CHAPTER – 3

Biomolecules

EXERCISES

2 Mark Questions

Q1: Describe isomerisation in monosaccharides.

Answer: Isomerisation in monosaccharides depends on the carbonyl carbon present in sugar. In monosaccharides except dihydroxy acetone all the monosaccharides

contain one or more asymmetric carbon which are optically active isomers. The -OH group present in monosaccharides which is most distant from carbonyl carbon determines that the sugar belong to D or L form of sugar. If the -OH group in the sugar is present on right side of the carbon atom bearing then the sugar is D isomer, and when it is present on left side of the carbon atom bearing then the sugar is L isomer.

Q2: Differentiate between saturated and unsaturated fatty acids.

Answer:

Saturated fatty acids	Unsaturated fatty acids
Saturated fatty acids have no double bonds.	Unsaturated fatty acids have one or more than one double bonds.
Fatty acids which are synthesized by 2 carbon units having no double bond is called as saturated fatty acids.	Fatty acids which are synthesized by 2 carbon units having one or more than one double bond is called as unsaturated fatty acids.
E.g. Lauric acid, stearic acid.	E.g.

Q3: What is zwitterion and how it is developed?

Answer: Zwitterion is an electrochemical property of amino acid in which at physiological pH (pH=7) α-COOH group and α-NH2 group of amino acids are ionised in the solution to form –COO- and –+NH3. This is a dipolar state which is known as zwitterion. Zwitterion is developed when there is migration of proton from carboxyl group to amino group.

Q4: What are non-standard and non-protein amino acids?

Answer: Non-standard amino acids are the amino acids which occur naturally in the cells but do not take part in the protein synthesis process. These are generated by modification of specific standard amino acids after the process of protein synthesis. E.g. 4- hydroxyproline, 5- hydroxylysine.

Non-protein amino acids are the amino acids which are not a part of protein. These types of amino acids are widely present in various animals, plants and microbes.

E.g. L-ornithine, L-citrullin.

Q5: How the peptide bonds are formed?

Answer: Peptide bonds are the bonds which link the linear chain of amino acid in primary structure of proteins. This peptide bond is also known as amide bond. The coupling of α-carboxyl group of one amino acid to an α-amino group of another amino acid forms the peptide bond.

Q6: Describe the various forms of DNA.

Answer: DNA is a deoxyribose nucleic acid. There are various forms of DNA which are as follows:-

- B-DNA- This is a DNA model of Watson and Crick which is double helical and right handed DNA.
- A-DNA- This is a DNA which is also double helical and right handed DNA. It is wider and contains 11 bp per helix.
- Z-DNA- The DNA which is left handed double helix is a Z-DNA. It contains 12 bp per helix.

Q7: Explain the primary structure of DNA?

Answer: The primary structure of DNA includes the nucleotides. This is a structure which is covalently linked with RNA nucleotides. In primary structure of DNA there is a polynucleotide chain with the phosphodiester bonds between the

nucleotides of DNA and RNA. The 3' hydroxyl (-OH) group of sugar which is esterified to –OH group of phosphate which is attached to 5' carbon atom of sugar of next nucleotide, this forms a polynucleotide chain with phosphodiester bond.

4 Mark Questions

Q1: Explain Watson and Crick model of DNA?

Answer: James Watson and Francis Crick in 1953 proposed a model of DNA. This DNA consist of double helical and 3 dimensional structure was proposed. This DNA consists of two polynucleotide chains which are double stranded which wound to form the same axis to form right handed helical structure. The two strands of DNA are in antiparallel direction with phosphodiester bonds. The 3' to 5' phospodiester bond runs in a opposite direction. In this DNA the sugar and phosphate act as a backbone of double helix structure. The Watson and Crick model of DNA is also known as B-DNA. The bases of this double helix are joined by hydrogen bonds.

