CHAPTER - 13 BIOMOLECULES

1. Define carbonydrates.
Carbonydrates are optically active polyhydroxy aldehyde or Ketones or the compounds which produces such units on hydrolysis.

2. What do you mean by monosaccharide units?
A carbonydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or Ketone is called a monosaccharide.
Ex Glucose, fructose, ribose ($C_5H_{10}O_5$)

3. Define oligosaccharides.
Carbonydrates that yield two to ten monosaccharide units on hydrolysis are called oligosaccharide.
Ex disaccharide - sucrose, maltose.

4. Define polysaccharide.
Carbonydrates that contain a large number of monosaccharide units joined together by glycosidic linkages.
Ex - Starch, cellulose, glycogen etc.

Carbonydrates

Reducing sugars
(Substance which reduce Fehling's solution and Tollen's reagents)
All monosaccharides are reducing &
Disaccharide in which functional group is free (Maltose, lactose)

Non reducing sugars
(Carbonydrates which do not reduce both)
If aldehydic or Ketonic group is bonded in a disaccharide (sucrose)

- Position of hydroxyl group in the second last carbon atom decides whether it is D- and L- configuration. If right OH - D- configuration
  Left OH - L- configuration

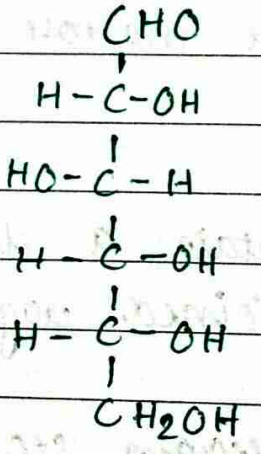
Glucose (Ripe sugar)

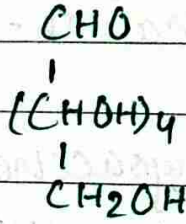
1. $C_{12}H_{22}O_{11} + H_2O \xrightarrow[H^+]{H_2SO_4} C_6H_{12}O_6 + C_6H_{12}O_6$
   Glucose Fructose

2. $(C_6H_{10}O_5)_n + n\,H_2O \xrightarrow{H^+} n\,C_6H_{12}O_6$

Glucose is an aldohexose and is known as dextrose Monomer of starch, cellulose.

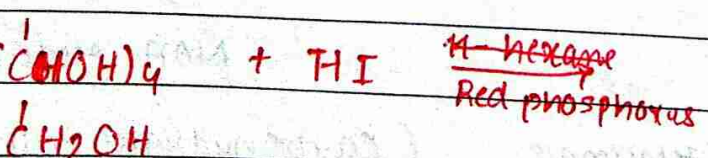
Structure





D- Glucose

Test for presence of straight chain



(n- hexane)

Test to prove the presence of carbonyl group

1. $(CHOH)_4$ (CHO, CH_2OH) + NH_4OH (hydroxyl amine) → $(CHOH)_4$ ($CH{=}N{-}OH$, CH_2OH) (Oxime)

2. $(CHOH)_4$ (CHO, CH_2OH) + HCN (hydrogen cyanide) → $(CHOH)_4$ ($CH(OH)CN$, CH_2OH) (Cyanohydrin)

3. $(CHOH)_4$ (CHO, CH_2OH) + [O] $\xrightarrow{Br_2 \text{ water}}$ $(CHOH)_4$ (COOH, CH_2OH)
Gluconic acid

Test to prove the presence of five hydroxyl group

$(CHOH)_4$ (CHO, CH_2OH) + $(CH_3CO)_2O$ (Acetic anhydride) → $(CHOOCCH_3)_4$ (CH_2OOCCH_3) + ~~5CH3COOH~~
Glucose pentacetate

Two hydroxyl group cannot be on the same carbon atom because it will make it unstable

Reaction with HNO_3

$(CHOH)_4$ (CHO, CH_2OH) $\xrightarrow{\text{Oxidation}}$ $(CHOH)_4$ (COOH, CH_2OH) Saccharic acid $\xleftarrow{\text{Oxidation}}$ $(CHOH)_4$ (COOH, CH_2OH) Gluconic acid

Test which were not shown by straight chain

i) Glucose does not react with $NHSO_3$ to yeild addition Hydrogen sulphide.

