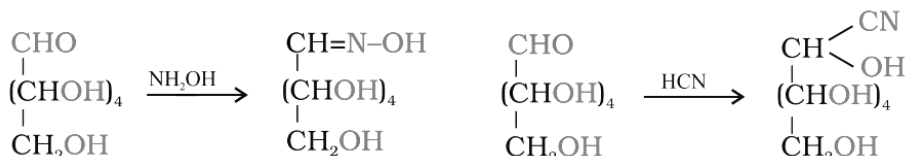
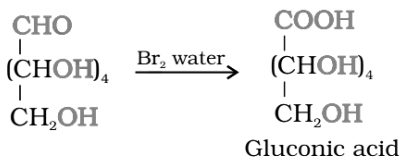




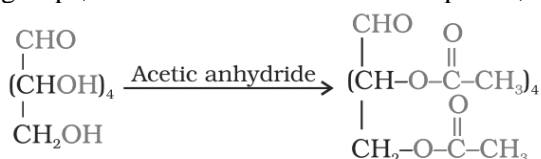
- Glucose reacts with hydroxylamine to form an oxime and adds a molecule of hydrogen cyanide to give cyanohydrin. These reactions confirm the presence of a carbonyl group ($>C=O$) in glucose.



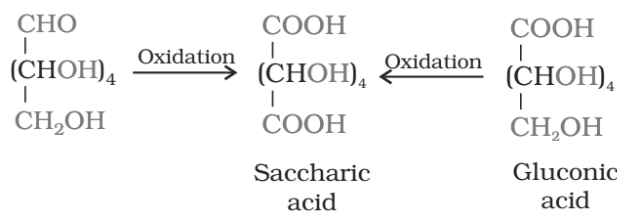
- Glucose gets oxidised to six carbon carboxylic acid (gluconic acid) on reaction with a mild oxidising agent like bromine water. This indicates that the carbonyl group is present as an aldehydic group.



- Acetylation of glucose with acetic anhydride gives glucose pentaacetate which confirms the presence of five $-OH$ groups, Since it exists as a stable compound, five $-OH$ groups should be attached to different carbon atoms.



- On oxidation with nitric acid, glucose as well as gluconic acid both yield a dicarboxylic acid, saccharic acid. This indicates the presence of a primary alcoholic ($-OH$) group in glucose.



- Glucose is correctly named as D(+)-glucose. 'D' before the name of glucose represents the configuration whereas '(+)' represents dextrorotatory nature of the molecule.

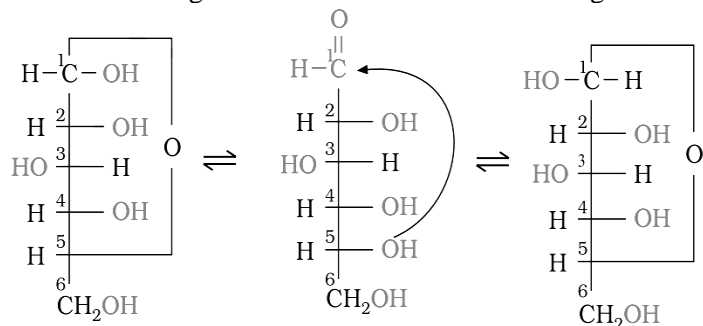
Cyclic Structure of Glucose

- Despite having the aldehyde group, glucose does not give Schiff's test and it does not form the hydrogensulphite addition product with NaHSO_3 .

The pentaacetate of glucose does not react with hydroxylamine indicating the absence of free $-CHO$ group.

- Glucose is found to exist in two different crystalline forms which are named as α and β . This behaviour could not be explained by the open chain structure for glucose.

- It was proposed that one of the $-OH$ groups may add to the $-CHO$ group and form a cyclic hemiacetal structure. It was found that glucose forms a six-membered ring in which $-OH$ at C-5 is involved in ring formation.



α -D-(+)-Glucose

β -D-(+)-Glucose

- The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C1, called anomeric carbon.



Polysaccharides : Polysaccharides contain a large number of monosaccharide units joined together by glycosidic linkages. They mainly act as the food storage or structural materials.

Starch: Starch is the main storage polysaccharide of plants. It is a polymer of α -glucose and consists of two components - Amylose and Amylopectin. Amylose is 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 together by C1 – C4 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 C1 – C4 glycosidic linkage whereas branching occurs by C1 – C6 glycosidic linkage.
- **Cellulose:** 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 C1 of one glucose unit and C4 of the next glucose unit.
- **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.
- When the body needs glucose, enzymes break the glycogen down to glucose. Glycogen is also found in yeast and fungi.

