Chapter 9
Biomolecules

Question 1:
What are macromolecules? Give examples.

Solution 1:
Chemical compounds, which are found in the acid insoluble fraction are called macromolecules or biomacromolecules. As suggestive of its name, their molecular weights lie above 1000 dalton. On the other hand micromolecules have molecular weights less than 1000 Daltons. For example, proteins, lipids and carbohydrate, etc. With the exception of lipids all the other macromolecules including carbohydrates, proteins and nucleic acids are polymeric substances.

Question 2:
Illustrate a glycosidic, peptide and a phosphodiester bond.

Solution 2:
Glycosidic bonds are bonds linking the individual sugar units (monosaccharides) in a disaccharide or a polysaccharide. When two sugar units join they join with the help of a glycosidic linkage with the release of a water molecule.
Peptide bonds link amino acids in a protein. Correspondingly, the proteins are called as polypeptide. Peptide bonds are formed when carboxyl group of one amino acid reacts with the amino group of the next amino acid with the elimination of a water molecule. As water molecule is eliminated so the reaction is that of dehydration.
Phosphodiester bonds link individual nucleotides in a nucleic acid. So, we say DNA (a nucleic acid) is a polynucleotide. A phosphodiester linkage is formed due to linking of a 3’ carbon of one sugar of a nucleotide with the 5’ carbon of of the sugar of adjacent nucleotide by a phosphate moiety . The bond between the phosphate and hydroxyl group of sugar is an ester bond. It is phosphodiester bond as there is one such ester bond on either side.

Question 3:
What is meant by tertiary structure of proteins?

Solution 3:
Tertiary structure refers to the spatial arrangement of amino acids that are far apart in the linear sequence as well as those residues that are adjacent. The sequence of amino acids species the final three dimensional structure. The polypeptide chain folds spontaneously so that the majority of its hydrophobic side chains are buried in the interior , and the majority of its polar charged sise chains are on the surface. The tertiary structure of protein is stabilized by hydrophobic interactions, electrostatic forces (salt bridges) and disulfide links.

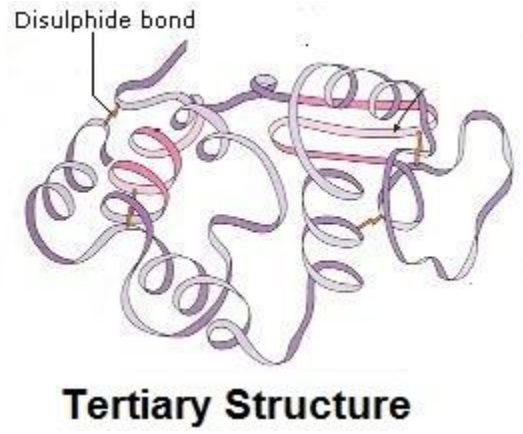
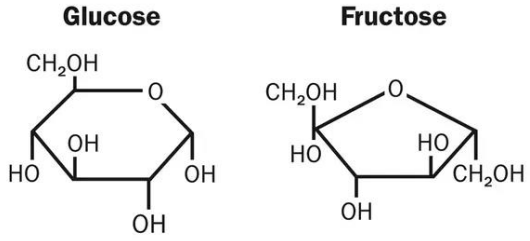


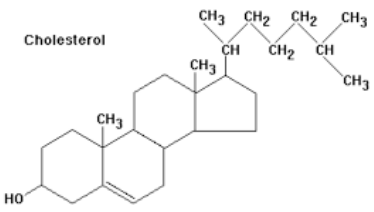
Diagram showing tertiary structure of proteins.

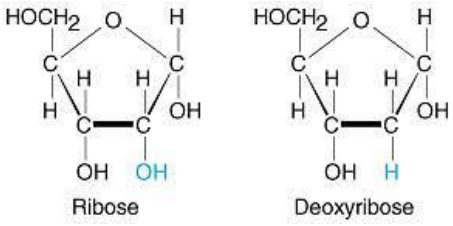
Question 4:

Find and write down structures of 10 interesting small molecular weight biomolecules. Find there is any industry which manufactures the compounds by isolation. Find out who are the buyers.