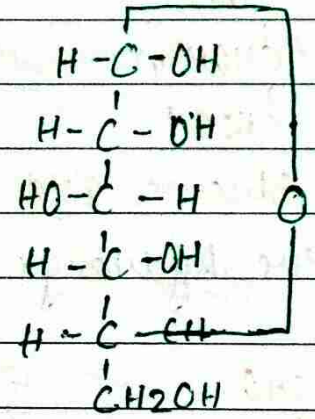
ii) Does not give test with 2,4-DNP and schiff's test.

iii) Does not react with ammonia.

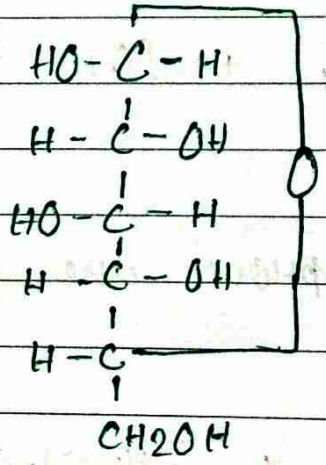
iv) Glucose pentacetate does not react with hydroxyl amine (NH_4OH) this shows the absence of free aldehydic group

- Glucose forms a cyclic structure in which OH at C5 is added to CHO to form a six membered ring.

Fischer projection formula



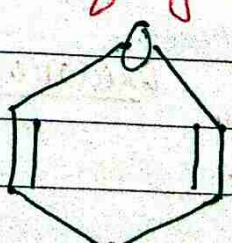
α-D-Glucose



β-D-Glucose

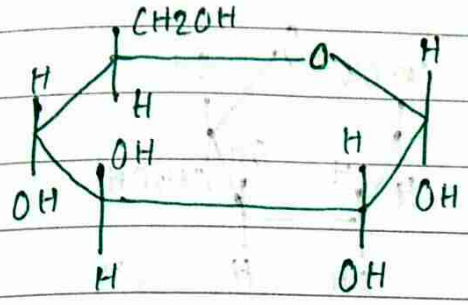
- Two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C1 called anomeric carbon. (Aldehyde carbon before cyclisation)

- Six membered cyclic structure of glucose is called pyranose.

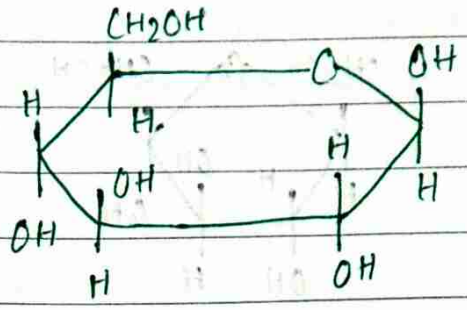


Pyran

Haworth structure



α-D-Glucose



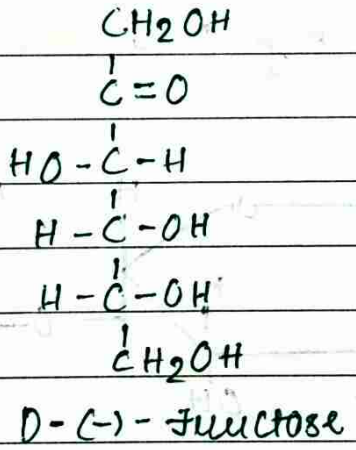
β-D-Glucose

- Right side on Fischer structure - Down
  Left side on Fischer structure - UP.

