ULTIMATE KCET

CRASH COURSE 2026

Chemistry | Lecture - 02

Biomolecules

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Recap *of previous lecture*

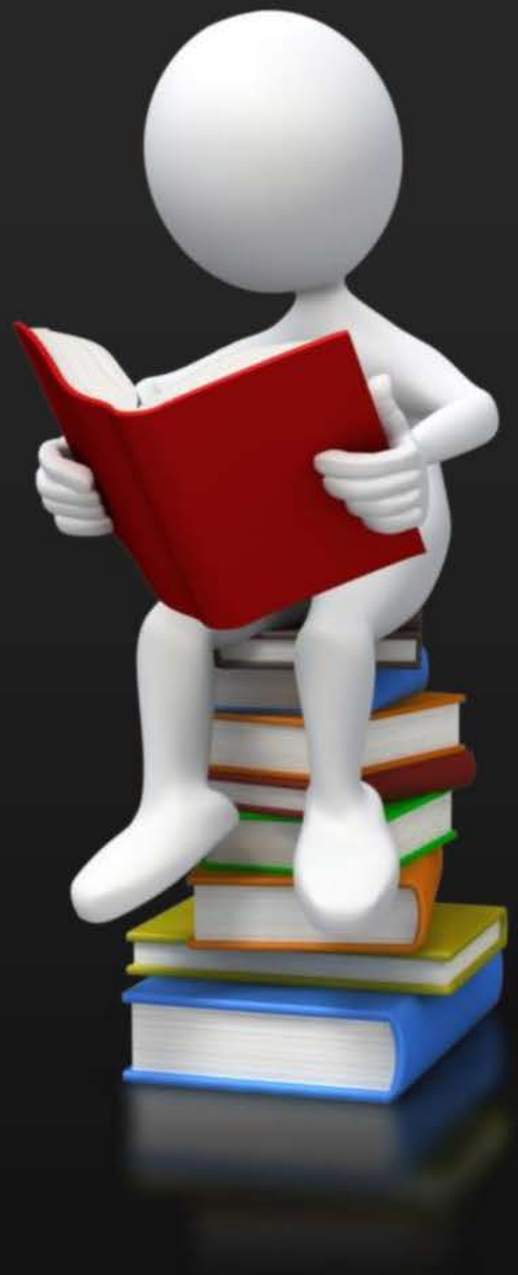
1. Synopsis – Amines
2. MCQ

Topics *to be covered*

1. Chapter revision
2. MCQ

Chapter weightage

03-04 Questions.



INTRODUCTION

Biomolecules may be defined as complex lifeless chemical substances which form the basis of life, i.e., they not only build up living systems (creatures) but are also responsible for their growth, maintenance and their ability to reproduce.

The various biomolecules are carbohydrates, proteins, enzymes, nucleic acids, lipids, hormones and compounds for storage and exchange of energy such as adenosine triphosphate (ATP)

CARBOHYDRATES:

Carbohydrates are defined as optically active polyhydroxy aldehydes or polyhydroxy ketones or substances which give these on hydrolysis.

$C_x(H_2O)_y$

Initial name : hydrate of carbon) $\mathbf{C_x(H_2O)_y}$.

- Exception : A number of compounds such as rhamnose, ($C_6H_{12}O_5$) and deoxyribose ($C_5H_{10}O_4$) are known which are carbohydrates by their chemical behaviors but cannot be represented as hydrates of carbon.
- There are other substances like formaldehyde (HCHO, CH_2O) and acetic acid [CH_3COOH, $C_2(H_2O)_2$] which do not behave like carbohydrates but can be represented by their general formula, $\mathbf{C_x(H_2O)_y}$.

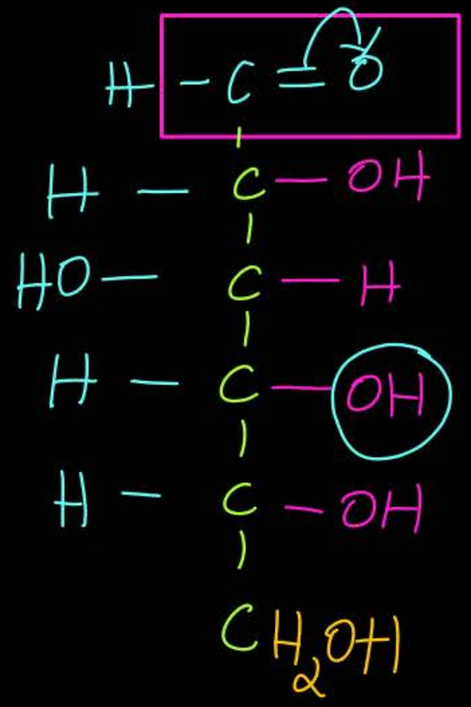
IMP

IMP.

HCHO or CH_2O $C_1(H_2O)_1$

Glucose

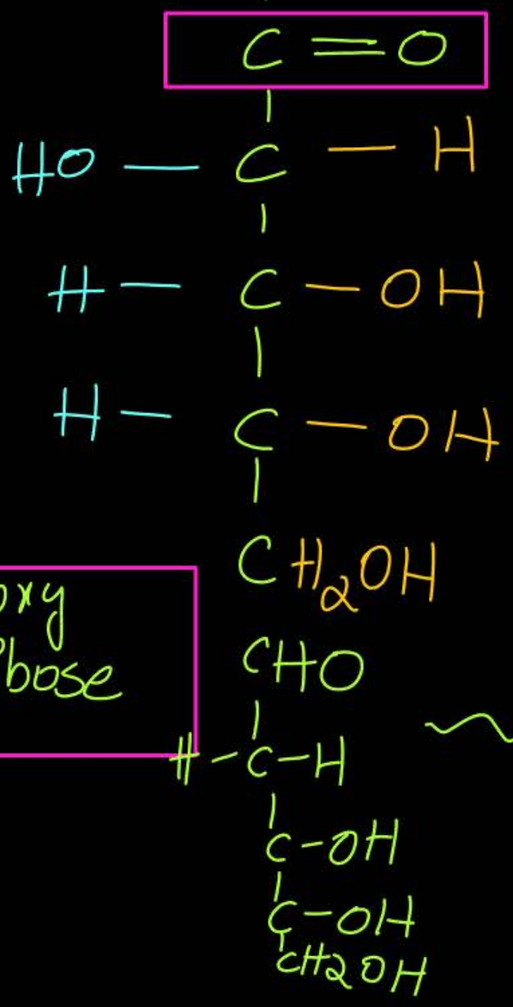
$C_6H_{12}O_6$



Epimers

fructose

$C_6H_{12}O_6$



$C_x(H_2O)_y$

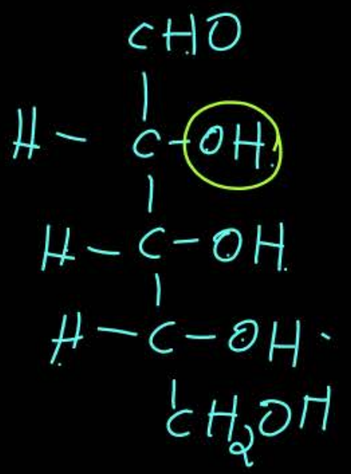
$C_6(H_2O)_6$

$C_6H_{12}O_6$

$C_5(H_2O_1)_5$

$C_5H_{10}O_5$ → Ribose sugar

Ribose



Deoxy ribose

$C_5H_{10}O_4$

$\rightarrow X C_x(H_2O)_y$

Sucrose

Lactose

Maltose

$\longrightarrow C_{12}H_{22}O_{11}$

$C_x(H_2O)_y$

$C_6(H_2O)_6$

$\downarrow$

$C_{12}(H_2O)_{11} \longrightarrow C_x(H_2O)_y$ ✓

$x = 12$

$y = 11$

CLASSIFICATION OF CARBOHYDRATES:

- Carbohydrates are also known as saccharides (Greek : sakcharon means sugar).

1. MONOSACCHARIDES:

→ Ribose, De-oxyribose, Glucose, Mannose, Galactose, fructose.

These are the simplest carbohydrates which cannot be hydrolysed to smaller molecules.
Their general formula is $(CH_2O)_n$ where n = 3 - 7.

2. OLIGOSACCHARIDES: (Greek, oligo means a few).

These are carbohydrates which on hydrolysis give 2 - 10 molecules of monosaccharides.
Based on number of units obtained, they are classified as di, tri, tetrasaccharides, etc.

(i) DISACCHARIDES: Carbohydrates which upon hydrolysis give two molecules of the same or different monosaccharides are called **disaccharides.**
For example, sucrose, maltose, lactose, etc. Their general formula is $C_{12}H_{22}O_{11}$.

(ii) TRISACCHARIDES: Carbohydrates which on hydrolysis give three molecules of the same or different monosaccharides are called **trisaccharides.**
For example, raffinose upon hydrolysis gives one molecule each of glucose, fructose and galactose. Their general formula is $C_{18}H_{32}O_{16}$.

extra point

(iii) TETRASACCHARIDES: Carbohydrates which upon hydrolysis give four molecules of the same or different monosaccharides are called **tetra saccharides.**
For example, stachyose upon hydrolysis gives one molecule each of glucose and fructose and two molecules of galactose. Their general formula is $C_{24}H_{42}O_{21}$.

3. POLYSACCHARIDES:

Carbohydrates which upon hydrolysis give a large number of monosaccharide molecules are called polysaccharides.

The most commonly occurring polysaccharides are **starch, cellulose and glycogen**.

Their general formula is $(C_6H_{10}O_5)_n$ where n = 100 - 3000.

Monosaccharides are the simplest carbohydrates which cannot be hydrolysed to smaller molecules. They contain 3 to 7 carbon atoms. There are about twenty monosaccharides which occur in nature. These are of two types :

(i) **ALDOSES:** Monosaccharides containing an aldehyde (—CHO) group are called aldoses. Since the aldehyde group is monovalent, therefore, it is always present at one end of the carbon chain, i.e., at C_1.

(II) **KETOSES:** Monosaccharides containing a keto (> C = O) group are called ketoses. Since the keto group is divalent, it can be present any where along the carbon chain. However, in all the naturally occurring ketoses, keto group is always present at a carbon atom next to the terminal carbon, i.e., at C_2.

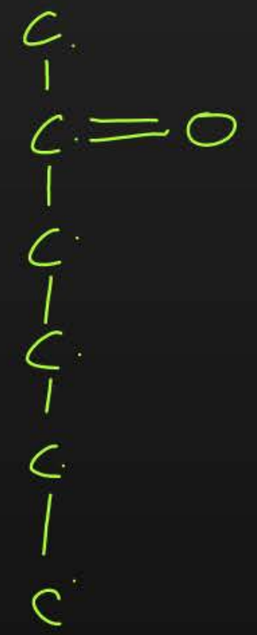
VIMP

ribose

Aldoses and ketoses are further classified as trioses, tetroses, pentoses, hexoses, heptoses, etc. according as they contain three, four, five six, seven, etc. carbon atoms respectively.

rbon atoms	General term	Aldehyde	Ketone
3	Triose	Aldotriose	Ketotriose
4	Tetrose	Aldotetrose	Ketotetrose
5	Pentose	Aldopentose	Ketopentose
6	Hexose	Aldohexose	Ketohexose
7	Heptose	Aldoheptose	Ketoheptose

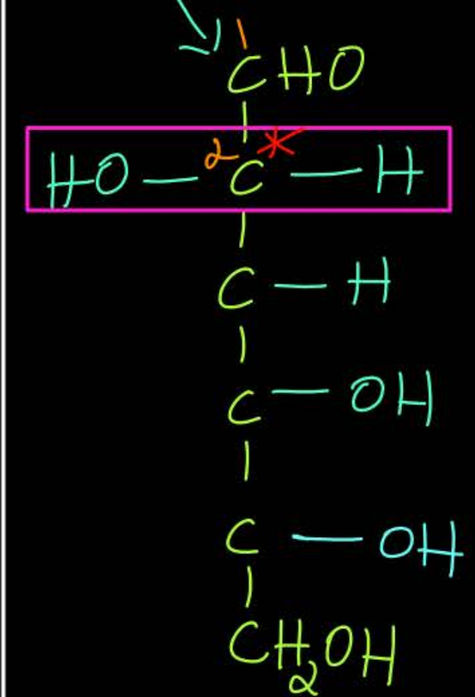
fructose



Carbon anomeric

Mannose

$C_6H_{12}O_6$

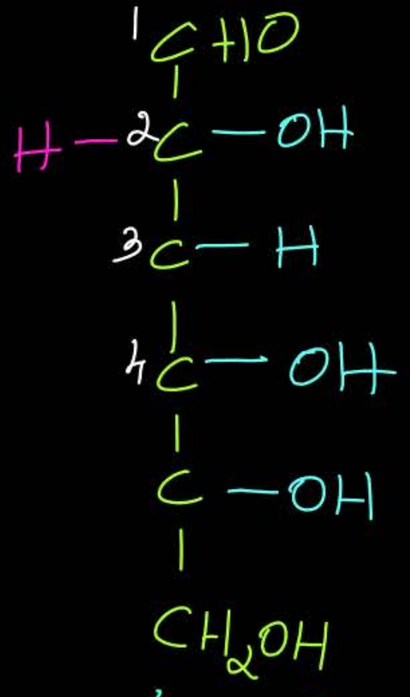


Aldohexose

Epimers

glucose

$C_6H_{12}O_6$

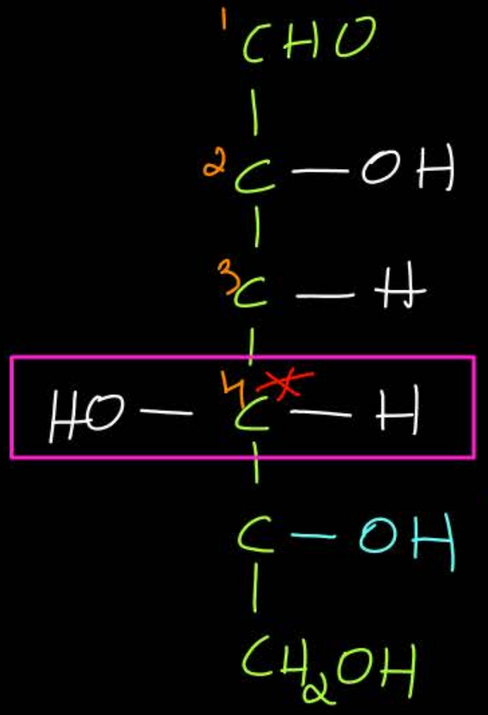


Aldohexose

Epimers

galactose

$C_6H_{12}O_6$



Aldohexose

Epimers

Epimers

- two monosaccharides differing in the configuration at any carbon other than anomeric carbon

Occurrence and Preparation of Glucose (Dextrose, Grape sugar) $C_6H_{12}O_6$

Preparation

(i) From sucrose (Cane-sugar):

When sucrose is hydrolyzed by boiling with dil. HCl or H_2SO_4 in alcoholic solution, an equimolar mixture of glucose and fructose is obtained.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{hydrolysis}]{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

Sucrose $\xrightarrow{\text{Invertase}}$ Glucose + fructose

(ii) FROM STARCH:

Commercially, glucose is obtained by hydrolysis of starch by boiling it with dil. H_2SO_4 at 393 K under pressure.

$$(C_6H_{10}O_5)_n + nH_2O \xrightarrow[393K;\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$$

Starch or cellulose — Glucose

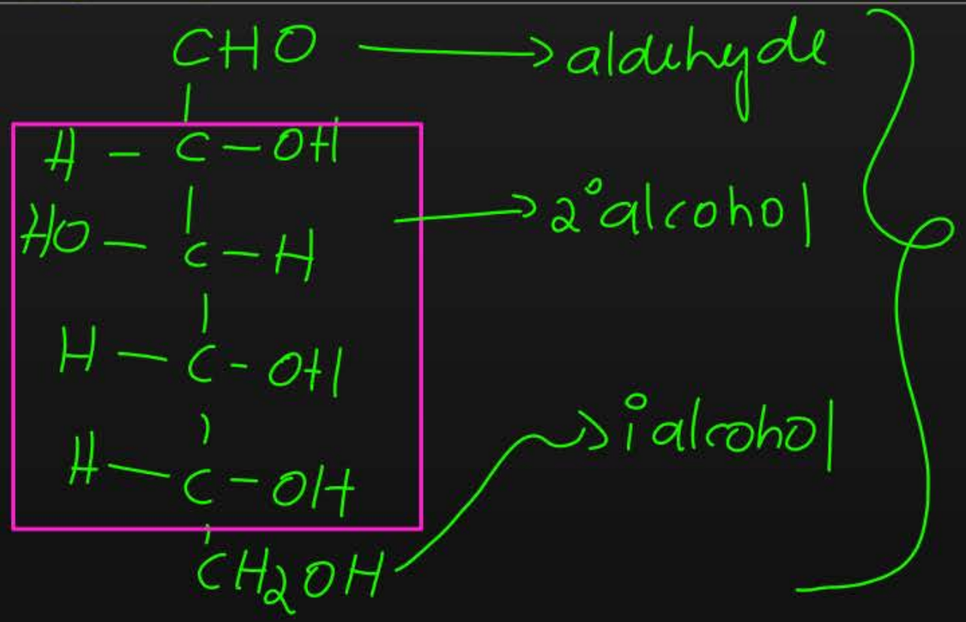
$(C_6H_{10}O_5)_n + nH_2O \xrightarrow{H^+} nC_6H_{12}O_6$

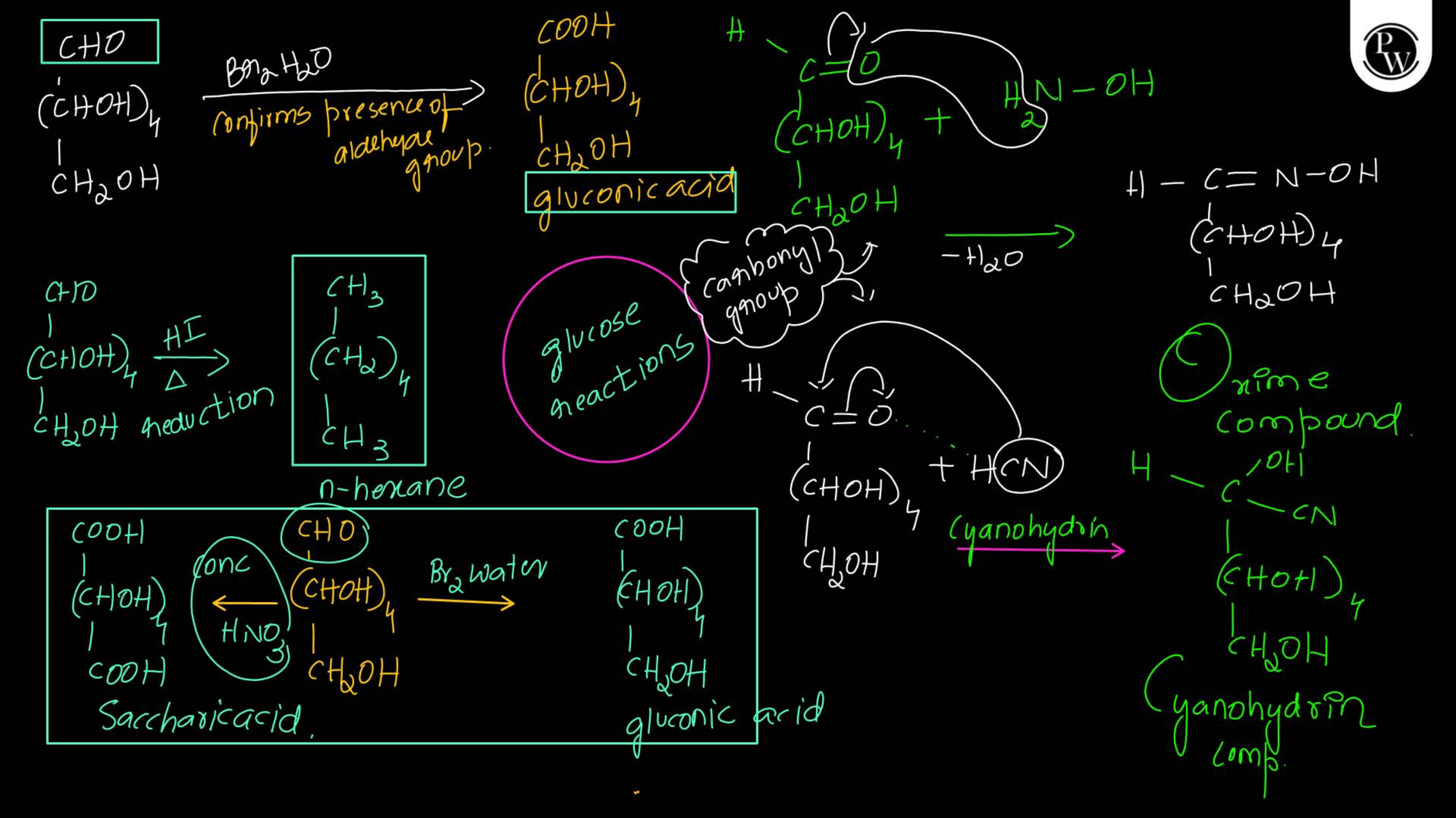
Starch / cellulose

Open Chain Structure of Glucose:

