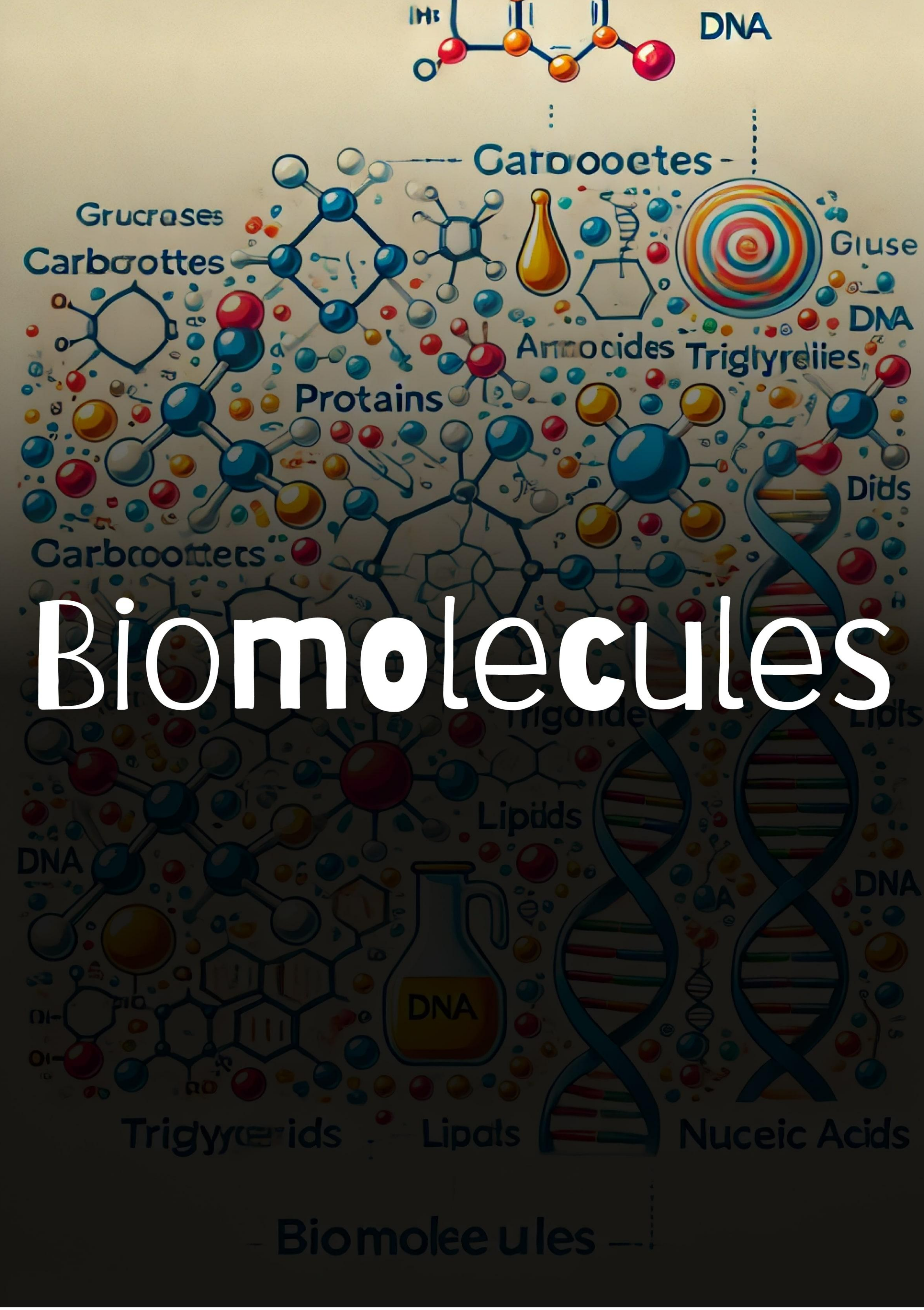
Biomolecules



Carbohydrates:

- Hydrates of carbon are called carbohydrate.
- General Formula $C_x(H_2O)_y$

  Ex :- $C_6H_{12}O_6$ — $C_6(H_2O)_6$
- Exception : $C_2(H_2O)_2$

  $C_2H_4O_2 \longrightarrow CH_3COOH$ (Acetic Acid) not a carbohydrate.
- Rhamnose, $C_6H_{12}O_5$ is a carbohydrate but does not fit in this definition.

- The Carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.
- Some of the carbohydrates which are sweet in taste are also called sugars
- The most common sugar, used in our homes is named as sucro whereas the sugar present in milk is known as lactose.

Classification of Carbohydrates:

- Based on hydrolysis

① Monosaccharides - Does not Hydrolyse Further. (simplest Unit

Ex: Glucose, Fructose, Galactose etc

② Oligosaccharides - Produces 2 to 10 monosac units on hydrolysis.
Disac — 2 units — sucrose, maltose and lactose etc.
Trisac — 3 units — Raffinose.

③ Polysaccharides - carbohydrates which yeild a large number of monosaccharides units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums.

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

• Reducing and Non-Reducing sugar:

① Reducing — Reduces Tollens Reagent, Fehlings Reagent, Bendicts Reagent. Ex: Monosac like Fructose, Galactose; Disac like maltose, lactose like etc.

② Non-Reducing
Do not Reduce TR / FR / BR
Ex: sucrose etc.

• Based on number of carbon atoms:

No. of carbons	Ald	Ket
3	Aldotriose	Ketotriose
4	Aldotetrose	Ketotetrose
5	Aldopentose	ketopentose
6	Aldohexose	Ketohexose (Fructose)

• MOP of Glucose:

① From Sucrose (Disac)

		Aldohexose		Ketohexose
		Glucose		Fructose
$C_{12}H_{22}O_{11}$	$\xrightarrow{H_3O^+}$	$C_6H_{12}O_6$	+	$C_6H_{12}O_6$
dextro		dextro		laevo
(+)		(+)		(−)

- Inversion of cane sugar.
- Enzyme - Invertase.

② From starch (Polysac) $(C_6H_{10}O_5)_n \xrightarrow{H_3O^+} n\,C_6H_{12}O_6$

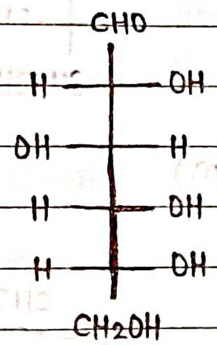
Glucose

- Properties :

① Glucose is also known as dextro (+) or d.

② Structure

$C_6H_{12}O_6$

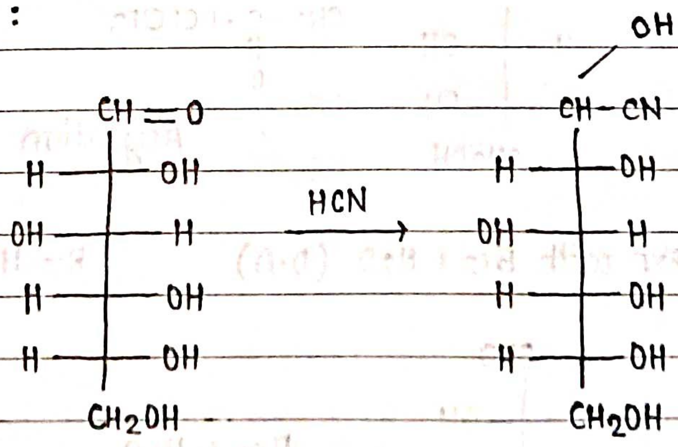


Total no. of chiral carbons = 4

Total stereo Isomers = $2^4 = 16$.

