06 Biomolecules

Biomolecules are chemical compounds which are building blocks of life and perform important functions in living organisms. The general biomolecules that our food contains are :

Biomolecules :

- **Carbohydrates**
- **Proteins**
- **Enzymes**
- **Vitamins**
- **Nucleic acids**
- **Hormones**

Carbohydrate :

General formula of carbohydrate can be written as $C_x(H_2O)_y$

Here, $x = y$ or $x \neq y$

Hence these are called, Hydrates of carbon

Exceptions

- Rhamnose ($C_6H_{12}O_5$) is a carbohydrate, but it does not fit in this formula.
- Acetic acid (CH_3COOH) is not a carbohydrate, but it fits in this formula.

Simplest ratio $\longrightarrow$ **C : H : O**

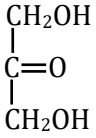
1 : 2 : 1

1. Glucose $\longrightarrow$ Mol. Formula ($C_6H_{12}O_6$)
   Glucose $\longrightarrow$ $C_6(H_2O)_6$
2. Sucrose $\longrightarrow$ Mol. Formula ($C_{12}H_{22}O_{11}$)
   Sucrose $\longrightarrow$ $C_{12}(H_2O)_{11}$

New definition of carbohydrates

Optically active polyhydroxy aldehydes and polyhydroxy ketones or compounds which give such compounds on hydrolysis are called carbohydrates.

Only dihydroxy acetone is optically inactive carbohydrate.



Carbohydrates are also called saccharides (greek word: saccharon means sugar).

Classification of Saccharides on the basis of behaviour on hydrolysis :-

- **Monosaccharides**
- **Oligosaccharides**
- **Polysaccharides**

Monosaccharides

- A carbohydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone is called a monosaccharide.
- About 20 monosaccharides are known to occur in nature.

  Example : glucose, fructose, ribose, etc.

Monosaccharides are further classified on the basis of number of carbon atoms and the functional group present in them. If a monosaccharide contains an aldehyde group, it is known as an aldose and if it contains a keto group, it is known as a ketose. Number of carbon atoms constituting the monosaccharide is also introduced in the name as is evident from the examples given in table.

No. of Carbon Atoms	Aldose (these contain aldehyde functional group)	Ketose (these contain ketone functional group)
3	Aldotriose = Glyceraldehyde	Ketotriose = Dihydroxy ketone
4	Aldotetrose = Erythrose	Ketotetrose = Erythrulose
5	Aldopentose = Ribose	Ketopentose = Ribulose
6	Aldohexose = Glucose	Ketohexose = Fructose
7	Aldoheptose = Manohaptose	Ketoheptose = Sedoheptulose

Oligosaccharides

- Carbohydrates that yield two to ten monosaccharide units on hydrolysis, are called oligosaccharides.
- They are further classified as disaccharides, trisaccharides, tetrasaccharides etc. depending upon the number of monosaccharides which provide on hydrolysis.

  Example: sucrose (glucose + fructose), maltose (glucose + glucose) etc.

Polysaccharides

Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, etc. Polysaccharides are not sweet in taste, hence they are also called non-sugars.

The carbohydrates may also be classified as either reducing or non-reducing sugars.

Reducing sugars

1. They reduce Fehling solution and Tollen's reagent
2. All monosaccharides & disaccharides in which aldehydic and ketonic groups are free, behave as reducing sugars.

   Example : Glucose, Fructose, Maltose & lactose.

Non-reducing sugars

1. They do not reduce Fehling's solution and Tollen's reagent.
2. All polysaccharides & disaccharides in which aldehydic or ketonic groups are bonded behave as non-reducing sugars.

   Example : Sucrose, Starch, Glycogen

Monosaccharides

Glucose

1. Laboratory Method

From Sucrose (Cane sugar)

$$\underset{\text{Sucrose 'd' +66.5°}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H_2SO_4 \text{ or } HCl} \underset{\text{Glucose 'd' +52.5°}}{C_6H_{12}O_6} + \underset{\text{Fructose 'ℓ' −92.4°}}{C_6H_{12}O_6}$$

On hydrolysis of sucrose, the sign of rotation changes from dextro (+) to laevo (–), so sucrose is called invert sugar.

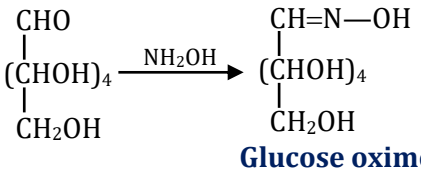
2. Commercial Method

From Starch

$$\underset{\text{Starch}}{(C_6H_{10}O_5)_n} + H_2O \xrightarrow[393\ K;\ 2\text{-}3\ atm]{H^+} \underset{\text{Glucose}}{nC_6H_{12}O_6}$$

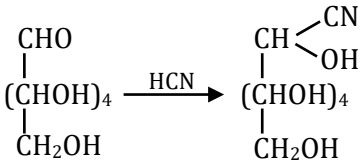
Chemical reactions of Glucose

(a) Reaction with NH_2OH



Glucose oxime

(b) Reaction with HCN

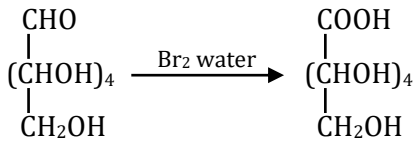


Glucose cyanohydrin

(c) Oxidation

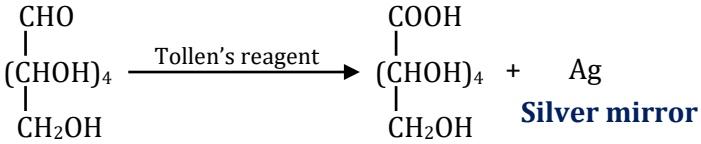
Oxidation of glucose to six carbon carboxylic acid (gluconic acid) indicates that the carbonyl group is present as an aldehydic group.