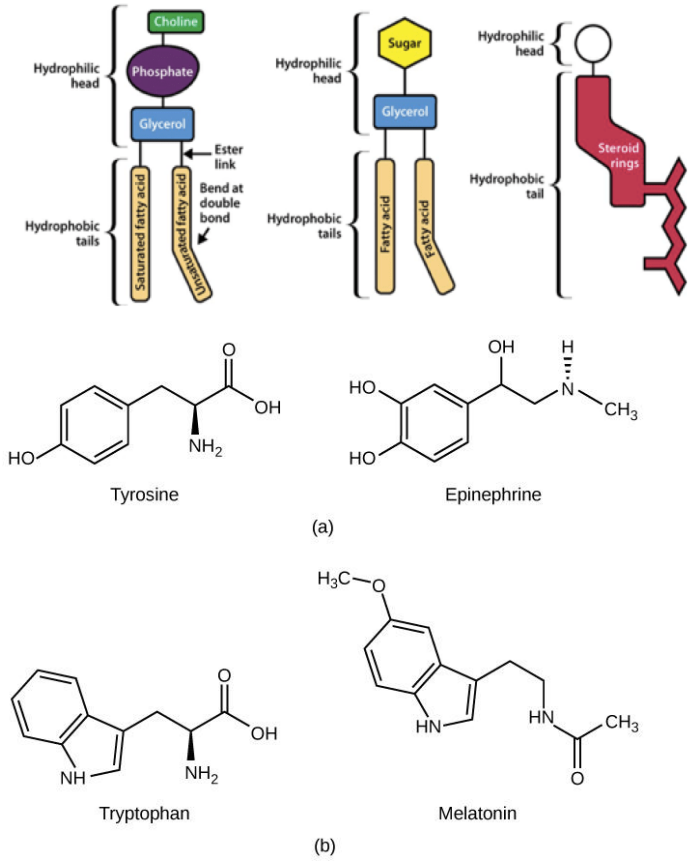
Solution 4:







Injecting insulin is an essential part of the daily regime for many diabetics.



Question 5:

Proteins have primary structure. If you are given a method to know which amino acid is at either of the two termini (ends) of a protein, can you connect this information to purity or homogeneity of a protein?

Solution 5:

The sequence of amino acids, i.e., the positional information in a protein which is the first amino acid, which is second and so on is called the primary structure of a protein. The first amino acid is also called as N-terminal amino acid. The last amino acid is called the C-terminal amino acid. Yes, we can connect this information to purity or homogeneity of a protein. Based on number of

amino and carboxyl groups, there are acidic (e.g., glutamic acid), basic (lysine) and neutral (valine) amino acids, proteins may be acidic, basic and neutral.

Question 6:

Find out and make a list of proteins used as therapeutic agents. Find other applications of proteins (e.g., cosmetics etc.)

Solution 6:

Proteins	Therapeutic use
Insulin	diabetes
Vasopressin	treatment of diabetes insipidus
Interleukin II	Used to prevent low platelets counts and to reduce the need for blood transfusions following cancer treatments
Oxytocin	used for inducing uterine contractions to induce labour during pregnancy.

Both animals and plants give suitable proteinaceous materials for the preparation of cosmetic ingredients. Proteins from fungi and algae, however, are also increasingly being used as protein sources.

High-protein plants most commonly used as starting material for producing vegetable proteins are wheat and corn gluten, soy, rice and oat protein concentrates, and defatted oil seeds (peanuts, almond, sunflower). Among the large variety of vegetable proteins wheat gluten and soy globulins are by far of the widest use. Wheat gluten (often just called wheat protein) is a unique cereal protein of high elasticity when hydrated. Soy proteins are useful due to their gelling and emulsifying effects.

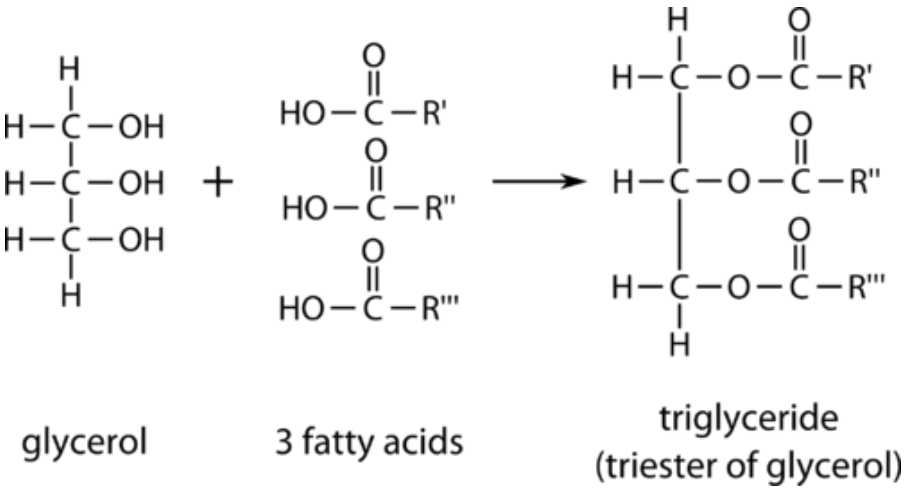
Question 7:

Explain the composition of triglyceride?

Solution 7:

Triglycerides are a kind of lipids that are formed due to esterification of three fatty acids with a glycerol molecule. These are also called as fats and oils based on their meltinf points. Oils have

lower melting points as compared to fats. The three fatty acids may be similar or different. Accordingly, they may be called simple or mixed.



Question 8:

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

Solution 8:

Milk contains a protein called casein. This protein gives milk its characteristic white colour. It is of high nutritional value because it contains all the essential amino acids required by man's body. The curd forms because of the chemical reaction between lactic acid bacteria and casein. When curd is added to milk, the lactic acid bacteria present in it cause coagulation of casein and thus, convert it into curd.

Question 9:

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

Solution 9:

Yes, we can make models of biomolecules using commercially available atomic models.