- Chemical Reactions :

① Rxn with HCN



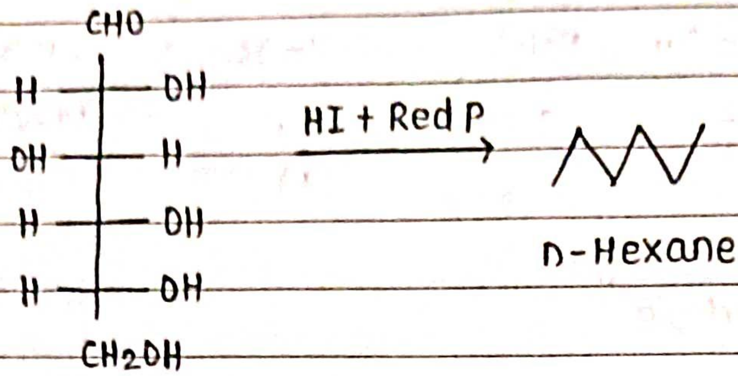
Glucose Cyanohydrin

Total no. of chiral carbons = 5

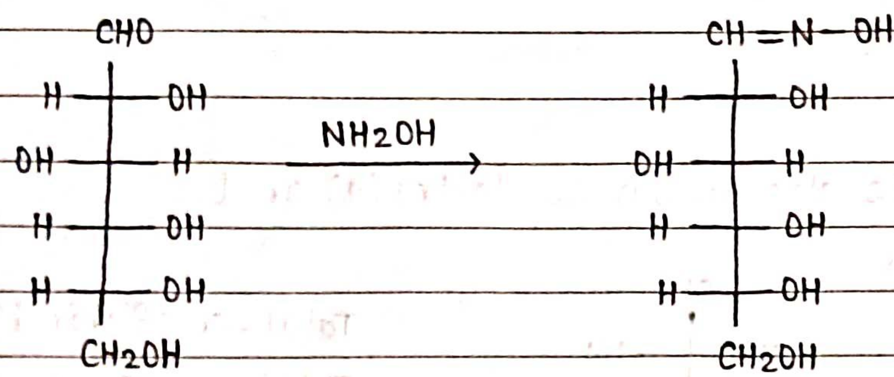
Total stereo Isomers = 32.

② Rxn with HI / Red P

-COOH ⟶ $-CH_3$
-C=O ⟶ $-CH_2$
-OH ⟶ -H

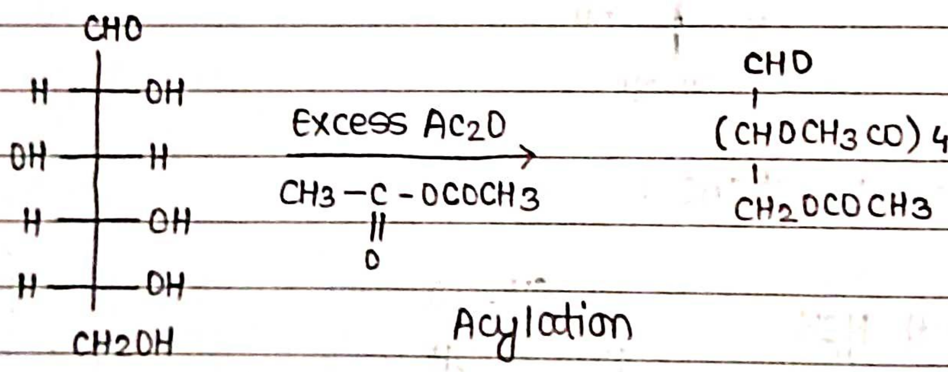


③ Rxn with NH_2OH



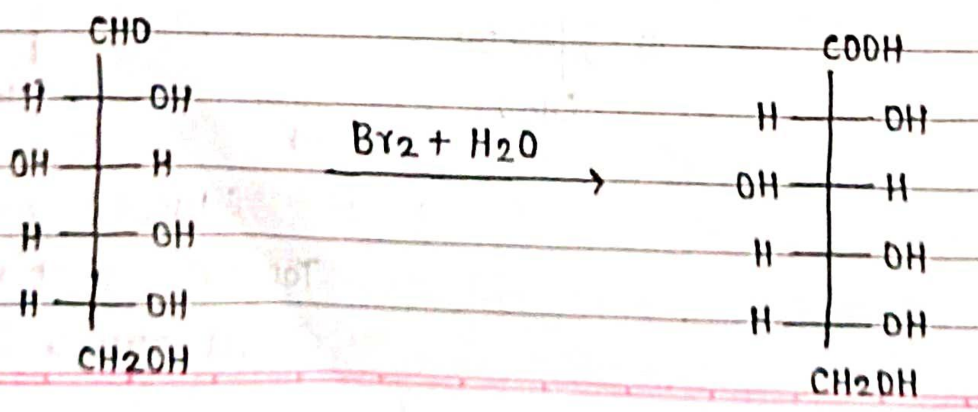
Glucose oxime

④ Rxn with anhydride (esterification)



Glucose Pentacetate

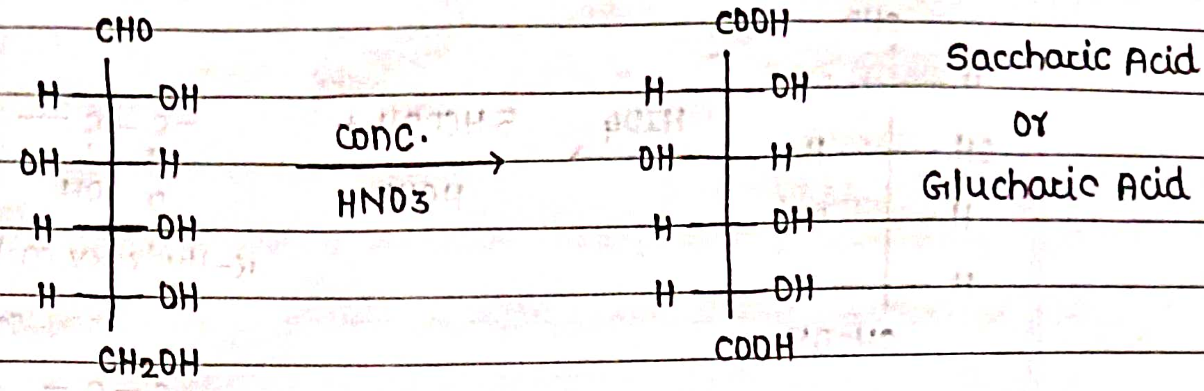
⑤ Rxn with $Br_2 + H_2O$ (D·A)   R-CHO ⟶ R-COOH