(i) Oxidation with Br_2 water



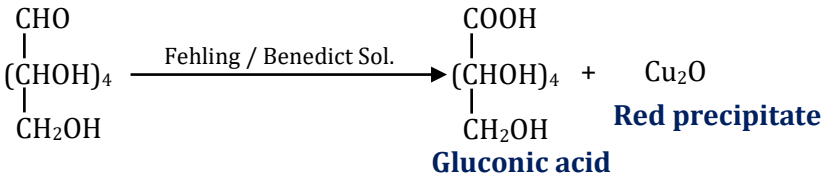
Gluconic acid

(ii) Oxidation by Tollen's Reagent, Fehling solution and Benedict's solution



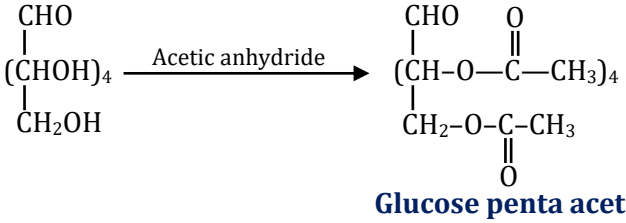
Silver mirror

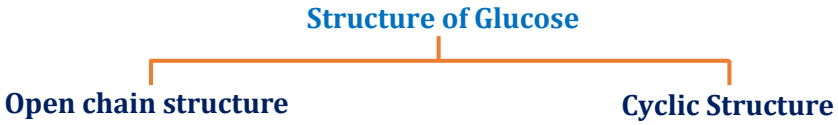
Gluconic acid



Oxidation of glucose to six carbon containing di carboxylic acid indicates the presence of primary Alcohol group.

(d) Acetylation of glucose with acetic anhydride gives glucose penta acetate which confirms the presence of five –OH groups

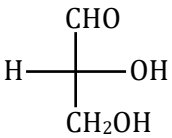




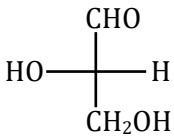
Open chain structure of Glucose

The exact spatial arrangement of different –OH groups was given by Fischer after studying many other properties.

Glucose is correctly named as D(+)-glucose. The meaning of D– and L– notations is given as follows.

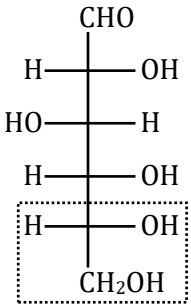


D – (+) – Glyceraldehyde

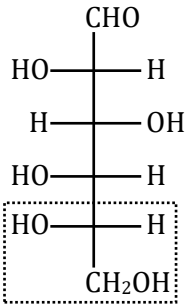


L – (–) – Glyceraldehyde

D before the name of glucose represents the configuration whereas (+) represents dextrorotatory nature of the molecule.

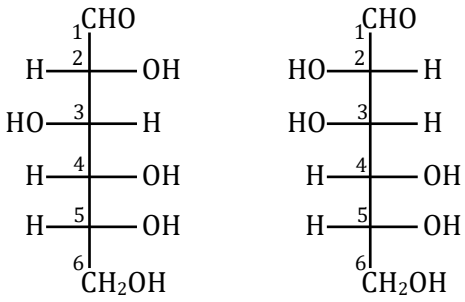


D– (+) – Glucose
[α] = + 52.7°



L– (–) – Glucose
[α] = – 52.7°

Epimers : Optically active diastereomers which have different configuration about one of the chiral carbon and same configuration at remaining carbon are called epimers.



D– (+) – Glucose **D– (+) – Mannose**

These have different configuration only at second carbon so called as C-2 epimers.

Cyclic Structure of Glucose

1. Glucose does not give 2,4-DNP test & Schiff's test.
2. Glucose does not form addition product with $NaHSO_3$.
3. Penta acetate of glucose does not react with NH_2OH

D-Glucose is found to exist in two different crystalline forms which are named as α and β.

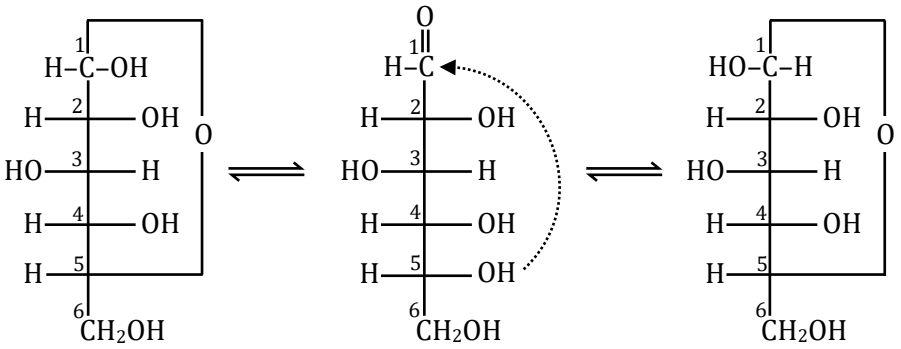
α-form: M.P. = 419 K

Obtained by crystallization of concentrated solution of glucose at 303K

β-form: M.P. = 423 K

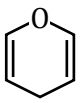
Obtained by crystallization of concentrated solution of glucose at 371K

It was proposed that one of the –OH groups may add to the –CHO group and form a cyclic hemiacetal structure.

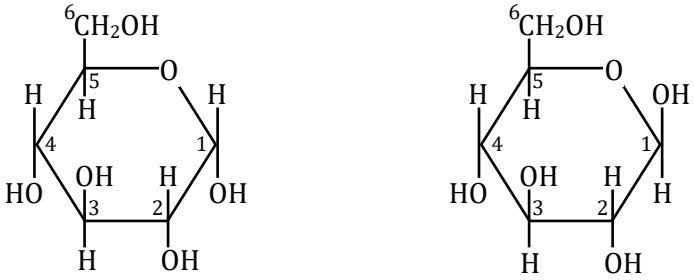


α – D – (+) – Glucose **β – D – (+) – Glucose**

The six membered cyclic structure of glucose is called pyranose structure in analogy with Pyran.