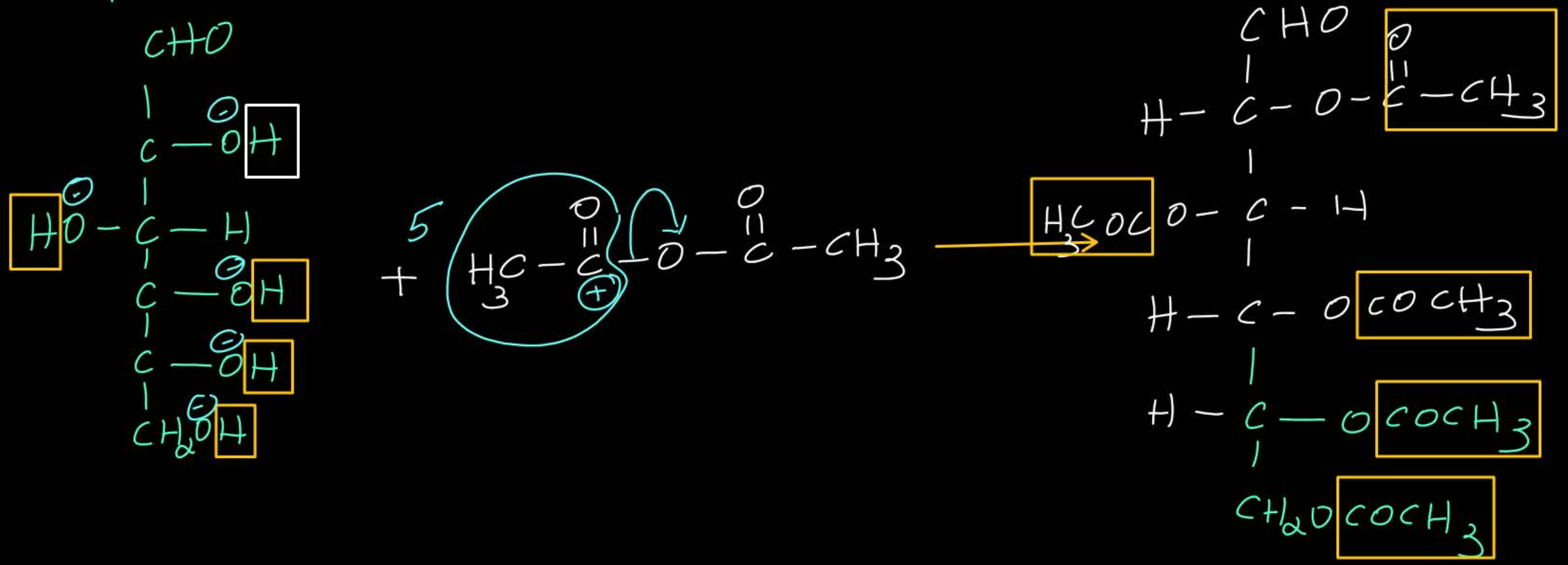
Glucose is an aldohexose. It is also called dextrose. It is the monomer of many polysaccharides such as starch, glycogen, cellulose, etc. It is probably the most abundant compound on the earth.

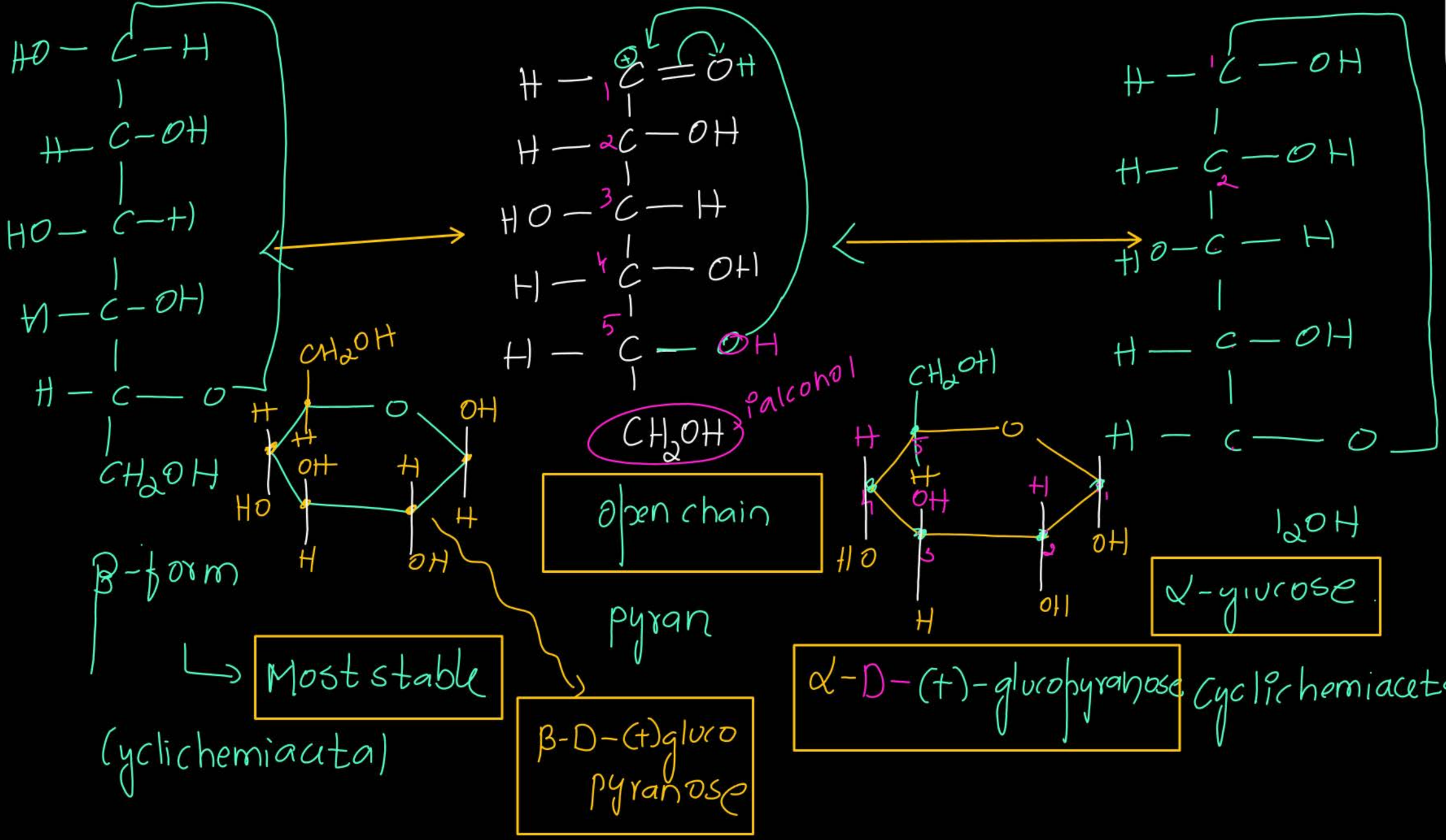
The open chain structure of glucose was proposed by Baeyer.
It contains one aldehyde (- CHO) group, one primary alcoholic (- CH_2OH) group and four secondary alcoholic (- CHOH) groups.




CHO
(CHOH)4
CH2OH
Br2 H2O
confirms presence of aldehyde group.
COOH
(CHOH)4
CH2OH
gluconic acid
H
C=O
(CHOH)4
CH2OH
+
H2N-OH
-H2O
H-C=N-OH
(CHOH)4
CH2OH
glucose reactions
carbonyl group
CHO
(CHOH)4
CH2OH
HI
Δ
reduction
CH3
(CH2)4
CH3
n-hexane
H
C=O
(CHOH)4
CH2OH
+ HCN
cyanohydrin
oxime compound.
H
C
OH
CN
(CHOH)4
CH2OH
cyanohydrin comp.
COOH
(CHOH)4
COOH
Saccharicacid.
conc HNO3
CHO
(CHOH)4
CH2OH
Br2 water
COOH
(CHOH)4
CH2OH
gluconic acid

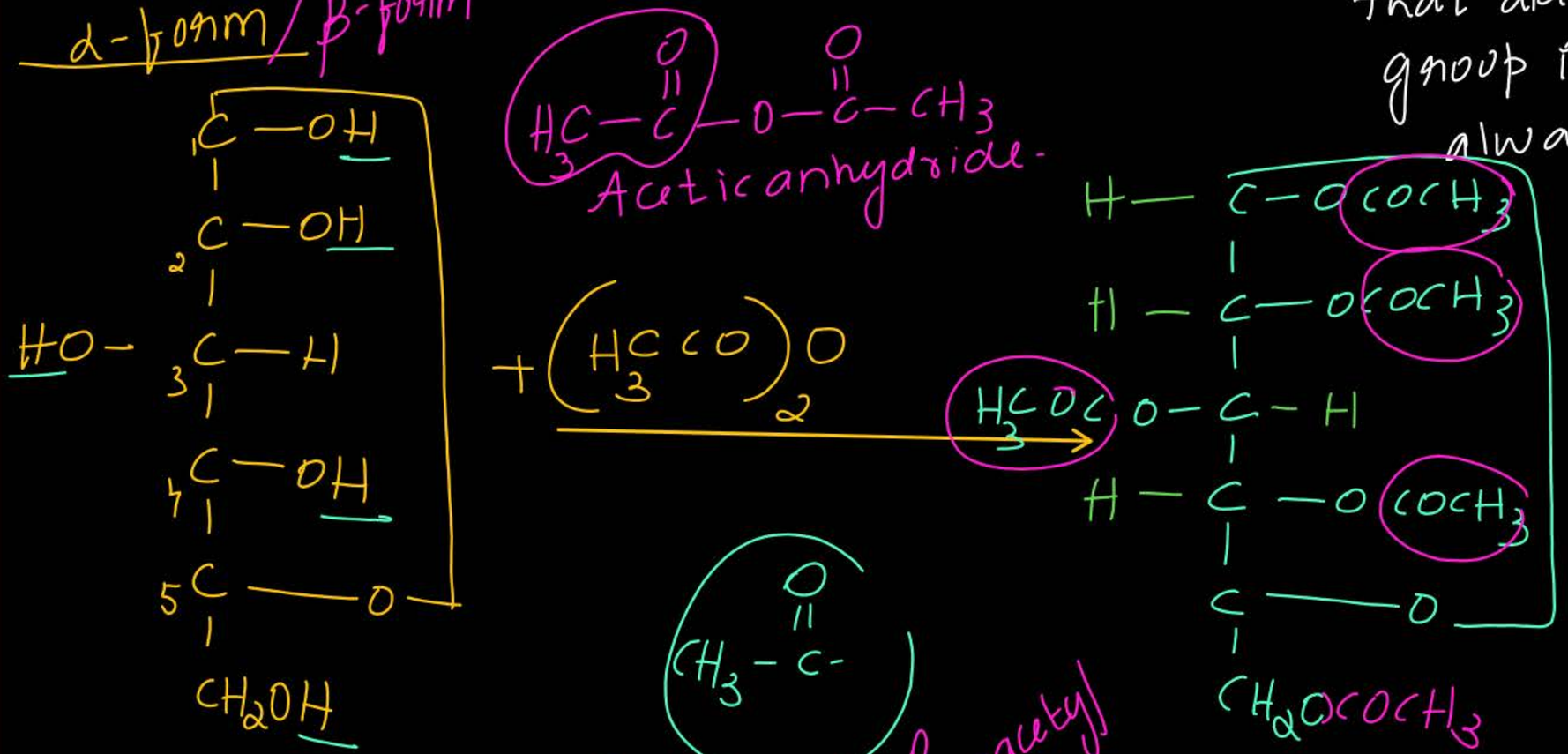
pentacetate ⟶ confirms ⟶ 5 OH group.




β-form
Most stable
(yclichemiacutal)
β-D-(+)gluco pyranose
pyran
open chain
1° alcohol
α-D-(+)-glucopyranose
Cyclichemiacetal
α-glucose

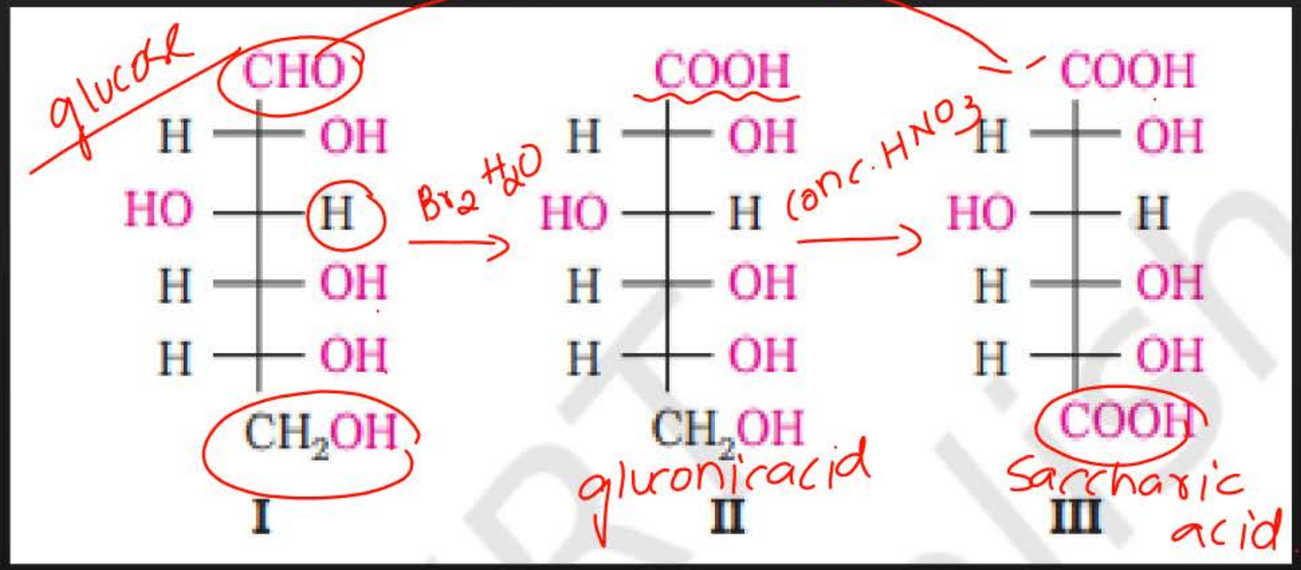
Cyclic structure of pentaacetate glucose molecule do not react with hydrazine or HCN ⟶ This confirms that aldehyde group is not always free

α-form / β-form



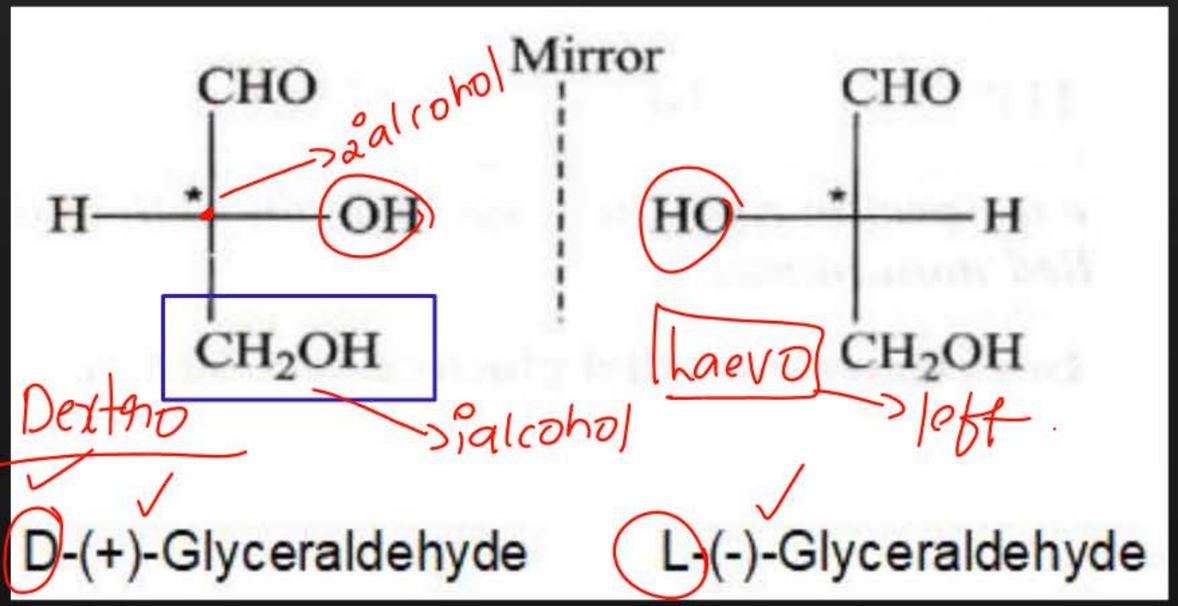
OPEN CHAIN STRUCTURE OF GLUCOSE:

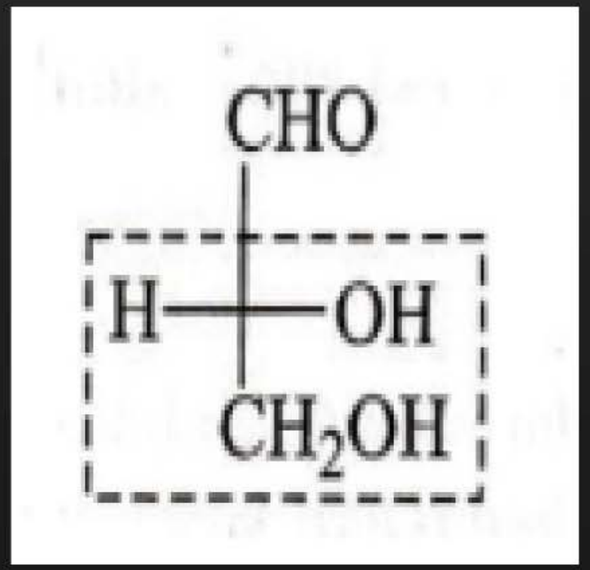
The exact configuration of glucose is represented as I.
So, gluconic acid must have configuration II and saccharic acid configuration III.



