CHAPTER

10 Biomolecules

CLASS 12TH

NCERT EXERCISE AND SOLUTIONS - CHEMISTRY

Q. 1. What are monosaccharides?

ANSWER:-

Monosaccharides are carbohydrates that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone. Monosaccharides containing an aldehyde group are known as aldoses and those containing a keto group are known as ketoses. Monosaccharides are further classified as trioses, tetroses, pentoses, hexoses, and heptoses according to the number of carbon atoms they contain. For example, a ketose containing 3 carbon atoms is called ketotriose and an aldose containing 3 carbon atoms is called aldotriose.

Q. 2. What are reducing sugars?

ANSWER:-

Reducing sugars are carbohydrates that reduce Fehling's solution and Tollen's reagent. All monosaccharides and disaccharides, excluding sucrose, are reducing sugars.

Q. 3. Write two main functions of carbohydrates in plants.

ANSWER:-

Two important functions of carbohydrates in plants are:

(i) Polysaccharides such as starch serve as storage molecules.

(ii) Cellulose, a polysaccharide, is used to build the cell wall.

Q. 4. Classify the following into monosaccharides and disaccharides. Ribose, 2-deoxyribose, maltose, galactose, fructose and lactose

ANSWER:-

Monosaccharides: Ribose, 2-deoxyribose, galactose, fructose.

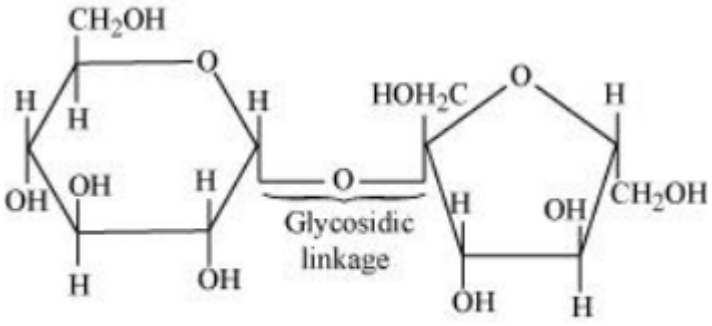
Disaccharides: Maltose, lactose.

Q. 5. What do you understand by the term glycosidic linkage?

ANSWER:-

Glycosidic linkage refers to the linkage formed between two monosaccharide units through an oxygen atom by the loss of a water molecule.

For example, in a sucrose molecule, two monosaccharide units, α-glucose and β-fructose, are joined together by a glycosidic link.



– D – glucose – D – fructose

Surcose

Q. 6. What is glycogen? How is it different from starch?

ANSWER:-

Glycogen is a highly branched polysaccharide made of glucose, stored in animals' liver and muscles as an energy reserve.

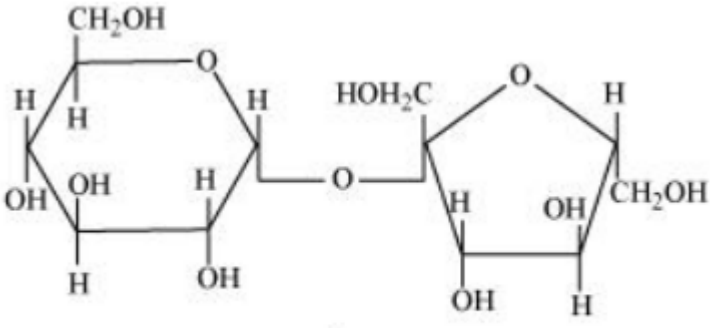
Starch is a polysaccharide found in plants, composed of amylose (unbranched) and amylopectin (branched), and serves as an energy storage in plant tissues like roots and seeds.