Pyran



α – D – (+) – Glucopyranose **β – D – (+) – Glucopyranose**

Haworth structure of glucose

Cyclic epimers are called anomers, so α-D-Glucose and β-D-Glucose are also called anomers which have first carbon as anomeric (hemiacetal) Carbon.

Mutarotation : α-form and β-form of D-Glucose slowly change optical rotation in aqueous solution to yield the same final rotation (α = + 52.7°), this process is known as Mutarotation. It becomes possible due to tautomerisation from cyclic hemiacetal form to acyclic form.

$$\underset{36\%}{\alpha - D - \text{Glucose}} \rightleftharpoons \underset{0.2\%}{D - \text{Glucose}} \rightleftharpoons \underset{63.8\%}{\beta - D - \text{Glucose}}$$

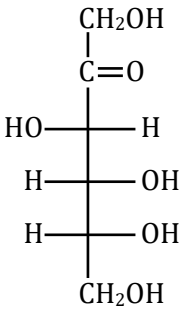
Fructose

Fructose is called fruit sugar

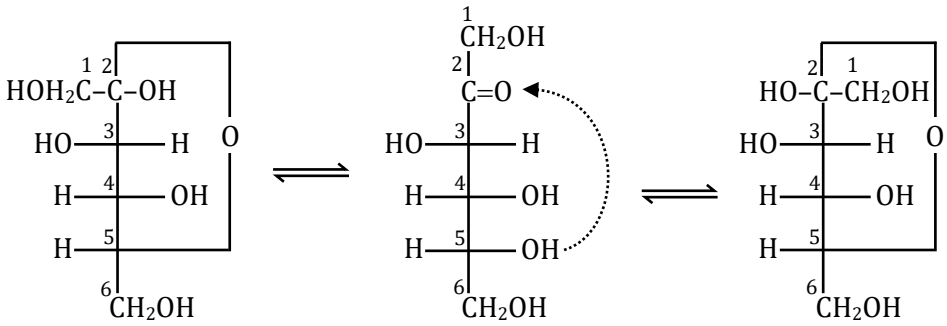
Fructose is an important ketohexose. It is obtained along with glucose by the hydrolysis of sucrose.

Molecular formula of fructose is also $C_6H_{12}O_6$ and it belongs to D-series. It is laevorotatory compound

It also exists in two cyclic forms which are obtained by the addition of –OH at C_5 to the $>C=O$ group.



D –(–) – Fructose
[α] = –92.4°



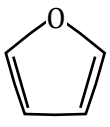
α – D– (–) – Fructose
[α] = –21°

D –(–) – Fructose
[α] = –92.4°

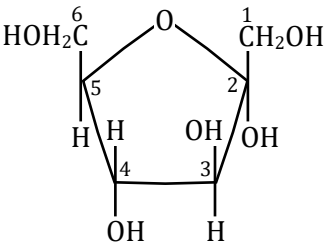
β – D– (–) – Fructose
[α] = – 133°

These differ at C_2 -Carbon so called C-2 epimers.

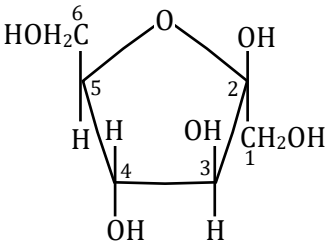
Cyclic structures of Fructose are also called fructofuranose structure due to analogy with furan.



Furan



α – D– (–) – Fructofuranose



β – D– (–) – Fructofuranose

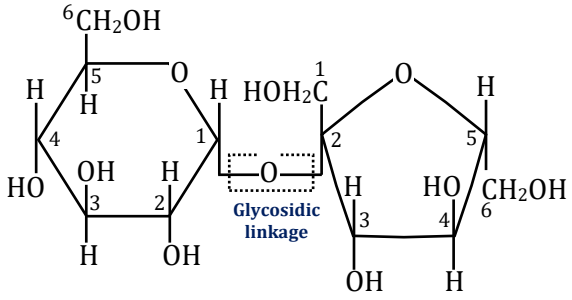
Disaccharides

(i) Sucrose : One of the common disaccharides is sucrose which on hydrolysis gives equimolar mixture of D- (+)-glucose and D-(-) fructose.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{D-(+)\text{ - Glucose}}{C_6H_{12}O_6} + \underset{D-(-)\text{ Fructose}}{C_6H_{12}O_6}$$

These two monosaccharides are held together by a glycosidic linkage between C_1 of **α-D-glucose** and C_2 of **β-D-fructose**. Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, sucrose is a non reducing sugar.

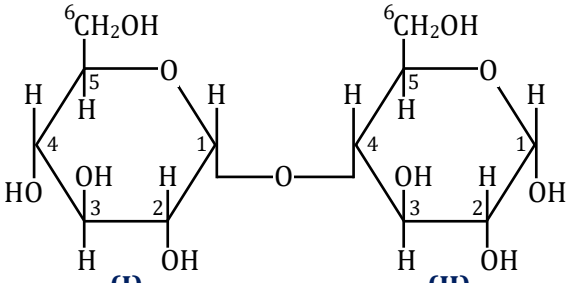
Hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as **invert sugar**.



α – D – Glucose β – D – Fructose

Sucrose

(ii) Maltose : Another disaccharide, maltose is composed of two **α-D-glucose** units in which C_1 of one glucose (I) is linked to C_4 of another glucose unit (II). The free aldehyde group can be produced at C_1 of second glucose in solution and it shows reducing properties so it is a reducing sugar.