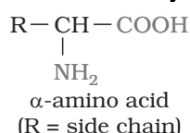
Importance of Carbohydrates

- Carbohydrates are essential for life in both plants and animals. They form a major portion of our food. 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.

Proteins

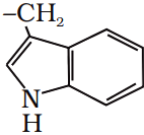
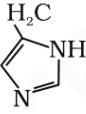
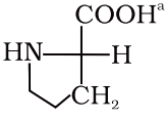
Proteins are the most abundant biomolecules of the living system. They occur in every part of the body and form the fundamental basis of structure and functions of life. They are also required for growth and maintenance of body. All proteins are polymers of α -amino acids.

Amino Acids: Amino acids contain amino ($-\text{NH}_2$) and carboxyl ($-\text{COOH}$) 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.

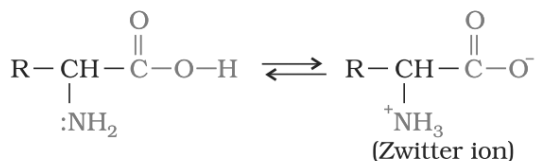


	Name of the amine acids	Characteristic feature of side chain, R
1.	Glycine	H
2.	Alanine	$-\text{CH}_3$
3.	Valine	$(\text{H}_3\text{C})_2\text{CH}-$
4.	Leucine	$(\text{H}_3\text{C})_2\text{CH}-\text{CH}_2-$
5.	Isoleucine	$\begin{array}{c} \text{H}_3\text{C}-\text{CH}_2-\text{CH}- \\ \\ \text{CH}_3 \end{array}$
6.	Arginine	$\begin{array}{c} \text{HN}=\text{C}-\text{NH}-(\text{CH}_2)_3- \\ \\ \text{NH}_2 \end{array}$
7.	Lysine*	$\text{H}_2\text{N}-(\text{CH}_2)_4-$
8.	Glutamic acid	$\text{HOOC}-\text{CH}_2-\text{CH}_2-$



9.	Aspartic acid	HOOC – CH ₂ –
10.	Glutamine	$\text{H}_2\text{N}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_2-$
11	Asparagine	$\text{H}_2\text{N}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-$
12.	Threonine	H ₃ C-CHOH-
13.	Serine	HO-CH ₂ -
14.	Cysteine	HS-CH ₂
15.	Methionine	H ₃ C-S-CH ₂ -CH ₂ -
16.	Phenylalanine	C ₆ H ₅ -CH ₂
17.	Tyrosine	(p)HO-C ₆ H ₄ -CH ₂ -
18.	Tryptophan	
19.	Histidine	
20.	Proline	

- essential amino acid, a = entire structure
- 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. Equal number of amino and carboxyl groups makes it neutral; more number of amino than carboxyl groups makes it basic and more carboxyl groups as compared to amino groups makes it acidic. The amino acids, which can be synthesised in the body, are known as non-essential amino acids.
- 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.
- 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 $-\text{NH}_2$ 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 $-\text{COOH}$ group and $-\text{NH}_2$ group.



Vitamins:

Certain organic compounds are required in small amounts in our diet but their deficiency causes specific diseases. These compounds are called vitamins.

- 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**
- **Fat soluble vitamins:** Vitamins which are soluble in fat and oils but insoluble in water are kept in this group. These are vitamins A, D, E and K. They are stored in liver and adipose (fat storing).
- **Water soluble vitamins:** B group vitamins and vitamin C are soluble in water so they are grouped together. They are readily excreted in urine and cannot be stored.

S1. No.	Name of Vitamins	Sources	Deficiency diseases
1.	Vitamin A	Fish liver oil, carrots, butter and milk	Xerophthalmia (hardening of cornea of eye) Night blindness
2.	Vitamin B ₁ (Thiamine)	Yeast, milk, green vegetables and cereals re	Beri beri (loss of appetite, retarded growth)
3.	Vitamin B ₂ (Riboflavin)	Milk, eggwhite, liver, kidney	Cheilosis (fissuring at comers of mouth and lips), digestive disorders and burning sensation of the
4.	Vitamin B ₆ (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
5.	Vitamin B ₁₂	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
6 .	Vitamin C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
7.	Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteo-malacia (soft bones and joint pain in adults)
8.	Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc.	Increased fragility of RBCs and muscular weakness
	Vitamin K	etc. Green leafy vegetables	Increased blood clotting time