Q. 7. What are the hydrolysis products of

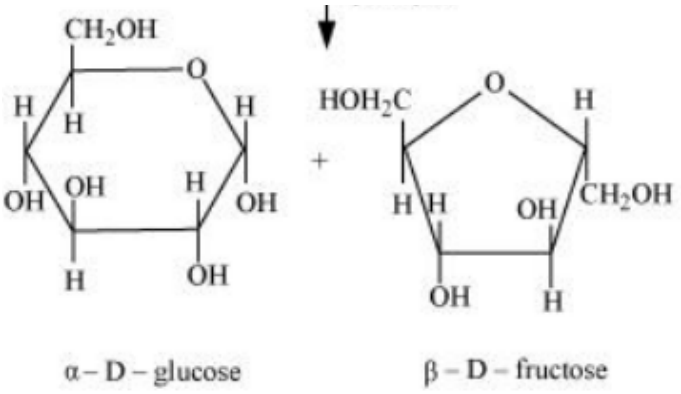
(i) sucrose and **(ii)** lactose?

ANSWER:-

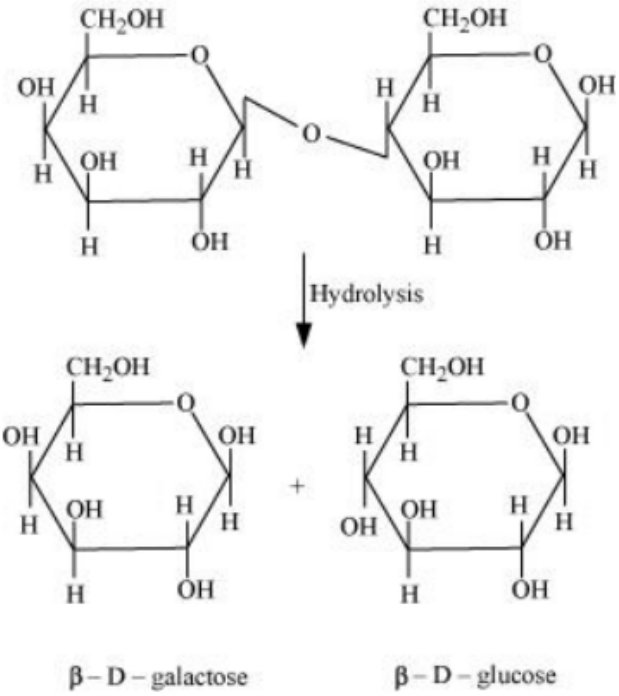
(i) On hydrolysis, sucrose gives one molecule of α-D glucose and one molecule of β- D-fructose.



Hydrolysis



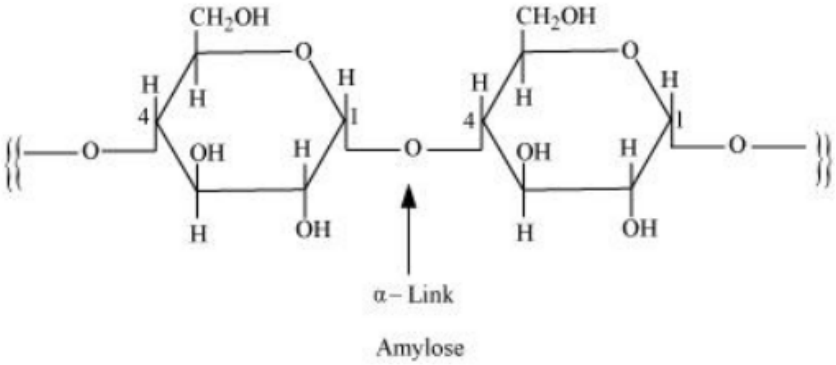
(ii) The hydrolysis of lactose gives β-D-galactose and β-D-glucose.