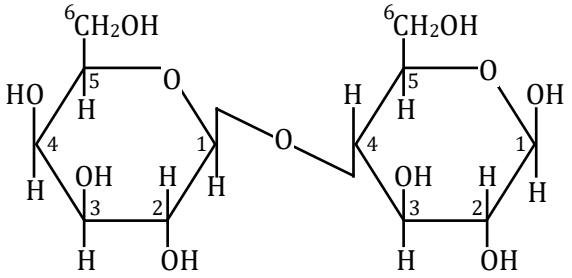


(I) **(II)**

α – D – Glucose α – D – Glucose

Maltose

(iii) Lactose : It is more commonly known as milk sugar since this disaccharide is found in milk. It is composed of **β-D-galactose** and **β-D-glucose**. The linkage is between C_1 of galactose and C_4 of glucose. It is also a reducing sugar.



β – D – Galactose β – D – Glucose

Lactose

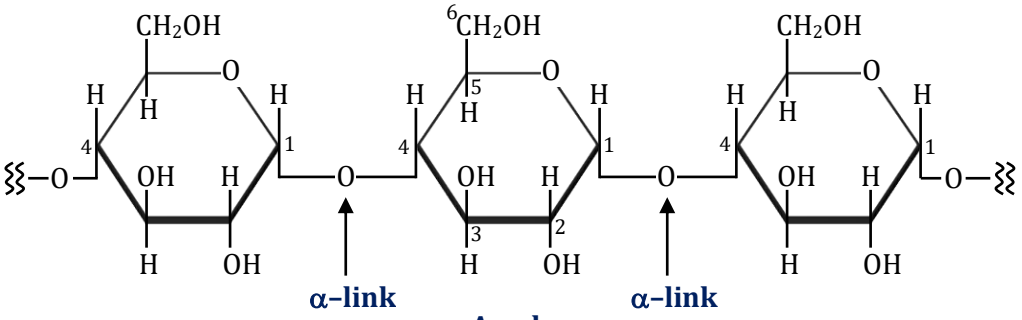
Polysaccharides

(i) Starch : Starch is the main storage polysaccharide of plants. It is the most important dietary source for human beings. High content of starch is found in cereals, roots, tubers and some vegetables. It is a polymer of α-glucose and consists of two components—

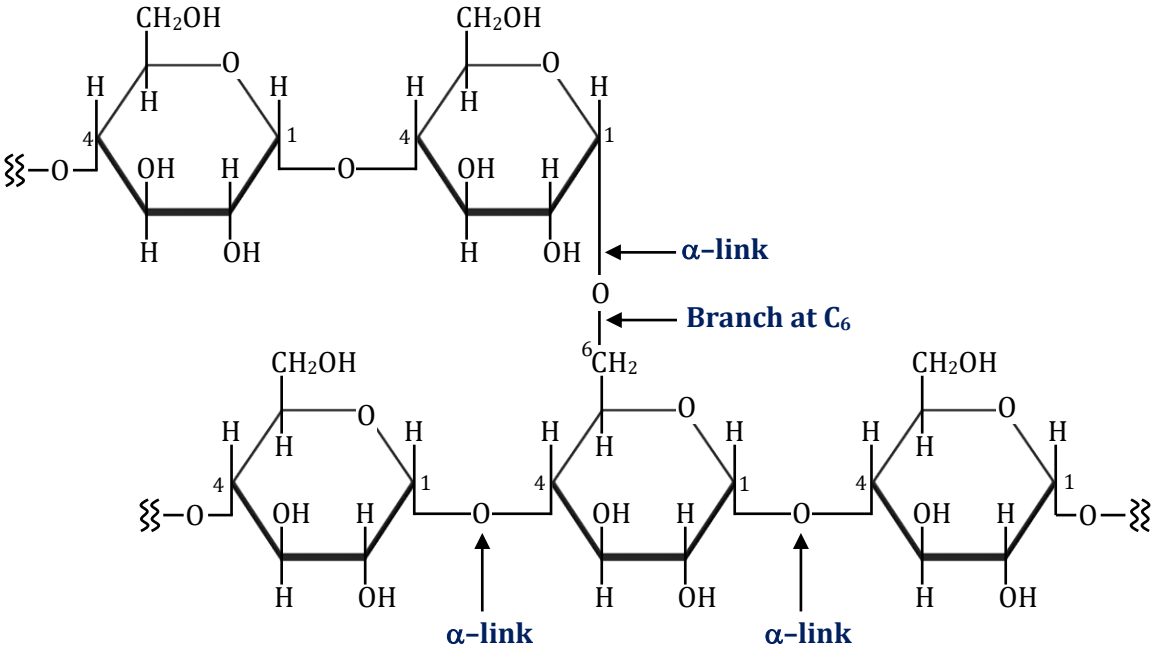
Amylose and Amylopectin :

Amylose is hot water soluble component which constitutes about 15-20% of starch. Chemically amylose is a long unbranched chain with 200-1000 α-D-(+)-glucose units held by C_1– C_4 glycosidic linkage.

Amylopectin is insoluble in water and constitutes about 80-85% of starch. It is a branched chain polymer of α-D-glucose units in which chain is formed by C_1–C_4 glycosidic linkage whereas branching occurs by C_1–C_6 glycosidic linkage.