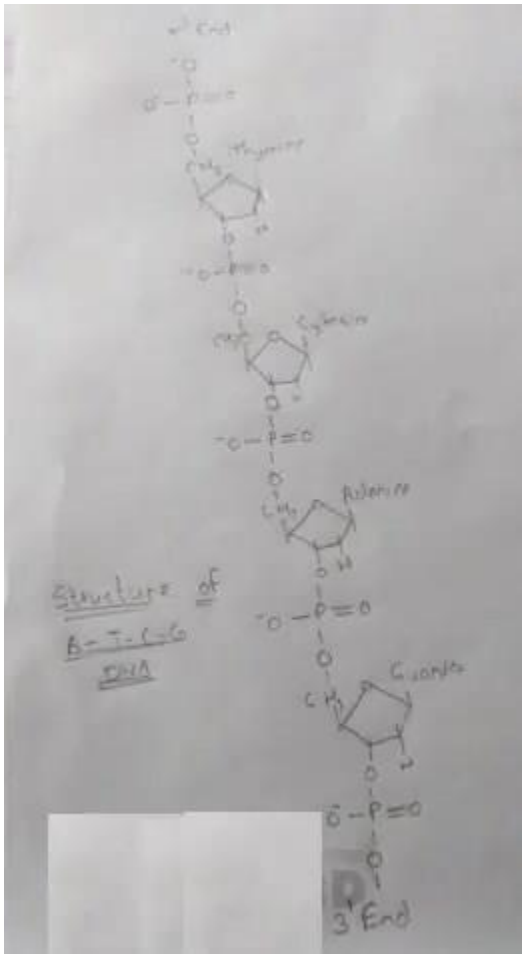
Q2: Differentiate between nucleotides and nucleosides.

Answer:

Nucleotides	Nucleosides
A base which is linked to a pentose sugar unit and a phosphate group is called as nucleotide.	A base which is linked only to pentose sugar unit without a phosphate group is called as nucleoside.
The nucleotides in DNA are called as deoxyribonucleotides.	The nucleosides in DNA are called as deoxyribonucleotides.
These are indicated by prefix'd' in DNA which contain deoxyribose rather than ribose sugar.	There are four nucleosides of RNA, when they are bound to phosphate group they make ribonucleotides.

Q3: Draw the structure of A-T-C-G polynucleotide

Answer:



Q4: Describe the various categories of amino acid.

Answer: Amino acids are the building blocks of protein. There are different categories of amino acids based on the side chain of amino acid. The side chain R varies in all 20 amino acids. The categories of amino acid are as follows:-

1. Polar, uncharged R groups
2. Aromatic R group
3. Non polar aliphatic amino acids
4. Positively charged (basic) R group
5. Negatively charged(acidic) R group

Q5: Write the major functions of carbohydrates.

Answer: The major functions of carbohydrates are as follows:-

- Carbohydrates act as primary source of energy to the cell.

- Carbohydrates also serve as energy stores and metabolic intermediate.
- It is a major component of bacterial and plant cell wall.
- They act as informational material.
- Carbohydrates are linked to the surfaces of proteins and lipids which help in cell to cell interaction.
- They play important role in interaction between cells with other elements in cellular environment.

Q6: Describe isomerisation in monosaccharides.

Answer: Isomerisation in monosaccharides depends on the carbonyl carbon present in sugar. In monosaccharides except dihydroxy acetone all the monosaccharides

Contain one or more asymmetric carbon which are optically active isomers. The -OH group present in monosaccharides which is most distant from carbonyl carbon determines that the sugar belong to D or L form of sugar. If the -OH group in the sugar is present on right side of the carbon atom bearing then the sugar is D isomer, and when it is present on left side of the carbon atom bearing then the sugar is L isomer.

Q7: Differentiate between sphingolipids and glycerolipids.

Answer:

Sphingolipids	Glycerolipids
Sphingolipids are type of compound lipids.	Glycerolipids are type of compound lipids.
The compounds which are composed of fatty acid chains attached with sphingoid base are sphingolipids.	The compounds which are composed of fatty acid chains attached to glycerol backbone are glycerolipids.
Sphingolipid contain a head group which is only hydrogen atom.	In glycerolipids the third carbon of glycerol is occupied by modified phosphate.

7 Mark Questions

Q1: Differentiate between tertiary and quaternary structures of proteins.

Answer:

Tertiary structure protein	Quaternary structure protein
The arrangement of three dimensional residues in a protein is called as tertiary structure protein.	The proteins which contain more than one polypeptide subunit is called as quaternary structure protein.
This includes larger range aspects of amino acid sequence.	This is a spatial arrangement of the protein subunits.
In this structure there is involvement of additional bonds.	In this structure the subunits are stabilised by hydrogen bonds, electrostatic interaction, ionic bonds and disulfide bridges

Q2: Describe various secondary structures of protein.

Answer: The proteins which deal with folding of polypeptide chain are the secondary structure proteins. There are two types of secondary structure proteins:

1.) Alpha helix- The helical structure formed by twisting about the Cα–N and the Cα–C bonds which is a polypeptide chain with planar peptide bonds is called as alpha helix. This alpha helix can be right handed or left handed. These alpha helix are connected by loops. These are present in myosin and tropomyosin of muscles and keratin of hair and also provides mechanical strength to the stiff bundles of fibres.

