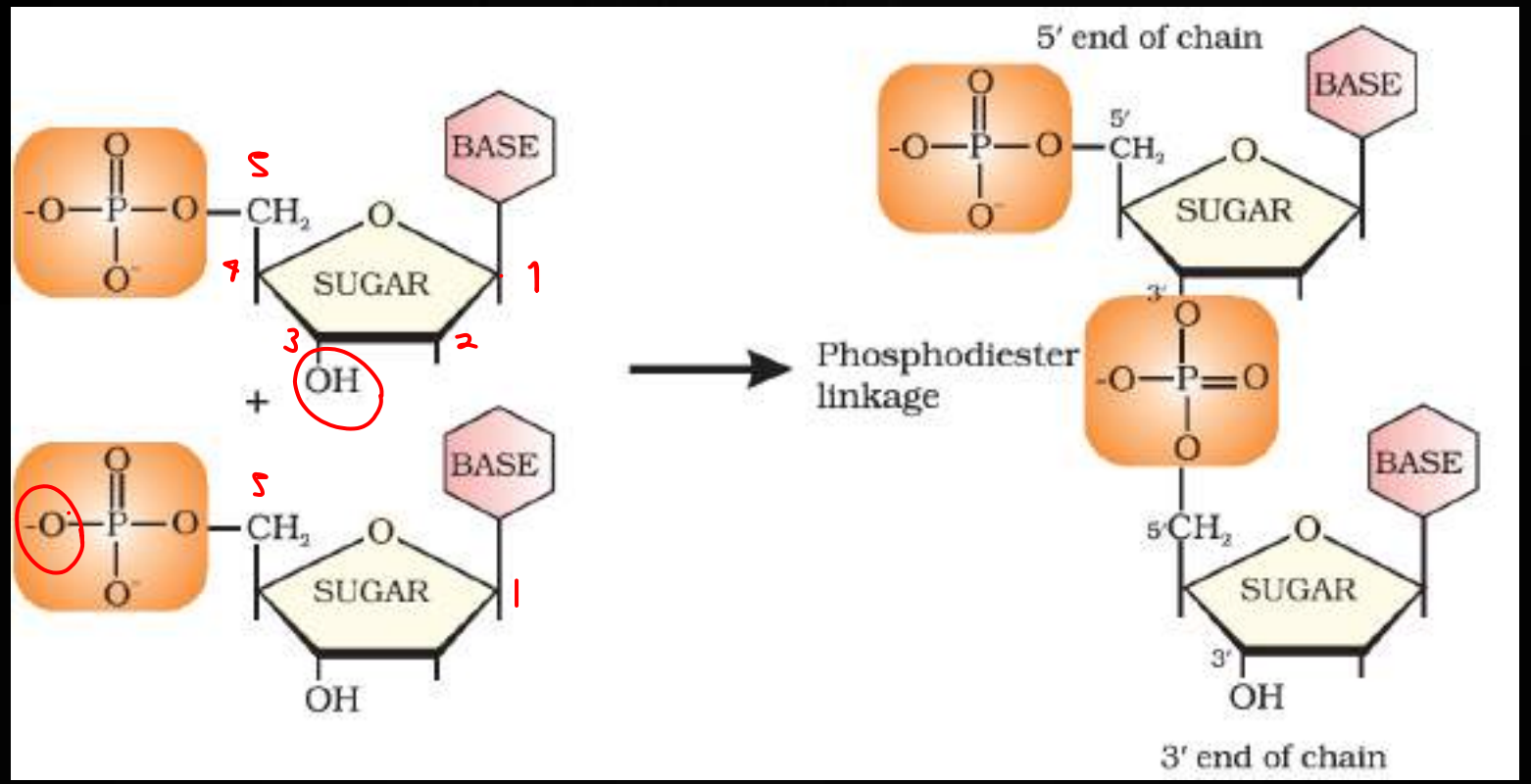
Nucleic acid = Polynucleotides

= Long chain polymer of nucleotides.