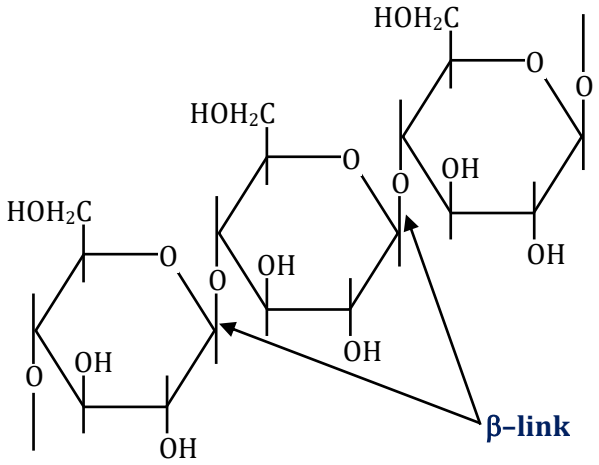
Amylose



Amylopectin

(ii) Glycogen : The carbohydrates are stored in animal body as glycogen. It is also known as animal starch because its structure is similar to amylopectin and is rather more highly branched. It is present in liver, muscles and brain. When the body needs glucose, enzymes break the glycogen down to glucose. Glycogen is also found in yeast and fungi.

(iii) Cellulose : Cellulose occurs exclusively in plants and it is the most abundant organic substance in plant kingdom. It is a predominant constituent of cell wall of plant cells. Cellulose is a straight chain polysaccharide composed only of β-D-glucose units which are joined by glycosidic linkage between C_1 of one glucose unit and C_4 of the next glucose unit.



Cellulose

BEGINNER'S BOX-1

1. Glucose can be tested by following –

(1) Tollen's reagent (2) Fehling's solution

(3) Both of these (4) None of these

CBM117

2. Glucose on oxidation with nitric acid as well as gluconic acid both gives –

(1) Saccharic acid (2) n-Hexane (3) Fructose (4) Glucosazone

CBM118

3. The spontaneous change in specific rotation of an optically active compound is called –

(1) Mutarotation (2) Rearrangements (3) Inversion (4) Retention

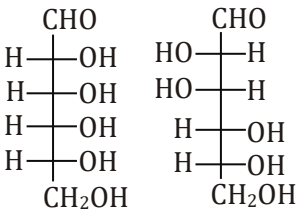
CBM119

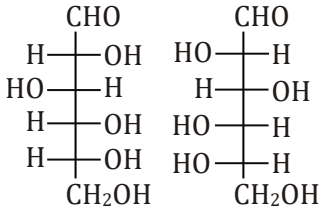
4. Hydrolysis of sucrose brings about a change in sign of rotation from dextro(+) to laevo(–) and such a sign change is known as –

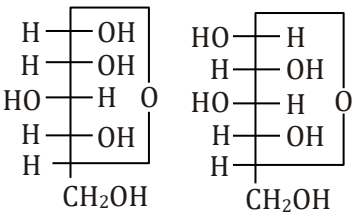
(1) Racemization (2) Inversion (3) Mutarotation (4) None of these

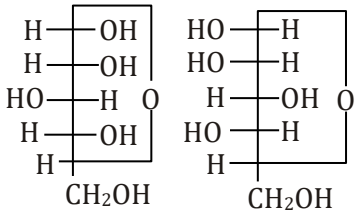
CBM120

5. Which of the following pairs represents anomer:-

(1) 

(2) 

(3) 

(4) 

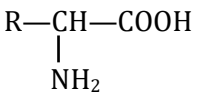
CBM121

Proteins :

The word protein is derived from Greek word, "proteios" which means primary or of prime importance. All proteins are polymers of α-L-amino acids.

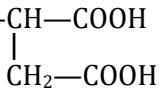
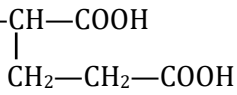
Amino acids: Amino acids contain amino ($-NH_2$) and carboxyl (–COOH) functional groups. Depending upon the relative position of amino group with respect to carboxyl group, the amino acids can be classified as α, β, γ, δ and so on. Only α-amino acids are obtained on hydrolysis of proteins. They may contain other functional groups also.

Classification of α-Amino acids
1. Acidic amino acids
2. Basic amino acids
3. Neutral amino acids

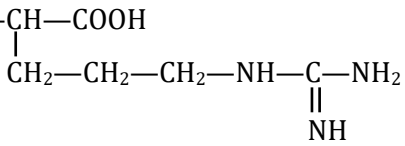
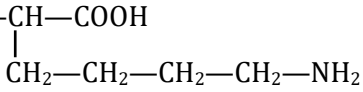
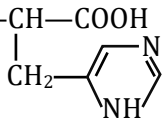


α-amino acid

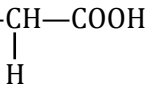
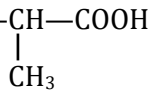
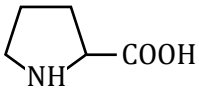
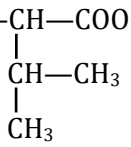
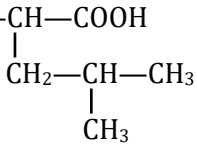
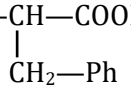
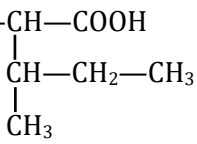
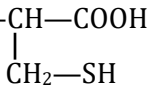
1. Acidic amino acids:- Number of acidic group > Number of basic groups

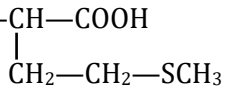
1. Aspartic acid [Asp] :- 
2. Glutamic acid [Glu] :- 

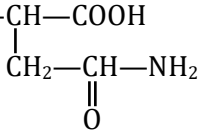
2. Basic amino acids:- Number of basic groups > Number of acidic groups

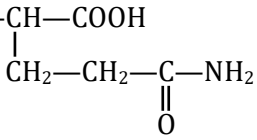
1. Arginine [Arg] :- 
2. Lysine [Lys] :- 
3. Histidine [His] :- 

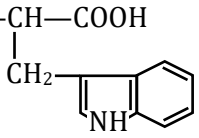
3. Neutral amino acids:- Number of acidic groups = Number of basic groups