Fructose (Fruit sugar)

It is a Ketohexoses

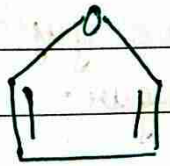
Structure



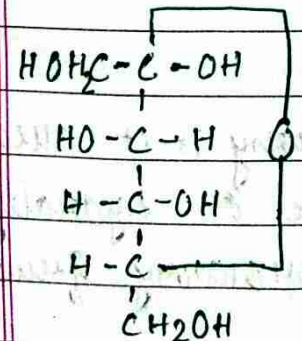
D-(-)-Fructose

Fischer projection formula

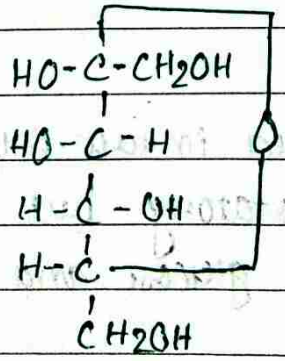
The five membered structure of fructose is called Furanose.



Furan

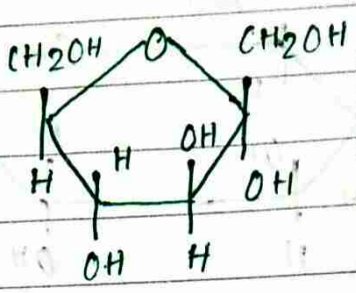


α-D-(-)-Fructose

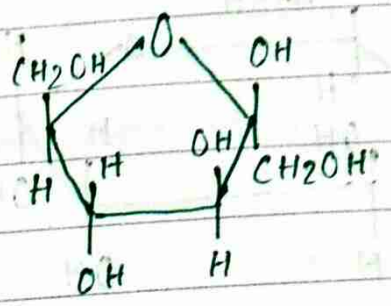


β-D-(-)-Fructose

Haworth structure



α-D-(-)-Fructose

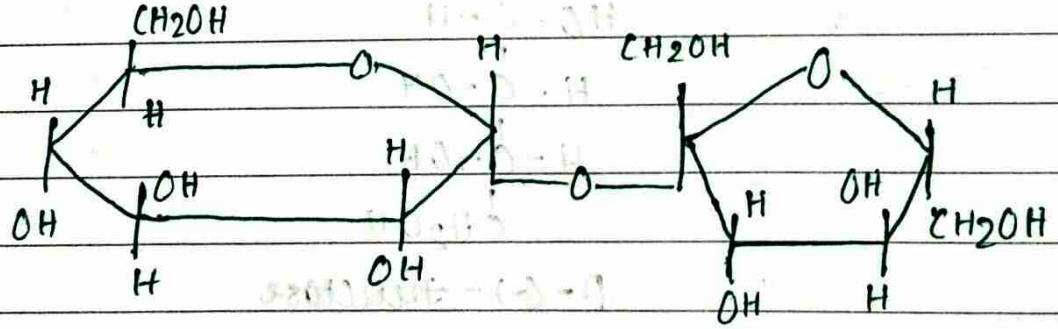


β-D-(-)-Fructose

5. What do you mean by glycosidic linkage?
A linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.

Sucrose (Beet sugar)/(Cane sugar)

Composed of α-D-Glucose and β-D-(-)-Fructose.
Glycosidic linkage is between C_1 of α-D-Glucose and C_2 of β-D-(-)-Fructose



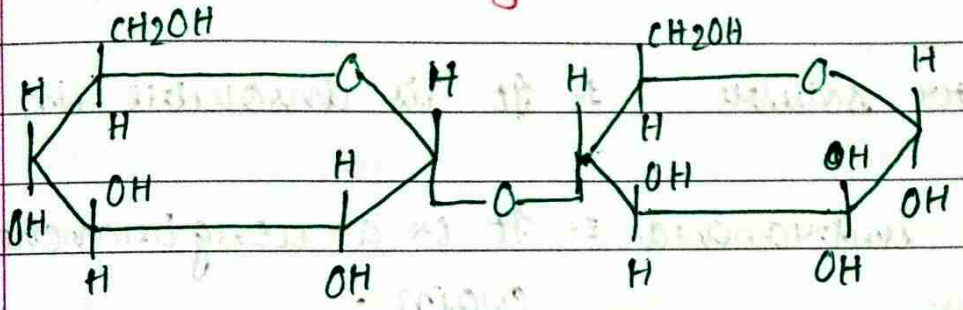
∵ Reducing groups of glucose and fructose are involved in glycosidic linkage, sucrose is a non reducing sugar.

