9. Biomolecules

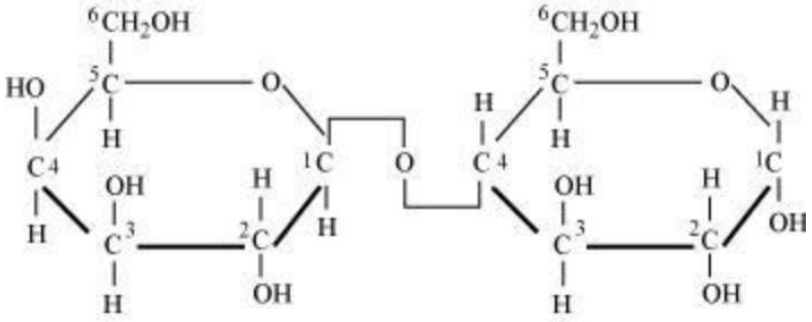
Question 1. What are macromolecules? Give examples.

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

Question 2. Illustrate a glycosidic, peptide and a phospho-diester bond.

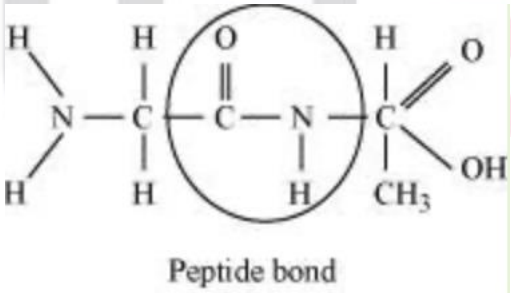
Answer:

(a) A glycosidic bond is formed between C1 and C4 of the adjacent monosaccharide units.



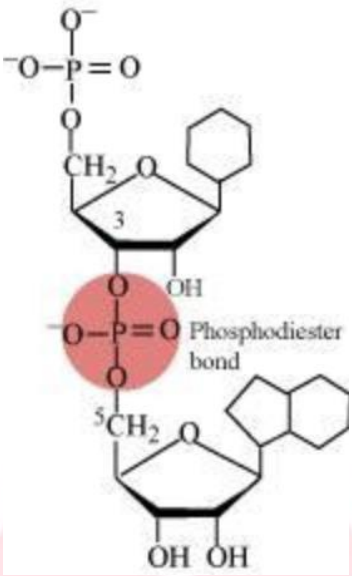
Glycosidic bond

(b) Peptide bond is the covalent bond formed between two adjacent amino acids by condensation of ammonia group of one amino acid and C=O group of other amino acid and depicted as,



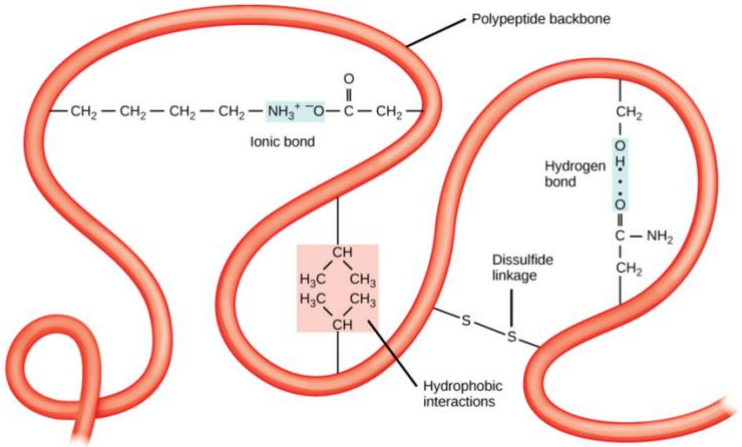
Peptide bond

(c) Phosphodiester bond is a strong covalent bond formed between phosphate and two adjacent sugar groups. Such bonds form the sugar-phosphate backbone of nucleic acids.