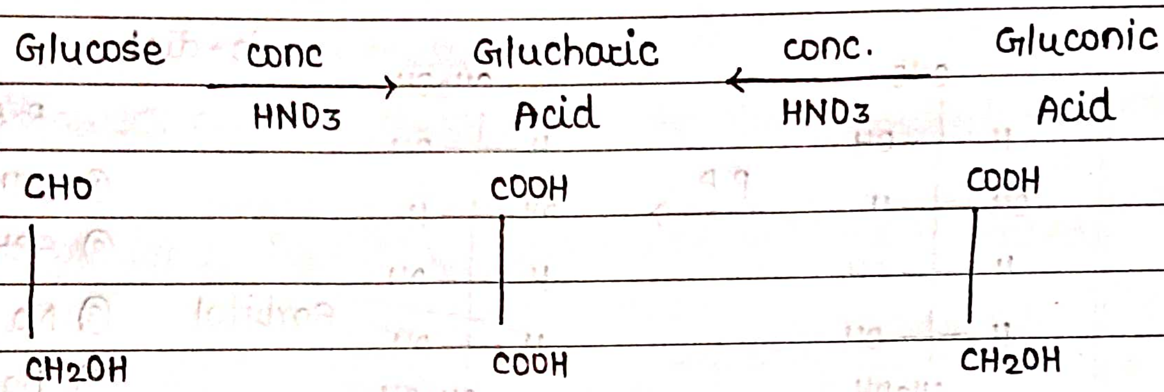


Gluconic Acid
or
Aldonic Acid

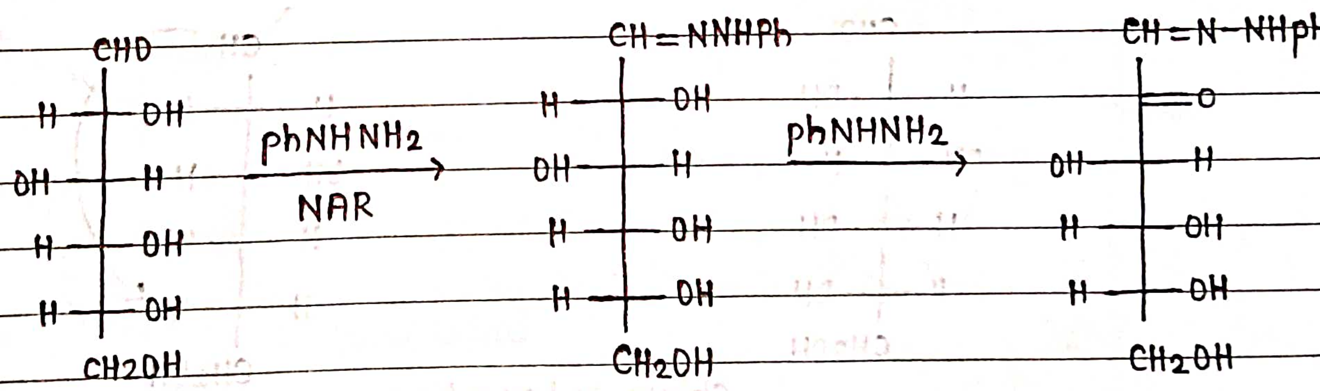
$R-CHO \longrightarrow R-COOH$

⑥ Reaction with HNO_3 $\quad R-CH_2OH \longrightarrow R-COOH$





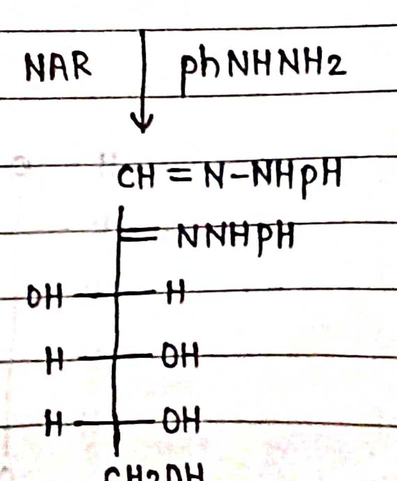
⑦ Osazone Formation



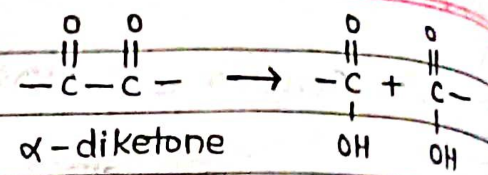
(3 Moles of phenyl Hydrazone are used)

Osazone

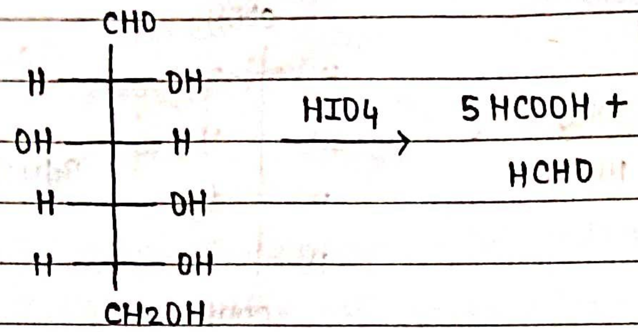
or Glucasazone

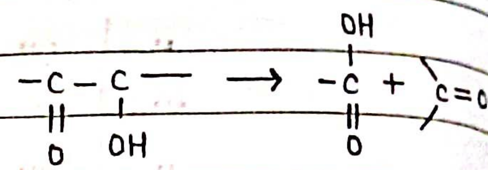


(8) Rxn with periodic acid (HIO_4)

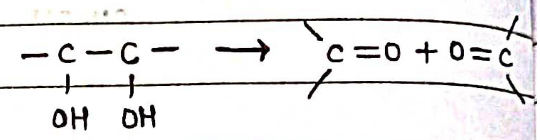


α-diketone



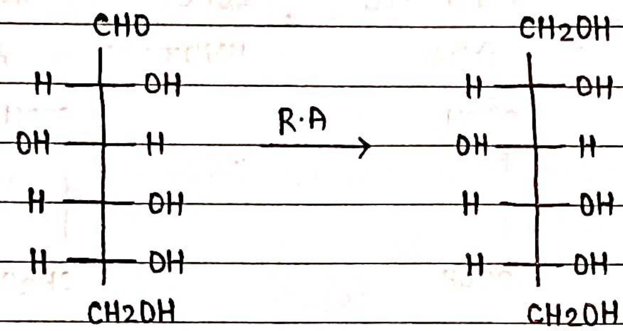


α-Hydroxy carbonyl



vic-diol

(9) Reduction of Glucose :

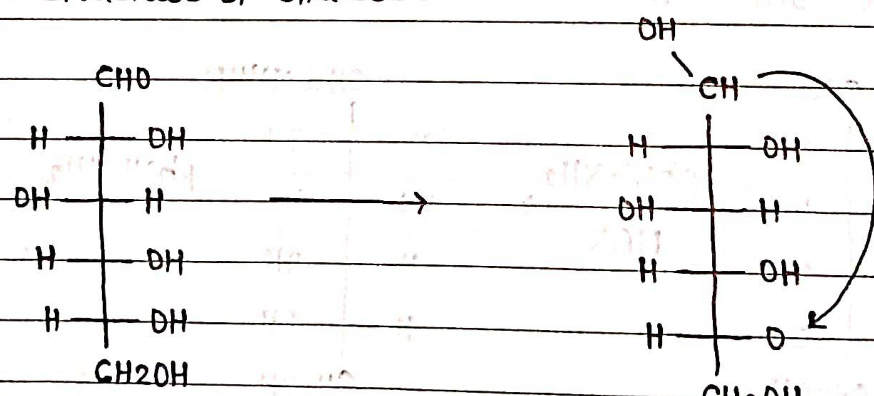


Sorbitol

R·A :-

1. LAH
2. SBH
3. Na(Hg) + ROH
4. H_2 + catalyst

• Cyclic structure of Glucose :



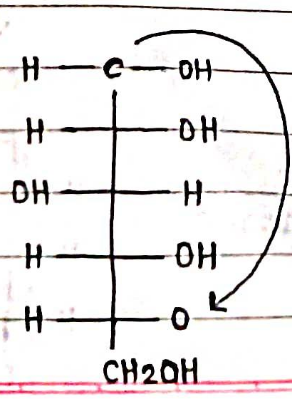
Hemi Acetal

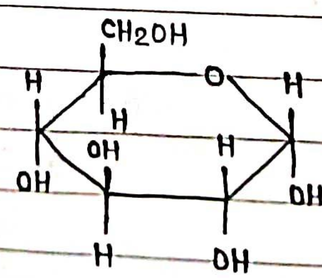
Chiral carbon = 4

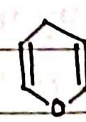
Stereoisomers = 16

Chiral carbon = 5

Stereoisomers = 32

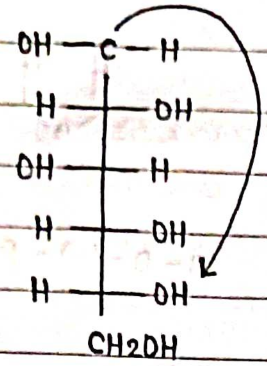


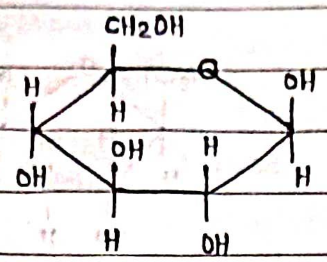




Pyran

α-D-(+)-Glucopyranose





Pyran

β-D-(+)-Glucopyranose

- OP POINTS :

① α and β-Forms are called Anomers (C-1 anomer)

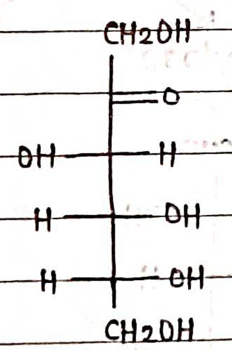
② Anomers are Diastereomers

③ All anomers are diastereomers but all diastereomers are not anomers.

