Biomolecules

- **Tertiary structure of proteins:** It represents the overall folding of the polypeptide chain i.e., further folding of the 2° structure.

- **Types of bonding which stabilize the 3° structure:**

1. Disulphide bridge (-S – S-)
2. H – bonding – (C = O … H – N)
3. Salt bridge (COO– … + NH_3)
4. Hydrophobic interactions
5. van der Waals forces

- **Two shapes of proteins:**

Fibrous proteins

a) When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre– like structure is formed.
b) These proteins are generally insoluble in water
c) Examples: keratin (present in hair, wool, silk) and myosin (present in muscles), etc

Globular proteins

a) This structure results when the chains of polypeptides coil around to give a spherical shape.
b) These are usually soluble in water.
c) Examples: Insulin and albumins

- **Quaternary structure of proteins:**

1. Some of the proteins are composed of two or more polypeptide chains referred to as sub- units.
2. The spatial arrangement of these subunits with respect to each other is known as quaternary structure of proteins.

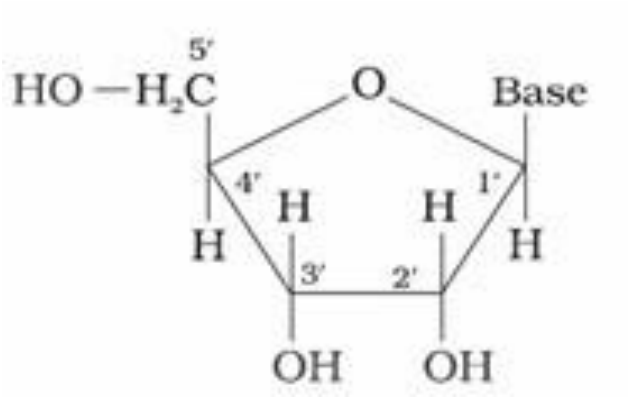
- **Denaturation of proteins:**

1. The loss of biological activity of proteins when a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH. This is called denaturation of protein.

2. Example: coagulation of egg white on boiling, curdling of milk.

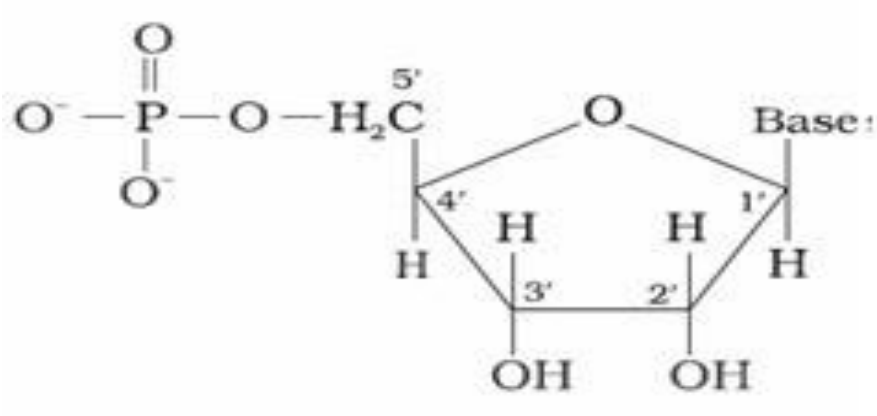
- **Nucleoside:**

1. Base + sugar



- **Nucleotide:**

1. Base + sugar + phosphate group



- **Nucleic acids (or polynucletides):**

Long chain polymers ofnucleotides.

1. Nucleotides are joined by phosphodiester linkage between 5' and 3' C atoms of a pentose sugar.

- **Two types of nucleic acids:**

DNA

1. It has a double stranded -helix structure in which two strands are coiled spirally in opposite directions.
2. Sugar present is β–D–2-deoxyribose
3. Bases:
   i) Purine bases: Adenine (A) and Guanine (G)
   ii) Pyrimidine bases: Thymine (T) and cytosine (C)
4. It occurs mainly in the nucleus of the cell.
5. It is responsible for transmission for heredity character.

RNA

1. It has a single stranded α-helix structure.
2. Sugar present is β–D–ribose
3. Bases:
   i) Purine bases: Adenine (A) and Guanine (G)
   ii) Pyrimidine bases: Uracil (U) and cytosine (C)
4. It occurs mainly in the cytoplasm of the cell.
5. It helps in protein synthesis.