6. Which sugar is called invert sugar? Why is it called so?
Sucrose is dextrorotatory but sucrose on hydrolysis gives dextrorotatory glucose and laevorotatory fructose

Hence, mixture becomes laevorotatory.
This sugar which on hydrolysis changes its sign of rotation from dextro to laevo is known as invert sugar.

Maltose

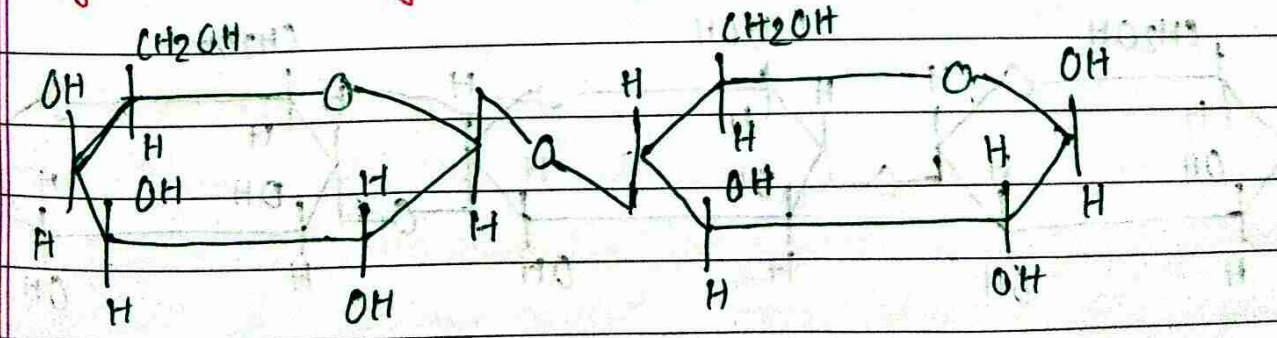
Monosaccharide units - α-D-Glucose and α-D-Glucose
Glycosidic linkage C_1 to C_4.



* It is a reducing sugar.

Lactose (Milk sugar)

Monosaccharide units - β-D- Galactose and β-D- Glucose
Glycosidic linkage - C_1 of Galactose to C_4 of Glucose