④ Mutarotation :- Equilibrium b/w α and β Forms is called Mutarotations

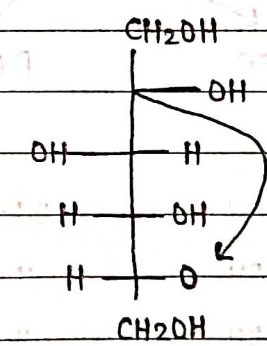
$$\alpha \rightleftharpoons \beta$$

- cyclic structure of Fructose :



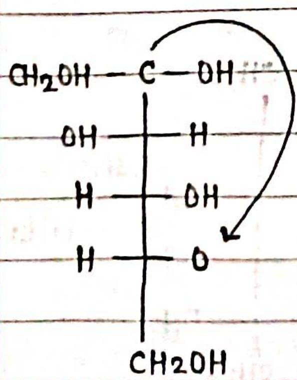
Total chiral carbon = 3

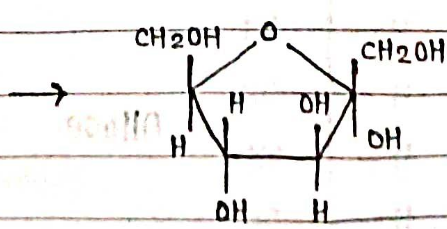
Stereoisomers = 8



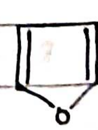
Total chiral carbon = 4

Stereoisomers = 16

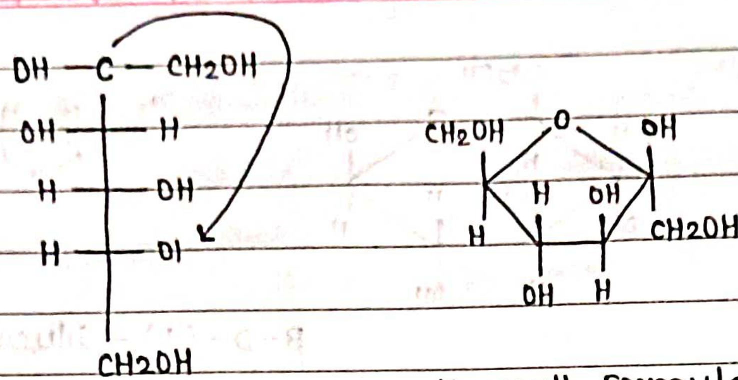


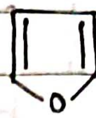


α-D-(-)-FructoFuranose



Furan




Furan

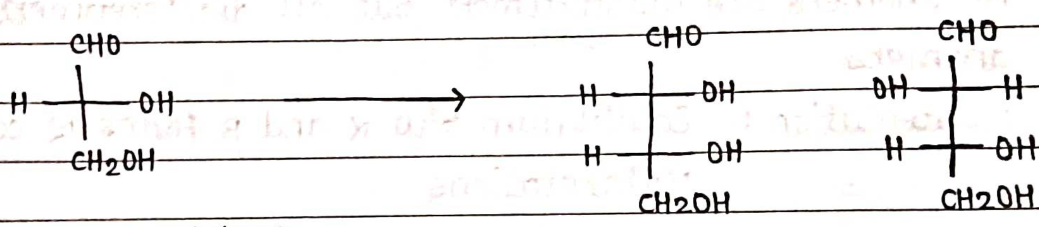
β-D-(-)-Fructofuranose

Haworth Formula.

- α and β Forms are called Anomers (C-2 Anomer)

• Remember all Monosaccharides:

