CHAPTER – 9

BIOMOLECULES

EXERCISES

2 Mark Questions

Q1: What are macromolecules? Give examples.

Answer:Macromolecules are large high molecular weight substances with complex molecular structure and occur in colloidal state (being insoluble) in intracellular fluid. These are formed by polymerization of large number of micromolecules. Polysaccharides, proteins and nucleic acids are few examples.

Q2: Find out and make a list of proteins used as therapeutic agents. Find other applications of proteins.

Answer:

Proteins used as therapeutic agents are: thrombin, fibrinogen, enkephalins, antigens, antibodies, streptokinase, protein tyrosine kinase, diastase, renin, insulin, oxytocin, vasopressin etc. Proteins are also used in cosmetics, dairy industries, textile industries, research techniques, biological buffers etc.

Q3: Can you describe what happens when milk is converted into curd or yoghurt, from your understanding of proteins.

Answer:

Milk is converted into curd or yoghurt due to denaturation of proteins. In denaturation, disruption of bonds that maintains secondary and tertiary structure leads to the conversion of globular proteins into fibrous proteins. This involves a change in physical, chemical and biological properties of protein molecules.

Q4: Attempt titrating an amino acid against a weak base and discover the number of dissociating (ionizable) functional groups in the amino acid.

Answer:

The existence of different ionic forms of amino acids can be easily understood by the titration curves. The number of dissociating functional group is one in case of neutral and basic amino acids and two in case of acidic amino acids.

Q5: What are gums made of ? Is fevicol different ?
Answer:

Gums are hetero-polysaccharides (poly-mers) of large number of different monosac-charide units. Yes, fevicol is a different kind of polymer. It is a synthetic sticky substance called resin which is manufactured by esteri-fication of organic compounds.

Q6:Find out how much cellulose is made by all the plants in the biosphere.
Answer:

About 100 billion tonnes of cellulose is prepared per year by the plants of the world.

4 Mark Questions

Q1:What is meant by tertiary structure of proteins?

Answer:The helical polypeptide molecule may fold on itself and assume a complex but specific form-spherical, rod-like or any form in between these. These geometrical shapes,are known as tertiary (3°) structure of protein molecules. The coils and folds of the polypeptide molecules are so arranged as to hide the non-polar amino acid chains inside and to expose the polar side chains. The tertiary structure of a protein brings distant amino acid side chains nearer to form active sites of enzymatic proteins. The tertiary structure is maintained by weak bonds such as hydrogen, ionic, disulphide and hydrophilic – hydrophobic bonds, formed between one part of a polypeptide and another. This structure is easily disrupted by pH, temperature and chemicals stopping the function of proteins.

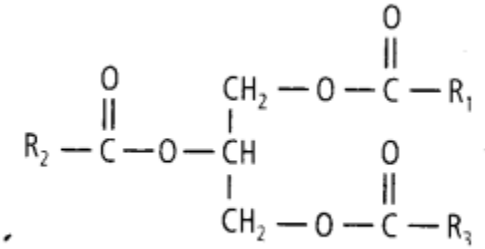
Q2:Proteins have primary structure. If you are given a method to know which amino acid is at either of two termini (ends) of a protein, can you connect this information to purity or homogeneity of a protein?
Answer:There are several methods provided by several scientists to find out the

sequence of amino acids. Frederick Sanger proposed Sanger's reagent to know the amino acid sequence in a polypeptide chain.

Sanger used 1-fluoro 2, 4 dinitrobenzene (FD NB) to determine insulin structure. FDNB specifically binds with N-terminal amino acid to form a dinitrophenyl (DNP) derivative of peptide. This DNP- derivative peptide can be identified by chromatography. The identified sequence of amino acids shows the homogeneity of a protein molecule.

Q3:Explain the composition of triglycerides. jSfflTriacylglycerols (triglycerides) are the esters of glycerol with fatty acids.

Answer: They are insoluble in water and non-polar in character and commonly known as neutral fats. The neutral or depot fats are composed of carbon, hydrogen and oxygen like carbohydrates but have far fewer oxygen atoms than carbon atoms unlike the carbohydrates.