β-D- Galactose β-D- Glucose

* It is a reducing sugar

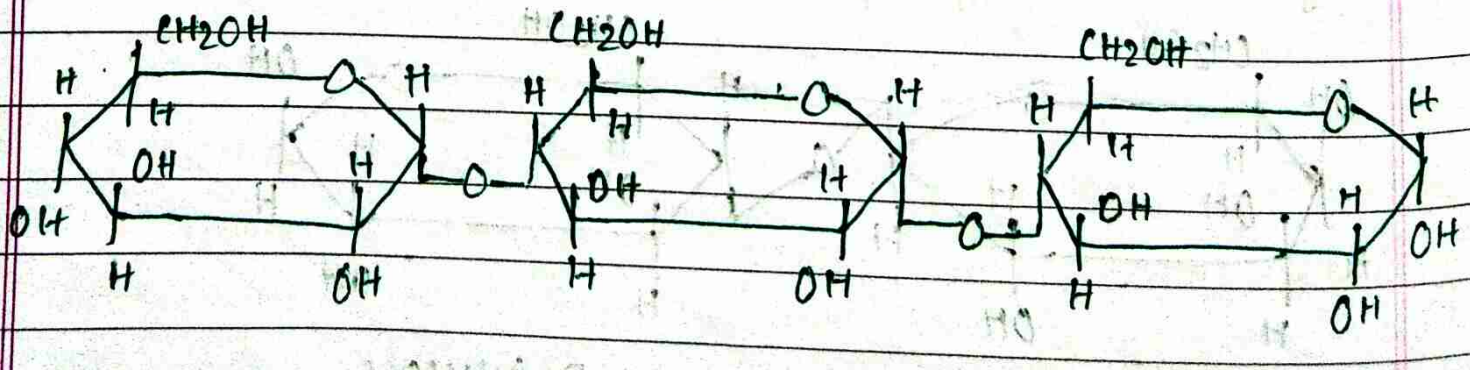
Polysaccharide

i) Starch - Main storage polysaccharide of plants
It is a polymer of α-Glucose
consist of - amylose and amylopectin

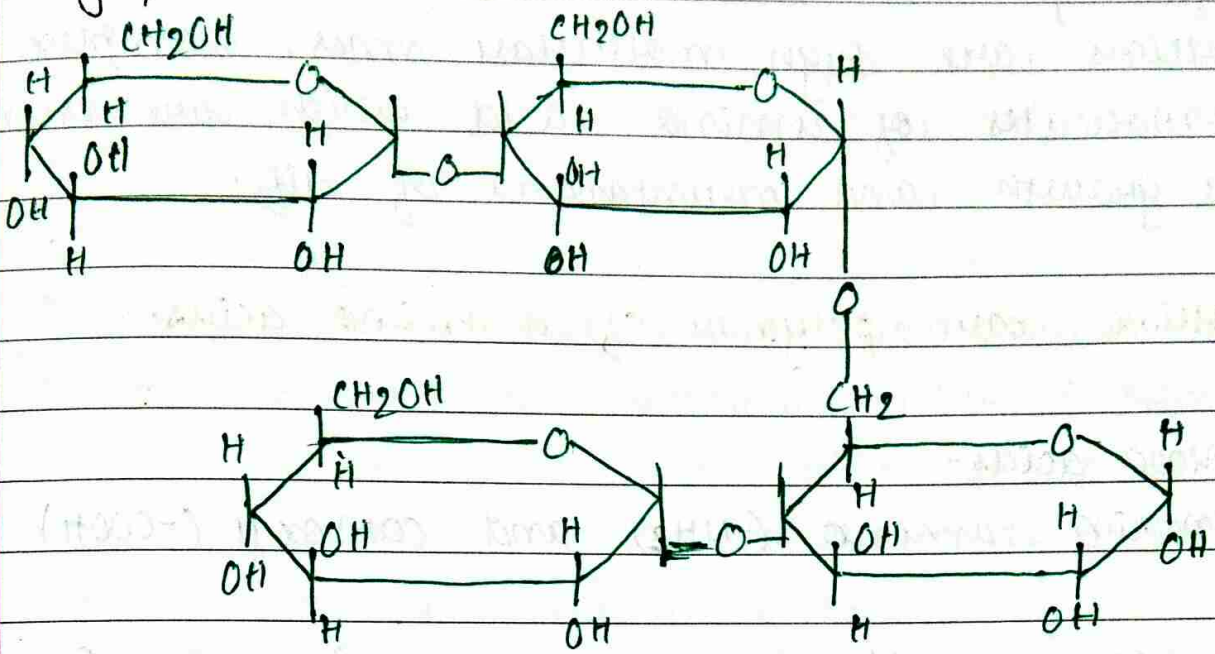
7. What is the difference between amylose and amylopection.