Erythrose Threose

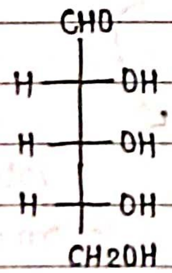


D-Glyceraldehyde

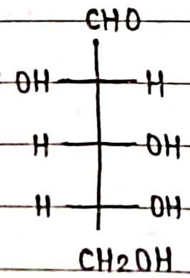
E → Ribose, Arabinose

T → Xylose, Lyxose

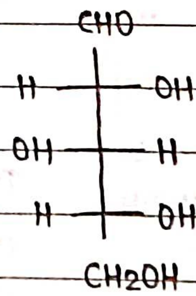
Ribose



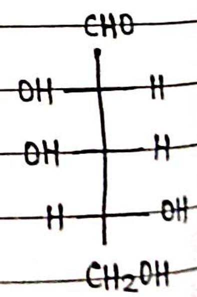
Arabinose



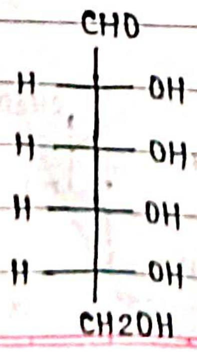
Xylose



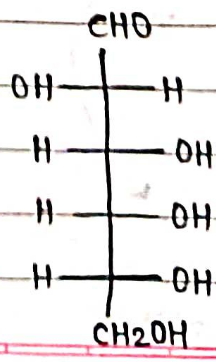
Lyxose



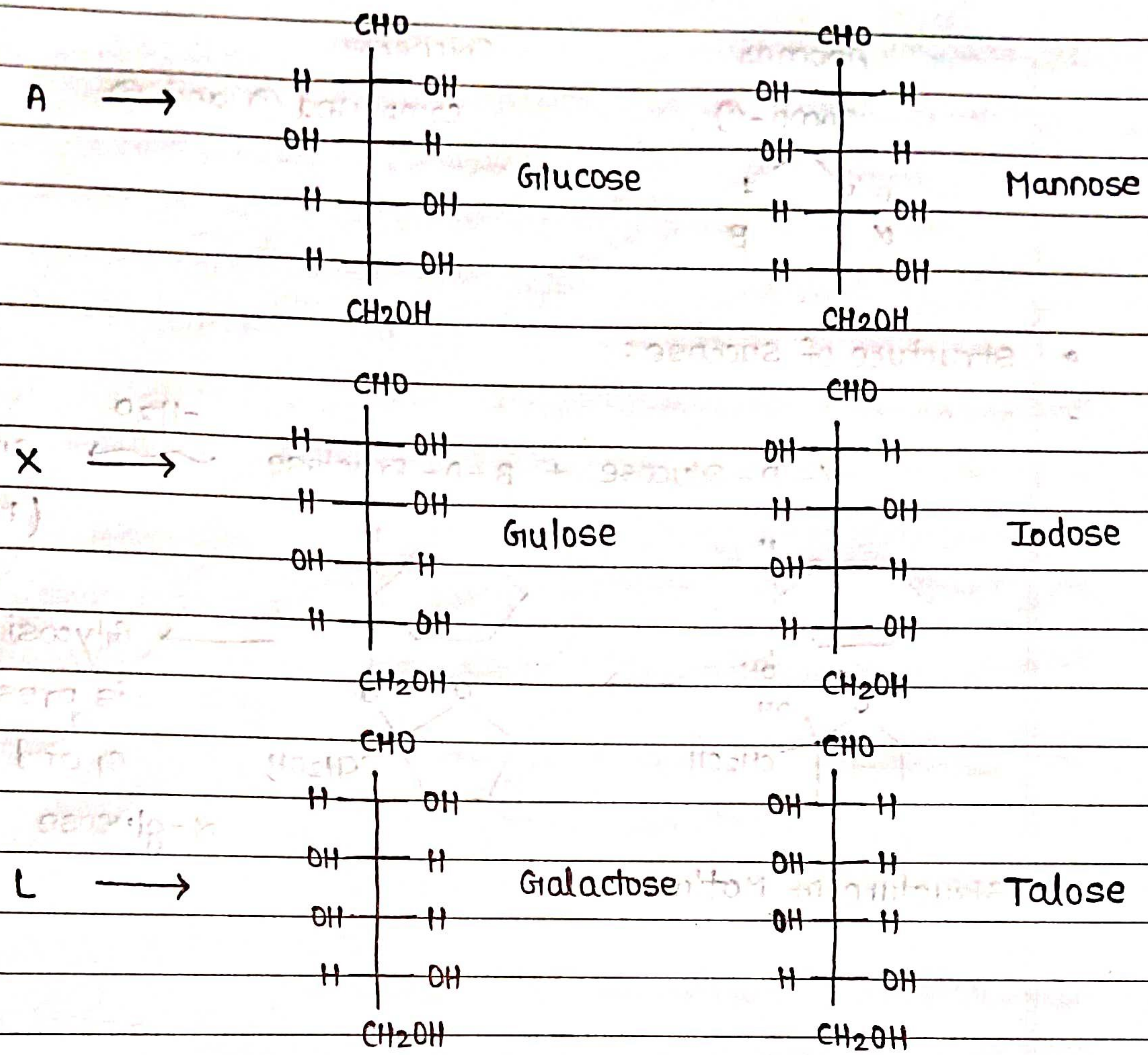
R →

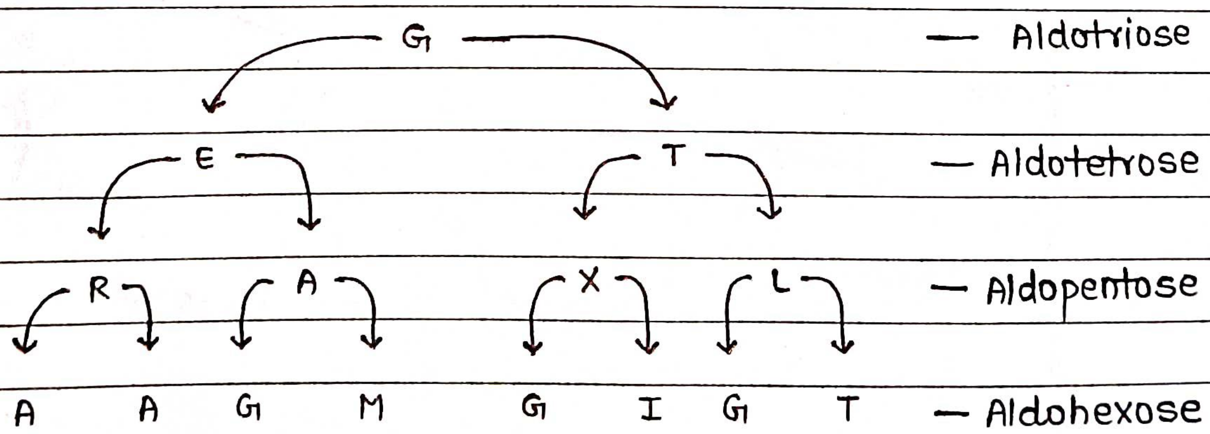


Allose



Altrose





- Epimers :

① Epimers are diastereomers.

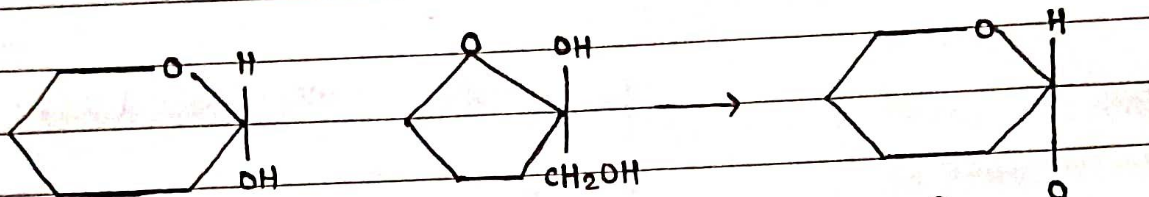
Examples : Glucose and mannose are C-2 Epimer

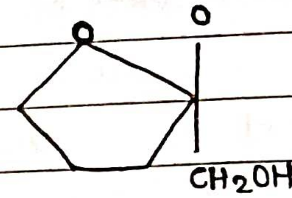
Anomer → comp - ① → α, β

Epimers → Compound A, Compound B

- Structure of sucrose :

α-D-Glucose + β-D-Fructose $\xrightarrow{-H_2O}$ Sucrose (M-O-M)

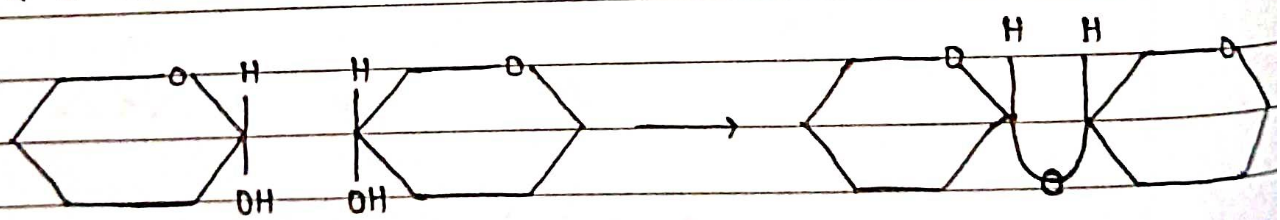




- Glycosidic linkage is present at C_1 and C_2 of α-glucose and β Fructose Respectively.

- Structure of Maltose :

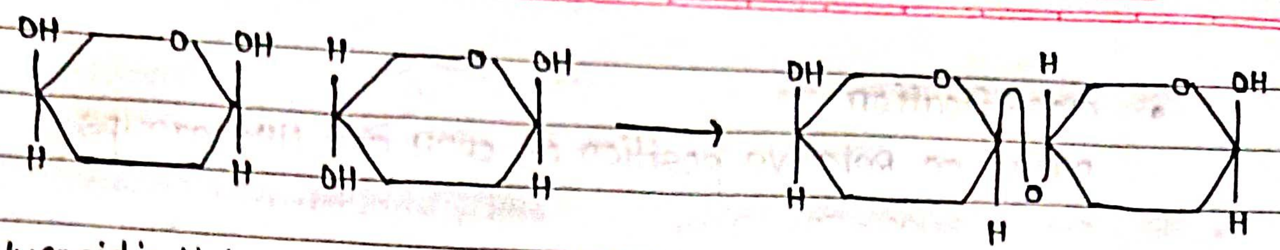
α-D-Glucose + α-D-Glucose $\xrightarrow{-H_2O}$ Matose.



Glycosidic linkage is present at C_1 and C_4 of α-Glucose and α-Glucose.

- Structure of lactose :

β-D-Galactose + β-D-Glucose $\xrightarrow{-H_2O}$ Lactose

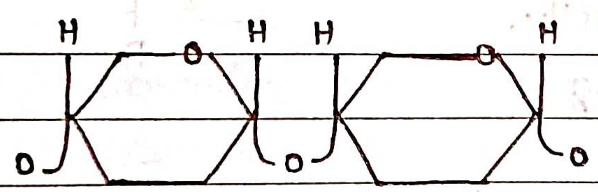


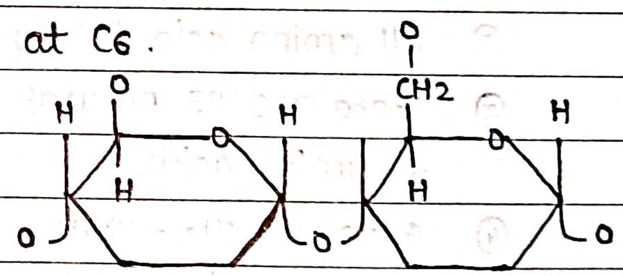
Glycosidic linkage is present at C_1 and C_4 of β - Galactose and β - Glucose Respectively.

- Starch (Polymer of α-D Glucose)

- There are two components ① Amylose (Linear) ② Amylopectin (Branched)

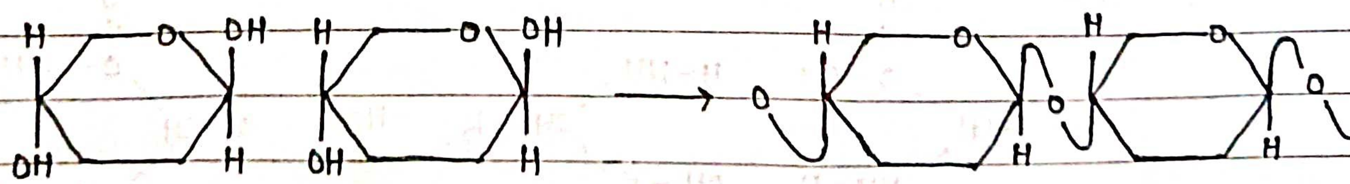
Amylose	Amylopectin
① Linear polymer	① Branched polymer
② 15-20 % starch	② 80-85 % starch.
③ water soluble.	③ water insoluble.
④ Glycosidic linkage at C_1 and C_4	④ Glycosidic linkage. At C_1 and C_4 and Branched at C_6.