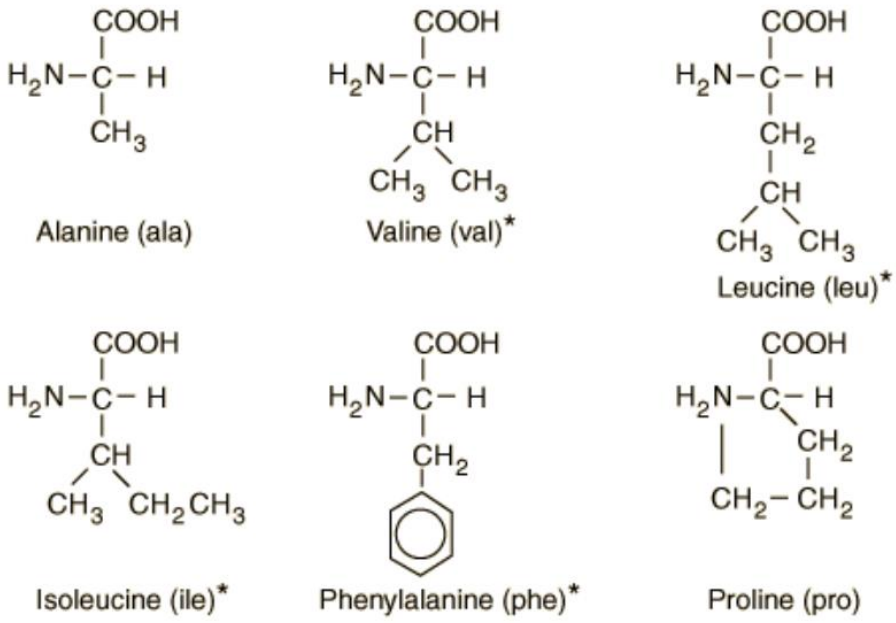
Question 3. What is meant by tertiary structure of proteins?

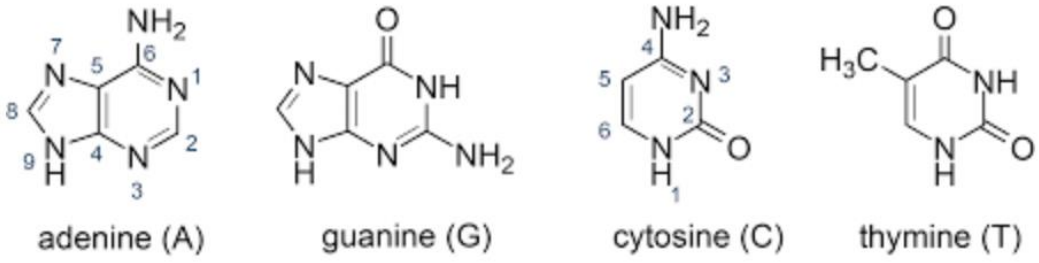
Answer: Tertiary structure is the next level of complexity in protein folding. Tertiary structure is the three-dimensional structure of a protein. While individual amino acids in the primary sequence can interact with one another to form secondary structures such as helices and sheets and individual amino acids from distant parts of the primary sequence can intermingle via charge-charge, hydrophobic, disulfide, or other interactions, the formation of these bonds and interactions will serve to change the shape of the overall protein.



Question 4. Find and write down structures of 10 interesting small molecular weight biomolecules. Find if there is any industry which manufactures the compounds by isolation. Find out who are the buyers.

Answer:





These biomolecules are manufactured in biotechnology industries.

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?

Answer: Yes, if we are given a method to know the sequence of proteins, we can use this information to determine purity of a protein. It is known that an accurate sequence of a certain amino acid is very

important for the functioning of a protein. If there is any change in the sequence, it would alter its structure, thereby altering the function. So by knowing sequence of a given protein, we can determine its structure and compare it with any of the known correct protein sequence. Any change in the sequence can be linked to the purity or homogeneity of a protein.

For example, a single change in the sequence of haemoglobin in P chain at 6th position can alter the normal haemoglobin structure to an abnormal structure that can cause sickle cell anaemia.

Question 6. Find out and make a list of proteins used as therapeutic agents. Find other applications of proteins (e.g., Cosmetics etc.).

Answer: Proteins are used as therapeutic agents because:

(i) Thrombin and fibrinogen- They help in blood clotting.

(ii) Insulin- It is used in diabetes as it helps in maintaining blood glucose level in the body.

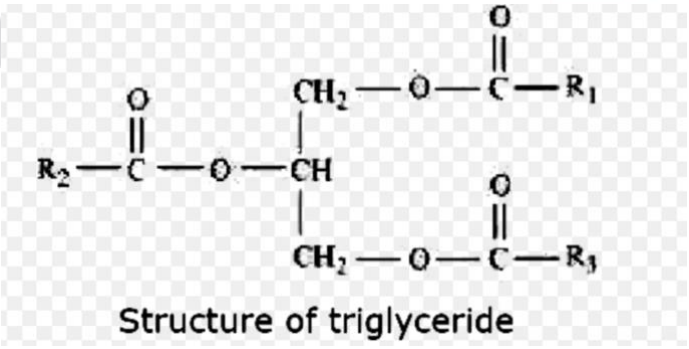
(iii) Renin- It helps in osmoregulation.