Question 10:

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

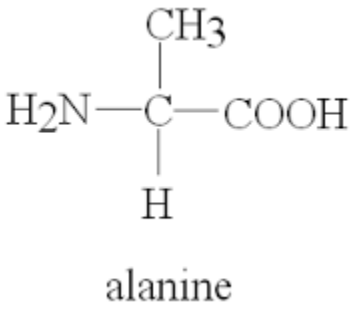
Solution 10:

When an amino acid is titrated against a weak base. It dissociates and gives two functional groups: (i) - COOH group (carboxylic group) (ii) Amino group (NH2)

Question 11:

Draw the structure of the amino acid alanine.

Solution 11:



alanine

Question 12:

What are gums made of? Is fevicol different?

Solution 12:

Gums are heteropolysaccharides . Fevicol is polyvinyl alcohol glue. It is different from natural gums. It is a synthetic product.

Question 13:

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

Solution 13:

(i) A qualitative test for proteins - (i) Xanthoproteic Test

Experimental Material	Observation	Inference
(a) Urine	Yellow precipitate	Formation of yellow precipitate
(b) Water	No precipitate	Indicates the presence of protein in the food material

(ii) A qualitative test for fats- Emulsification Test

Experimental Material	Observation	Inference
(a) Sweat	Oil droplets	Formation of oil droplets
(b) Water	No oil droplet	i.e., emulsification indicates the presence of fats in the given food material.

(iii) A qualitative test for oils - Paper Test

Experimental Material	Observation	Inference
(a) Food material (sample) (b) Water	Paper becomes Translucent	Opaque paper becomes translucent which indicates the presence of fats in the food material

. (iv) A qualitative test for starch - Iodine Test

Experimental Material	Observation	Inference
(a) Fruit juices (b) Water	Blue black colour	Formation of blue black colour indicates the presence of starch in the given food material.

Question 14:

Find out how much cellulose is made by the plants in the biosphere and compare it with how much of paper is manufactured by man and hence, what is the consumption of plant material by man annually. What a loss of vegetation?

Solution 14:

Most paper is formed from wood pulp. The main component of wood pulp is cellulose, a polymer made of many glucose molecules linked together. The cellulose molecules and their bonding to each other gives paper its properties. About 33% of all plant matter is cellulose. The cellulose content of cotton is 90% and that of wood is 40-50%. For industrial use, cellulose is mainly obtained from wood pulp and cotton. It is mainly used to produce paperboard and paper; to a smaller extent. It is converted into a wide variety of derivative products such as cellophane and rayon.

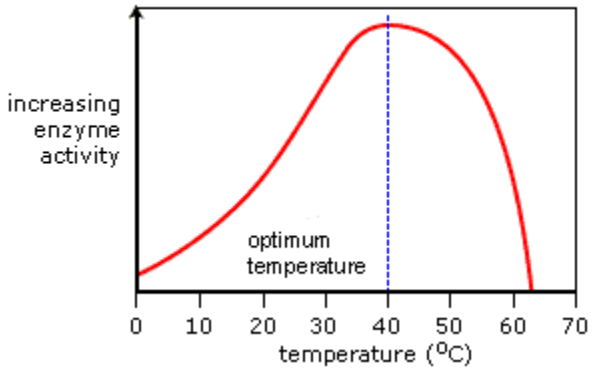
Question 15:

Describe the important properties of enzymes.

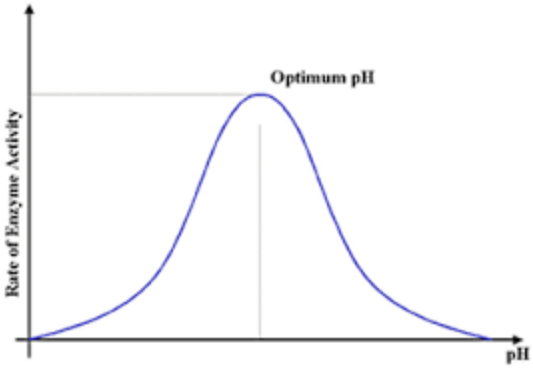
Solution 15:

(i) Enzymes are proteins which catalyse biochemical reactions in the cells. So, usually enzymes are proteins but sometimes RNA also behaves catalytically. Catalytic RNAs are called Ribozymes.

(ii) Each enzyme works best at its optimum temperature. Since enzymes are proteins , they are denatured at high temperatures.



(iii) Enzymes work best at their optimum pH.



Graph showing effect of pH on enzyme activity.

(iv) With the increase in substrate concentration, the velocity of the enzymatic reaction rises at first. The reaction ultimately reaches a maximum velocity (v max) which is not exceeded by any further rise in concentration of the substrate.
(v) The activity of an enzyme is also sensitive to the presence of specific chemicals(may be inhibitors or modulators of enzyme action) that bind to the enzyme.
(vi) Enzymes are substrate specific .Due to three dimensional folding of the enzyme, it forms pockets or crevices. One such pocket is called the active site. An active site of enzyme is a crevice or a pocket at which the substrate binds.