- Structure of Cellulose :

Glycosidic linkage of present at C_1 and C_4 of β-D- Glucose



- Amino Acid .

- Classification

Based on Relative position of COOH and NH_2 groups

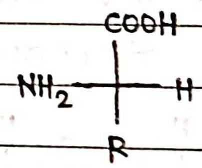
① α - Amino acid $R-\underset{\underset{NH_2}{|}}{CH}-COOH$

② β - Amino acid $R-\underset{\underset{NH_2}{|}}{CH}-CH_2-COOH$

③ γ - Amino acid $R-\underset{\underset{NH_2}{|}}{CH}-CH_2-CH_2-COOH$

④ δ - Amino acid $R-\underset{\underset{NH_2}{|}}{CH}-CH_2-CH_2-CH_2-COOH$

- OP POINTS :



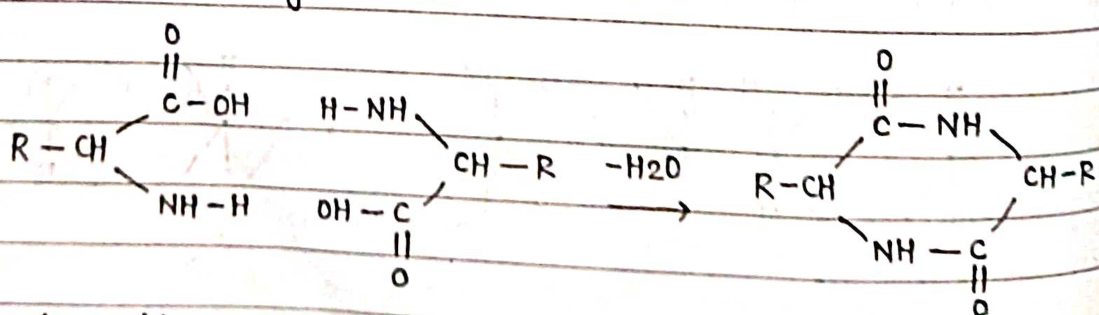
① α - Amin acid is the monomer of protien.

② All amino acid belongs L-Family.

③ There are 23 natural occuring α-amino acids.

④ Glycine $\underset{\underset{NH_2}{|}}{CH_2}-COOH$ is only optically inactive.

- Amino acid (Heating effect)



① α - Amino acid

lactide.

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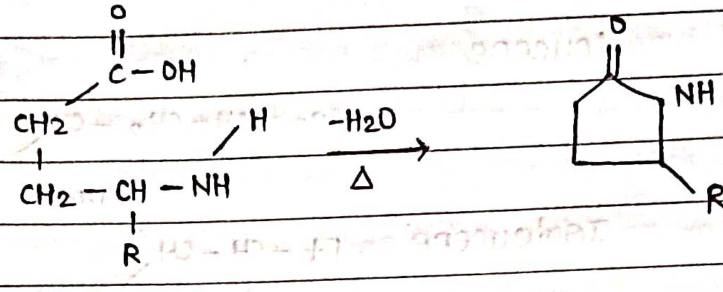
② β- amino acid

$$R-\underset{NH_2}{CH}-\underset{H}{CH}-COOH \xrightarrow[\Delta]{-NH_3} R-CH=CH-COOH$$

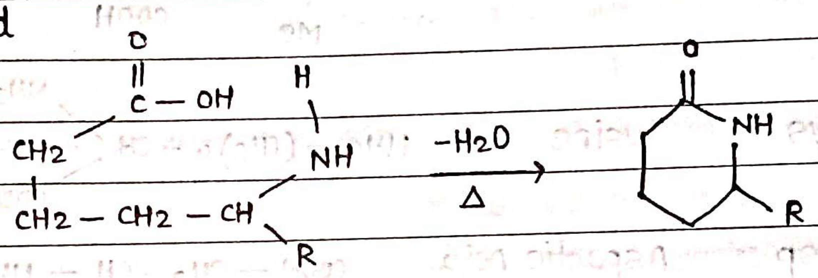
α, β - unsaturated acid.

③ γ- amino acid



γ- Lactam

④ δ- Amino acid



δ- Lactam

• α- Amino Acids

Based on R

$$R-CH\begin{matrix} COOH \\ NH_2 \end{matrix}$$

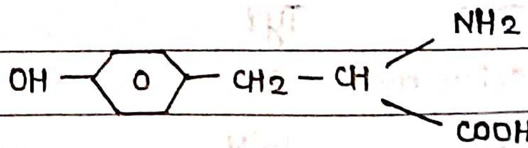
① R contains COOH — Acidic Amino Acid

② R contains NH_2 — Basic Amino Acid

③ R neither contains COOH or NH_2 — Neutral Amino Acid.

• Imp α- amino acids.

① Tyr — Tyrocene



② ser — Serine — $OH-CH_2-CH\begin{matrix} NH_2 \\ COOH \end{matrix}$

③ Gly — Glycine — $H-CH\begin{matrix} NH_2 \\ COOH \end{matrix}$

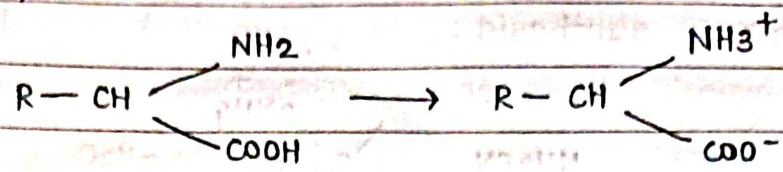
④	Ala	Alanine	$Me-CH(NH_2)(COOH)$
★ ⑤	Phe	phenyl Alanine	$ph-CH_2-CH(NH_2)(COOH)$
★ ⑥	Val	Valine	$Me_2-CH-CH(NH_2)(COOH)$
★ ⑦	Leu	Leucene	$Me_2-CH-CH_2-CH(NH_2)(COOH)$
★ ⑧	Ile	Isoleucene	$Et-CH(Me)-CH(NH_2)(COOH)$
★ ⑨	Lys	Lysine	$NH_2-(CH_2)_4-CH(NH_2)(COOH)$
⑩	Asp	Aspactic Acid	$COOH-CH_2-CH(COOH)-NH_2$
⑪	Glu	Glutamic Acid	$COOH-CH_2-CH_2-CH(NH_2)(COOH)$
★ ⑫	Arg	Arginine	$NH_2-C(=NH)-NH-(CH_2)_3-CH(NH_2)(COOH)$

- Most Basic Group — Guianidine Group $[NH_2-C(=NH)-NH-]$

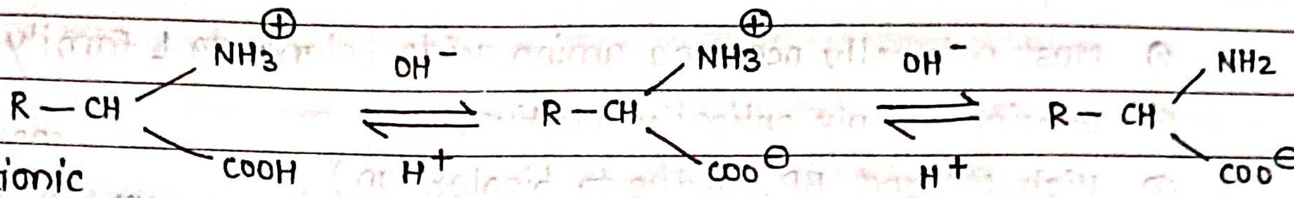
- Tere — Tyr
  - Sehar main — Ser
  - Giw — Gly
  - Ala — Ala
  - ✓ Pheri — Phe
  - ✓ Vala — Val
  - ✓ Lene — Leu

- ✓ Aaye — Ile
- ✓ L — Lysine
- A — Aspactic
- G — Glutamic
- ✓ AN — Arginine

- Zwitter ion (Bipolar ion)