	AMYLOSE		AMYLOPECTIN
1.	It is a water soluble component	1.	It is insoluble in water.
2.	It is a long unbranched chain.	2.	It is a long branched chain.
3.	It constitutes about 15-20% of starch.	3.	It constitutes about 80-85% of starch.
4.	Glycosidic linkange is only between C_1 and C_4 of α-D-Glucose.	4.	Glycosidic linkage is between C_1 and C_4, and $C_1 - C_6$ of α-D-Glucose

Amylose:



Amylopectin

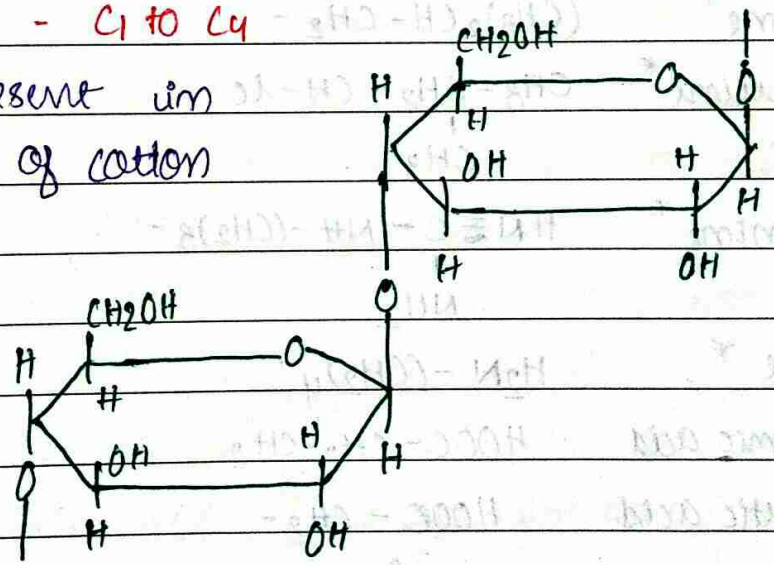


ii) Cellulose - constituent of cell wall of plant cells.

Monosaccharide unit - β-D- Glucose and β-D- Glucose

Glycosidic linkage - C_1 to C_4

Cellulose is present in wood and fibre of cotton



iii) Glycogen -

a) Carbohydrate stored in animal

b) Structure is similar to amylopectin

c) Present in liver, muscles and brain

d) Found in yeast and fungi.

8. Define proteins.

Proteins are high molecular mass, complex nitrogenous biomolecules of amino acid which are essentials for growth and maintainance of life.

- Proteins are polymer of α-amino acids.

Amino acids-

contain amino ($-NH_2$) and carboxyl ($-COOH$)

1.	Glycine	H	Gly	G
2.	Alanine	CH_3	Ala	A
3.	Valine *	$(CH_3)_2CH-$	Val	V
4.	Leucine*	$(CH_3)_2CH-CH_2-$	Leu	L
5.	Isoleucine*	$CH_3-\underset{\underset{CH_3}{|}}{CH_2}-CH-$	I	I
6.	Arginine*	$HN=\underset{\underset{NH_2}{|}}{C}-NH-(CH_2)_3-$	Arg	R
7.	Lysine *	$H_2N-(CH_2)_4-$	Lys	K
8.	Glutamic acid	$HOOC-CH_2-CH_2$	Glu	E
9.	Aspartic acid	$HOOC-CH_2-$	Asp	D
10.	Glutamine	$H_2N-\overset{\overset{O}{\|\|}}{C}-CH_2-CH_2-$	Glm	Q

Classification of amino acids

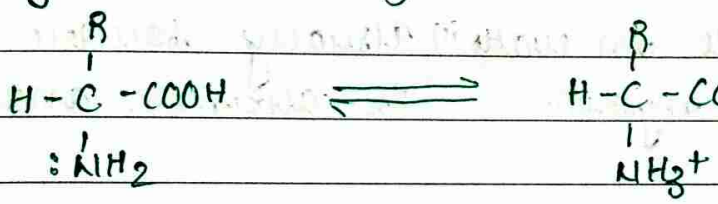
Neutral - Equal number of carboxyl group and amino group
Ex- Glycine, alanine

Basic - More number of amino group than carboxyl group.
Ex- Arginine, Lysine

Acidic - More carboxyl group than amino group
Ex- Aspartic acid, Glutamic acid.