Triglyceride (R_1, R_2 and R_3 are fatty acids)

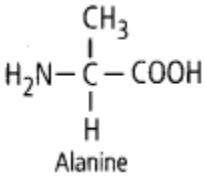
(i) Glycerol – A glycerol molecule has 3
carbons, each bearing a hydroxyl (-OH) group. .
(ii) Fatty acids – A fatty acid molecule is an unbranched chain of carbon atoms with each carbon atom (C) forming four bonds to other atoms. It has a carboxyl group- COOH at one end and hydrogen atom (H) bonded to all or most carbon atoms forming a hydrogen chain. The carbon- hydrogen bonds are non-polar. Therefore, the hydrocarbon chain does not dissolve in water. Because the carboxyl group contains the polar C = O and OFI groups. It tends to dissolve in water even though the rest of fatty acid molecule will not. Triacylglycerols of plants, in general, have higher content of unsaturated fatty acids as compared to that of animals.

Q4:Can you attempt building models of biomolecules using commercially available atomic models (Ball and stick models).

Answer:Yes, models of biomolecules can be prepared using commercially available atomic models.
Ball and stick models and space filling models are 3D or spatial molecular models which serve to display the structure of chemical products and substances or biomolecules. With ball and stick models, the centers of the atoms are connected by straight lines which represent the covalent bonds. Double and triple bonds are often represented by springs which form curved connections between the balls. The bond angles and bond lengths reflect the actual relationships, while the space occupied by the atoms is either not represented at all or only denoted essentially by the relative sizes of the spheres.

Q5:Draw the structure of the amino acid, alanine.

Answer:

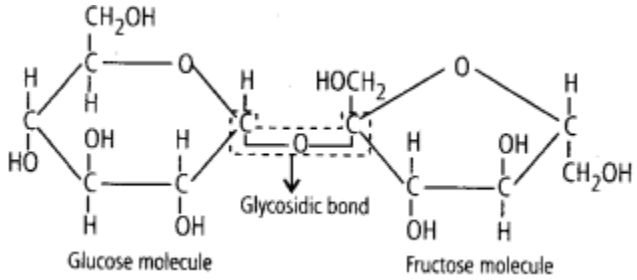


7 Mark Questions

Q1:Illustrate a glycosidic, peptide, and a phospho- diester bond.

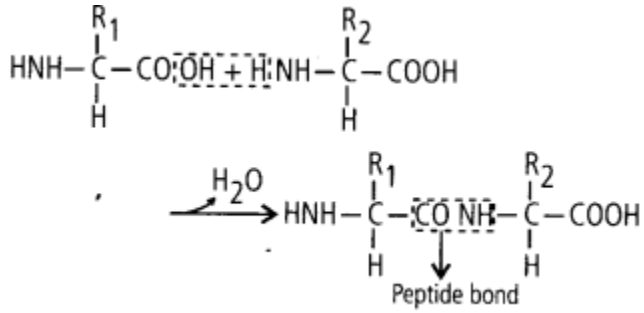
Answer:

(i) Glycosidic bond is the type of chemical linkage between the monosaccharide units of disaccharides, oligosaccharides and polysaccharides, which is formed by the removal of a molecule of water.