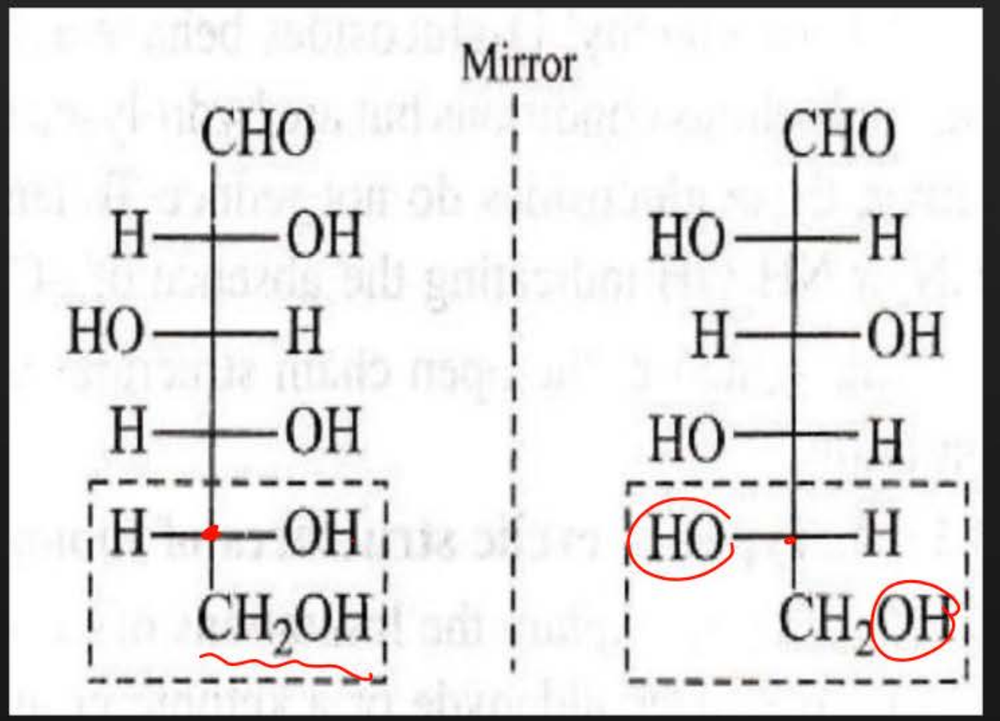
D and L-Configurations:

To assign D and L-configurations to monosaccharides, the simplest carbohydrate, glyceraldehyde, is chosen as the standard. It contains one chiral carbon atom and hence exists in two enantiomeric forms as shown below:





D-(+)-Glyceraldehyde



D-(+)-Glucose L-(-)-Glucose

Cyclic Structure of D-Glucose:

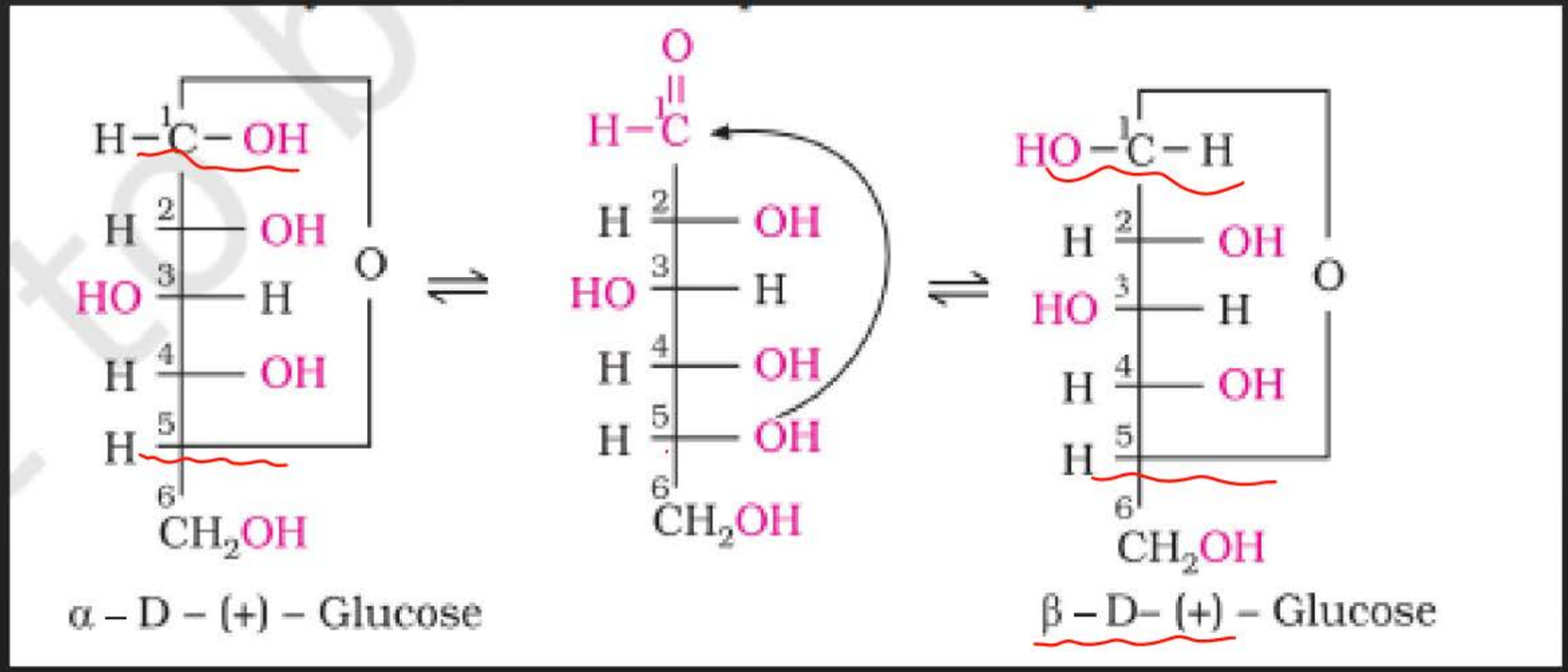
LIMITATION OF THE OPEN CHAIN STRUCTURE:

Although the open chain structure of D-(+)-glucose explains most of its reactions, yet it fails to explain the following facts :

1. D-(+)-GIucose does not undergo certain characteristic reactions of aldehydes:
For example, glucose does not form $NaHSO_3$ addition product, aldehyde-ammonia adduct, 2, 4-DNP derivative.

2. Glucose reacts with NH_2OH to form an oxime but glucose pentaacetate does not. This implies that the aldehyde group is absent in glucose pentaacetate.

- D-(+)-Glucose exists in two stereoisomeric forms, i.e., α-glucose and β-glucose.
- α-D-(+)- Glucose is obtained when a concentrated aqueous or alc solution is crystallised at 303 K. It has a m.p. of 419 K and has a specific rotation of + 111° in a freshly prepared aqueous solution.
- *However, when glucose is crystallised from water above 371 K, β-D-(+)-glucose is obtained. It has a m.p. of 423 K and has a specific rotation of + 19.2° in a freshly prepared aqueous solution.*

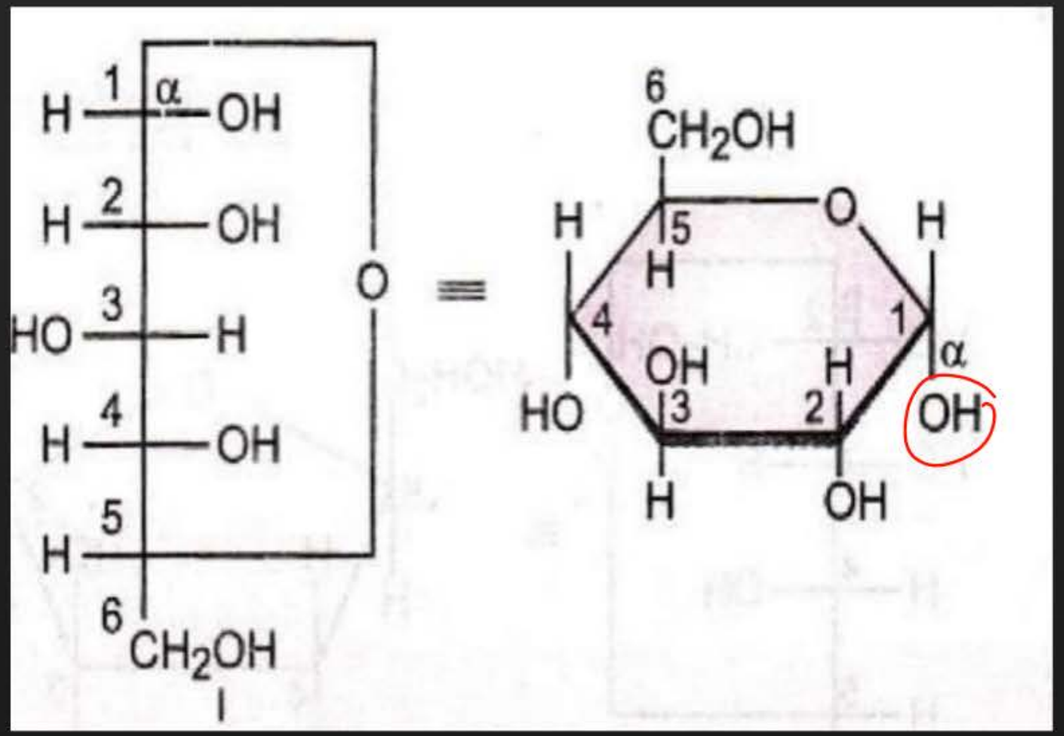


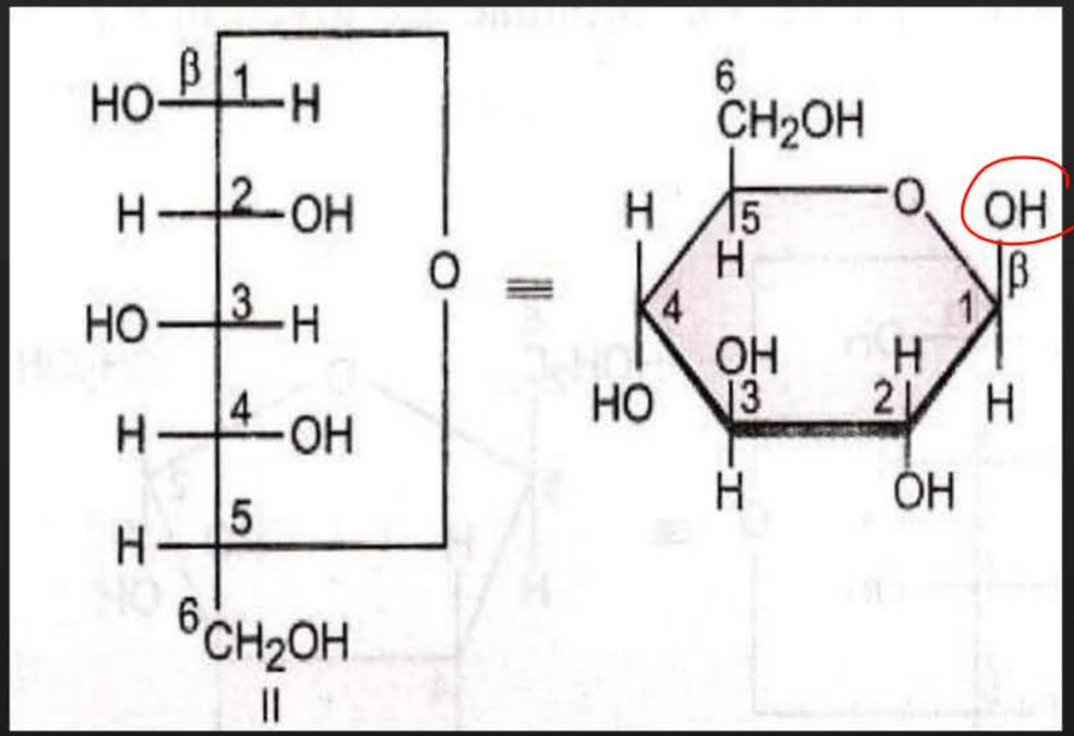
α-D-(+)-Glucose	⇌	Equilibrium mixture	⇌	β- D-(+)-Glucose
$[\alpha]_D^{298\,K}$ = +111°		$[\alpha]_D^{298\,K}$ = +52.5°		$[\alpha]_D^{298\,K}$ = +19.2°

α-D-(+)-Glucose or α-D-(+)-Glucopyranose (36%)	D-(+)-Glucose (< 0.5%) (Open chain form)	β-D-(+)-Glucose or β-D-(+)-Glucopyranose (64%)

This spontaneous change in specific rotation of an optically active compound with time, to an equilibrium value, is called mutarotation.

HAWORTH PROJECTION FORMULAE OF MONOSACCHARIDES:





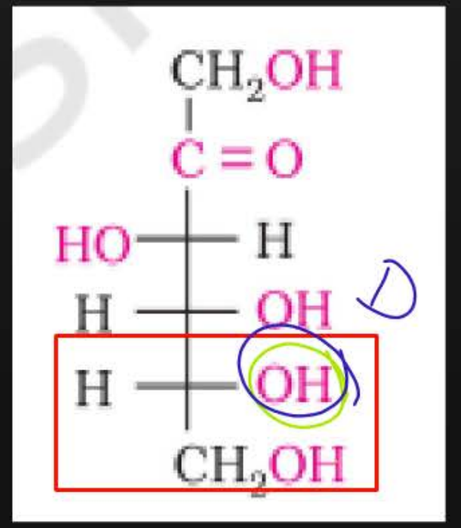
Fischer projection	Haworth structure	Fischer projection	Haworth structure
α-D-(+)-Glucopyranose		β-D-(+)-Glucopyranose	

- Fructose is the most important of all the ketoses. It occurs free along with glucose in honey and sweet fruits and hence the name fruit sugar.

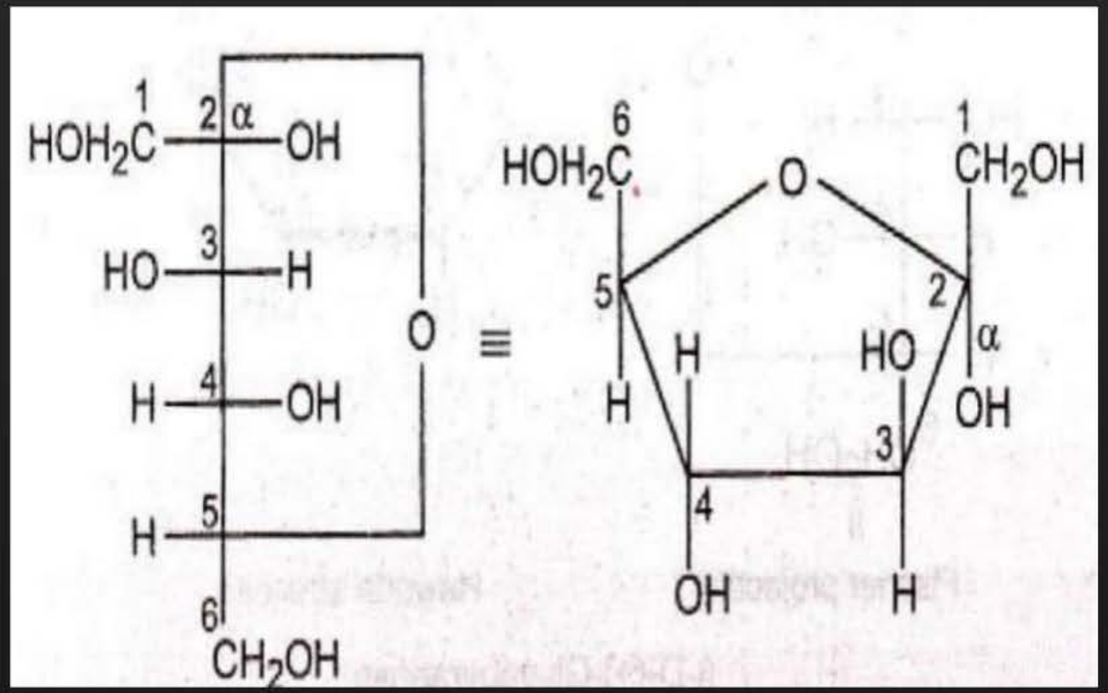
- Fructose is obtained along with glucose by the hydrolysis of disaccharide, sucrose. Its molecular formula is $C_6H_{12}O_6$.

- On the basis of its reactions, it has been established that fructose contains a keto group at C-2 and the six carbon atoms are arranged in a straight chain as in case of glucose.

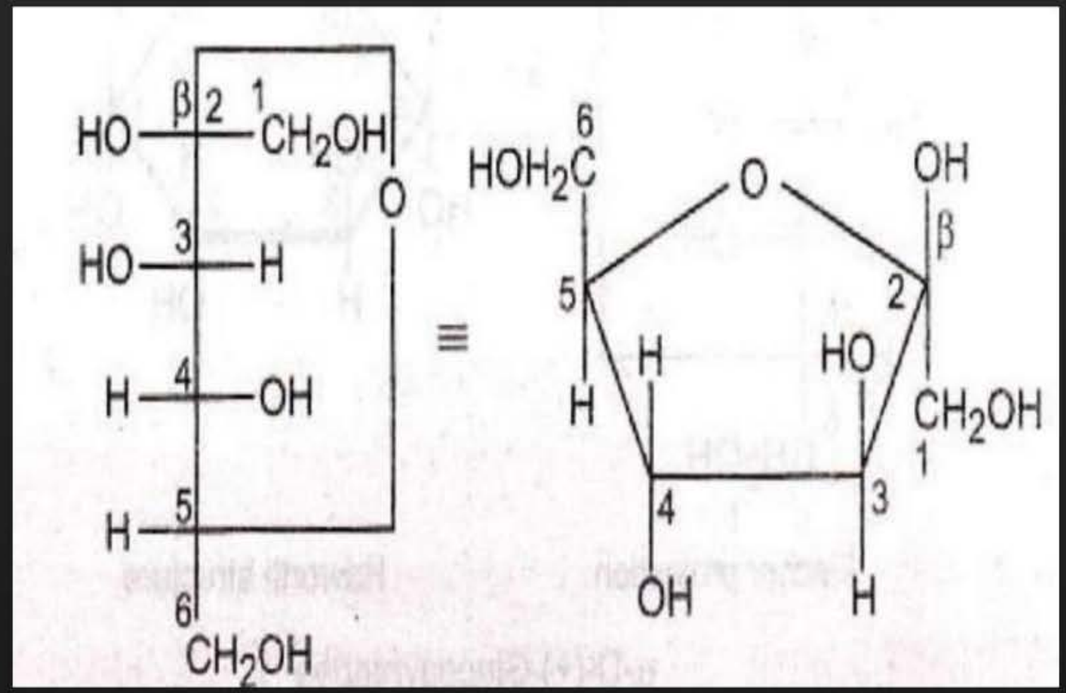
- It belongs to D-series and is laevorotatory. Therefore, its correct name is D-(-)- fructose.



CYCLIC STRUCTURE OF FRUCTOSE:

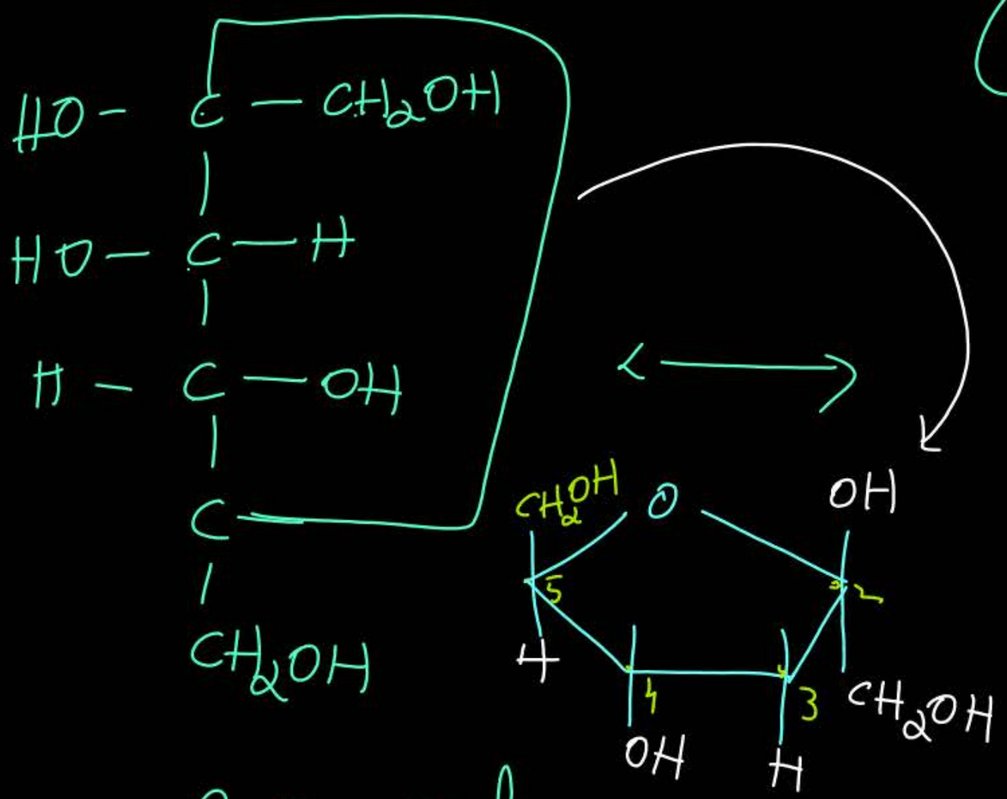


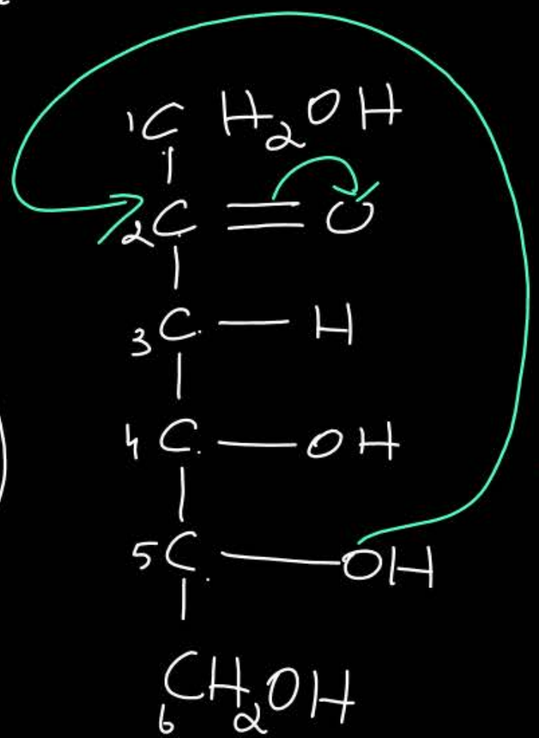
α - D - (-) - Fructofuranose

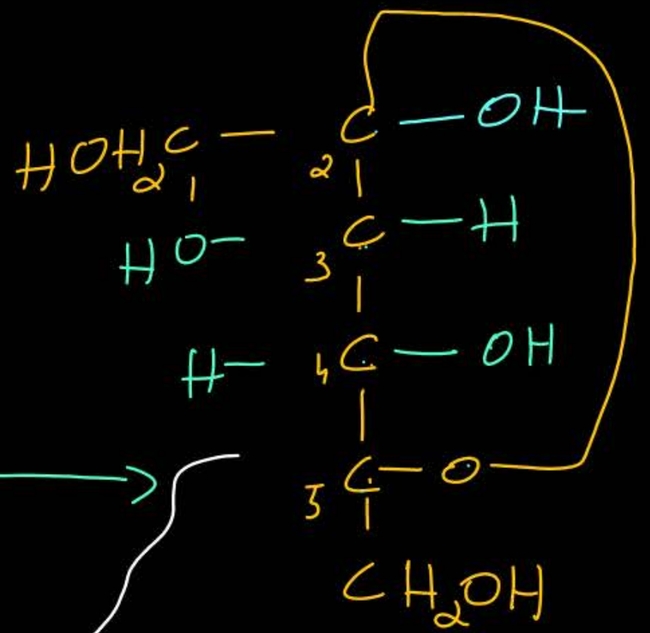


β - D - (-) - Fructofuranose

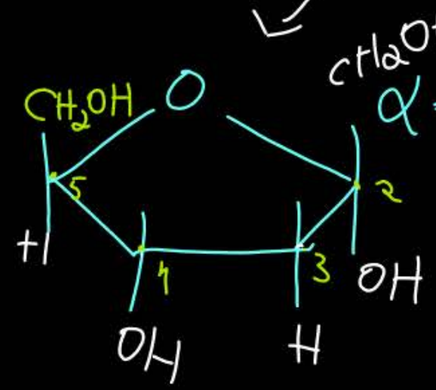
Fructose $\longrightarrow C_6H_{12}O_6$







β-D-(-) fructose.