2.) Beta pleated sheet- This is a second type of secondary structure protein. This beta pleated sheet involves hydrogen bonds between groups from residues which are distant from each other in the linear sequence. These are arranged side by side and it has two or more strands widely separated in the protein sequence.

Q3: Describe the classification of carbohydrates.

Answer: Carbohydrates are the biomolecules which contain aldehyde and ketone derivatives of polyhydric alcohols. These molecules act as energy source for the plant and animal cells.

Classification of carbohydrates: These are classified into three groups according to sugar molecules containing from one unit to many, they are as follows:

1.) Monosaccharide – Monosaccharides are the simple sugars containing free aldehyde and ketone group with two or more hydroxyl groups. The formula of monosaccharide is Cn (H2O) n. Monosaccharide cannot be further hydrolysed into simpler forms. Monosaccharides are further classified into 4 groups based on no. of carbon atoms and functional group; they are trioses, tetroses, pentoses, hexoses.

2.) Oligosaccharides – Oligosaccharides are the carbohydrates which contain two to ten units of monosaccharides which are joined by glycosidic bond.

3.) Polysaccharides – Polysaccharides are the carbohydrates which contain ten or more monosacchride units joined by glycosidic linkage.

These are classified into two types by depending upon no. of repeating units of monosaccharide they are, homopolysacchrides and hetero polysaccharides.

Q4: Describe various secondary structures of protein.

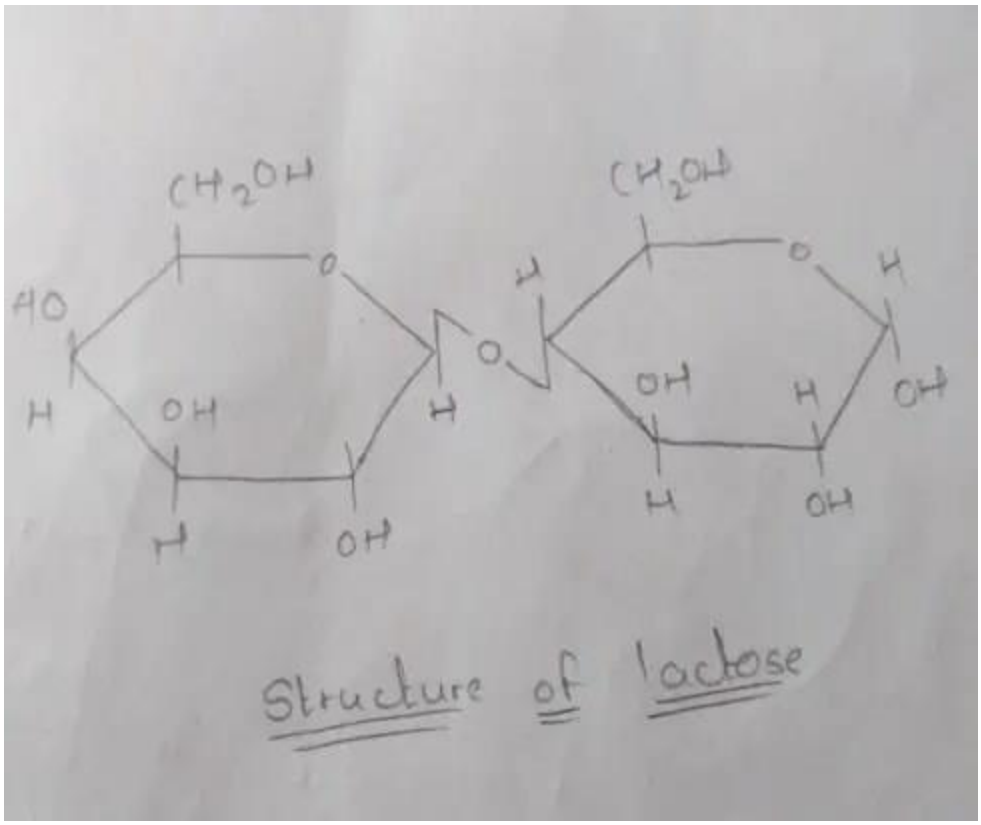
Answer: The proteins which deal with folding of polypeptide chain are the secondary structure proteins. There are two types of secondary structure proteins:

1.) Alpha helix- The helical structure formed by twisting about the Cα–N and the Cα–C bonds which is a polypeptide chain with planar peptide bonds is called as alpha helix. This alpha helix can be right handed or left handed. This alpha helix are connected by loops. These are present in myosin and tropomyosin of muscles and keratin of hair and also provides mechanical strength to the stiff bundles of fibres.