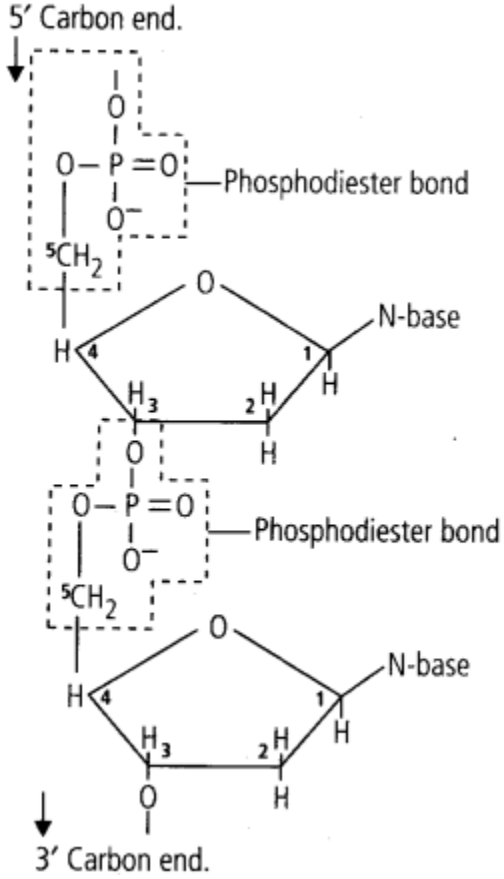


(ii)Peptide bonds are formed by the reaction between carboxyl (- COOH) of one amino acid and amino (- NH2) group of other amino acid with the elimination of

water.



(iii) In a polynucleotide chain, adjacent nucleotides are joined together by a bond called phosphodiester bond. This bond links a phosphate group and sugar group of two adjacent nucleotides by means of an oxygen bridge.



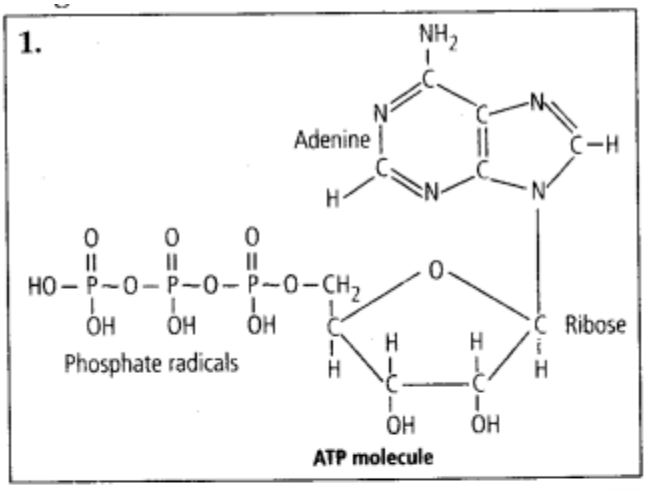
Q2:Find and write down structures ©f 10 interesting small molecular weight biomolecules.

Answer:

Interesfing small molecular weight biomolecules are minerals (like sodium, potassium, calcium, zinc, iodine etc), gases (like Oz, N2, C02, NH3) sugars –

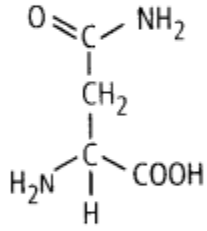
(ribose, deoxyribose, glucose, fructose), lipids, amino acids, nucleotides (pyrimidines & purine). Structures of 10 interesting small molecular weight biomolecules are as follows:

1.



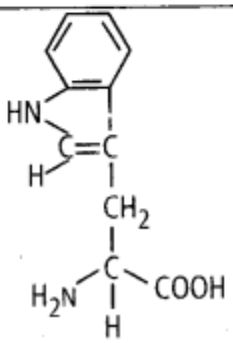
ATP molecule

2.



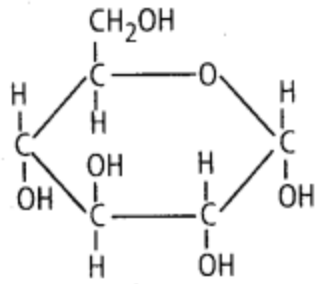
Asparagine (Asn)

3.



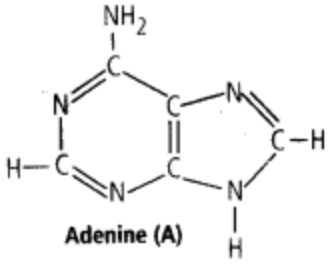
Tryptophan (Trp)

4.



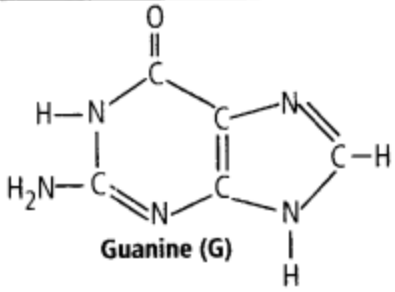
Glucose

5.