α-D-(-) fructose.

- The two monosaccharide units are joined together through an ethereal or oxide linkage formed by loss of a molecule of H_2O.
- Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.

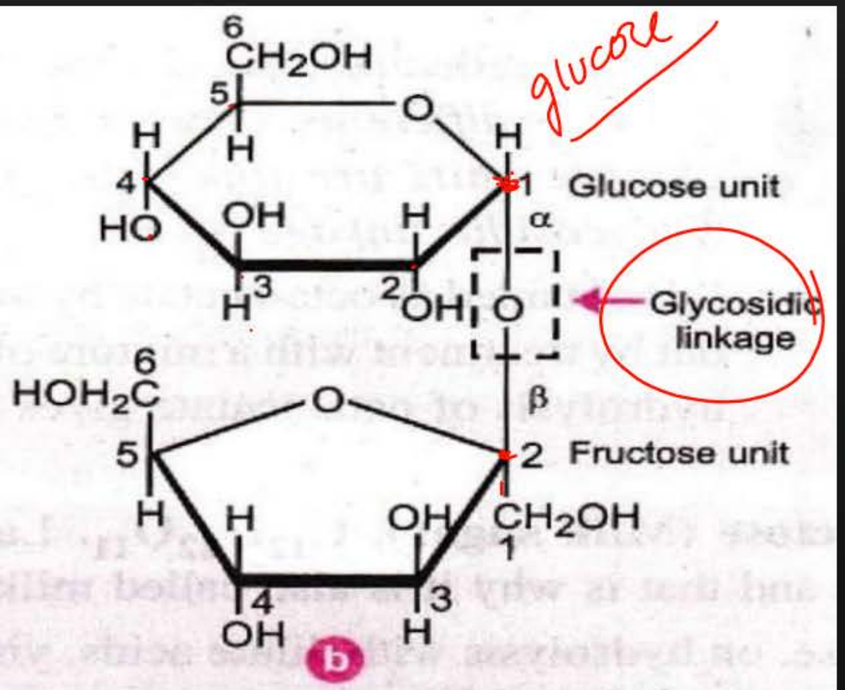
- Depending upon the position of linkages between the two monosaccharide units, the disaccharide may be reducing or non-reducing.
- If the two monosaccharide units are linked through their respective carbonyl groups (i.e. reducing centres), the disaccharide is said to be non-reducing, e.g., sucrose.
- On the other hand, if the carbonyl group of any one of the two monosaccharide units is free, the disaccharide is said to be reducing, e.g., maltose, lactose.

1. SUCROSE, CANE-SUGAR (TABLE SUGAR),

glucose + fructose

$C_{12}H_{22}O_{11}$	$+ H_2O$	$\xrightarrow{HCl}$	$C_6H_{12}O_6$	+	$C_6H_{12}O_6$
			invert sugar		
Sucrose			D-Glucose		D-Fructose
$[\alpha]_D = + 66.5°$			$[\alpha]_D = + 52.5°$		$[\alpha]_D = - 92.4°$

STRUCTURE:



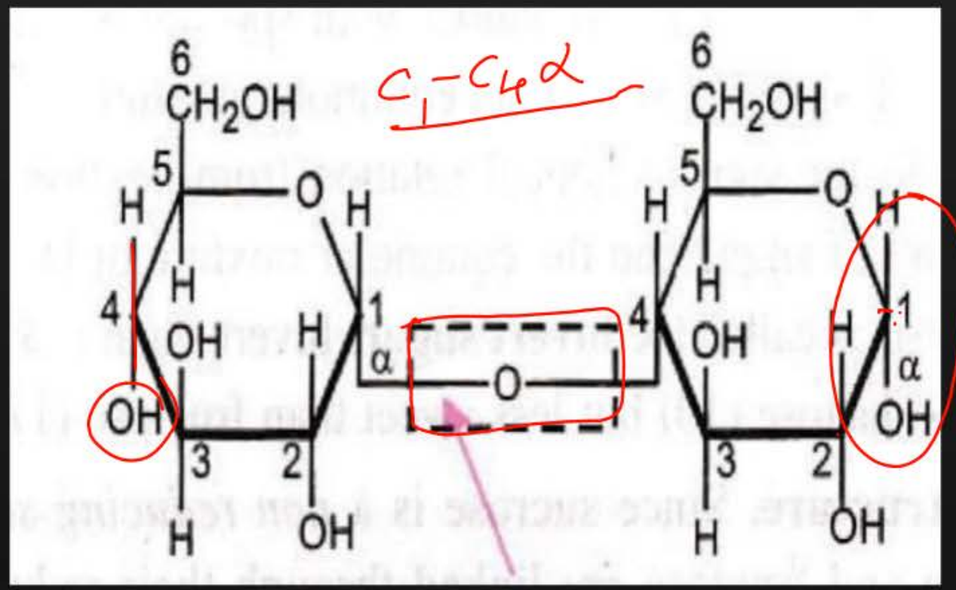
Ag+
Cu2+

2. Maltose (Malt sugar), $C_{12}H_{10}O_{11}$

It is obtained by partial hydrolysis of starch by the enzyme diastase present in malt, i.e., sprouted barley seeds.

$2\,(C_6H_{10}O_5)_n$	$+\ n\ H_2O$	Diastase →	$n\ C_{12}H_{22}O_{11}$
Starch			Maltose

α-glucose + α-glucose



(I)	(III)
α - D - Glucose	α - D - Glucose

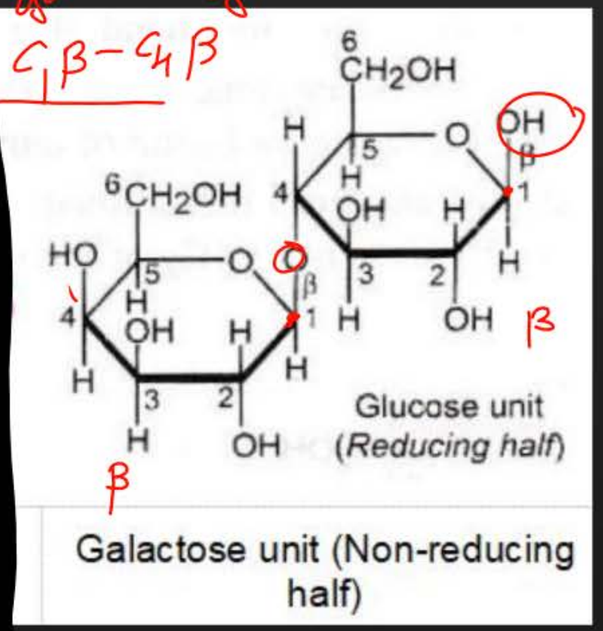
Ag⊕ → Ag

Cu2+ → Cu+1

CHO

3. Lactose (Milk sugar), $C_{12}H_{22}O_{11}$.

Lactose occurs in milk (6-8% in human milk and 4-5% in cow's milk) and that is why it is also called milk sugar.



- Both glucose and galactose are present in the pyranose form.
- Glucose is the reducing half while galactose is the non-reducing half.
- C_1 of galactose unit is connected to C_4 of glucose unit.

$[Ag(NH_3)_2]^{+} \longrightarrow Ag\downarrow$

Glucose ✓ galactose ✓
Maltose ✓ Mannose ✓
Lactose ✓
fructose ✓

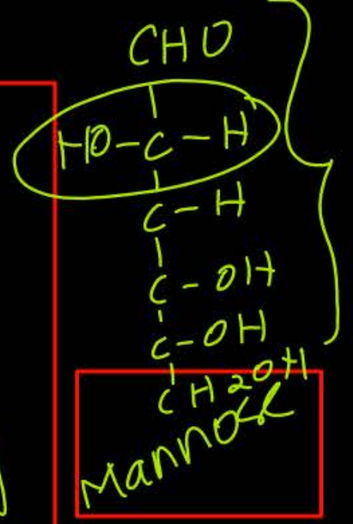
} Reducing Sugars

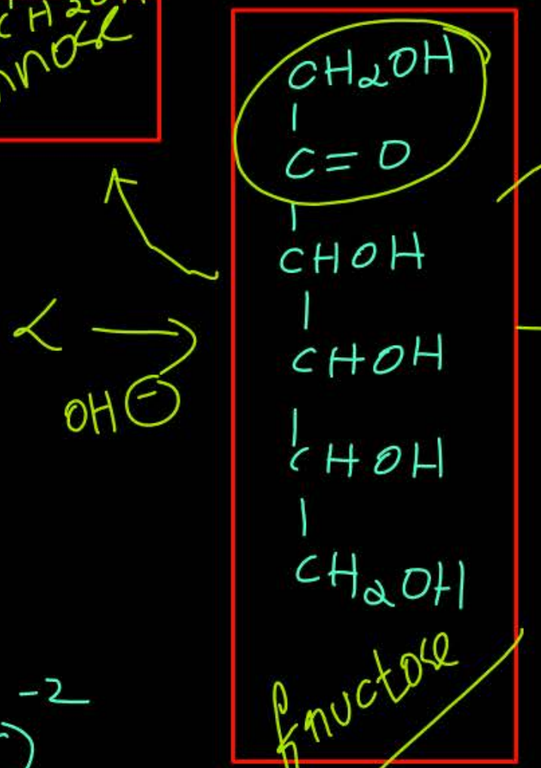
Only Surrose → do not reduce.

Tollen's reagent (Ag^{+})

Fehling solu $\longrightarrow Cu^{2+} \longrightarrow Cu^{+1}O^{-2}$

Benedict solution $\longrightarrow Cu^{2+} \longrightarrow CuI \longrightarrow Cu_2O$ (brown)





OH^{-}

strong OH^{-}

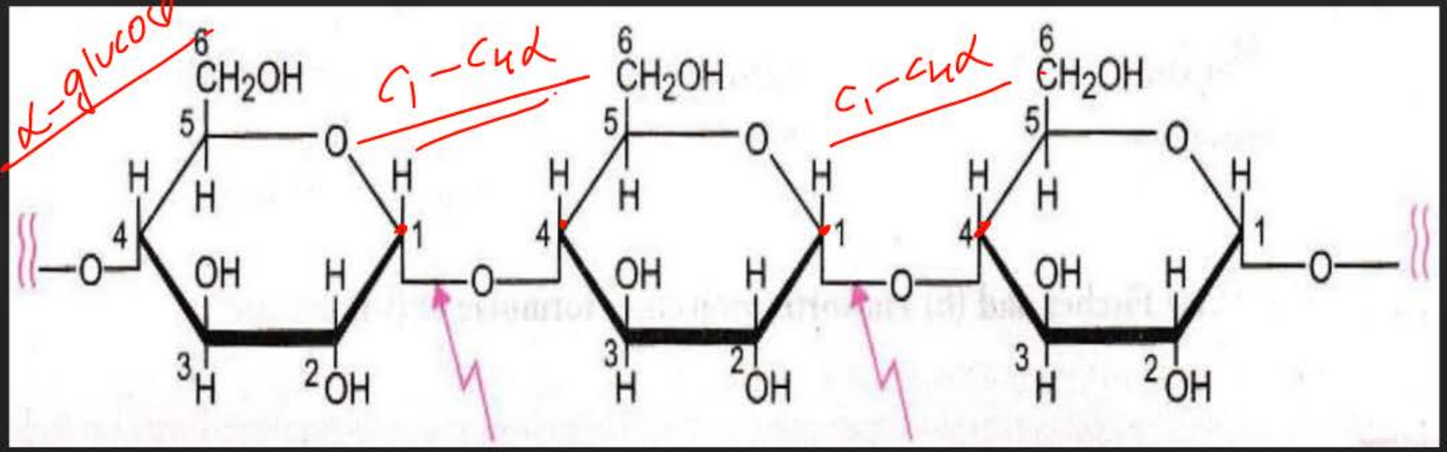
glucose

1. STARCH $(C_6H_{10}O_5)_n$

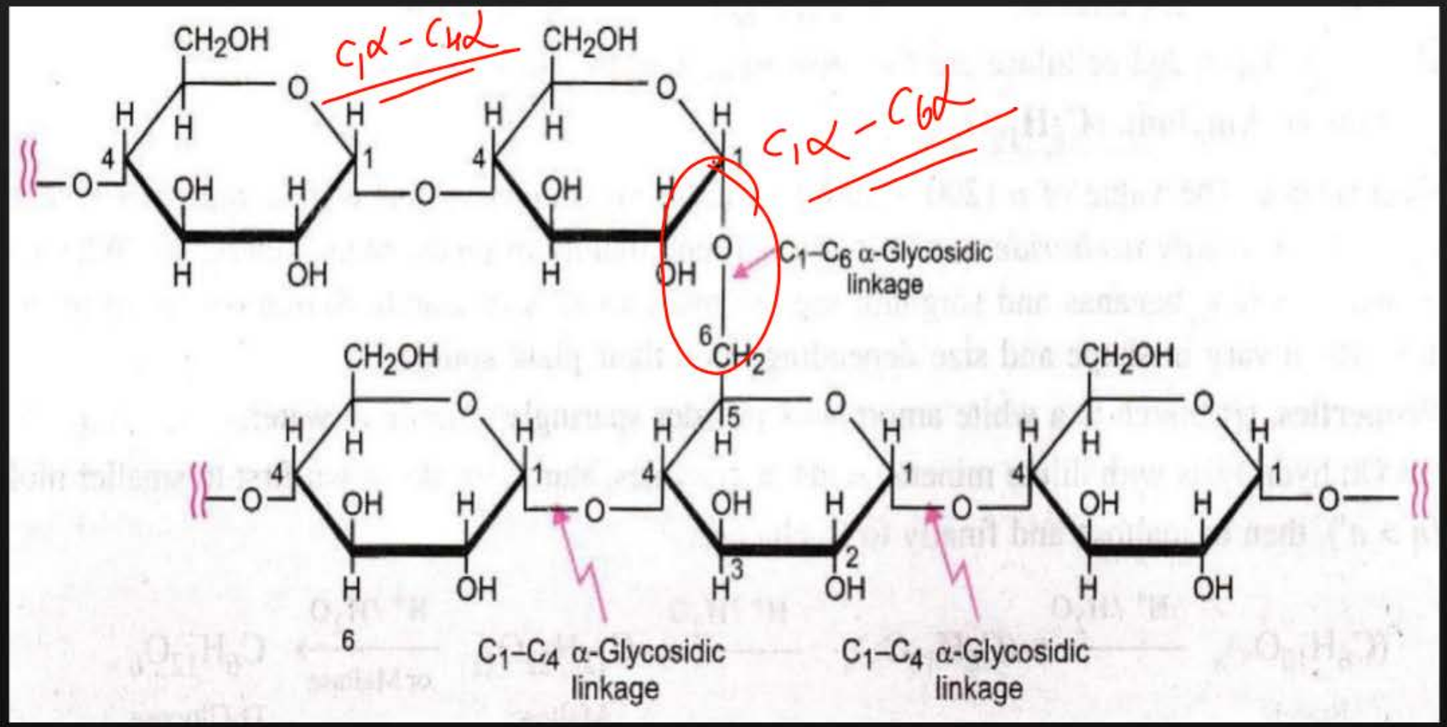
- Starch is not a single compound but is a mixture of two components –
- a water soluble component called amylose (15-20%)
- and a water insoluble component called amylopectin (80-85%).

Both amylose and amylopectin are polymers of α-D-(+)- glucose. A molecule of amylose may contain 200-1000 units whereas a molecule of amylopectin may contain 2000-3000 glucose units.

STRUCTURE OF AMYLOSE



STRUCTURE OF AMYLOPECTIN



Starch is a non-reducing saccharide.

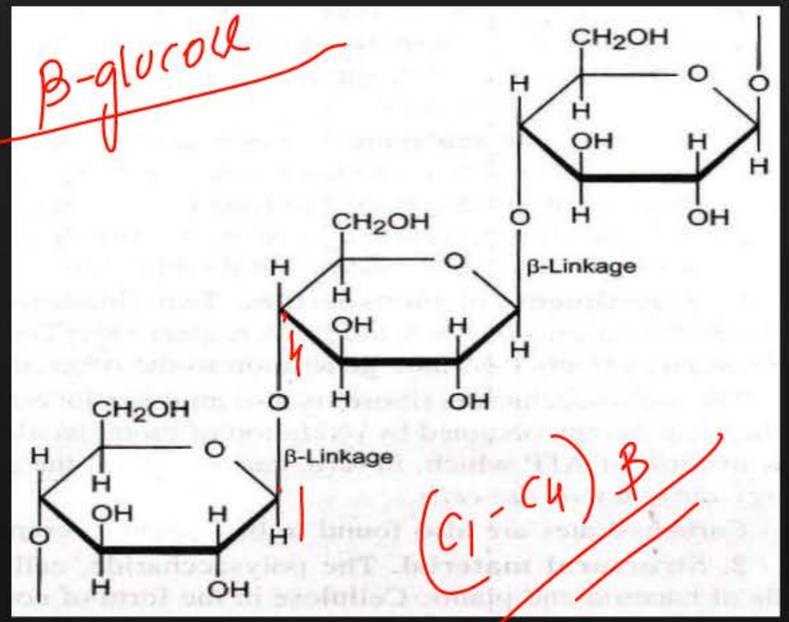
This suggests that all hemiacetal OH groups of glucose units at C_1 are not free but are involved in glycosidic linkages.

Starch, rellulose
glucose, Sucrose
→ Non reducing.

2. Cellulose, $(C_6H_{10}O_5)_n$

- The molecular mass of cellulose varies from 50,000 to 500,000 suggesting thereby that cellulose may contain 300-3000 glucose units.

- Like starch, cellulose is also non-reducing since it does not reduce Tollens' reagent or Fehling's solution.
- Cellulose is a linear condensation of polymer of β-D-glucose in which C_1 of one glucose unit is connected to C_4 of the other through β- D-glycosidic linkage.



3) GLYCOGEN: $(C_6H_{10}O_5)_n$

→ Amylopectin → α-D-glucose

- Like starch, glycogen is also a condensation polymer of α-D-glucose. It is hydrolysed by the enzyme β-amylase to form maltose.
- Just as glucose is stored in plants as starch, it is stored as glycogen in the liver and muscles of human beings. It is also present in brain.
- When the body needs glucose during fasting or strenuous exercise, the enzymes break down glycogen to provide glucose.

IMPORTANCE OF CARBOHYDRATES:

The main functions and uses of carbohydrates are described below :

1. Living systems:

(a) Biofuels: Carbohydrates are essential for life in both plants and animals. They form a major portion of our food. Honey has been used for a long time as an instant source of energy by Voids in Ayurvedic system of medicine. Thus, carbohydrates provide energy for the functioning of living systems and thus act as biofuels.

(b) Reserve food material: The polysaccharide starch is the major reserve food material in plants. It is stored in seeds and acts as the reserve food material for the tiny plant till it is capable of making its own food by photosynthesis.

2. Structural material:

The polysaccharide, cellulose, acts as the chief structural material of cell walls of bacteria and plants. Cellulose in the form of cotton is used for making clothes and cellulose in the form of wood is used for making furniture, doors, windows, etc.

3. Industrial material: Carbohydrates provide us raw materials for many industries like textiles, paper etc

Disaccharides

Sucrose → $C_1\alpha$ (α glucose) — $C_2\beta$ (β fructose) → Non reducing

Maltose → $C_1\alpha - C_4\alpha$ (α glucose)

Lactose → $C_1\beta - C_4\beta$ → glucose
- L → galactose

} reducing.