2.) Beta pleated sheet- This is a second type of secondary structure protein. This beta pleated sheet involves hydrogen bonds between groups from residues which are distant from each other in the linear sequence. These are arranged side by side and it has two or more strands widely separated in the protein sequence.

Q5: Draw the structure of disaccharide made up of two monosaccharides glucose and fructose.

Answer:



Fill in the Blanks

1. Carbohydrates are composed of _____, which are the basic units of carbohydrates.

Answer: Monosaccharides

2. Proteins are made up of building blocks called _____.

Answer: Amino acids

3. The genetic information in cells is stored in the form of _____.

Answer: DNA (Deoxyribonucleic Acid)

4. ATP (Adenosine Triphosphate) is a molecule that stores and transfers _____ in cells.

Answer: Energy

5. Lipids serve as a major source of _____ in biological systems.

Answer: Energy

Multiple Choice Questions

1. Carbohydrates are classified into:

(a) Monosaccharides, disaccharides, and polysaccharides only
(b) Aldohexoses, ketohexoses, aldopentoses, and ketopentoses
(c) Reducing sugars and non-reducing sugars
(d) All of the above

Answer: (d) All of the above

2. Glucose is a:

(a) Disaccharide
(b) Polysaccharide
(c) Monosaccharide
(d) None of the above

Answer: (c) Monosaccharide

3. The glycosidic bond is formed between:

(a) Two hydroxyl groups of monosaccharides
(b) A hydroxyl group and a carboxyl group of monosaccharides
(c) An amino group and a carboxyl group of amino acids
(d) A phosphate group and a hydroxyl group of nucleotides

Answer: (a) Two hydroxyl groups of monosaccharides

4. Starch is a:

(a) α-glucose polymer
(b) β-glucose polymer
(c) α-galactose polymer
(d) β-fructose polymer

Answer: (a) α-glucose polymer

5. Cellulose is a:

(a) Linear polymer of β-glucose
(b) Branched polymer of α-glucose
(c) Linear polymer of α-galactose
(d) Branched polymer of β-fructose

Answer: (a) Linear polymer of β-glucose

6. Proteins are made up of:

(a) Monosaccharides
(b) Disaccharides
(c) Amino acids
(d) Nucleotides

Answer: (c) Amino acids

7. Peptide bond is formed between:

(a) Two amino groups of amino acids
(b) Two carboxyl groups of amino acids
(c) An amino group and a carboxyl group of different amino acids
(d) A hydroxyl group and a carboxyl group of amino acids

Answer: (c) An amino group and a carboxyl group of different amino acids

8. Denaturation of protein refers to:

(a) Loss of its biological activity
(b) Change in its primary structure
(c) Change in its secondary structure
(d) All of the above

Answer: (d) All of the above

9. DNA is a polymer of:

(a) Monosaccharides
(b) Disaccharides
(c) Nucleotides
(d) Amino acids

Answer: (c) Nucleotides

10. The double helix structure of DNA was proposed by:

(a) Watson and Crick
(b) Franklin and Wilkins
(c) Rosalind Franklin
(d) Erwin Chargaff

Answer: (a) Watson and Crick

SUMMARY:

This chapter delves into the fascinating world of molecules essential for life, aptly named biomolecules. Here's a summary of key points:

Carbohydrates:

- The building blocks of life, providing energy and structural support.
- Classified as monosaccharides (single sugar units), disaccharides (two sugar units), and polysaccharides (many sugar units).
- Glucose, a monosaccharide, is the primary fuel source for cellular respiration.
- Starch and cellulose are common polysaccharides with diverse functions, from energy storage to cell wall formation.

Proteins:

- Made up of amino acids linked by peptide bonds, forming chains that fold into complex structures.

- Function in diverse roles, including enzymes, hormones, antibodies, and structural components.
- Denaturation disrupts protein structure, leading to loss of function.

Lipids:

- A diverse group of hydrophobic molecules, including fats, oils, and waxes.
- Store energy, insulate organs, and provide waterproofing.
- Phospholipids form the basic bilayer structure of cell membranes.

Nucleic Acids:

- DNA and RNA carry genetic information and dictate cellular functions.
- DNA, a double helix polymer of nucleotides, stores genetic information.
- RNA, a single-stranded molecule, participates in protein synthesis and other cellular processes.

Additional points:

- Chapter 3 likely explores the structure, function, and importance of various biomolecules in detail.
- Specific examples of each biomolecule type and their roles in different biological processes might be covered.
- Understanding the properties and interactions of biomolecules is crucial for comprehending various biological phenomena.