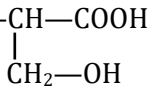
1. Glycine [Gly] :- 
2. Alanine [Ala] :- 
3. Proline [Pro] :- 
4. Valine [Val] :- 
5. Leucine [Leu] :- 
6. Phenyl alanine [Phe] :- 
7. Isoleucine [Ile] :- 
8. Cysteine [Cys] :- 

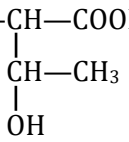
9. Methionine [Met] :- 

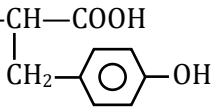
10. Asparagine [Asn] :- 

11. Glutamine [Gln] :- 

12. Tryptophan [Trp] :- 

13. Serine [Ser] :- 

14. Threonine [Thr] :- 

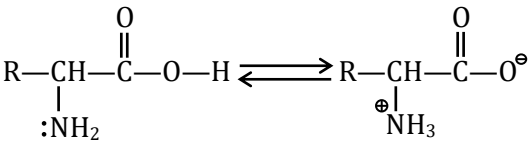
15. Tyrosine [Tyr] :- 

Classification of Amino Acids :

Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecule.

The amino acids, which can be synthesised in the body, are known as non-essential amino acids. On the other hand, those which cannot be synthesised in the body and must be obtained through diet, are known as essential amino acids.

Amino acids are usually colourless, crystalline solids. These are water-soluble, high melting solids and behave like salts rather than simple amines or carboxylic acids. This behaviour is due to the presence of both acidic (carboxyl group) and basic (amino group) groups in the same molecule.



(Zwitter ion)

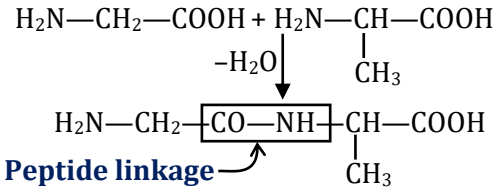
In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as zwitter ion. This is neutral but contains both positive and negative charges.

In zwitter ionic form, amino acids show amphoteric behaviour as they react both with acids and bases.

Except glycine, all other naturally occurring α-amino acids are optically active, since the α-carbon atom is asymmetric. These exist both in 'D' and 'L' forms. Most naturally occurring amino acids have L-configuration. L-Aminoacids are represented by writing the $-NH_2$ group on left hand side.

Structure of Proteins :

Proteins are the polymers of α-amino acids and they are connected to each other by peptide bond or peptide linkage. Chemically, peptide linkage is an amide formed between –COOH group and $-NH_2$ group.



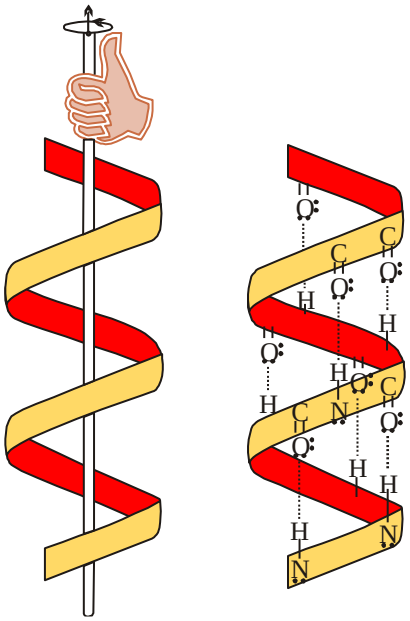
Glycylalanine [Gly-Ala]

The reaction between two molecules of similar or different amino acids, proceeds through the combination of the amino group of one molecule with the carboxyl group of the other. This results in the elimination of a water molecule and formation of a peptide bond –CO–NH–.

Proteins can be classified into two types on the basis of their molecular shape.

(a) Fibrous proteins

When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre- like structure is formed. Such proteins are generally insoluble in water. Some common examples are keratin (present in hair, wool, silk) and myosin (present in muscles), etc.



(b) Globular proteins

This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water. Insulin and albumins are the common examples of globular proteins.

Structure and shape of proteins can be studied at four different levels, i.e., primary, secondary, tertiary and quaternary, each level being more complex than the previous one.

1. Primary structure of Proteins:

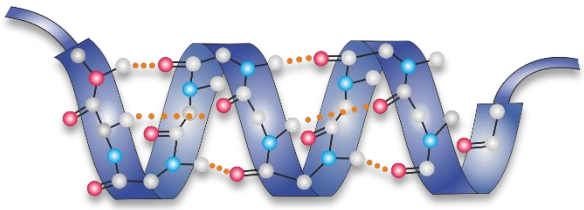
The primary structure of proteins refers to the sequence of amino acids held together by peptide bonds.

Any change in this sequence of amino acids creates a different protein.

Primary structure

2. Secondary structure of Proteins:

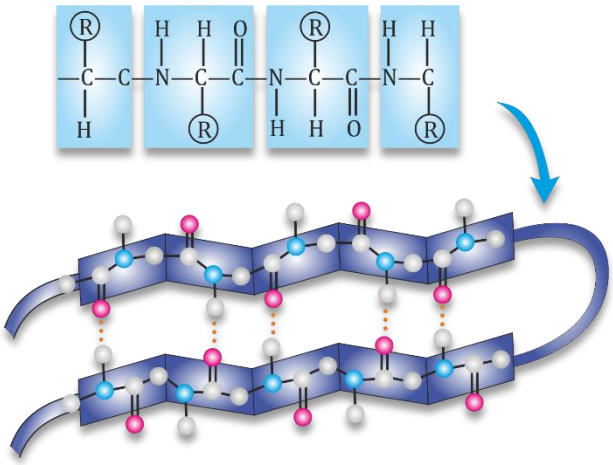
(i) α-Helix structure :- In α-helix a polypeptide chain forms all possible hydrogen bonds by twisting into right-handed screw



α–helix

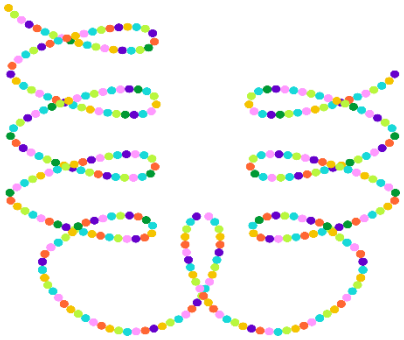
Secondary structure

(ii) β - pleated sheet structure :- In β- structure all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by inter molecular hydrogen bonds.