Polysaccharides

Starch
- Amylose → $C_1\alpha - C_4\alpha$
- Amylopectin → $C_1\alpha - C_4\alpha$, $C_1\alpha - C_6\alpha$ ($C_1 - C_4\alpha$, $C_1 - C_6\alpha$)

Cellulose → $C_1\beta - C_4\beta$ ($C_1 - C_4$) β

glucogen → amylopectine → α linkages → $C_1 - C_4\alpha$, $C_1 - C_6\alpha$

} Non reducing

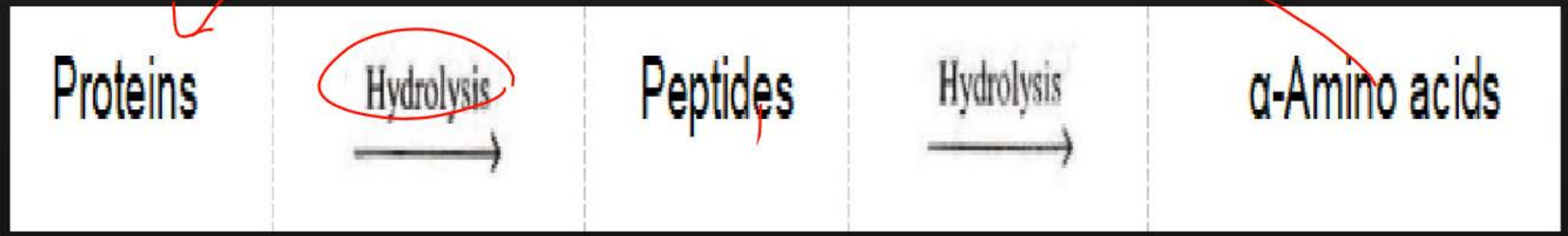
PROTEINS:

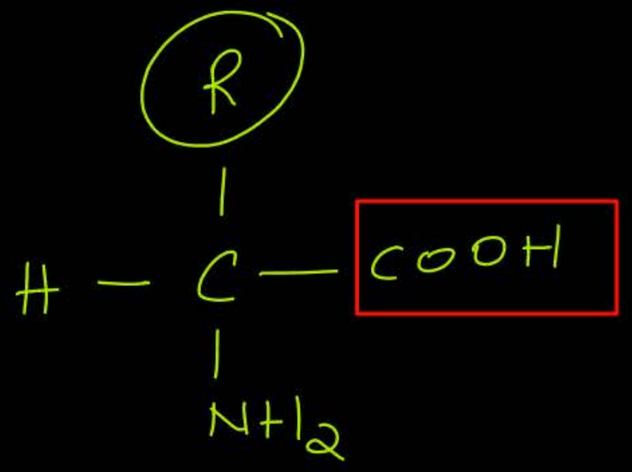
The chief sources of proteins are milk, cheese, pulses, peanuts, fish, meat, etc.

These are high molecular mass complex biopolymers of α-amino acids.

The name protein is derived from the Greek word proteios meaning prime importance.

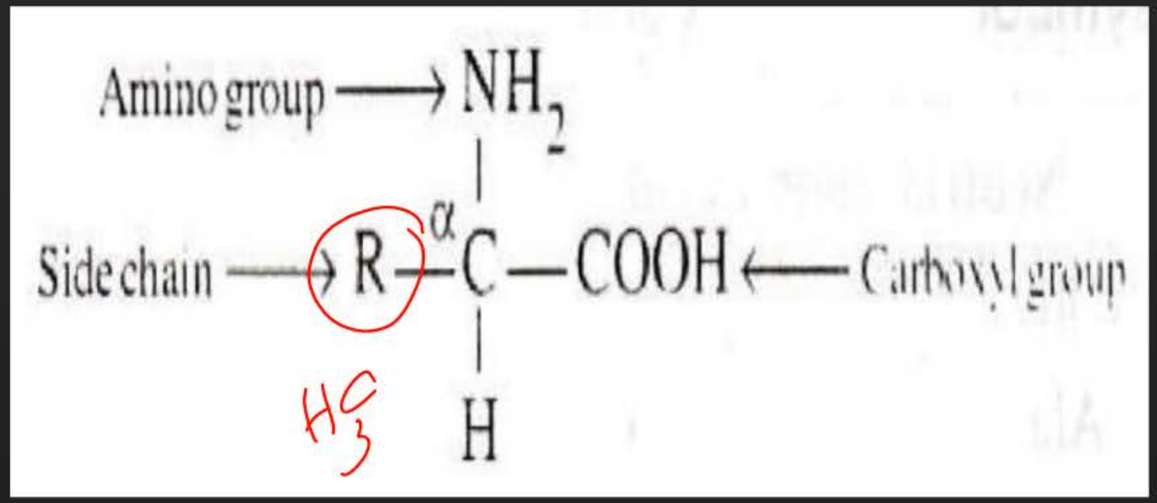
Chemically proteins are condensation polymers (actually polyamides) in which the monomeric units are the α-amino acids.





α- Aminoacids

α-Amino Acids

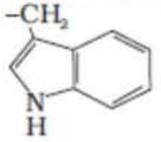
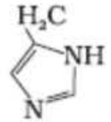
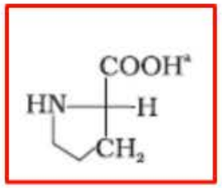


Only α-amino acids are obtained by hydrolysis of proteins.
Thus, α-amino acids are the building blocks of proteins.

Twenty six different α-amino acids have been isolated by the hydrolysis of various proteins.
Out of these, 20 amino acids occur in almost all the proteins while the remaining 6 are found in special tissues.

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

Aromatic
Phenylalanine
Tyrosine
Tryptophan
Histidin.

Acidic
glutamic acid
Aspartic acid.

Basic
→ Arginine
→ Lysine
→ Histidine.

Name	Acidic	Basic	Neutral
Alanine			√
Arginine		√	
Asparagine			√
Aspartic acid	√		
Cysteine			√
Glutamic acid	√		
Glutamine			√
Glycine			√
Histidine		√	
Isoleucine			√
Leucine			√
Lysine		√	
Methionine			√
Phenylalanine			√
Proline			√
Serine			√
Threonine			√
Tryptophan			√
Tyrosine			√
Valine			√

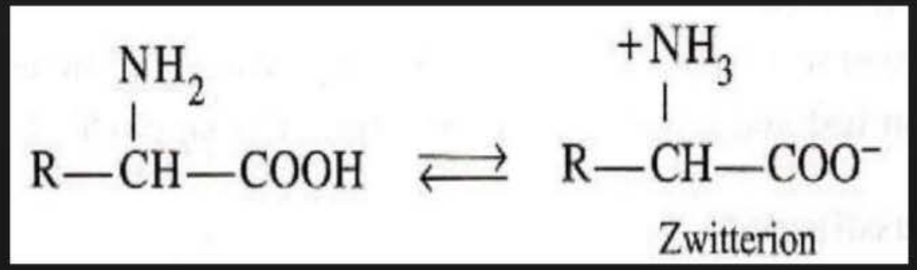
PHYSICAL PROPERTIES OF α-AMINO ACIDS

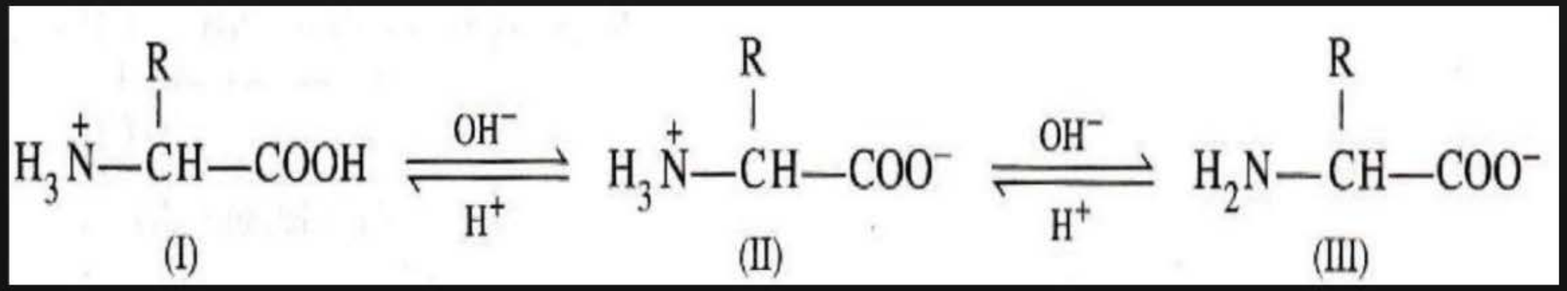
TLC → Ninhydrin

(i) Amino acids are usually colourless, non-volatile crystalline solids which melt with decomposition at fairly high temperatures.

(ii) They are insoluble in non-polar solvents like petroleum ether, benzene or ether but are appreciably soluble in water.

(iii) Their aqueous solutions behave like solution of substances of high dipole moment.





Each amino acid has a characteristic isoelectric point.

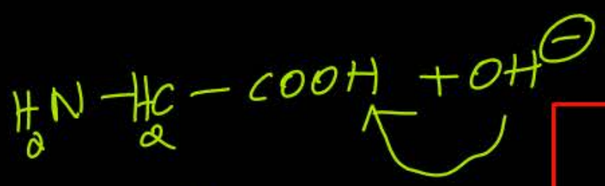
For neutral amino acids, isoelectric point is slightly less than pH 7 (glycine = 6.1), for acidic amino acids, it lies between pH 3.0-5.4 (aspartic acid = 3.0) and for basic amino acid, it lies between pH 7.6-10.8 (lysine = 9.7)

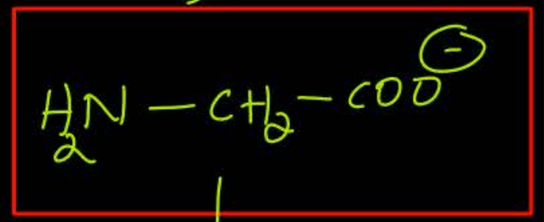
At isoelectric point, an amino acid has the least solubility in water and hence this property has been used in the separation of different amino acids obtained from the hydrolysis of proteins.

CONFIGURATION:

The α-carbon of all the amino acids (except glycine) is chiral (asymmetric) and hence amino acids can exist in two stereoisomeric forms, i.e., D and L. However, all the naturally occurring amino acids belong to the L-series.

Basic medium · pH > 7



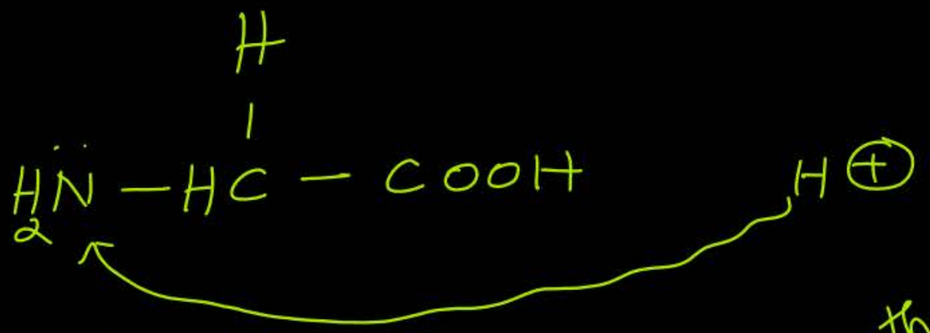


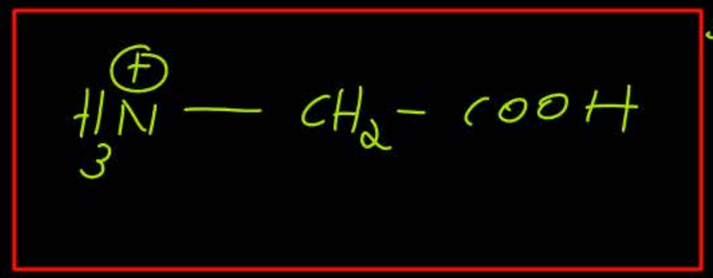
anion

↓

Anode.

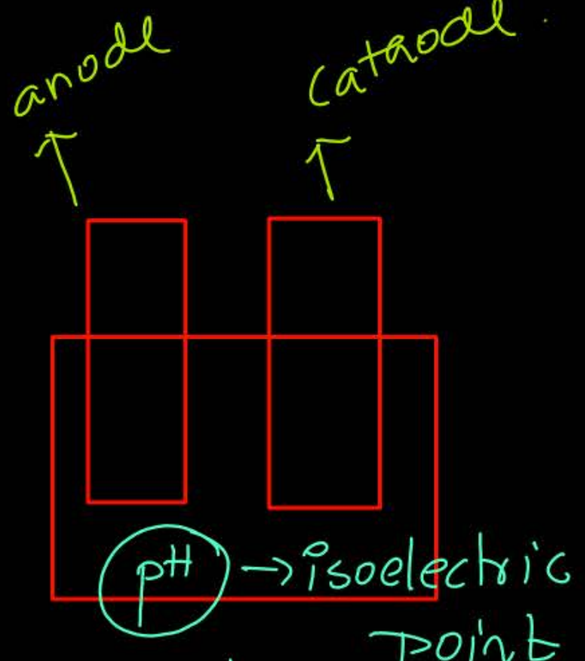
Acidic medium pH < 7





→ cathode

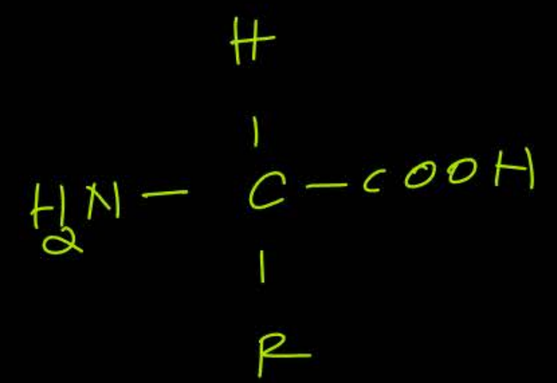
→ cations.



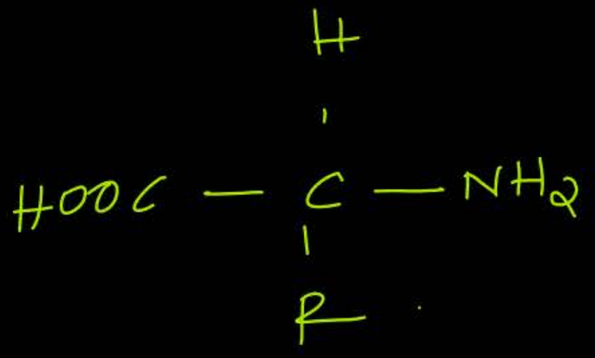
↓

Aminoacid stops migrating

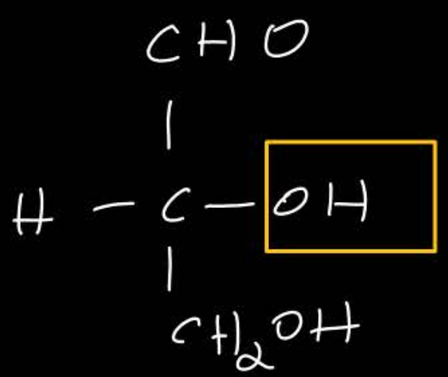
Configuration.



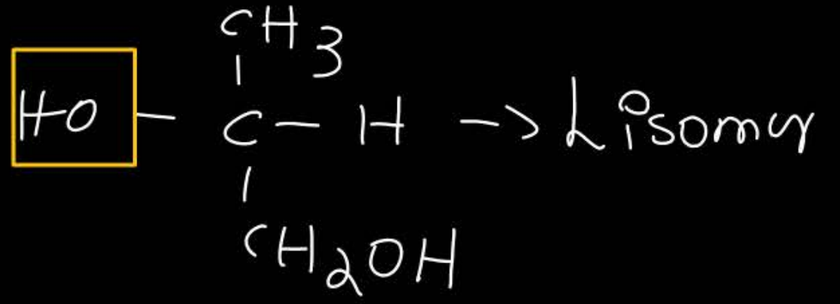
L aminoacid



D-amino acid

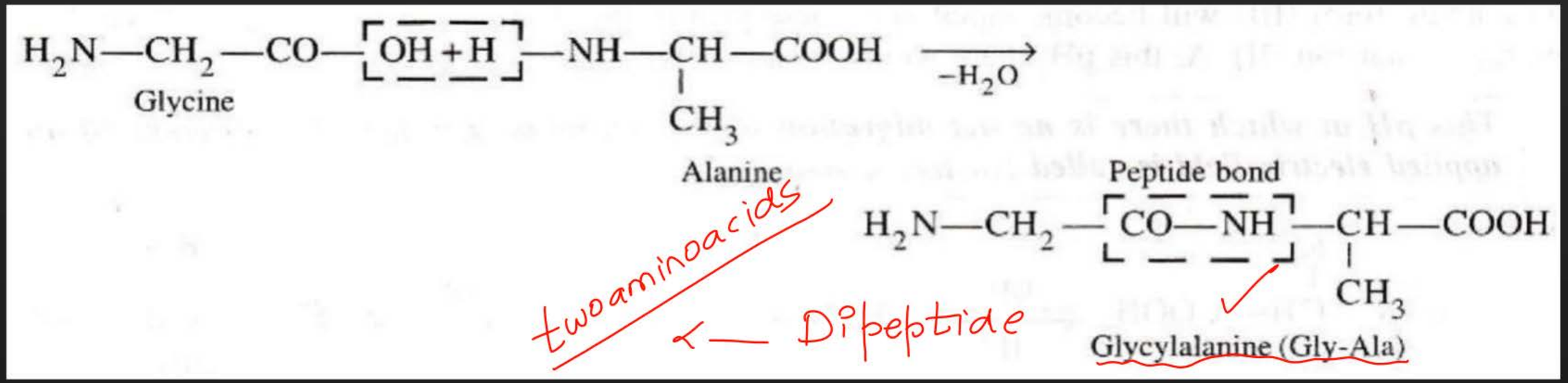


D isomer.

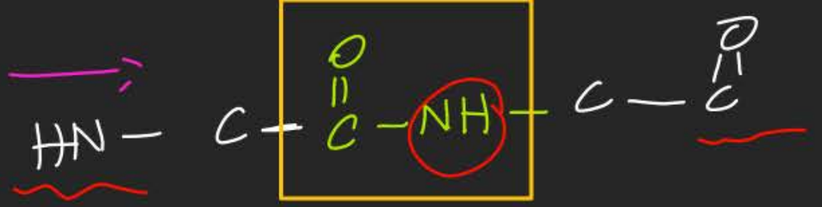


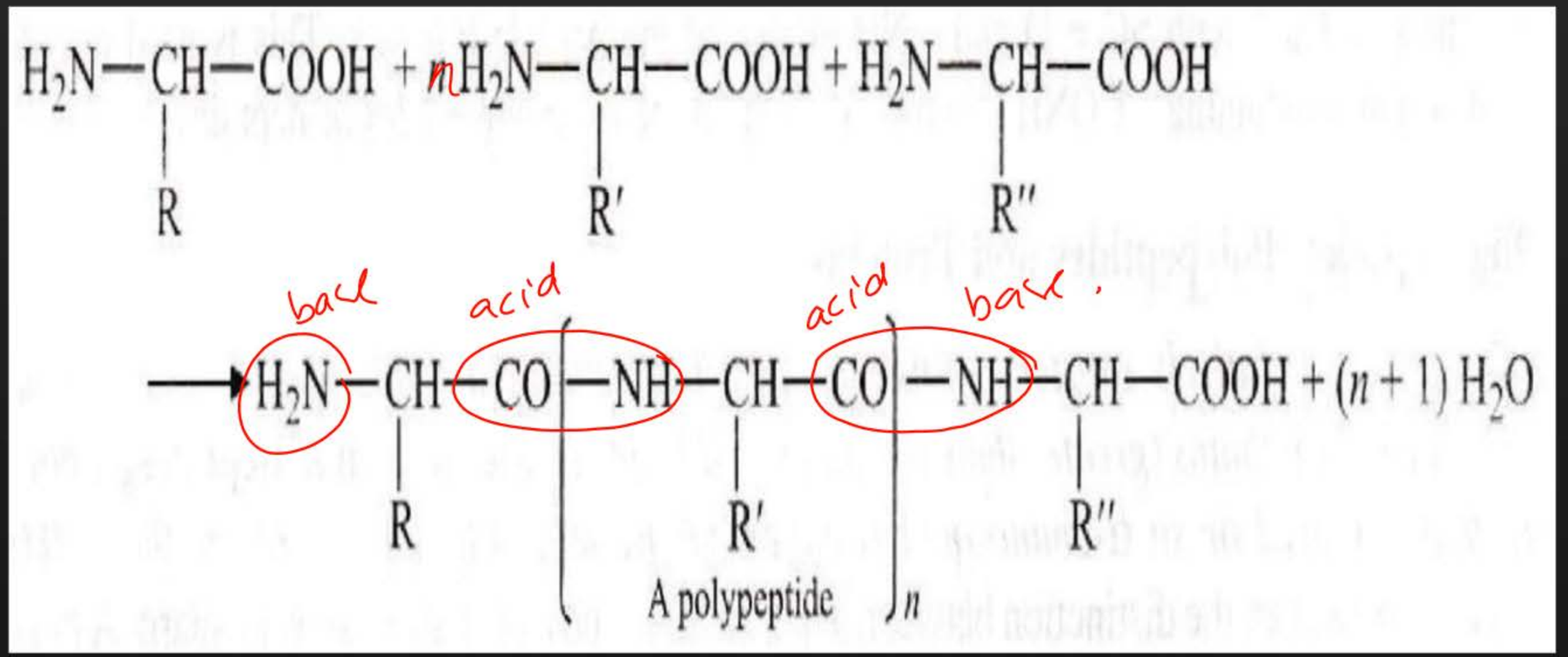
L isomer

PEPTIDES


Glycine
Alanine
Peptide bond
two amino acids
Dipeptide
Glycylalanine (Gly-Ala)

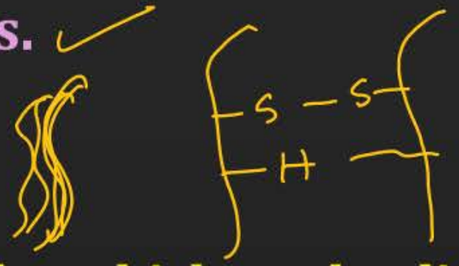
Tips




$H_2N-CH(R)-COOH + nH_2N-CH(R')-COOH + H_2N-CH(R'')-COOH$
base
acid
acid
base
$\rightarrow H_2N-CH(R)-CO-NH-CH(R')-CO-NH-CH(R'')-COOH + (n+1)\,H_2O$
A polypeptide
n

CLASSIFICATION OF PROTEINS:

On the basis of molecular structure, proteins have been classified as :
(i) Fibrous proteins and (ii) Globular proteins.