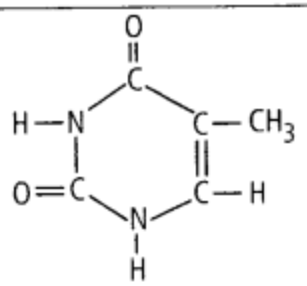
Adenine (A)

6.



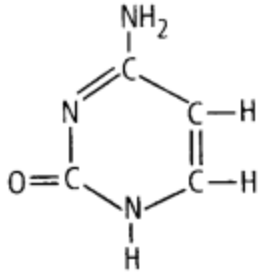
Guanine (G)

7.



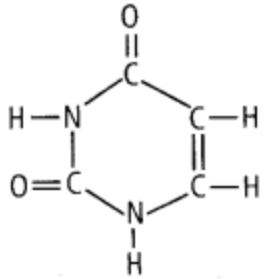
Thymine (T)

8.



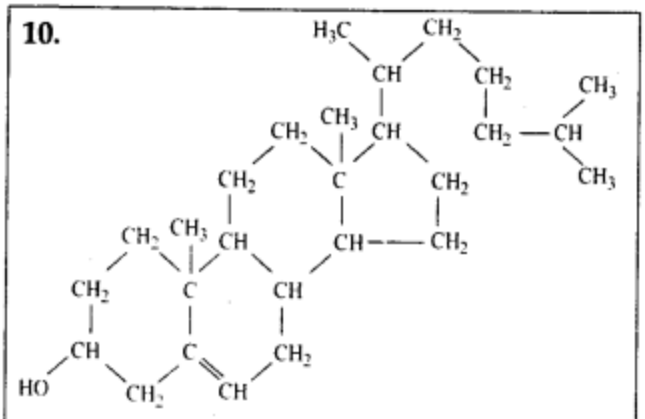
Cytosine (C)

9.



Uracil (U)

10.

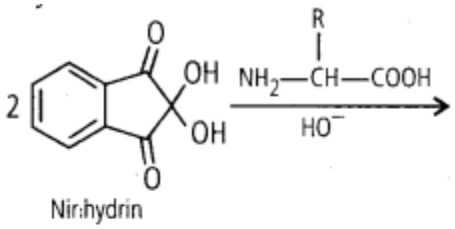


Cholesterol

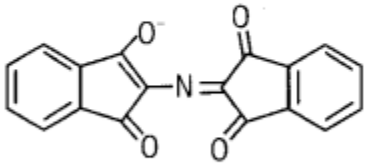
Q3:Find out a qualitative test for proteins, fats and oils, amino acids and test, any fruit juice, saliva, and urine for them.

Answer:

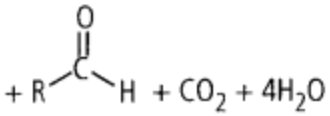
Biuret test for protein : The biuret test is a chemical test used for determining the presence of peptide bonds. In a positive test, a copper II ion (Cu2+ ion) is reduced to copper I (Cu+) which forms a complex with the nitrogen and carbon of peptide bonds in an alkaline solution. A violet colour indicates the presence of proteins.
Ninhydrin test for amino acid: Ninhydrin (2,2 Dihydroxy indane-l,3-dione) is a chemical used to detect ammonia or primary and secondary amines. When reacting with these free amines, a deep blue or purple colour known as Ruhemann's purple is evolved. Amino acid analysis of proteins is also done by ninhydrine. Most of the amino acids (including a-amino acids) are hydrolysed and reacted with ninhydrin except proline (a secondary amine). Amino acid containing a free amino group and a free carboxylic acid group reacts together with ninhydrin to produce coloured product. When the amino group is secondary, the condensation product is yellow.



Nir:hydrin



Ruhemann's purple



Solubility test for fats and oils : A positive solubility test for fats is that the fat dissolves in lighter fluid and not in water. In this test, 5 drops of fat or oil are added in two test tubes containing 10 drops of lighter fluid and 10 drops cold water respectively.
Fruit juice contains sugar so it cannot be tested by the above-mentioned tests. Saliva contains proteins, mineral salts, amylase etc., so it can be tested for protein and amino acids. Urine contains proteins, so it can be tested for it.