Nucleic Acids:

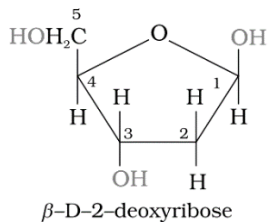
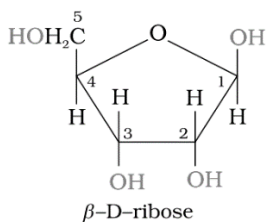
- Nucleus of a living cell is responsible for this transmission of inherent characters, also called heredity. The particles in nucleus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called nucleic acids. These are mainly of two types, the deoxyribonucleic acid (DNA) and



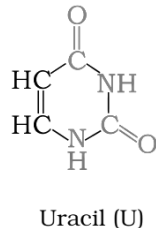
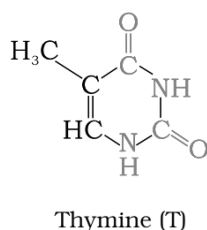
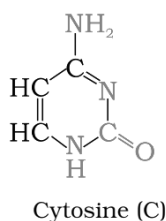
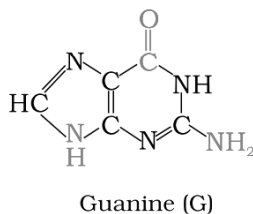
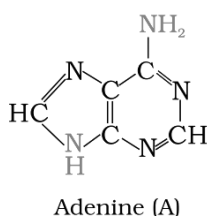
ribonucleic acid (RNA). Since nucleic acids are long chain polymers of nucleotides, so they are also called polynucleotides.

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.

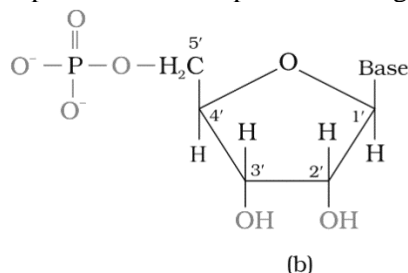
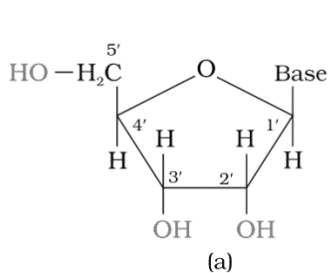


- DNA contains four bases viz. adenine (A), guanine (G), cytosine (C) and thymine (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is uracil (U).

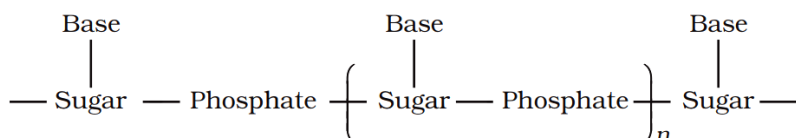


Structure of Nucleic Acids

- A unit formed by the attachment of a base to 1' position of sugar is known as nucleoside.
- When nucleoside is linked to phosphoric acid at 5'-position of sugar moiety, we get a nucleotide.



Nucleotides are joined together by phosphodiester linkage between 5' and 3' carbon atoms of the pentose sugar.



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. 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.



RNA molecules are of three types and they perform different functions. They are named as messenger RNA (m-RNA), ribosomal RNA (*r*-RNA) and transfer RNA (*t*-RNA).

Biological Functions of Nucleic Acids

DNA is the chemical basis of heredity and may be regarded as the reserve of genetic information. DNA is exclusively responsible for maintaining the identity of different species of organisms over millions of years. Another important function of nucleic acids is the protein synthesis in the cell.

Hormones

- Hormones are molecules that act as intercellular messengers. These are produced by endocrine glands in the body and are poured directly in the blood stream which transports them to the site of action. Hormones have several functions in the body. They help to maintain the balance of biological activities in the body. The role of insulin in keeping the blood glucose level within the limit.
- Epinephrine and norepinephrine mediate responses to external stimuli. Thyroxine produced in the thyroid gland is an iodinated derivative of amino acid tyrosine.
- Steroid hormones are produced by adrenal cortex and gonads (testes in males and ovaries in females).
- Glucocorticoids control the carbohydrate metabolism.
- The mineralocorticoids control the level of excretion of water and salt by the kidney.
- Hormones released by gonads are responsible for development of secondary sex characters. Testosterone is the major sex hormone produced in males.



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