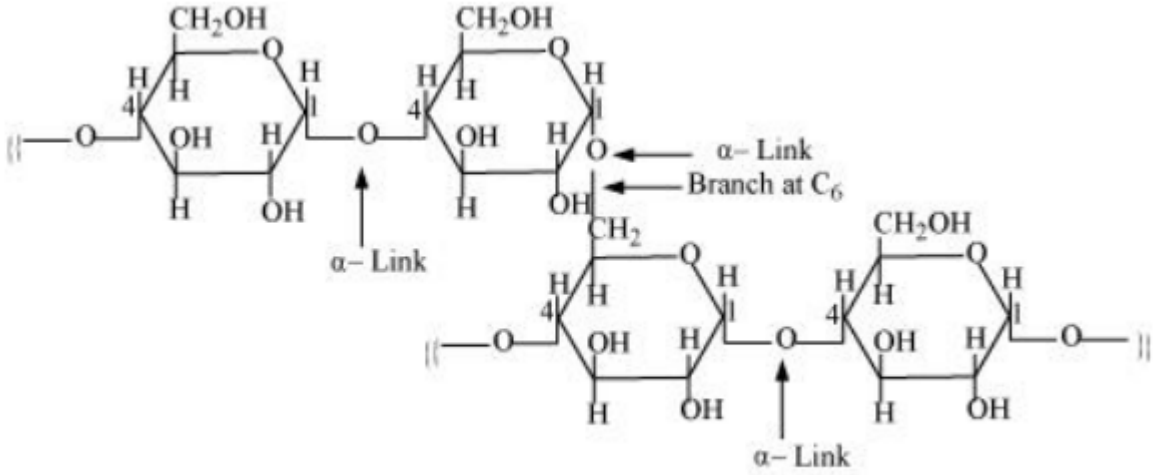
Q. 8. What is the basic structural difference between starch and cellulose?

ANSWER:-

Starch consists of two components − amylose and amylopectin. Amylose is a long linear chain of α−D−(+)−glucose units joined by C1−C4 glycosidic linkage (α-link).

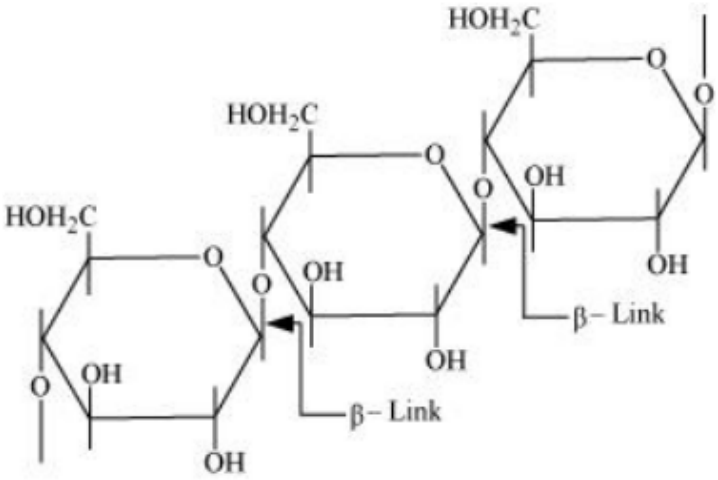


Amylopectin is a branched-chain polymer of α-D-glucose units, in which the chain is formed by C1−C4 glycosidic linkage and the branching occurs by C1−C6 glycosidic linkage.



Amylopectin

On the other hand, cellulose is a straight-chain polysaccharide of β-D-glucose units joined by C1−C4 glycosidic linkage (β-link).



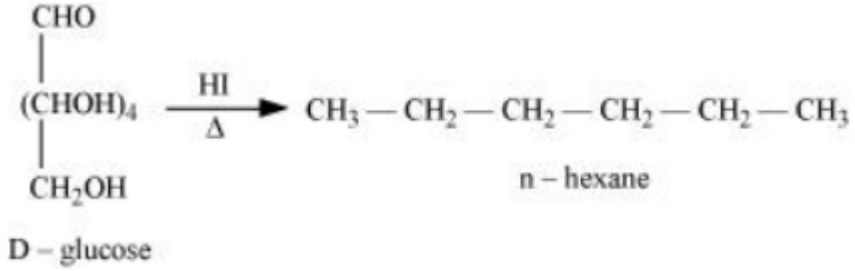
Cellulose

Q. 9. What happens when D-glucose is treated with the following reagents?

(i) HI **(ii) Bromine water** **(iii) HNO_3**

ANSWER:-

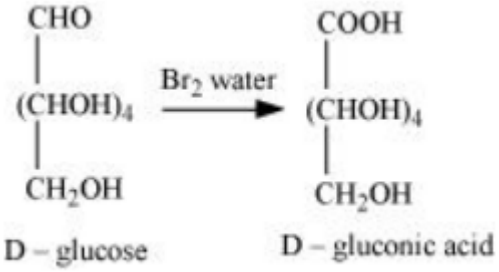
(i) When D-glucose is heated with HI for a long time, n-hexane is formed.