Q4:Describe the important properties of enzymes.

Answer:

The important properties of enzymes are as follows:
(i) The enzymes are generally proteins which are high molecular weight complex globular proteins. They can associate with non-protein substance for their activity.
(ii) The enzymes do not start a chemical reaction but only accelerate it. They combine temporarily with the substrate molecules and are not consumed or changed permanently in the reaction which they catalyse.
(iii) The enzyme controlled reactions are reversible.
(iv) The enzymes are specific in action. An enzyme catalyses only a particular kind of reaction or acts on a particular substrate only.
(v) The enzymes are thermolabile i.e., heat sensitive and can function best at an optimum temperature. Similarly, enzymes show maximum activity at optimum pH.
(vi) The enzymes are inactivated by poisons and radiation.

Multiple Choice Questions

1. Which biomolecule is distributed more widely in a cell?

a. Chloroplast
b. RNA
c. DNA
d. Spaherosomes

Answer: RNA

2. Which is a reducing sugar?

a. Galactose
b. Gluconic acid
c. Sucrose
d. β-methyl galactosidase

Answer: Galactose

3. Most abundant RNA in the cell

3. Name the simplest amino acid

a. Alanine
b. Tyrosine
c. Asparagine
d. Glycine

Answer: Glycine

4. Mineral associated with cytochrome is

a. Mg
b. Cu and Ag
c. Fe
d. Cu

Answer:Fe

5. The most common secondary structure of proteins is

a. β-pleated sheet
b. β-pleated sheet parallel
c. β-pleated sheet non-parallel
d. α-helix

Answer: α-helix

6. The term enzyme was coined by

a. Urey Miller
b. Pasteur
c. Kuhne
d. Buchner

Answer: Kuhne

SUMMARY

Although there is a bewildering diversity of living organisms, their chemical composition and metabolic reactions appear to be remarkably similar. The elemental composition of living tissues and non-living matter appear also to be similar when analysed qualitatively. However, a closer examination reveals that the relative abundance of carbon, hydrogen and oxygen is higher in living systems when compared to inanimate matter. The most abundant chemical in living organisms is water. There are thousands of small molecular weight (<1000 Da) biomolecules. Amino acids, monosaccharide and disaccharide sugars, fatty acids, glycerol, nucleotides, nucleosides and nitrogen bases are some of the organic compounds seen in living organisms. There are 20 types of amino acids and 5 types of nucleotides. Fats and oils are glycerides in which fatty acids are esterified to glycerol. Phospholipids contain, in addition, a phosphorylated nitrogenous compound. Only three types of macromolecules, i.e., proteins, nucleic acids and polysaccharides are found in living systems. Lipids, because of their association with membranes separate in the macromolecular fraction. Biomacromolecules are polymers. They are made of building blocks which are different. Proteins are heteropolymers made of amino acids. Nucleic acids (RNA and DNA) are composed of nucleotides. Biomacromolecules have a hierarchy of structures – primary, secondary, tertiary and quaternary. Nucleic acids serve as genetic material. Polysaccharides are components of cell wall in plants, fungi and also of the exoskeleton of arthropods. They also are storage forms of energy (e.g., starch and glycogen). Proteins serve a variety of cellular functions. Many of them are enzymes, some are antibodies, some are receptors, some are hormones and some others are structural proteins. Collagen is the most abundant protein in animal world and Ribulose bisphosphate Carboxylase-Oxygenase (RuBisCO) is the most abundant protein in the whole of the biosphere. Enzymes are proteins which catalyse biochemical reactions in the cells. Ribozymes are nucleic acids with catalytic power. Proteinaceous enzymes exhibit substrate specificity, require optimum temperature and pH for maximal activity. They are denatured at high temperatures. Enzymes lower activation energy of reactions and enhance greatly the rate of the reactions. Nucleic acids carry hereditary information and are passed on from parental generation to progeny