(I) FIBROUS PROTEINS:

These proteins consist of linear thread-like molecules which tend to lie side by side to form fibres.

The polypeptide chains in them are held together usually at many points by hydrogen bonds and some disulphide bonds.

As a result, intermolecular forces of attraction are very strong and hence fibrous proteins are insoluble in water.

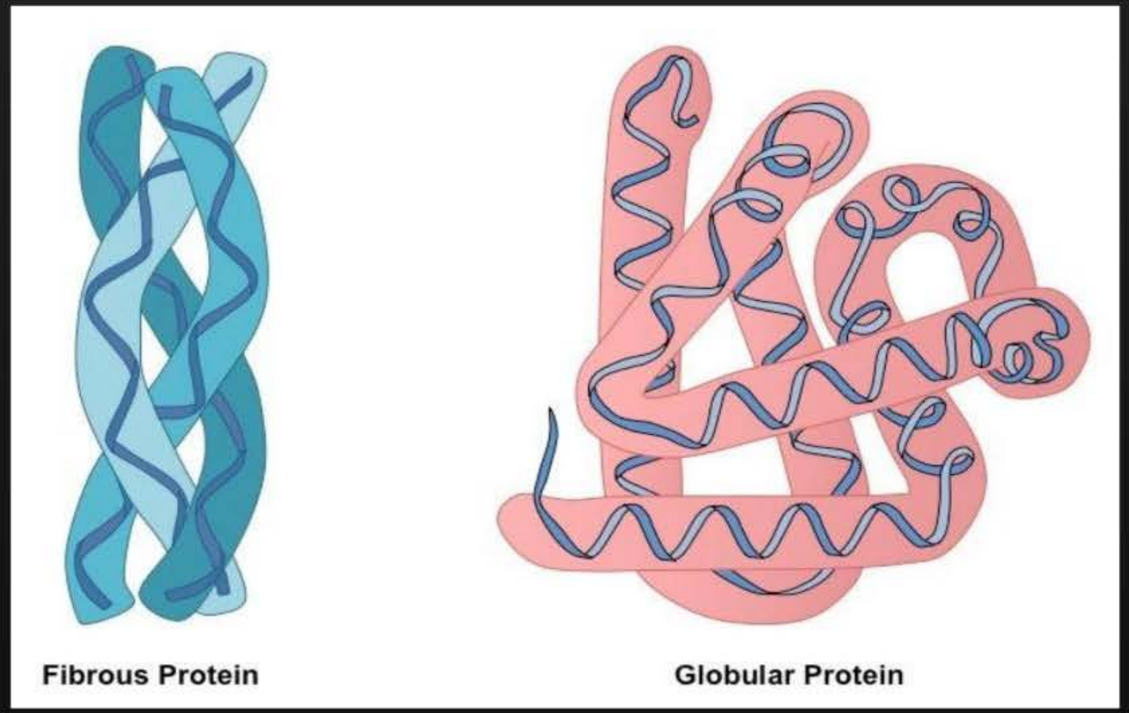
Further, these proteins are stable to moderate changes in temperature and pH.

Fibrous proteins serve as the chief structural material of animal tissues.

For example, keratin in skin, hair, nails and wool, fibroin in silk and myosin in muscles.

(II) GLOBULAR PROTEINS:

Ex: All enzymes, hormones such as insulin from pancreas, haemoglobin which transports oxygen from the blood to die muscles, fibrinogen which is converted into the insoluble protein fibrin and thus causes clotting of the blood, albumin in eggs etc.



Insulin
haemoglobin
albumin

STRUCTURES OF PROTEINSSTRUCTURES OF PROTEINS

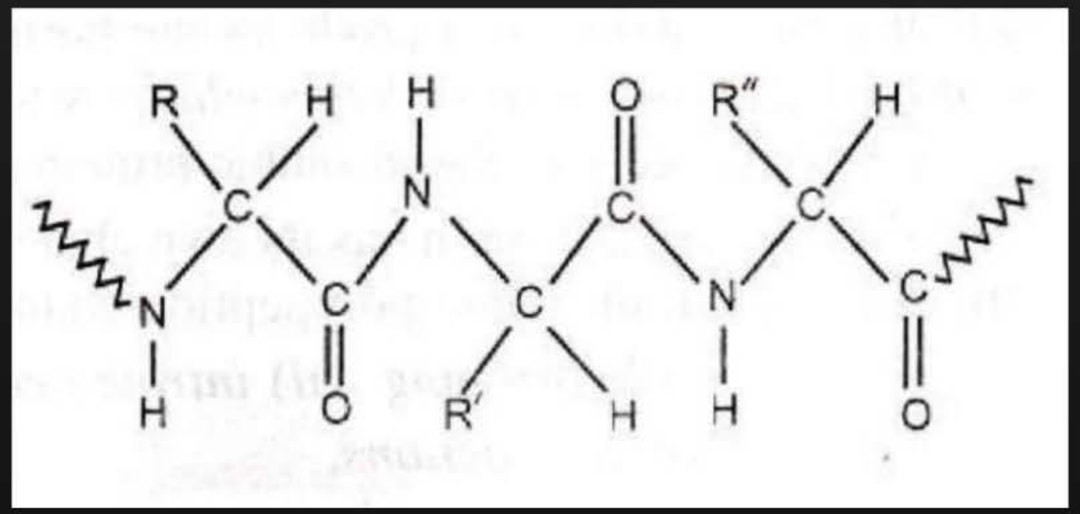
Proteins are biopolymers obtained by condensation of a large number of α-amino acids joined together through peptide bonds having three-dimensional (3D) structures.

The structures of proteins are quite complex.

Their complete structures are usually discussed at four different levels, **i.e., primary, secondary, tertiary and quaternary structures**, each level being more complex than the previous one.

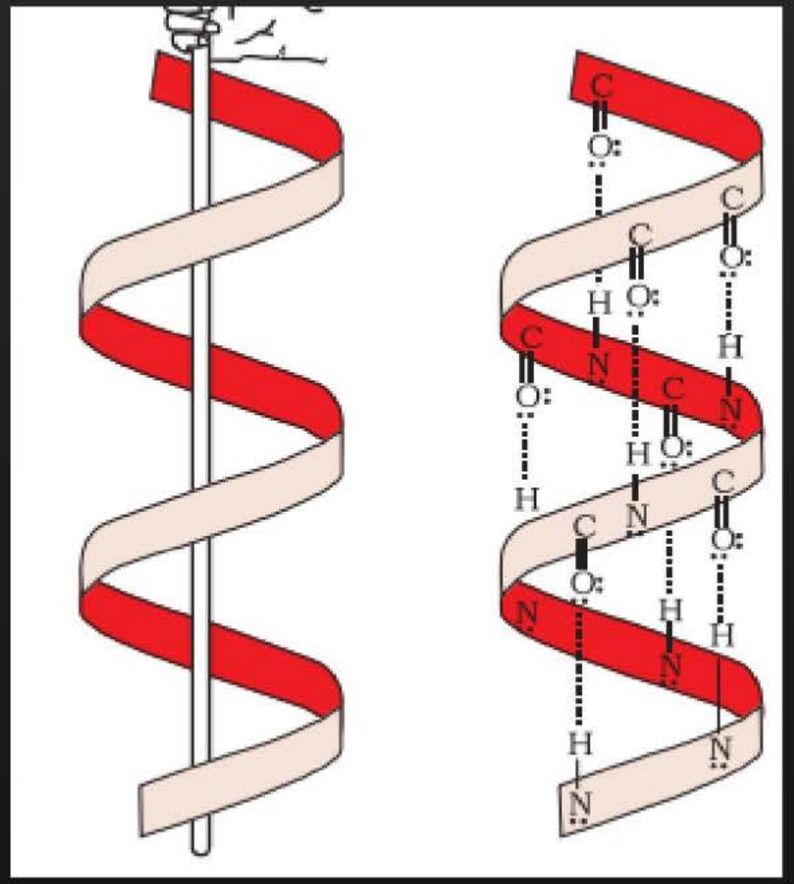
1)PRIMARY STRUCTURE:

✓ Sequence.

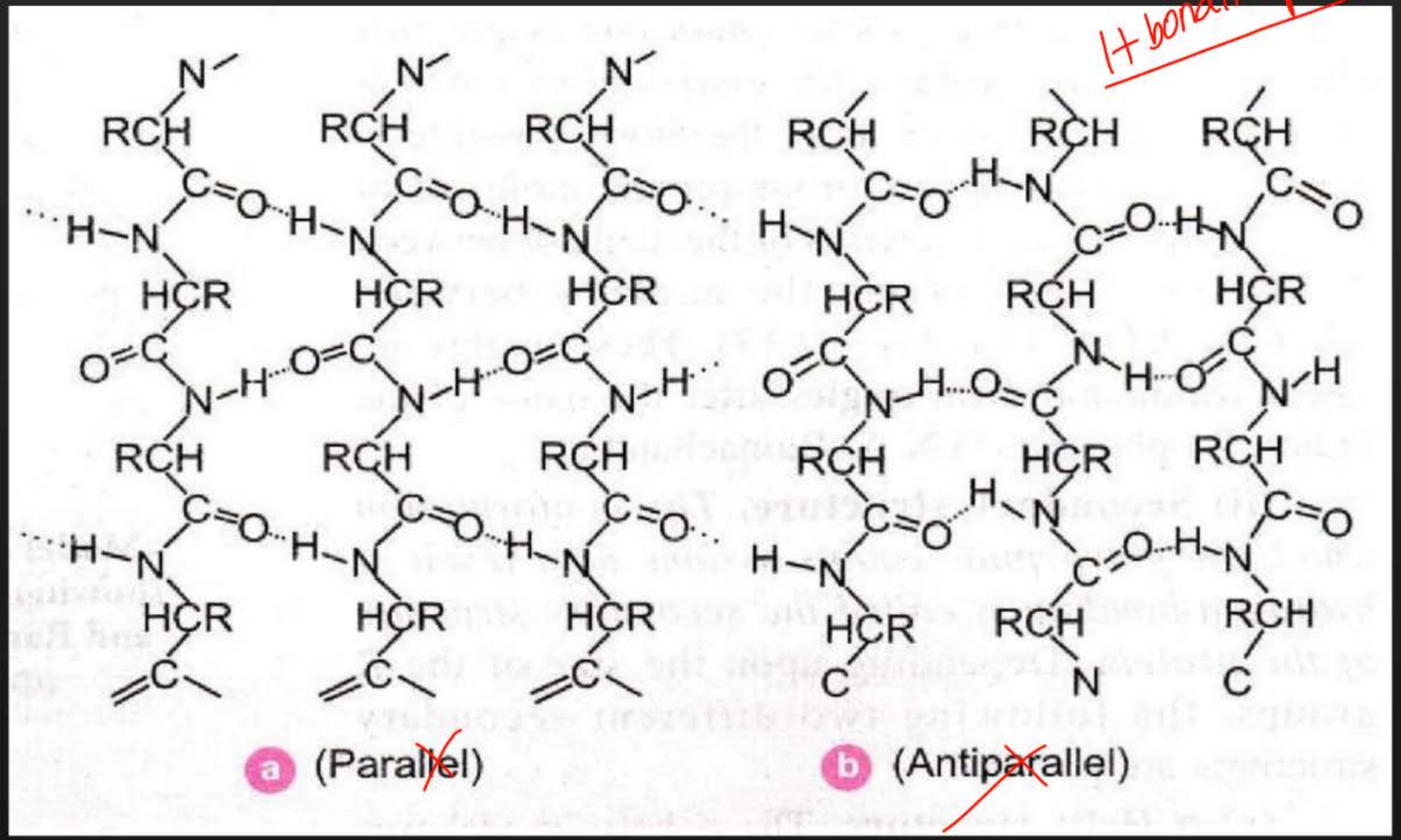


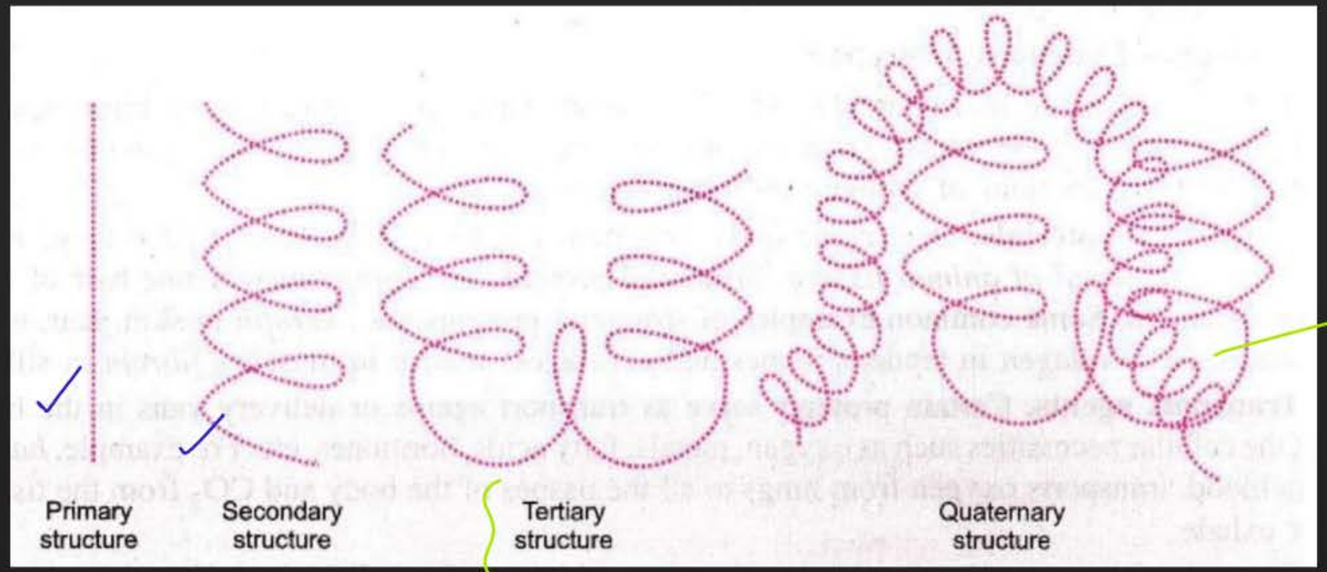
2) SECONDARY STRUCTURE:

(a) α-Helix structure:



(b) β-Pleated sheet structure or simply β-structure:





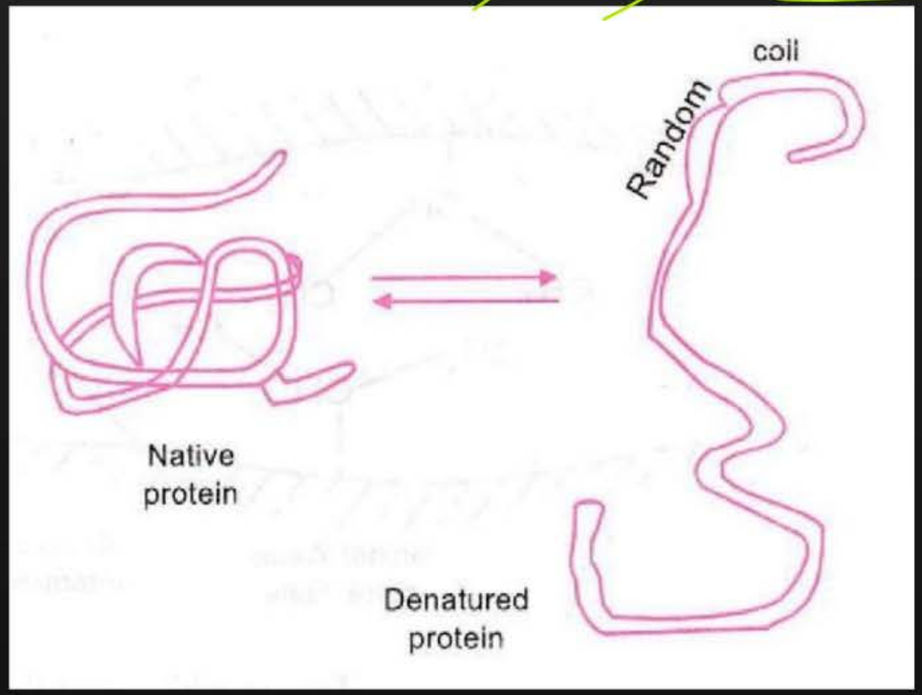
→ spatial arrangement of polypeptide chain.

→ Coagulation
pH / temp

overall folding

↓

→ H bonding
→ disulphide
→ Van der waal force
→ ionic force / electrostatic force

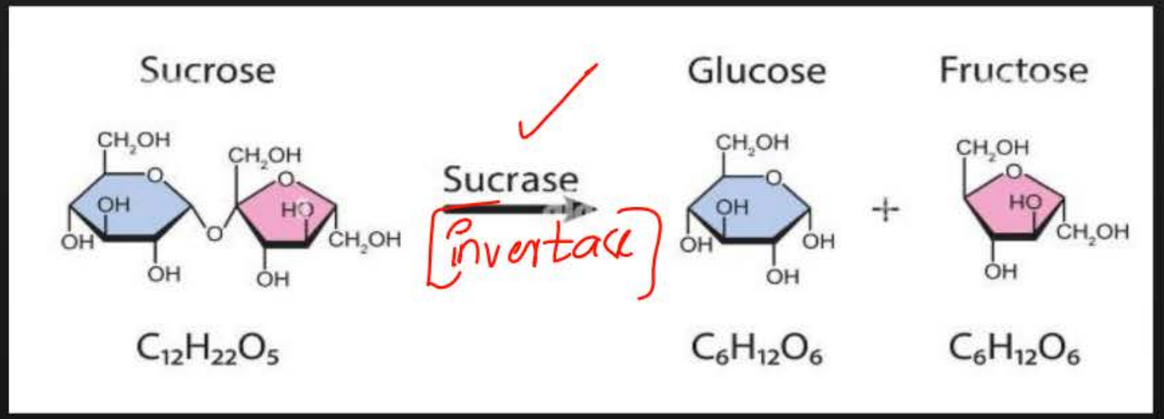


Enzyme

- All biological reactions are catalysed by special catalysts called enzymes. Thus, enzymes are defined as biological catalysts or simply biocatalysts.

- An enzyme facilitates a biochemical reaction by providing alternate lower activation energy pathways thereby increasing the rate of the reaction.

- For example, activation energy for acid hydrolysis of sucrose is 6.22 kJ^{-1} while the activation energy is only 2.15 kJ mol^{-1} when hydrolysed by the enzyme sucrase.



- Chemically all enzymes are globular proteins.

- However, some enzymes are also associated with some non-protein component
- called the cofactor like Prosthetic groups which are tightly held to the protein by covalent bonds or Inorganic ions such as Zn^{2+}, Mg^{2+}, Mn^{2+}, Fe^{2+}, Cu^{2+}, Co^{2+}, Mo^{3+}, K^{+}, Na^{+}, etc. for their activity.

- Every biological reaction requires a different kind of enzyme.

- Since there is a large number of such biological reactions, therefore, there is a large number of enzymes functioning in a living system.

- Enzymes due to high efficiency are required in small quantity.