- **Double helix structure of DNA:**

1. It is composed of two right handed helical polynucleotide chains coiled spirally in opposite directions around the same central axis.
2. Two strands are anti-parallel i.e., their phosphodiester linkage runs in opposite directions.
3. Bases are stacked inside the helix in planes $\perp$ to the helical axis.
4. Two strands are held together by H – bonds (A = T, G ≡ C).
5. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases.
6. Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine.
7. Diameter of double helix is 2 nm.
8. Double helix repeats at intervals of 3.4 nm. (One complete turn)
9. Total amount of purine (A + G) = Total amount of pyramidine (C + T)

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

- **Classification of vitamins:** Vitamins are classified into two groups depending upon their solubility in water or fat.

1. Water soluble vitamins

i) These vitamins are soluble in water.
ii) Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B12) in our body.
iii) Example: Vitamin C, B group vitamins.

2. Fat soluble vitamins

i) These vitamins are soluble in fat and oils but insoluble in water.

ii) They are stored in liver and adipose (fat storing) tissues.

iii) Example: Vitamin A, D, E and K

- **Important vitamins, their sources and their deficiency diseases:**

Name of vitamins	Sources	Deficiency diseases
Vitamin A	Fish liver oil, carrots, butter and milk	xerophthalmia(hardening of cornea of eye) Night blindness
Vitamin B1 (Thiamine)	Yeast, milk, green vegetables and cereals	Beriberi (loss of appetite, retarded growth)
Vitamin B2 (Riboflavin)	Milk, egg white, liver, kidney	Cheilosis(fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
Vitamin B6 (Pyridoxine)	Yeast, milk, eggyolk, cereals and grams	Convulsions
Vitamin B12	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
Vitamin C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	Scurvy bleeding gums)
Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc.	Increased fragility of RBCs and muscular weakness
Vitamin K	Green leafy vegetables	Increased blood clotting time

Q1. Give the methods used for the preparation of glucose?

1. *From sucrose (Cane sugar):* If sucrose is boiled with dilute HCl or H_2SO_4 in alcoholic solution, glucose and fructose are obtained in equal amounts.

$$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$$

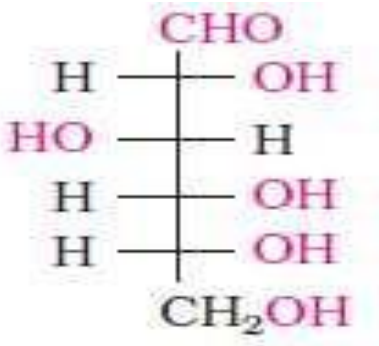
2. *From starch:* Commercially glucose is obtained by hydrolysis of starch by boiling it with dilute H_2SO_4 at 393 K under pressure.

$(C_6H_{10}O_5)_n + nH_2O \rightarrow nC_6H_{12}O_6$

Q2. Write a note on the structure of glucose?

Glucose is an aldohexose and is also known as dextrose. Its molecular formula is $C_6H_{12}O_6$. Experiments suggest that i) all the six carbon atoms are linked in a straight chain ii) there is a free aldehydic group and 5 hydroxyl groups and iii) one of the alcoholic group is primary.

Based on the above informations, Fischer proposed an open chain structure for glucose as follows:

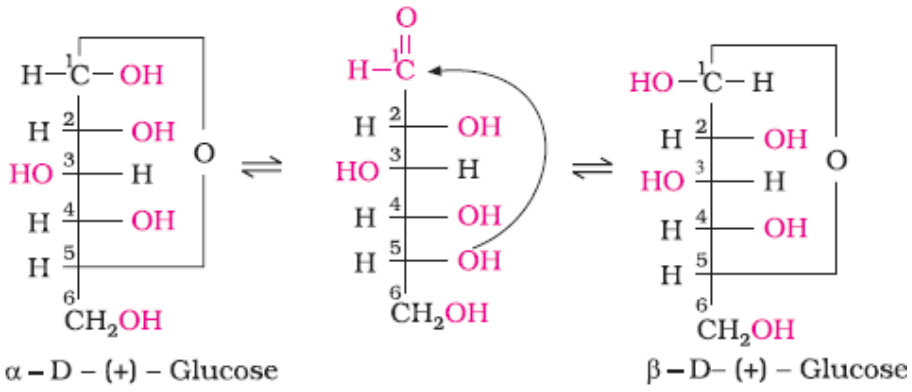


D- Glucose (Open chain structure)