Essentials - Not synthesised by our body.
Ex - Glycine, alanine
Non-essentials - Synthesised in our body
Ex - Valine, Leucine, Arginine.

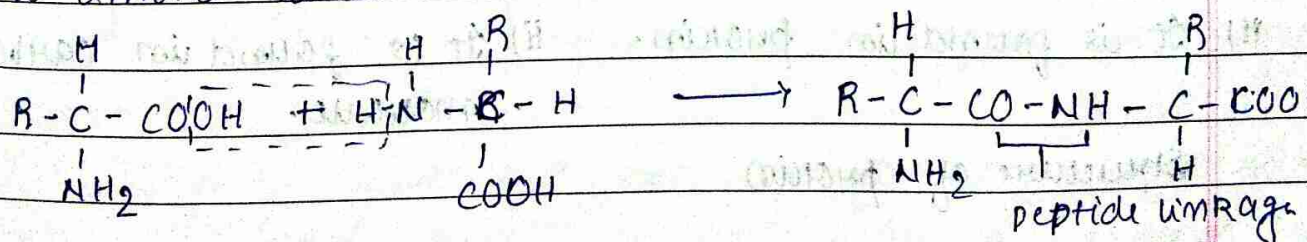
9. Amino acids behave like salts rather than simple amines or carboxylic acids. Explain.
Amino acids have acidic COOH group as well as basic NH_2 group hence, COOH looses its H to NH_2, hence they exist as zwitter ion.



Acidic character of zwitter ion is due to NH_3^+
Basic character of zwitter ion is due to COO^-

- Except glycine all other α-amino acids are optically active.

Peptides are the compound formed by the condensation of two or more, same or different α-amino acids.



When n number of peptides are present n-peptide linkages are formed and are called polypeptide.

10. Write difference between fibrous protein and globular protein.

Fibrous	Globular
i) In these polypeptides chain run parallel and are held together by hydrogen and disulphide bonds.	i) In these chains of polypeptide coil around to give a spherical shape.
ii) Usually insoluble in water. Ex- keratin and myosin.	ii) Usually soluble in water. Ex- albumin and insulin

11. Write difference between peptide linkage and glycosidic linkage.

Peptide linkage	Glycosidic linkage
i) It is an amide linkage formed between -COOH group of one amine and $-NH_2$ group of second amino group molecule.	i) It is an oxide linkage, that is two monosaccharide are joined together through an oxygen atom.
ii) It is found in protein.	ii) It is found in carbohydrate molecule.

Structure of protein

i) Primary structure - Sequence in which amino acid is linked to one or more polypeptide chain of a protein is called primary structure.
Sequence determines the function of protein

- α-helix structure of proteins is stabilized by hydrogen bonds between -NH group of each amino acid and -COOH group of amino acid at adjacent turn.

12. Why do α-helix and β-pleated structure arises?
Due to regular folding of the backbone of the polypeptide chain due to hydrogen bonding between -C- and -NH- group of peptide bond.

- Fibrous protein and globular protein structure arises due to tertiary structure.

18. Define native protein
Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein.

14. Define denaturation of protein
A process that changes the physical and biological properties of protein without effecting the chemical composition of protein is called denaturation.

15. During curdling of milk, what happens to sugar present in it?
Curdling of milk is caused due formation of lactic acid by bacteria present in milk. It is an example of denaturation of protein i.e when a protein is subjected some physical or chemical change, hydrogen bond get disturbed, globules unfold and helix uncoil and protein loses its biological activity.

- All the enzymes are globular protein
- Oxidoreductase enzyme is a class of enzyme which catalyses the oxidation of one substrate with simultaneous reduction of another

16. Define vitamins

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

Fat soluble vitamin	Water soluble vitamin
i) Vitamins which are soluble in fat and oils.	i) Vitamin soluble in water.
ii) Vitamin A, D, E and K are fat soluble.	ii) B group vitamin and vitamin C are water soluble
iii) Vitamins are stored in liver and adipose.	iii) Not stored (except vitamin B_{12}).