Starch $\xrightarrow{\text{amylase}}$ glucose

Enzymes are widely used :

(i) in the manufacture of beer and wine by the fermentation of carbohydrates (amylase).

(ii) in the production of cheese by coagulation of milk (Chimosin).

VITAMINS:

- Vitamins may be defined as a group of biomolecules (other than fats, carbohydrates and proteins) most of which cannot be produced by the body and must be supplied in small amounts in diet to perform the specific biological functions for the life, growth and health of human beings and animal organisms.

- **IMPORTANCE:**

Vitamins neither supply energy nor help in building tissues of the cells. Nevertheless, they play an important role in keeping good health of human beings and animals. Their deficiency causes serious disturbances and diseases in the body.

Classification of Vitamins

These are usually designated by alphabet letters such as A, B, C, D, E and K. Some of these are named as sub groups, e.g., B_1, B_2, B_6, B_{12}, etc. These have been broadly classified into the following two categories

(i) Water soluble vitamins:

These include vitamin B-complex (B_1, B_2, B_5 i.e. nicotinic acid, B_6, [redacted] vitamin C.

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

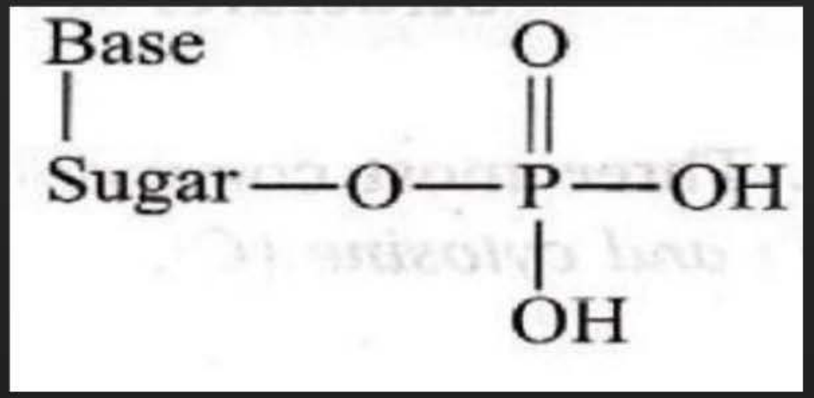
(ii) Fat soluble vitamins:

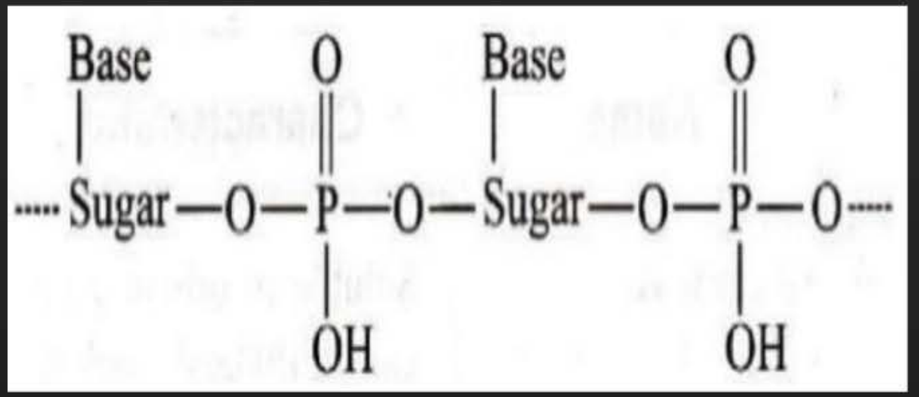
These are oily substances not readily soluble in water. However, they are soluble in fat.

These include vitamins A, D, E and K. They are stored in liver and adipose (fat storing) tissues. Excess intake of these vitamins (A and D) is harmful and may cause hypervitaminoses.

Sl. No.	Name of Vitamins	Sources	Deficiency diseases
1.	Vitamin A	Fish liver oil, carrots, butter and milk	Xerophthalmia (hardening of cornea of eye) Night blindness
2.	Vitamin B_1 (Thiamine)	Yeast, milk, green vegetables and cereals	Beri beri (loss of appetite, retarded growth)
3.	Vitamin B_2 (Riboflavin)	Milk, eggwhite, liver, kidney	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
4.	Vitamin B_6 (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
5.	Vitamin B_{12}	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
6.	Vitamin C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
7.	Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
8.	Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc.	Increased fragility of RBCs and muscular weakness
9.	Vitamin K	Green leafy vegetables	Increased blood clotting time

NUCLEIC ACIDS



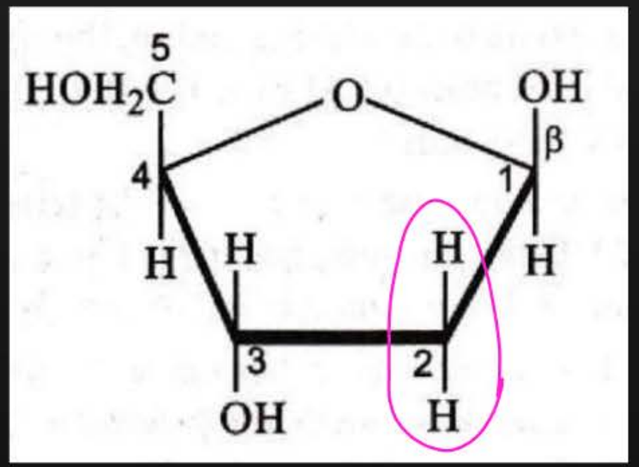


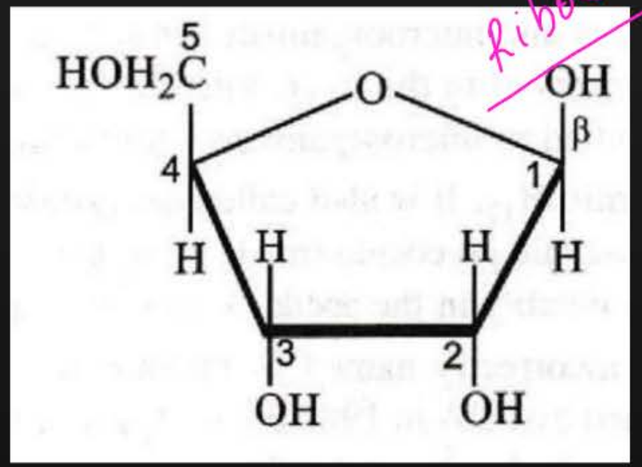
CHEMICAL COMPOSITION OF NUCLEIC ACIDS

Complete hydrolysis of DNA or RNA gives a mixture of three different compounds :
(i) a pentose sugar,
(ii) nitrogen containing heterocyclic compounds also called nitrogenous bases
(iii) phosphoric acid(H_3PO_4).

SUGARS:

Two pentose sugars have been isolated. Whereas DNA contains, β-D-2 deoxyribose, RNA contains β-D-ribose. Both these sugars are found in the furanose form as shown below :





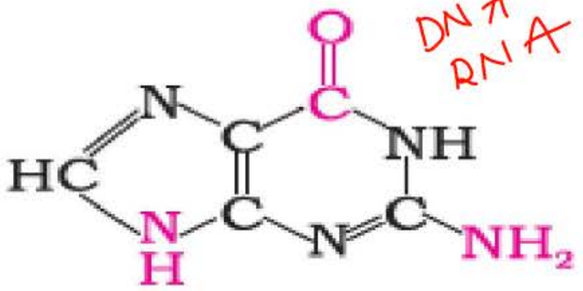
DNA contains four bases viz. adenine (A), guanine (G), cytosine (C) and thymine (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is uracil (U).

Purines

Adenine (A)

DNA
RNA

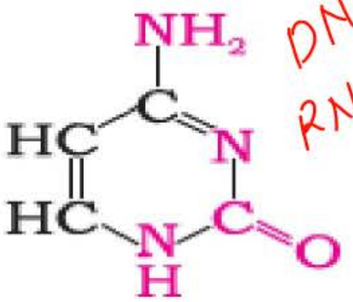
A → T
G → C



Guanine (G)

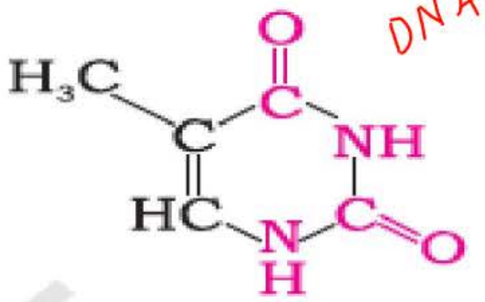
DNA
RNA

Pyramidine



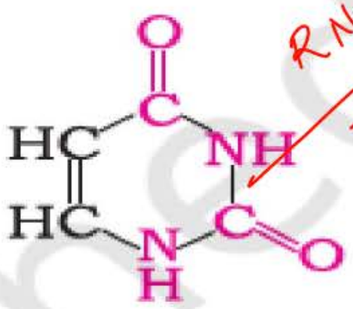
Cytosine (C)

DNA
RNA



Thymine (T)

only
DNA

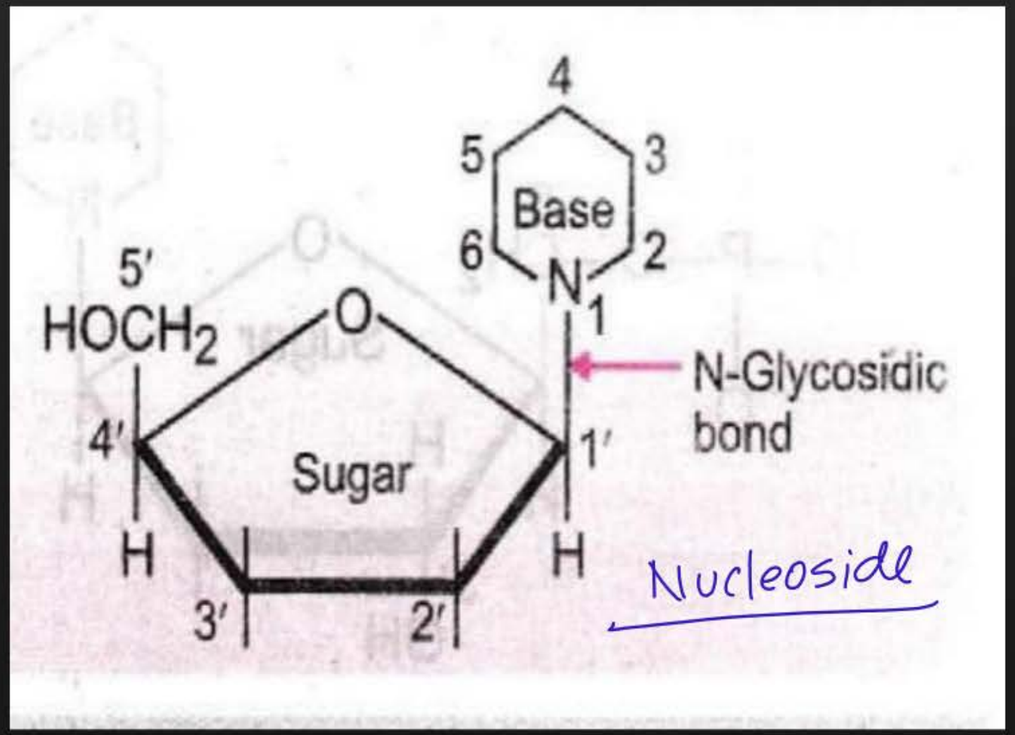


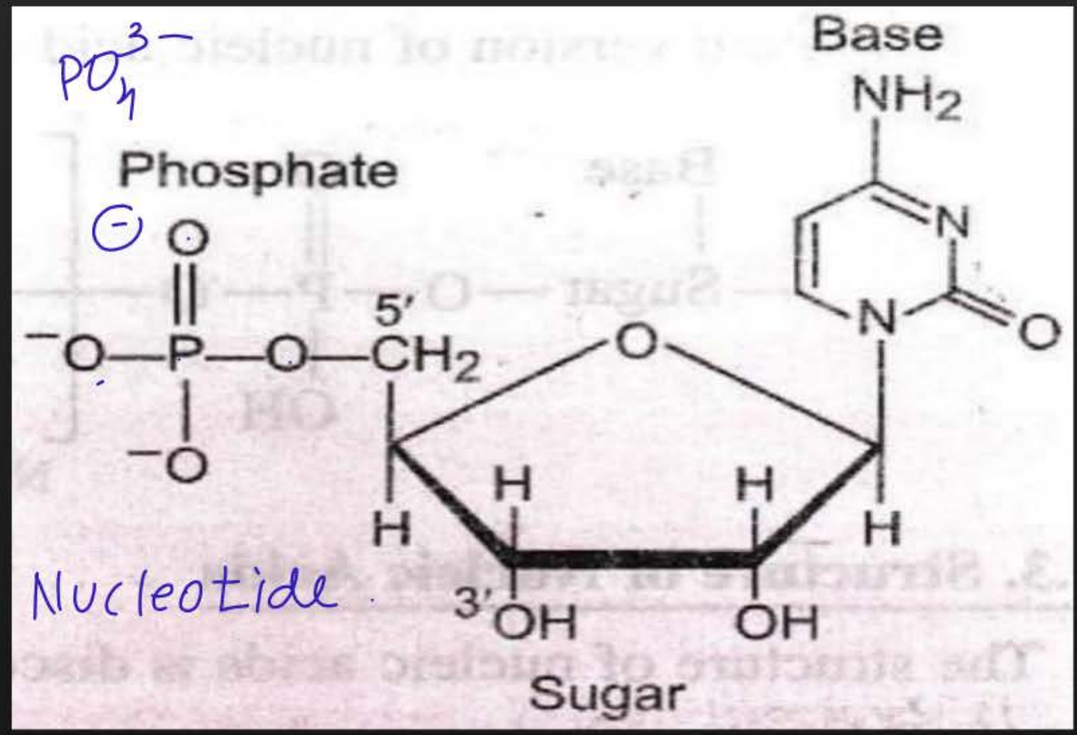
Uracil (U)

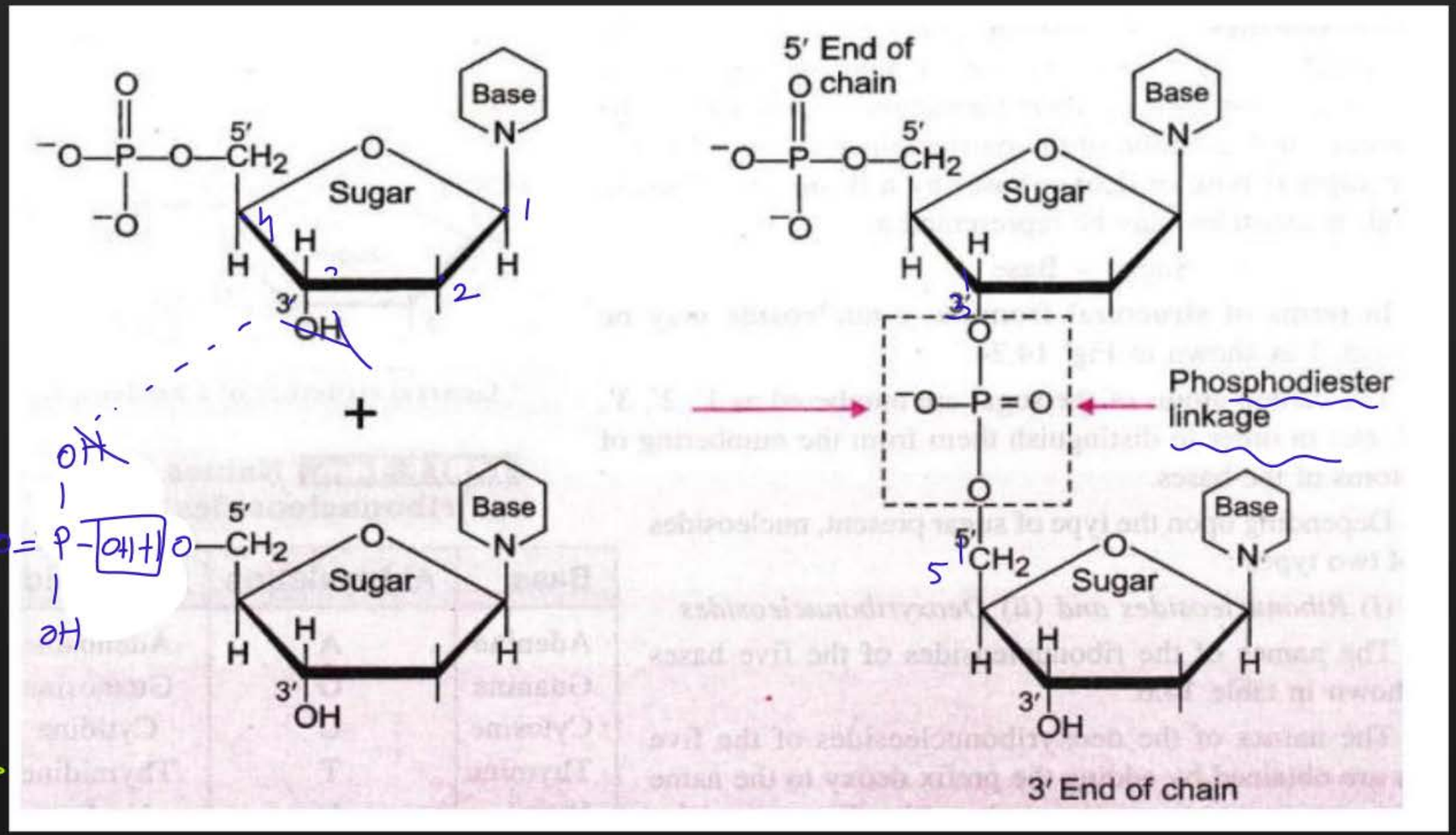
only
RNA

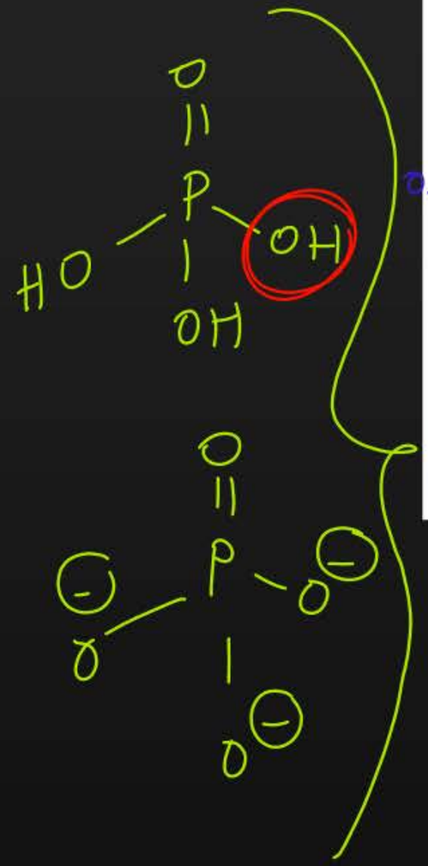
Structure of Nucleic Acids

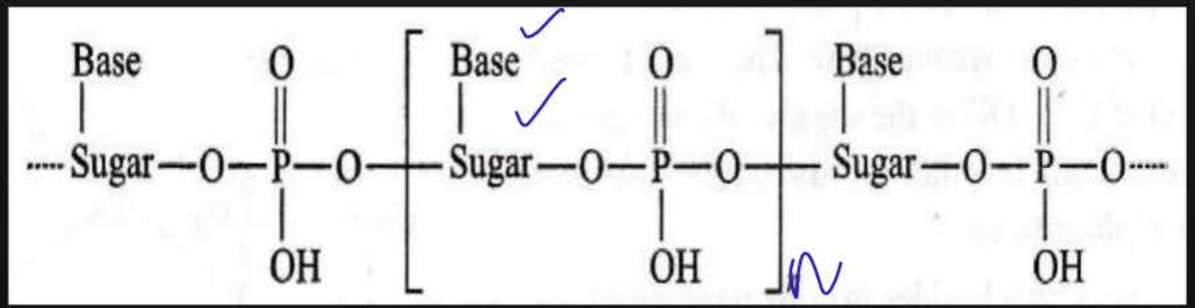
Nucleosides and Nucleotides






5′ End of chain
Base
Sugar
Phosphodiester linkage
3′ End of chain




Base
Sugar
OH

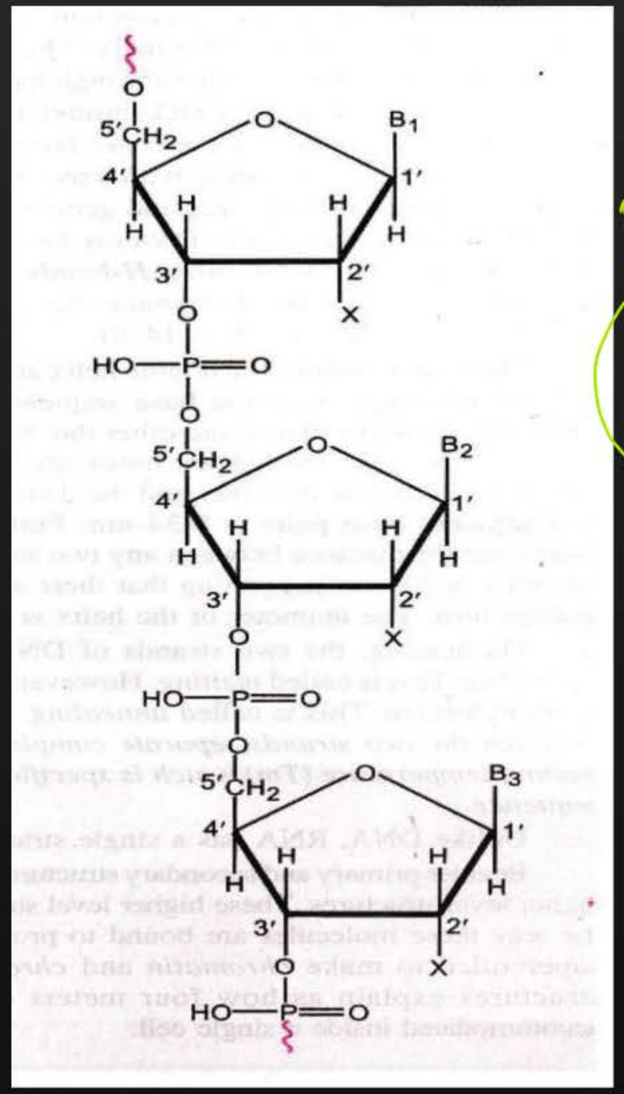
The structure of nucleic acids is discussed at the following two levels :