Nucleic acid ⇒ Base Base Base

....— Sugar — Phosphate — Sugar — Phosphate — Sugar

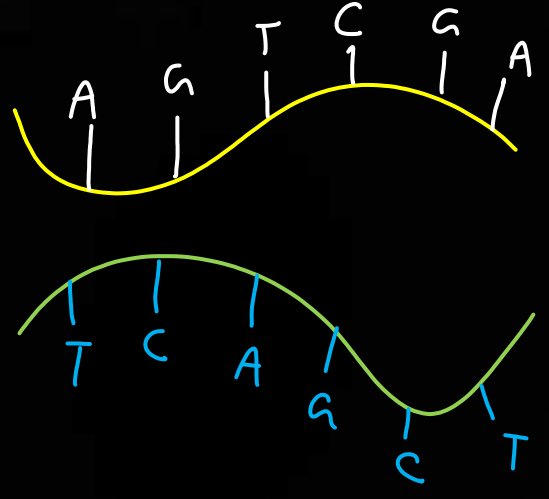


- **Double strand helix structure for DNA :** The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases.

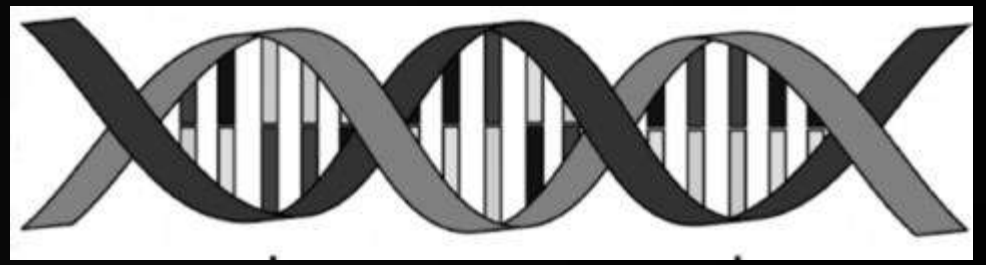
AGCT DNA

AGCU RNA

G ≡ C , A = T

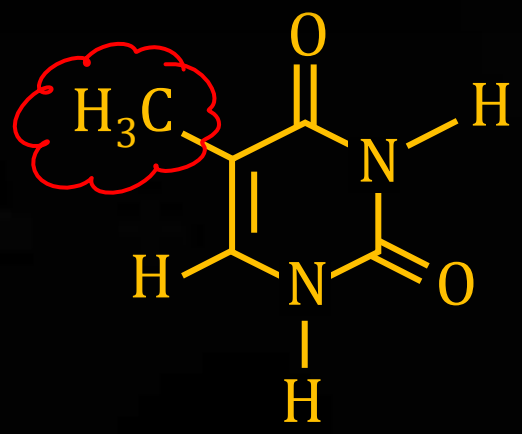


Phosphate + Sugar



2021/27 July/Shift-I

AG Pure



compound 'A'

T = A

The compound 'A' is a complementary base of _____ in DNA strands.

A Uracil

B Guanine

C Adenine

D Cytosine

RNA

Structure → Single stranded helix.

- RNA molecule are of 3 types
  1. Messenger RNA [m-RNA]
  2. Ribosomal RNA [r-RNA]
  3. Transfer RNA [t-RNA]

Biological Functions of Nucleic acids: DNA is the chemical basis of heredity and may be regarded as the reserve of genetic information. Another important function of nucleic acids is the protein synthesis in the cell.

2019/12 April/Shift-I

Which of the following statements is not true about RNA ?

DNA

(A) It has always double stranded α-helix structure.

(B) It usually does not replicate.

(C) It is present in the nucleus of the cell.

(D) It controls the synthesis of protein.

Vitamins Organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism.

Fat soluble vitamins : A , D , E and K . They are stored in liver . [ADEK : Fat]

Water soluble vitamins : B and C

- Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B_{12}) in our body.

Name of Vitamins	Deficiency diseases
Vitamin A	Xerophthalmia (hardening of cornea of eye) Night blindness
Vitamin B_1 (Thiamine)	Beri beri (loss of appetite, retarded growth)
Vitamin B_2 (Riboflavin)	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
Vitamin B_6 (Pyridoxine)	Convulsions
Vitamin B_{12}	Pernicious anaemia (RBC deficient in haemoglobin)
Vitamin C (Ascorbic acid)	Scurvy (bleeding gums)
Vitamin D	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
Vitamin E	Increased fragility of RBCs and muscular weakness
Vitamin K	Increased blood clotting time

2021/18 March/Shift-II

Deficiency of vitamin K causes :

A Cheilosis

B Increase in blood clotting time.

C Decrease in blood clotting time.

D Increase in fragility of RBC's.


Thank
You