Depending upon the pH of Solⁿ zwitter ion exist in 3 different ion



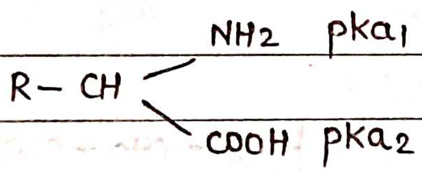
Cationic Form — Low pH

Zwitter ion Form — Intermediate pH

Anionic Form — High pH

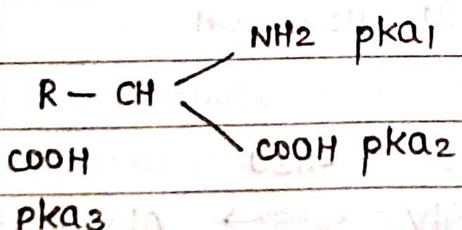
- Calculation of pH at isoelectric point : (PI)
  ↳ where no net migration of ions takes place or where zwitter ion exist

① For neutral Amino acid



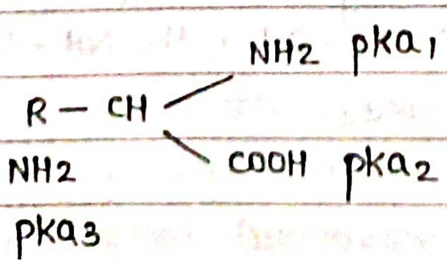
$$PI = \frac{pka_1 + pka_2}{2}$$

② For Acidic Amino acid



$$PI = \frac{pka_2 + pka_3}{2}$$

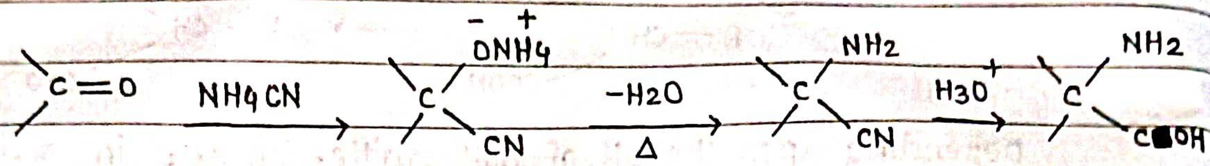
③ For Basic Amino acid



$$PI = \frac{pka_1 + pka_3}{2}$$

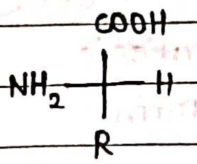
- MOP :

Strecker's synthesis :



\- Properties :

1. Most naturally occuring amino acids belongs to L family.
2. Glycine is only optically inactive.
3. High MP and BP. (due to bipolar ion)
4. Water soluble.
5. Behave like salt.



- Dipeptide : Ala (OH) + Gly (H) $\xrightarrow{-H_2O}$ Ala-Gly

Ala-Gly

$CH_3-CH(NH_2)-C(=O)-OH + H-NH-CH_2-COOH$

↓

$CH_3-CH(NH_2)-C(=O)-$ [OH + H] $-NH-CH_2-COOH$

Peptide Linkage ⟶ $CH_3-CH(NH_2)-C(=O)-NH-CH_2-COOH$

- Tripeptide :

Ala-Val-Gly

Ala (OH) + Val (H, OH) + Gly (H) $\xrightarrow{-H_2O}$ Ala-Val-Gly

$CH_3-CH_2(NH_2)-C(=O)-OH + H-NH-CH(CHMe_2)-C(=O)-OH + H-NH-CH_2-COOH$

↓

$CH_3-CH(NH_2)-C(=O)-NH-CH(CHMe_2)-C(=O)-NH-CH_2-COOH$ — Peptide Bond linkage

- **Globular and Fibrous protien:**

	Fibrous (collagen)	Globular (Myoglobin)
- Molecules	Long, Thin Lie side by side to Form Fibres	Fold into spherical 3D shape
- Examples	Collagen (in skin and bone) Keratin (hair, wool, silk) myosin (muscles)	Haemoglobin Insulin Enzymes / albumins
- Solubility in water	Insoluble	Soluble.
- Roles	Structural: Collagen – Bone and cartilage Keratin in Fingernails and hair.	Metabolic: Enzymes in all Organ. Plasma protiens, antibodies in mammal

- **Denaturation of protiens:**

① Protien Found in a biological system with a unique three dimensional structure and biological activity is called a native protien.

② When a protien in its native Form is subjected to physical change like change in temp or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protien loses its biological activity. This is called denaturation of protien.

③ During denaturation of egg white on boiling, curdling of milk which is caused due to the Formation of lactic acid by the bacteria present in the milk.

(4) During denaturation secondary and tertiary structures are destroyed but primary structure remains intact.

- Nucleic Acid:

⊖ It has been observed that nucleus of a living cell is responsible For this transmission of inherent characters also called heredity.

⊖ The particles in nucleus of a cell, responsible For Heredity are called chromosomes which are made up of protiens.

⊖ Another type of Biomolecules called nucleic Acids. These are mainly of two types, the deoxyribonucleic acid (DNA) and Ribonucleic acid (RNA)

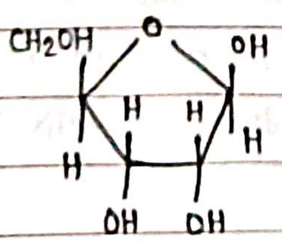
⊖ Nucleic Acids are long chain polymers of nucleotides, so they are also called polynucleotides.

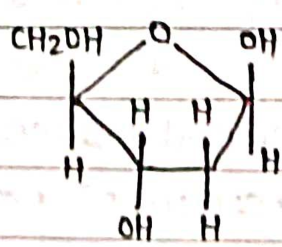
- Chemical composition of Nucleic Acid:

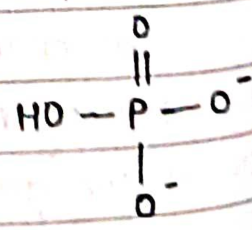
(1) Complete hydrolysis of DNA (or RNA) yeilds a pentose sugar phosphoric acid and nitrogen containing heterocyclic compounds (called Bases).

(2) In DNA molecules, the sugar is β-D-2-deoxyribose whereas in RNA molecule it is β-D-Ribose.

Diphosphate





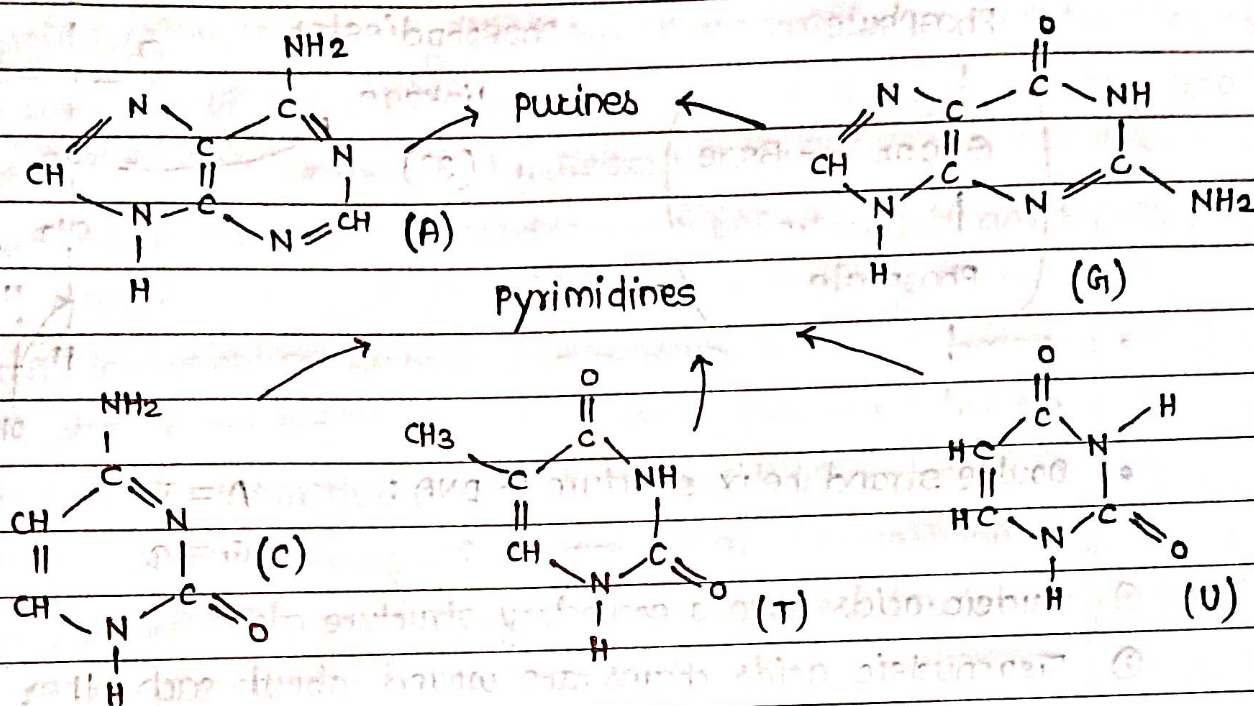


β-D-Ribose (In RNA)   β-D-2-Deoxyribose (In DNA)