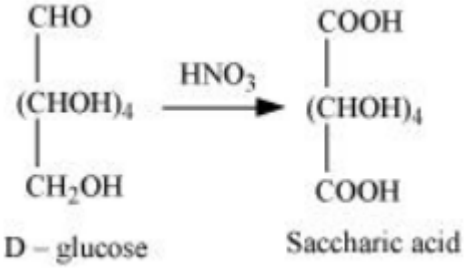
n – hexane

D – glucose

(ii) When D-glucose is treated with Br_2 water, D- gluconic acid is produced.



(iii) On being treated with HNO_3, D-glucose get oxidised to give saccharic acid.



Q. 10. Enumerate the reactions of D-glucose which cannot be explained by its open chain structure.

ANSWER:-

(1) Aldehydes give 2, 4-DNP test, Schiff's test, and react with $NaHSO_4$ to form the hydrogen sulphite addition product. However, glucose does not undergo these reactions.

(2) The pentaacetate of glucose does not react with hydroxylamine. This indicates that a free − CHO group is absent from glucose.

(3) Glucose exists in two crystalline forms – α and β. The α-form (m.p. = 419 K) crystallises from a concentrated solution of glucose at 303 K and the β-form (m.p = 423 K) crystallises from a hot and saturated aqueous solution at 371 K. This behaviour cannot be explained by the open chain structure of glucose.

Q. 11. What are essential and non-essential amino acids? Give two examples of each type.

ANSWER:-

Essential Amino Acids are those that cannot be synthesized by the body and must be obtained through the diet.

Examples:

(i) Leucine

(ii) Valine

Non-Essential Amino Acids are those that can be synthesized by the body.

Examples:

(i) Alanine

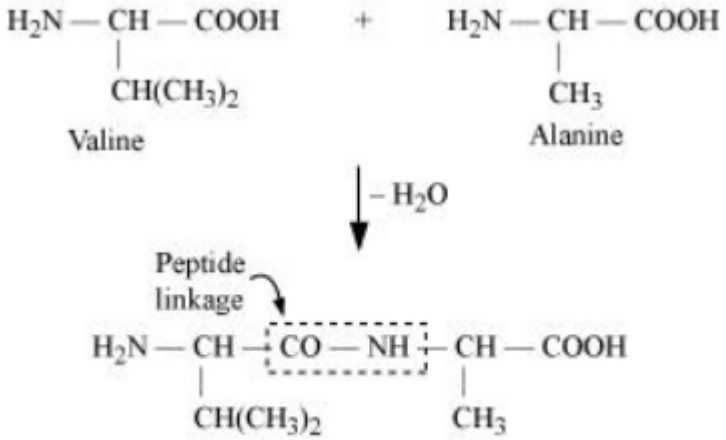
(ii) Glutamine

Q. 12. Define the following as related to proteins

(i) Peptide linkage (ii) Primary structure (iii) Denaturation.

ANSWER:-

(i) Peptide linkage: The amide formed between −COOH group of one molecule of an amino acid and $-NH_2$ group of another molecule of the amino acid by the elimination of a water molecule is called a peptide linkage.



Valylalanine (Val – Ala)

(ii) Primary structure: The primary structure of protein refers to the specific sequence in which various amino acids are present in it, i.e., the sequence of linkages between amino acids in a polypeptide chain. The sequence in which amino acids are arranged is different in each protein. A change in the sequence creates a different protein.

(iii) Denaturation: In a biological system, a protein adopts a specific three-dimensional structure that is crucial for its unique biological function. This configuration is referred to as the protein's native state. However, when the native protein is exposed to physical changes such as temperature fluctuations or chemical alterations like changes in pH, the disruption of hydrogen bonds occurs. This disruption causes the protein's tertiary structure to unravel and the secondary structures, such as α-helices and β-sheets, to unwind. Consequently, the protein loses its biological activity, a process known as denaturation. During denaturation, the protein's secondary and tertiary structures are compromised, while its primary structure—comprised of the linear sequence of amino acids—remains intact.