Name of vitamin	Sources	Deficiency diseases
1. Vitamin A	Milk, carrots, butter	Xerophthalmia, night blindness
2. Vitamin B_1 (Thiamine)	Milk, Green vegetables, Cereals	Beri Beri,
3. Vitamin B_2 (Riboflavin)	Milk, Liver, Kidney	Cheilosis, digestive disorder, burning sensation in skin.

4.	Vitamin B6 Pyridoxine	Milk, cereals, grams	Convulsions
5.	Vitamin B12	Curd, meat, fish	Pernicious anaemia
6.	Vitamin C Ascorbic acid	Citrus fruits, amla	Scurvy
7.	Vitamin D	Exposure to sunlight fish	Rickets, osteomalacia
8.	Vitamin E	Sunflower oil, germ oil	Muscular weakness, increased fragility of RBCs.
9.	Vitamin K	Green leafy vegetable	Increased blood clotting time.

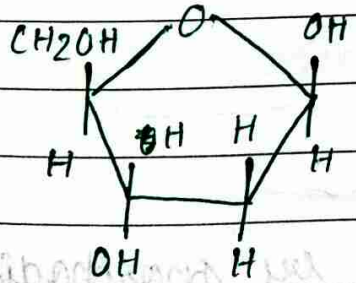
- Nucleic acids are polymers of nucleotides

Chemical composition of nucleic acid

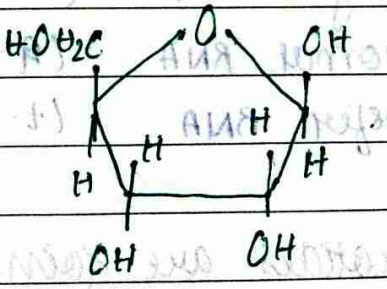
DNA (Deoxyribonucleic acid) - sugar - β-D-2-deoxyribose

RNA (Ribonucleic acid) - sugar - β-D-ribose

Pentose sugar, phosphoric acid and nitrogenous heterocyclic ring.



β-D-2-deoxyribose



β-D-ribose

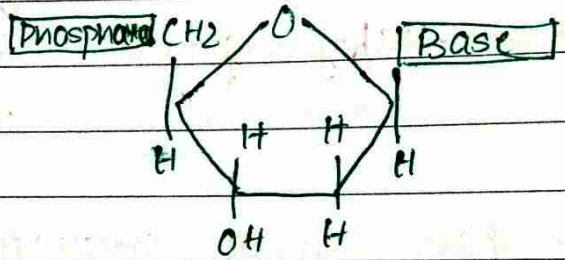
DNA - Adenine (A), Guanine (G), Cytosine (C), Thymine (T)

RNA - Adenine (A), Guanine (G), cytosine (C), Uracil (U)

Nucleoside - The molecule in which one of the nitrogen base is bonded with a sugar molecule is called nucleoside.

17. Define nucleotides

They are building blocks of DNA / RNA. These consist of a pentose sugar moiety attached to a nitrogenous base at 1' position and a phosphoric acid molecule at 5' position.



- Guanine is hydrogen bonded to cytocin by 3 hydrogen bond. in a double helix structure
- Adenine is hydrogen bonded to thymine by 2 hydrogen bond. in a double helix structure

RNA (single strand)

1. Messanger RNA (m-RNA)
2. Ribosomal RNA (R-RNA)
3. Transfer RNA (t-RNA)

- Nucleotides are joined together by phosphodiester linkage.

18. Write the difference between α-helix and β-pleated structures of protein

α- helix	β-pleated
1. It is rod like structure.	1. It is sheet like structure.
2. It is stabilized by intra-molecular hydrogen.	2. It is stabilized by inter-molecular hydrogen bonding.