- Bases in DNA and RNA :

① DNA — Adenine (A) Guanine (G) Cytosine (C) Thymine (T)

② RNA — Adenine (A) Guanine (G) Cytosine (C) Uracil (U)



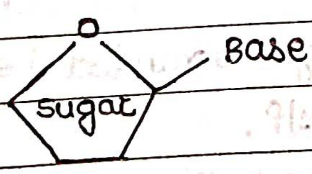
– A G C T — DNA

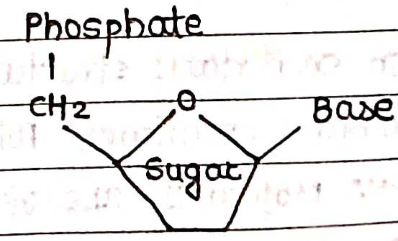
, , , U — RNA

- Structure of Nucleic Acid :

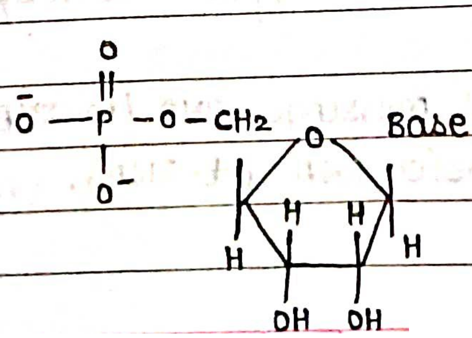
Nucleosides — Pentose sugar + Base

Nucleotides — Pentose sugar + Base + Phosphate Ester



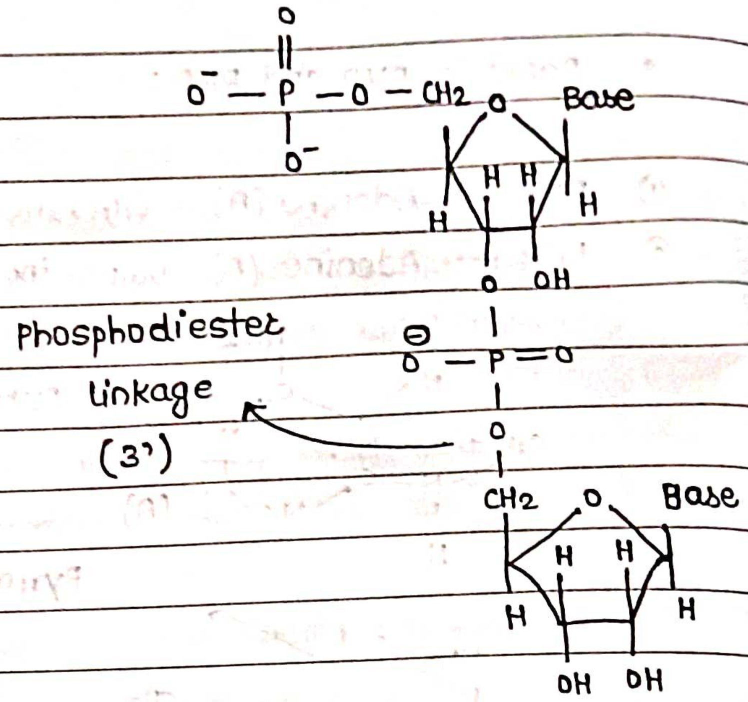


- Nucleotide



- **Formation of Dinucleotide :**

¦
Sugar — Base
|
Phosphate
(
|
Sugar — Base
|
Phosphate
)n
¦



- **Double strand helix structure of DNA :**

A = T
G ≡ C

1. Nucleic acids have a secondary structure also.
2. Two nucleic acids chains are wound about each other and held together by Hydrogen bonds between pairs of bases.
3. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of Bases.
4. Adenine forms Hydrogen bonds with thymine whereas cytosine forms Hydrogen bonds with Guanine.

- **Secondary structure of RNA :**

1. In secondary structure of RNA single stranded helics is present which sometimes foldsback on itself.
2. RNA Molecules are of three types and they perform different functions.
3. They are named as messenger RNA (m-RNA), ribosomal RNA (r-RNA) and transfer RNA (t-RNA).

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- DNA Fingerprinting :

① It is known as that every individual has unique fingerprints.
② These occur at the tips of the Fingers and have been used For identification for a long time but these can be altered by surgery.
③ A sequence of bases of DNA is also unique for a person and info regarding this is called DNA Fingerprinting.
④ It is same For every cell and cannot be altered by any known treatment.
⑤ DNA Fingerprinting is now used :

(I) In Forensic laboratories For identification of criminals.
(II) to Determine paternity of an individual.
(III) to Identify the dead bodies in any accident by comparing the DNA's of parents or children.
(IV) to Identify racial groups to rewrite biological evolution.

- Vitamins :

Fat soluble Vitamins
- Vitamin K
- Vitamin E
- Vitamin D
- Vitamin A (Retinol)

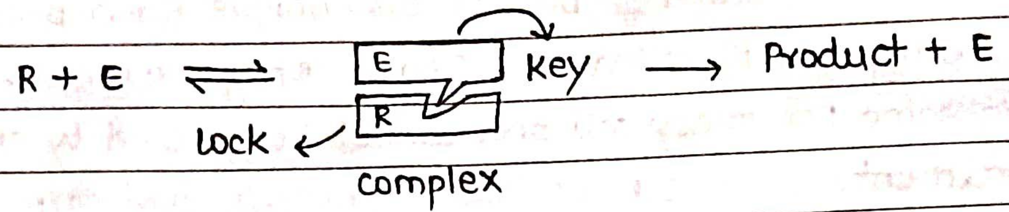
Water soluble Vitamins

Vitamin	Name
B1	Thiamine
B2	RiboFlavin
B3	Niacin
B5	Pantothenic Acid
B7	Biotin
B9	Folate
B12	Cobalamin
B6	Pyridoxine
C	Abscorbic Acid

- Name of Vitamins
Sources
Deficiency Diseases
(NCERT CHART)

- Enzymes:

- catalyst: ① Catalyse the Rxn in the Body.
  ② Small quantity can do millions of the Rxn.
  ③ Also known as Biochemical catalyst.



Name	Substrate	Products
Urease	Urea	Ammonia and CO_2
Maltase	Maltose	Glucose
Invertase	Sucrose	Glucose + Fructose
Amylase	Starch	Maltose
Trypsin	Protiens	Amino Acids
Ascorbic Acid Oxidase	Ascorbic Acid	Dehydro Ascorbic Acid.

- Harmones:

① Harmones are molecules that act as intercellular messengers
② These are produced by endocrine glands in the body and poured directly in the blood stream which transports them to the site of the Action.
③ Some of these are steroids e.g. estrogens and androgens; some are poly peptides for example insulin and endorphins and some others are amino acids derivatives such as epinephrine and norepinephrine.
④ Hormones have several functions in the Body. They help to maintain the balance of biological activities in the Body.

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(5) The role of insulin in keeping the blood glucose level within the narrow limit is an example of this Function. Insulin is released to the rapid rise in blood glucose level.

(6) Hormones glucagon tends to increase the glucose level in the blood.

(7) steroid Harmones are produced by adrenal cortex and gonads (testes in males and ovaries in Female)

(8) Hormones released by gonads are responsible for development of secondary sex characters.

(9) Testosterone is the major sex hormone produced in males.

(10) It is responsible For development of secondary male charecters (deep voice, Facial hair, general physical constitution)

(11) estradiol is the main Female sex hormone.

(12) It is responsible For development of secondary Female characters and participates in the control of menstrual cycle.

(13) Progesterone is responsible For preparing the uterus For implantation of fertilised egg.