E.g. denaturation of proteins is the coagulation of egg white when an egg is boiled.

Q. 13. What are the common types of secondary structure of proteins?

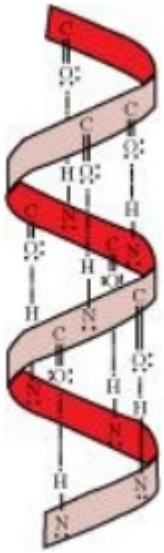
ANSWER:-

There are two common types of secondary structure of proteins:

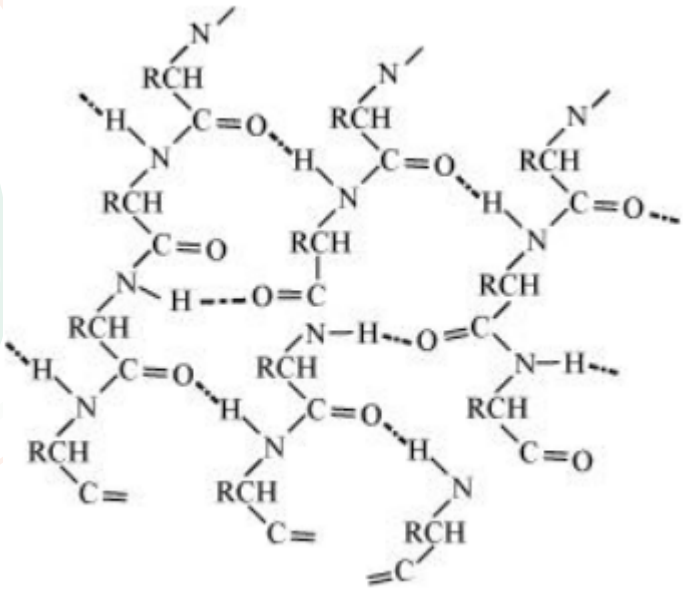
(i) α-helix structure

(ii) β-pleated sheet structure

(i) α-helix structure: In this structure, the −NH group of an amino acid residue forms H-bond with the $>C=O$ group of the adjacent turn of the right-handed screw (α-helix).



(ii) β-pleated sheet structure: In this structure, all the peptide chains are stretched out to nearly the maximum extension and then laid side by side. These peptide chains are held together by intermolecular hydrogen bonds.



Q. 14. What type of bonding helps in stabilising the α-helix structure of proteins?

ANSWER:-

The hydrogen bonding stabilizes the α-helix structure of proteins. It occurs between the carbonyl oxygen of one amino acid and the amide hydrogen of another amino acid, typically four residues away in the polypeptide chain. This bonding holds the helical structure in place.

Q. 15. Differentiate between globular and fibrous proteins.

ANSWER:-

Feature	Globular Proteins	Fibrous Proteins
Shape	Spherical or oval-shaped.	Long, thread-like or elongated.
Solubility	Soluble in water.	Insoluble or poorly soluble in water.
Structure	Compact and folded into a spherical shape.	Elongated, linear, and often in a helical form.
Function	Involved in metabolic processes (enzymes, hormones, antibodies).	Provide structural support (collagen, keratin).
Examples	Hemoglobin, enzymes, antibodies.	Collagen, keratin, elastin.
Stability	Relatively unstable, sensitive to heat and pH.	Stable, resistant to heat and chemical changes.
Amino acid sequence	Random coil structure in parts.	Repetitive amino acid sequences (e.g., glycine, proline).