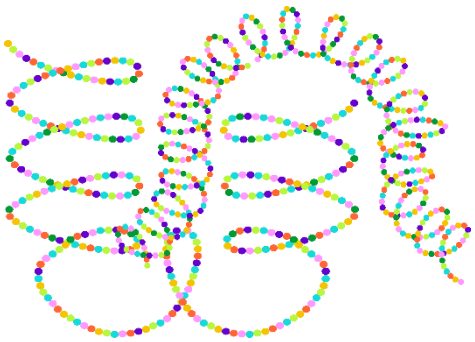
3. Tertiary structure of Proteins:

The tertiary structure of proteins represents overall folding of the peptide chains. It gives rise to two molecular shapes fibrous and globular.



Tertiary structure

4. Quaternary structure of Proteins:



Quaternary structure

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

Denaturation of Proteins :

Physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called denaturation of protein.
The coagulation of egg white on boiling is a common example of denaturation. Another example is curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.
During denaturation, secondary and tertiary structures are destroyed but primary structure remains unchanged.

Enzymes :

- Enzymes are biological catalysts which bring about chemical reactions in living cells. They are produced by the living organism and are usually present in only very small amounts in the various cells.
- Enzymes are very specific for a particular reaction and for a particular substrate.
- All enzymes are globular proteins.
  Examples: Pepsin, Trypsin, Proteases etc.

Vitamins :

The 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 are called vitamins.

1. Fat soluble vitamins : **A**, **D**, **E** and **K**
2. Water soluble vitamins : **B** and **C**

S. N.	Vitamin	Chemical name	Deficiency disease	Source
1.	Vitamin-A	**Retinol**	**Xerophthalmia** (Hardening of cornea of eye) and Night blindness	Fish liver oil, Carrot, Butter, Milk
2.	Vitamin-B_1	**Thiamine**	**Beri-beri** (Loss of appetite and retarded growth), Paralysis	Yeast, Milk, Green vegetables, Cereals
3.	Vitamin-B_2	**Riboflavin**	**Cheilosis** (Fissuring at corners of mouth and lips)	Milk, Egg white, Liver, Kidney
4.	Vitamin-B_6	**Pyridoxine**	**Convulsion**	Milk, Yeast, Egg yolk, Cereals
5.	Vitamin B_{12}	**Cyanocobalamine**	**Pernicious anaemia** (RBC deficient in Hb)	Fish, Meat, Egg, curd
6.	Vitamin-C	**Ascorbic acid**	**Scurvy** (bleeding gums)	Citrus fruits, Amla Green leafy vegetables
7.	Vitamin-D	**Calciferol**	**Rickets** (Bone deformities in children) **Osteomalacia** (soft bones & joint pain in adults)	Exposure to sunlight, Fish, Egg yolk
8.	Vitamin-E	**Tocoferol**	Increased fragility of RBC Muscular weakness	Vegetable oil, Sunflower oil
9.	Vitamin-K	**Phylloquinone**	**Increased blood clotting time**	Green leafy vegetables

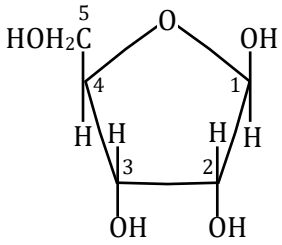
Nucleic Acids :

It has been observed that nucleus of a living cell is responsible for the transmission of inherent characters, also called heredity. The particles in nucleus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called nucleic acids.

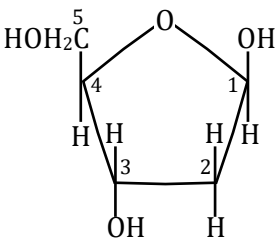
These are mainly of two types, the deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Since nucleic acids are long chain polymers of nucleotides, so they are also called polynucleotides.

1. Chemical composition of Nucleic Acids :

Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds (called bases). In DNA molecules, the sugar moiety is β-D-2-deoxyribose whereas in RNA molecule, it is β-D-ribose.

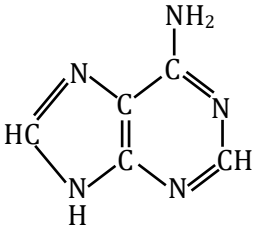


β–D–ribose

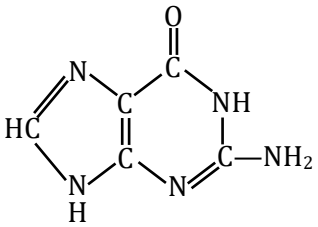


β–D–2–deoxyribose

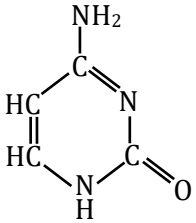
DNA contains four bases viz. adenine (A), guanine (G), cytosine (C) and thymine (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is uracil (U).