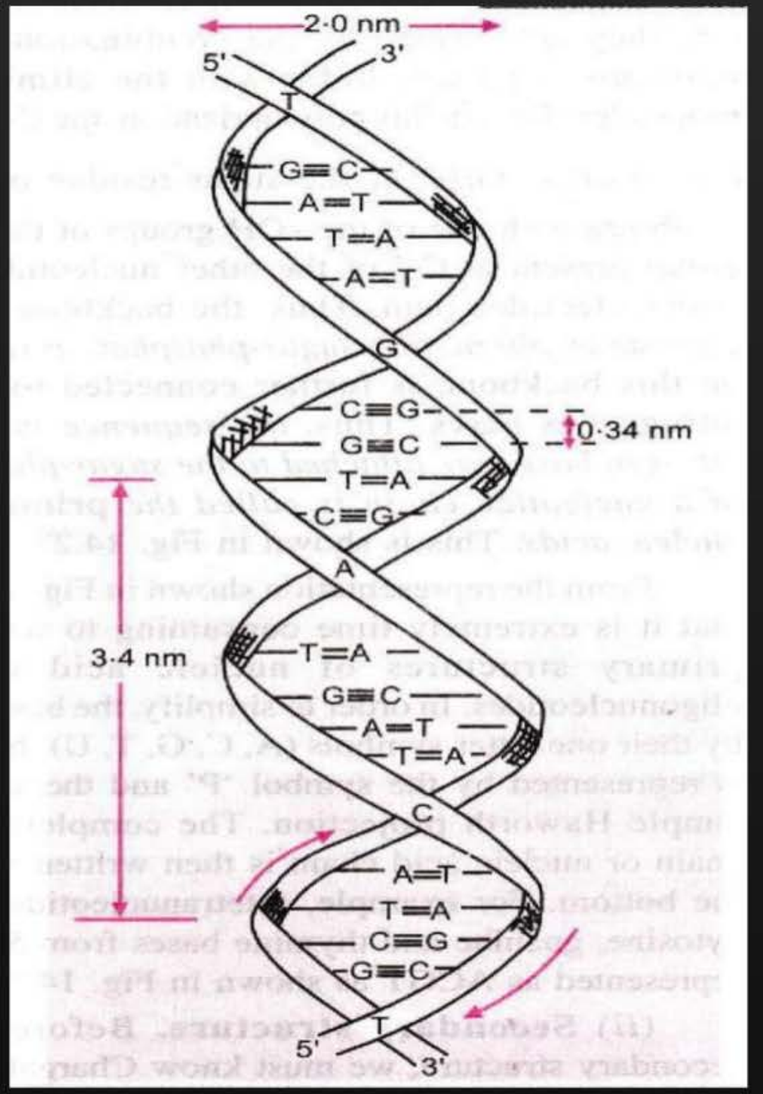
(i) Primary structure

(ii) Secondary structure

Purine
5+6 ⟶ A, G

Pyramidine
C T U

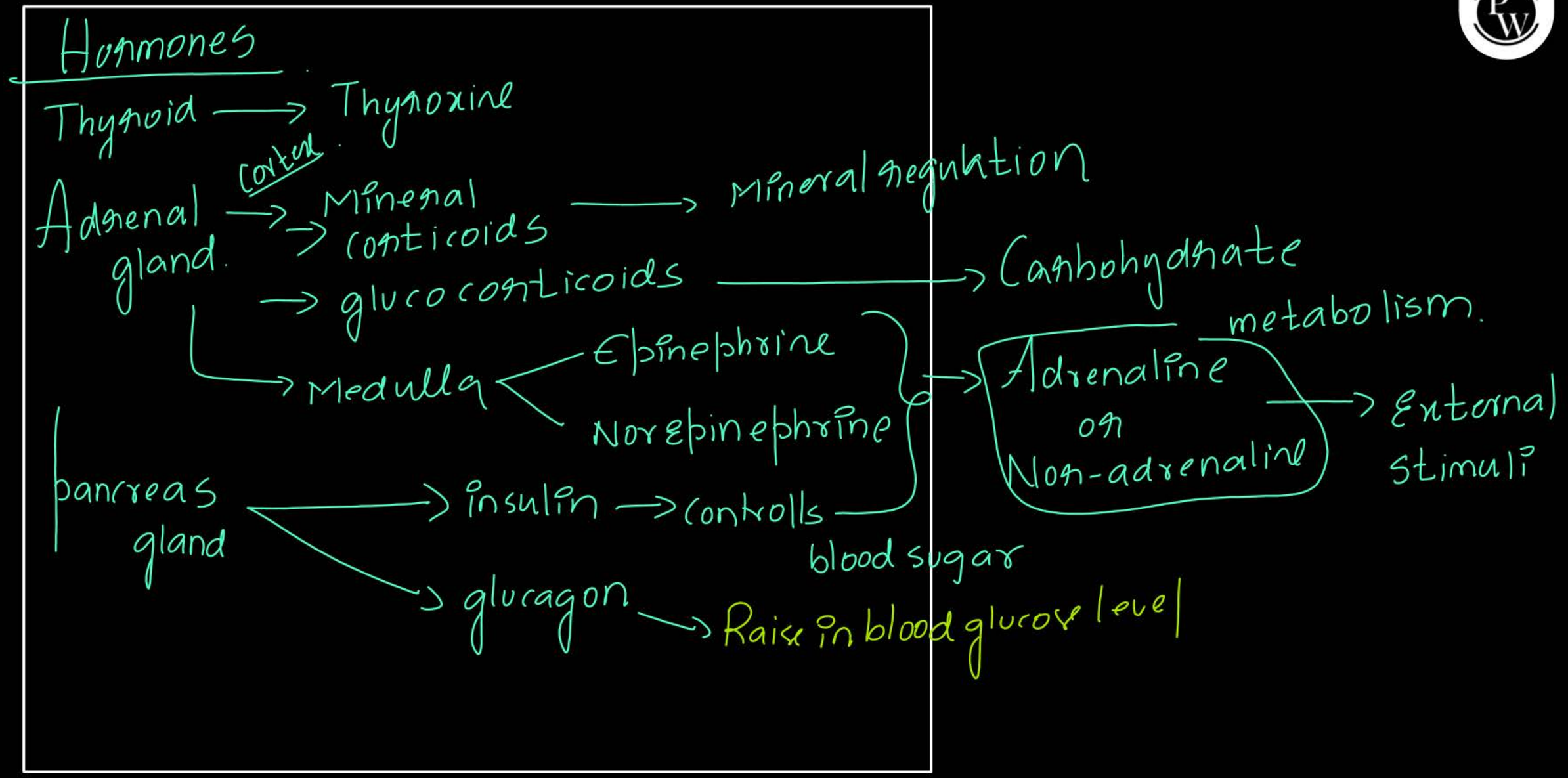




At A–T

G–C.

Girls
↳ Crowd.


Hormones
Thyroid → Thyroxine
Adrenal gland
Cortex
→ Mineral corticoids → Mineral regulation
→ glucocorticoids → Carbohydrate metabolism.
→ Medulla
Epinephrine
Norepinephrine
Adrenaline or Non-adrenaline
→ External stimuli
Pancreas gland
→ insulin → controls blood sugar
→ glucagon → Raise in blood glucose level

Question

Sucrose on hydrolysis gives

A. β-D-glucose + α – D – fructose

B. α-D-glucose + β – D – glucose

C. α-D-glucose + β – D – fructose

D. α-D-fructose + β – D – fructose

Question

The reaction of concentrated sulphuric acid with carbohydrates ($C_{12}H_{22}O_{11}$) is an example of

A. Dehydration

B. Oxidation

C. Reduction

D. Sulphonation

$$C_{12}H_{22}O_{11} \xrightarrow{\text{conc. } H_2SO_4} C\downarrow + H_2O$$

black compound

Question

Which of the following statement is not true about glucose?

A It is an aldohexase

B It contains five hydroxyl groups

C It is a reducing sugar

D It is an aldopentose

Question

The difference between amylose and amylopectin is

A. Amylopectin have $1 \longrightarrow 4, \alpha$ – linkage and $1 \longrightarrow 6, \beta$ – linkage

B. Amylose have $1 \longrightarrow 4, \alpha$ – linkage and $1 \longrightarrow 6, \beta$ – linkage

C. Amylopectin have $1 \longrightarrow 4, \alpha$ – linkage and $1 \longrightarrow 6, \beta$ – linkage

D. Amylose is made up of glucose and galactose

Question

Which one given below is a non – reducing sugar?

A. Lactose

B. Glucose

C. Sucrose → Non reducing sugar (starch, cellulose, glycogen)

D. Maltose

QUESTION

Receptors are proteins and crucial to body communication process. These receptors are embedded in [2023]

A cell membrane

B protein

C endocrine gland

D chromosomes

QUESTION

Sucrose is dextrorotatory but after hydrolysis the mixture show laevorotation, this is because of [2023]

A laevorotation of glucose is more than dextrorotation of fructose.

B sucrose is a non-reducing sugar.

C racemic mixture is formed.

D laevorotation of fructose is more than dextrorotation of glucose.

QUESTION

Thyroxine produced in the thyroid gland is an iodinated derivative of ..... [2023]

A threonine

B lysine

C tyrosine

D tryptophan

QUESTION

The correct order of match between column X and column Y is [2023]

X		Y	
I.	Vitamin A	i.	Muscular weakness
II.	Vitamin D	ii.	Increased blood clotting time
III.	Vitamin E	iii.	Night-blindness
IV.	Vitamin K	iv.	Ostgomalacia

A I-iv, II-iii, III-ii, IV-i

B I-ii, II-i, III-ii, IV-iv

C I-iii, Il-ii, III-iv, IV-i

D I-iii, II-iv, III-i, IV-ii

QUESTION

Which institute has approved the emergency use of 2-deoxy-D-glucose as additive therapy for COVID-19 patients? [2022]

A World Health Organisation

B Ministry of Health and Family Welfare

C Drug Controller General of India

D India Council of Medical Research

QUESTION

Primary structure in a nucleic acid contains bases as GATGC ... The chain which is complementary to this chain is [2021]

A GGTGA...

B TGAAG...

C CTACG...

D TTTAG...

QUESTION

$C_1 - C_4$ glycosidic bond is not found in [2020]

A maltose ⟶ α-glucose ⟶ $(C_1 - C_4)\alpha$

B sucrose ⟶ α glucose + β-fructose $C_1\alpha - C_2\beta$

C lactose ⟶ β-galactose + β-glucose ⟶ $C_1\beta - C_4\beta$.

D starch Amylose ⟶ $(C_1 - C_4)$ α glucose.

Amylopectine ⟵ $C_1 - C_4\,\alpha$ glucose. / $C_1 - C_6\,\alpha$

QUESTION

Hypothyroidism is caused by the deficiency of [2020]

A vitamin B-12

B adrenalin

C thyroxine

D glucocorticoid

QUESTION

Which one of the following vitamins is not stored in adipose tissue? [2020]

A A

B B_6

C D

D E

QUESTION

In nucleic acids, the nucleotides are joined together by [2019]

A phosphoester linkage

B phosphodiester linkage

C phosphodisulphide linkage

D sulphodiester linkage

QUESTION

Which of the following is generally water insoluble? [2019]

A Fibrous protein

B Vitamin-C

C Amylose

D Glycine

QUESTION

α-glucose

$C_1 - C_4$ α.

The glycosidic linkage involved in linking the glucose units in amylase part of starch is [2018]

A C_1 - C_4 β-linkage

B C_1 – C_6 α-linkage

C C_1 – C_6 β-linkage

D C_1 – C_4 α-linkage

QUESTION

The two forms of D-glucopyranose are called

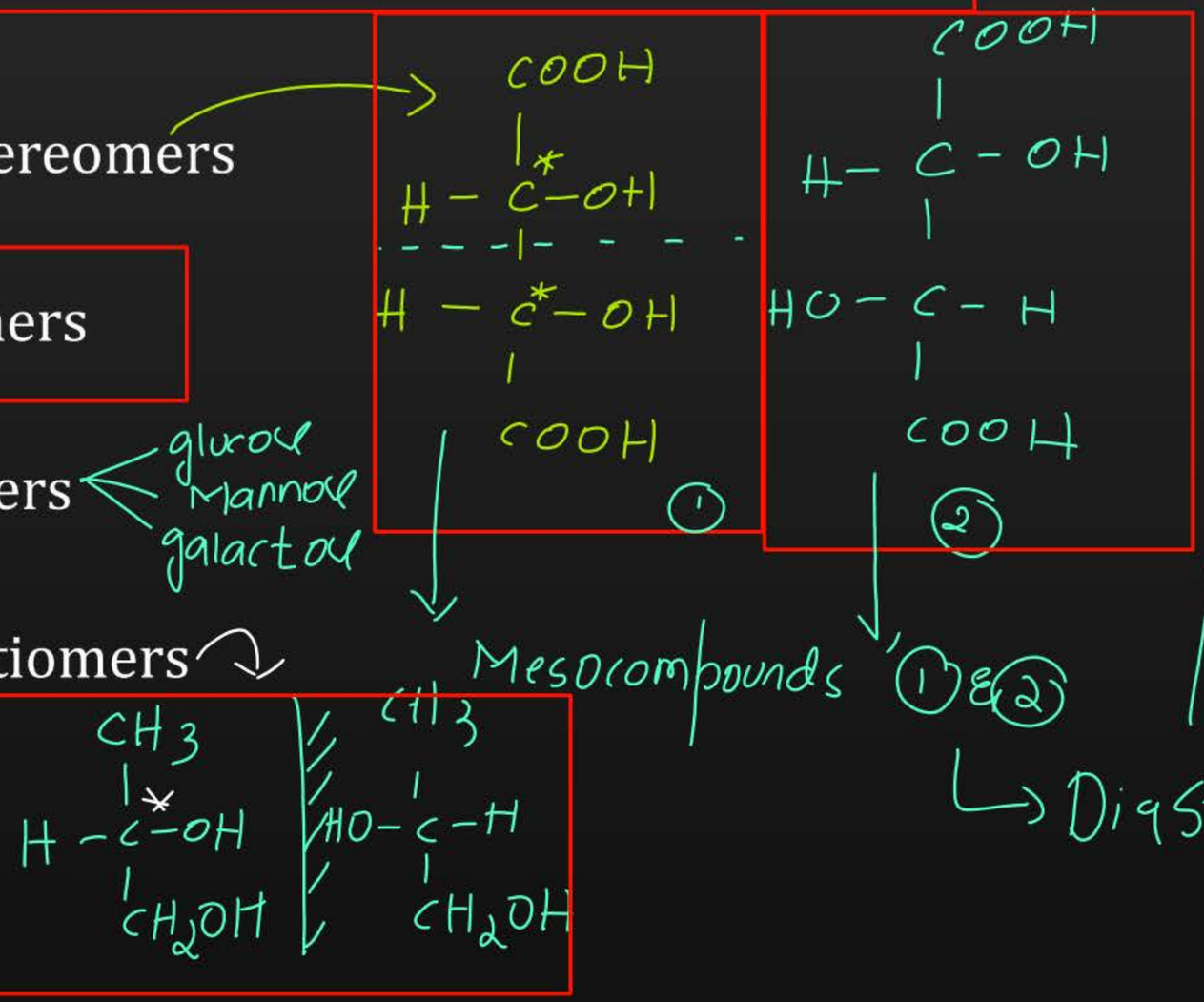
A diastereomers

B anomers

C epimers

D enantiomers

[2018]



QUESTION

Which of the following bases is not present in DNA? [2018]

A Adenine

B Guanine

C Cytosine

D Uracil

QUESTION

Hormones are secreted by ductless glands of human body. Iodine containing hormone is [2017]

A adrenoline

B thyroxine

C testosterone

D Insulin

QUESTION

The glycosidic linkage is present in sucrose between [2017]

A C-1 of β-glucose and C-4 of α-glucose

B C-1 of α-glucose and C-4 of β-fructose

C C-1 of α-glucose and C-4 of α-glucose

D C-1 of α-glucose and C-2 of β-fructose

QUESTION

A Pick the wrong statements from the following. [2007]

A Deficiency of vitamin B6 (pyridoxime) results in convulsions

B Sources of vitamin are yeast, milk, green vegetables and cereals.

C Deficiency of vitamin D cause xerophthalmia.

D Consumption of citrus fruits and green leafy vegetables in food prevents scurvy.

QUESTION

Which of the following gives positive Fehling's solution test? [2016]

A Sucrose

B Glucose

C Fats

D Protein

QUESTION

Which of the following is correct about H-bonding in DNA ? [2016]

A A-T, G-C

B A-G, T-C

C G-T, A-C

D A-A, T-T

QUESTION

Cheilosis and digestive disorders are due to the deficiency of [2015]

A thiamine

B ascorbic acid

C riboflavin

D pyridoxine

QUESTION

Adenosine is an example of [2015]

A nucleotide

B purine base

C pyrimidine base

D nucleoside

QUESTION

Which one of the following is an essential amino acid? [2015]

A Tyrosine

B Cysteine

C isoleucine

D Serine

QUESTION

Glycogen is [2015]

A a polymer of β-D-glucose units

B a structural polysaccharide

C structurally very much similar to amylopectin

D structurally similar to amylopectin but extensively branched

QUESTION

1.78 g of an optically active L-amino acid (A) is treated with $NaNO_2/HCl$ at 0°C. 448 cm^3 of nitrogen was at STP is evolved. A sample of protein has 0.25% of this amino acid by mass. The molar mass of the protein is [2014]

A $36500\ g\ mol^{-1}$

B $34500\ g\ mol^{-1}$

C $35400\ g\ mol^{-1}$

D $35600\ g\ mol^{-1}$

QUESTION

The number of disulphide linkages present in insulin are [2013]

A 4

B 3

C 2

D 1

QUESTION

Sucrose is not a reducing sugar since [2012]

A it contains no free aldehyde or keto group adjacent to >CHOH group

B it is built up of a fructose unit

C it is optically active

D it is chemically stable

QUESTION

α-maltose consists of [2011]

A one α-D-glucopyranose unit and one β-D-glucopyranose unit with 1,2- glycosidic linkage

B two α-D-glucopyranose units with 1-2 glycosidic linkage.

C two β-D-glucopyranose units with 1-4 glycosidic linkage.

D two α-D-glucopyranose units with 1-4 glycosidic linkage.

QUESTION

The letter 'D' in D-glucose signifies [2010]

A configuration at all chiral carbons

B dextrorotatory

C that it is a monosaccharide

D configuration at a particular chiral carbon

QUESTION

There are 20 naturally occurring amino acids. The maximum number of tripeptides that can be obtained is [2009]

A 8000

B 6470

C 7465

D 5360

QUESTION

The amino acid which is not optically active is [2007]

A lactic acid

B serine

C alanine

D glycine

QUESTION

A metal present in vitamin B_{12} is [2007]

A aluminium

B zinc

C iron

D cobalt

QUESTION

Acrolein test is positive for [2006]

A polysaccharides

B proteins

C oils and fats

D reducing sugars

QUESTION

Insulin regulates the metabolism of [2006]

A minerals

B amino acids

C glucose

D vitamins

QUESTION

Glucose contains in addition to aldehyde group [2006]

A one secondary OH and four primary OH groups

B one primary OH and four secondary OH groups

C two primary OH and three secondary OH groups

D three primary OH and two secondary OH groups

Thank You