Q. 16. How do you explain the amphoteric behaviour of amino acids?

ANSWER:-

(1) Amino group acting as a base (accepting a proton):

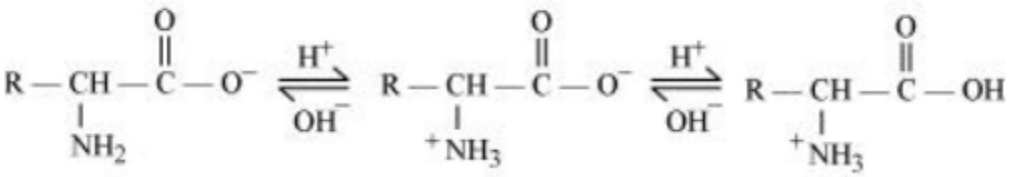
The amino group ($-NH_2$) can act as a base and accept a proton (H^+) to form a positively charged ammonium ion ($-NH_3^+$).

(2) Carboxyl group acting as an acid (donating a proton):

The carboxyl group (-COOH) can act as an acid and donate a proton (H^+) to form a negatively charged carboxylate ion ($-COO^-$).

(3) Formation of the zwitterion:

At physiological pH (~7), the amino acid usually exists as a zwitterion. In this form, the carboxyl group (-COOH) donates a proton to become ($-COO^-$), while the amino group ($-NH_2$) accepts a proton to become ($-NH_3^+$). The overall result is a neutral molecule with both a positive and a negative charge:



Q. 17. What are enzymes?

ANSWER:-

Enzymes are proteins that catalyse biological reactions. They are very specific in nature and catalyse only a particular reaction for a particular substrate. Enzymes are usually named after the particular substrate or class of substrate and sometimes after the particular reaction.

For example, the enzyme used to catalyse the hydrolysis of maltose into glucose is named as maltase.

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} \xrightarrow{\text{Maltase}} 2\underset{\text{Glucose}}{C_6H_{12}O_6}$$

Q. 18. What is the effect of denaturation on the structure of proteins?

ANSWER:-

In Denaturation process where a protein loses its three-dimensional structure due to the disruption of non-covalent bonds. This leads to the unfolding of the protein, causing it to lose its function. The process can be caused by factors like heat, extreme pH, or chemicals, and often results in irreversible loss of biological activity.

Q. 19. How are vitamins classified? Name the vitamin responsible for the coagulation of blood.

ANSWER:-

Vitamins are classified based on their solubility:

1. Fat-soluble vitamins:
- These are absorbed with dietary fat and stored in the body's fat tissues and liver.
- Vitamins: A, D, E, K.
2. Water soluble vitamins:
- These dissolve in water and are not stored in the body. They need to be replenished regularly through diet.
- Vitamins: B-complex (B1, B2, B3, B5, B6, B7, B9, B12) and Vitamin C.

The vitamin responsible for blood coagulation is Vitamin K.

Q. 20. Why are vitamin A and vitamin C essential to us? Give their important sources.

ANSWER:-

The deficiency of vitamin A leads to xerophthalmia (hardening of the cornea of the eye) and night blindness. The deficiency of vitamin C leads to scurvy (bleeding gums).

The sources of vitamin A are fish liver oil, carrots, butter, and milk. The sources of vitamin C are citrus fruits, amla, and green leafy vegetables.

Q. 21. What are nucleic acids? Mention their two important functions.

ANSWER:-

Nucleic acids are biomolecules found in the nuclei of all living cells, as one of the constituents of chromosomes. There are mainly two types of nucleic acids − deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Nucleic acids are also known as polynucleotides as they are long-chain polymers of nucleotides.

Two main functions of nucleic acids are:

- DNA is responsible for the transmission of inherent characters from one generation to the next. This process of transmission is called heredity.
- Nucleic acids (both DNA and RNA) are responsible for protein synthesis in a cell. Even though the proteins are actually synthesised by the various RNA molecules in a cell, the message for the synthesis of a particular protein is present in DNA.

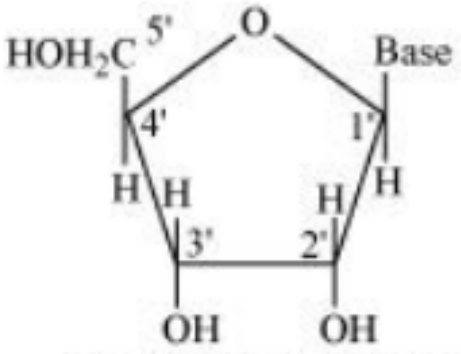
Q. 22. What is the difference between a nucleoside and a nucleotide?