But this open chain structure cannot explain the following observations:

1. Glucose does not react with 2,4-Dinitrophenyl hydrazine, Schiff's reagent and with $NaHSO_3$.
2. The existence of two different crystalline forms of glucose (α and β form).

In order to explain the above, it was proposed that one of the –OH groups may add to the –CHO group and form a cyclic hemi-acetal structure. The –OH at C_5 is involved in ring formation. (1,5 – oxide ring).

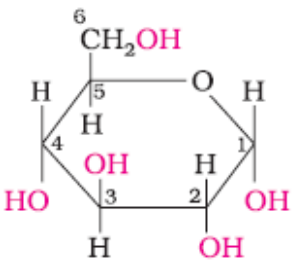


Thus the two cyclic forms exist in equilibrium with the open chain structure. The two cyclic hemi-acetal forms of glucose differ only in the configuration at first carbon

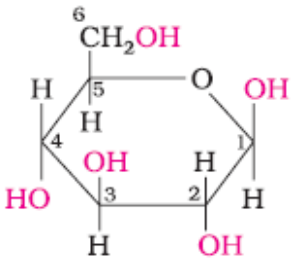
(anomeric carbon). So they are called ***anomers***. *They are stereo isomers which differ only in the configuration at the first carbon*.

The Pyranose structure of Glucose

The six member cyclic structure of glucose is called Pyranose structure. The anomeric forms of glucose can be represented as follows:



α – D – (+) – Glucopyranose



β – D – (+) – Glucopyranose

Q3. Hydrolysis of cane sugar is also called inversion of cane sugar. Why?

Cane sugar is sucrose, which on hydrolysis gives an equimolar mixture of D(+)glucose and D(-)fructose. $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

Sucrose D(+)Glucose ($+52.5^0$) D(-)Fructose (-92.4^0)

Sucrose is dextro rotatory but after hydrolysis gives dextro rotatory glucose and laevo rotatory fructose. Since the laevo rotation of fructose ((-92.4^0) is more than dextro rotation of glucose ($+52.5^0$), the mixture is laevo rotatory. So the process is called *inversion of cane sugar* and the product formed is called *invert sugar*.

Q4. What is mean by glycosidic linkage?

During the formation of a disaccharide or polysaccharide, the monosaccharides are joined together through oxide linkage by losing water molecules. Such a linkage (C-O-C) between monosaccharide units through oxygen atom is called glycosidic linkage.

Q5. Give the monosaccharide, reducing character and glycosidic linkage of the following?

No.	Sugar	Reducing	Monosaccharides	Glycosidic linkage

		character		
1.	Sucrose	Non-reducing sugar	One units each of α-D- glucose and β-D-fructose	C_1 of α-glucose and C_2 of β-fructose (C_1–C_2)
2.	Maltose	Reducing sugar	2 units of α-D-glucose	C1 of one α-glucose and C4 of another α-glucose (C_1 – C_4)
3.	Lactose	Reducing sugar	One units each of β-D-galactose and β-D-glucose	C_1 of galactose and C_4 of glucose
4.	Cellulose	Non-reducing	β-D-glucose	C_1 of one glucose and C_4 of anotherglucose
5.	Starch	Non-reducing	α-D-glucose	It contains two components – amylose and amylopectin. Amylose is a linear polymer of α-D-glucose (C_1-C_4) and amylopectin is a branched chain polymer of α-D-glucose (C1-C4 & C_1-C_6)

Q5. Give the uses of carbohydrates?

Carbohydrates are used as storage molecules as starch in plants and glycogen in animals. Cell wall of bacteria and plants is made up of cellulose. Carbohydrates are used as raw materials for many important industries like textiles, paper, lacquers and breweries. Carbohydrate in the form of wood is used for making furniture etc.

****