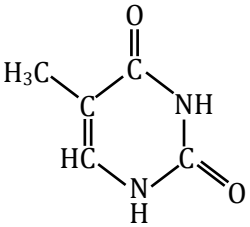
Adenine (A)



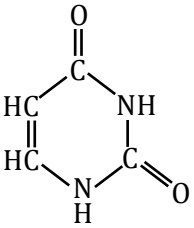
Guanine (G)



Cytosine (C)



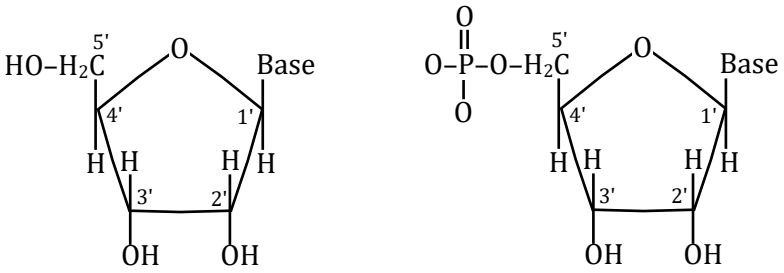
Thymine (T)



Uracil (U)

2. Structure of Nucleic Acids :-

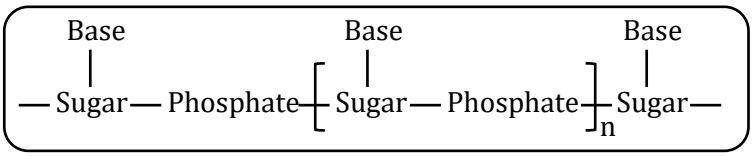
A unit formed by the attachment of a base to 1' position of sugar is known as nucleoside. In nucleosides, the sugar carbons are numbered as 1', 2', 3', etc. in order to distinguish these from the bases. When nucleoside is linked to phosphoric acid at 5'-position of sugar moiety, we get a nucleotide.



(a) (b)

Structure of (a) a nucleoside and (b) a nucleotide

Nucleotides are joined together by phosphodiester linkage between 5' and 3' carbon atoms of the pentose sugar. A simplified version of nucleic acid chain is as shown below. Fig.

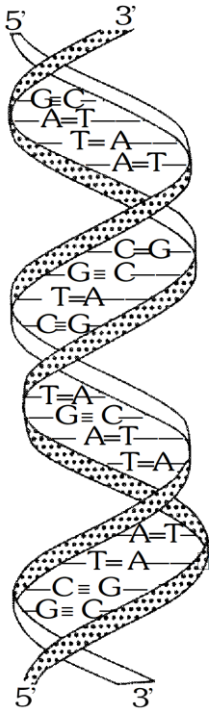


Information regarding the sequence of nucleotides in the chain of a nucleic acid is called its primary structure. Nucleic acids have a secondary structure also.

James Watson and Francis Crick gave a double strand helix structure for DNA (Fig.). Two nucleic acid chains are wound about each other and held together by hydrogen bonds between pairs of bases. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases.

Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine.

In secondary structure of RNA, helix are present which are only single stranded. Sometimes they fold back on themselves to form a double helix structure.



Double strand helix structure for DNA

RNA molecules are of three types and they perform different functions.

1. messenger RNA (m-RNA)

2. ribosomal RNA (r-RNA)

3. transfer RNA (t-RNA).

Hormones :

Hormones are biomolecules which are produced in the ductless (endocrine) glands and are carried to different parts of the body by the blood stream where they control various metabolic processes. These are required in minute quantites and unlike fats and carbohydrates these are not stored in the body but are continuously produced.

Some important hormones along with the sources and functions are summarised below :

Name	Organ of secretion	Functions
(I) Steroidal hormones		
(A) Sex hormones		
(i) Androgens (Testosterone)	Testes	Control the development and normal functioning of Androsterone and male sex organs.
(ii) Estrogens (Estrone, Estradiol, Estriol)	Ovary	Control the development and normal functioning of female sex organs.
(iii) Gestogens (Progesterone)	Corpus luteum	Control the development and maintenance of pregnancy.
(B) Adrenal cortex hormones or corticoids (Cortisone, Corticosterone Aldosterone etc.)	Adrenal cortex	Regulate the metabolism of fats, proteins and carbohydrates; control the balance of water and minerals in the body.
(II) Peptide hormones		
(i) Oxytocin	Posterior pituitary gland	Controls the contraction of the uterus after child birth and releases milk from the mammary glands.
(ii) Vasopressin	Posterior pituitary gland	Controls the reabsorption of water in the kidney.
(iii) Angiotensin II	Blood plasma of persons with high blood pressure.	Potent vasoconstrictor i.e. contracts the blood vessels.
(iv) Insulin	Pancreas	Controls the metabolism of glucose, maintains glucose level in the blood.
(III) Amine hormones		
(i) Adrenaline or Epinephrine	Adrenal medulla	It is an amine compound and was the first hormone to be isolated. Prepares animals and humans for emergency in many ways by raising the pulse rate, blood pressure etc. stimulates the breakdown of liver glycogen into blood glucose and fats into fatty acids during emergency. These properties make adrenaline as one of the most valuable drugs used in medicine.
(ii) Thryoxine	Thyroid gland	Controls metabolism of carbohydrates, lipids and proteins.

BEGINNER'S BOX-2

1. Zwitter ion is –
(1) Neutral ion (2) Positive charge ion
(3) Negative ion (4) None of these
CBM122

2. In β-sheet of proteins, conformers are held together by (Secondary structure of protein) –
(1) Intermolecular H-bond (2) Intramolecular H-bond
(3) Conformers not held together (4) None of these
CBM123

3. DNA contains following purines bases –
(a) Adenine (b) Guanine (c) Thymine (d) Cytosine
(1) a, c (2) a, b (3) a, c, d (4) a, b, c, d
CBM124

4. Which of the following statement is/are true –
(1) DNA has deoxyribose while RNA has ribose sugar
(2) DNA contains thymine while RNA has uracil
(3) Both of these
(4) None of these
CBM125

5. RNA on translation gives –
(1) Protein (2) DNA (3) Both (4) None of these
CBM126

BEGINNER'S BOX ANSWER KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5
	Ans.	3	1	1	2	3

BEGINNER'S BOX-2	Que.	1	2	3	4	5
	Ans.	1	1	2	3	1