ANSWER:-

Nucleoside: This is a basic building block made up of two components:

1. A nitrogenous base (either a purine or pyrimidine)
2. A sugar (either ribose, in RNA, or deoxyribose, in DNA)

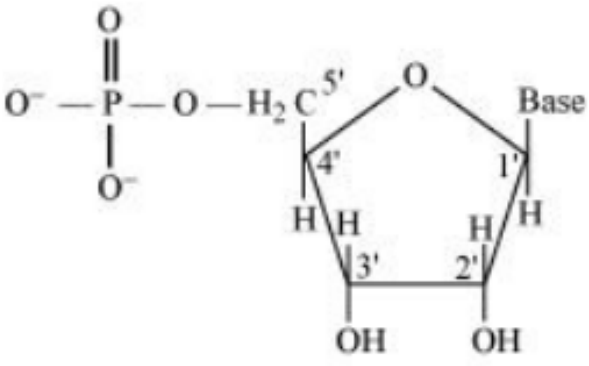
Nucleoside = Sugar + Base



Structure of a nucleoside

Nucleotide: A nucleotide is a more complex structure that includes three components:

1. A nitrogenous base (purine or pyrimidine)
2. A sugar (ribose in RNA or deoxyribose in DNA)
3. One or more phosphate groups
4. Nucleotide = Sugar + Base + Phosphoric acid



Structure of a nucleotide

Q. 23. The two strands in DNA are not identical but are complementary. Explain.

ANSWER:-

The two DNA strands are complementary because the bases on one strand pair specifically with bases on the other strand: Adenine (A) with Thymine (T), and Cytosine (C) with Guanine (G). This allows for accurate replication and maintains the structure of the double helix.

Q. 24. Write the important structural and functional differences between DNA and RNA.

ANSWER:-

The structural differences between DNA and RNA are as follows:

Feature	DNA (Deoxyribonucleic Acid)	RNA (Ribonucleic Acid)
Sugar	Deoxyribose	Ribose
Nitrogenous Bases	Adenine (A), Thymine (T), Cytosine (C), Guanine (G)	Adenine (A), Uracil (U), Cytosine (C), Guanine (G)
Strands	Double-stranded (Double Helix)	Single-stranded
Function	Stores genetic information	Involved in protein synthesis (transcription & translation)
Stability	More stable (due to lack of 2' hydroxyl group)	Less stable (due to 2' hydroxyl group)
Location	Found in the nucleus and cytoplasm (prokaryotes)	Found in the nucleus and cytoplasm
Helical Structure	Double helix (right-handed)	Single strand, can form secondary structures
Length	Typically longer	Typically shorter

The functional differences between DNA and RNA are as follows:

Feature	DNA (Deoxyribonucleic Acid)	RNA (Ribonucleic Acid)
Structure	Double-stranded helix	Single-stranded
Sugar	Deoxyribose (lacks one oxygen atom)	Ribose (contains an oxygen atom)
Bases	Adenine (A), Thymine (T), Cytosine (C), Guanine (G)	Adenine (A), Uracil (U), Cytosine (C), Guanine (G)
Function	Stores genetic information, directs synthesis of RNA	Translates genetic information into proteins, helps in gene expression
Stability	More stable, long-lasting	Less stable, transient
Replication	Replicates to pass genetic information to offspring	Synthesized from DNA (transcription)

Types	One main type (genomic DNA)	Several types (mRNA, tRNA, rRNA, etc.)
Function in Protein Synthesis	Does not directly participate	mRNA carries genetic instructions, tRNA helps in translation, rRNA makes up ribosomes
Length	Generally long (millions of base pairs)	Generally short (few hundred to thousands of base pairs)

Q. 25. What are the different types of RNA found in the cell?

ANSWER:-

(i) Messenger RNA (m-RNA)
(ii) Ribosomal RNA (r-RNA)
(iii) Transfer RNA (t-RNA)