(iv) Lactoferrin- It is used as an antimicrobial.

(v) Trypsin- It is used in pharmaceutical.

Question 7. Explain the composition of triglyceride.

Answer:
(1) The components of triglyceride are single molecule of glycerol and 3 fatty acids.
(2) In glycerol 3 carbon atoms are present along with 30 n groups.
(3) Fatty adds consist of a long chain hydrocarbon with a carboxylic group at one end.
(4) Both of them form ester bond. This bond is saturated when single bonded carbons are present and unsaturated when double bonded carbon atom (—c = c—) are present



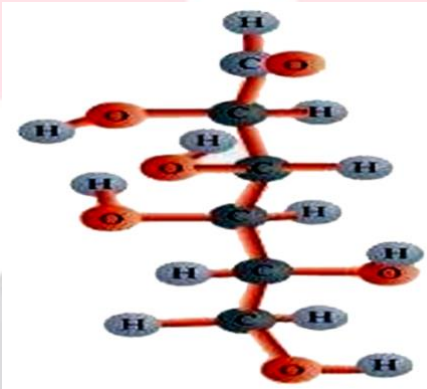
Structure of triglyceride

Question 8. Can you describe what happens when milk is converted into curd or yoghurt, from your understanding of proteins.

Answer: 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).

Answer: Ball and stick models are 3-D molecular models that can be used to describe the structure of biomolecules.
In ball and stick model, the atoms are represented as balls whereas the bonds that hold the atoms are represented by the sticks. Double and triple bonds are represented by springs that form curved connections between the balls. The size and colour of various atoms are different and are depicted by the relative size of the balls.
It is the most fundamental and common model of representing biomolecular structures.



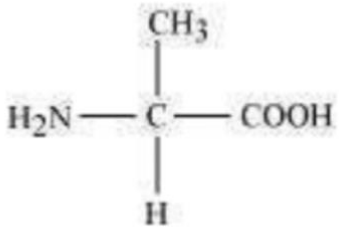
In the above ball and stick model of D-glucose, the oxygen atoms are represented by red balls, hydrogen atoms by blue balls, while carbon atoms are represented by grey balls.

Question 10. Attempt titrating an amino acid against a weak base and discover the number of dissociating (ionizable) functional groups in the amino acid.

Answer: Titrating a neutral or basic amino acid against a weak base will dissociate only one functional group, whereas titration between acidic amino acid and a weak base will dissociate two or more functional groups.

Question 11. Draw the structure of the amino acid, alanine.

Answer: The structure of Alanine is:



Question 12. What are gums made of? Is Fevicol different?

Answer: Natural gum is a polysaccharide of natural origin. It has high viscosity even at low concentration. Fevicol is a synthetic glue. Synthetic glue is usually made of polymers which are dissolved in a solvent. When the adhesive is exposed, the solvent evaporates; resulting in hardening of the adhesive. Synthetic adhesives come in various strengths and are used accordingly.

Question 13. Find out a qualitative test for proteins, fats and oils, amino acids and test any fruit juice, saliva, sweat and urine for them.

Answer:

(i) A qualitative test for proteins. 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 all 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!

Answer: Around 85 billion tonnes of cellulose is formed annually in the biosphere (out of 170 billion tonnes of total organic matter). Paper making consumes roughly 0.5 billion tonnes of wood, food grains comprise 1.5 billion tonnes. Full wood required 2 billion tonnes. The increase in consumption of cellulose has resulted in great loss of vegetation.

Question 15. Describe the important properties of enzymes.

Answer: Enzymes are proteinaceous substances which are capable of catalysing chemical reactions of biological origin without themselves undergoing any change. They are commonly called as **biocatalysts**. The properties of enzymes are as follows:

1. Enzymes are proteins by nature

2. Optimum temperature- An enzyme is active within a narrow range of temperature. The temperature at which an enzyme is most active is called the optimum temperature. The enzyme activity decrease above and below this temperature.

3. Optimum pH- Every enzyme has an optimum pH at which it is maximum active. Most of the intracellular enzymes work at neutral pH.

4. Enzymes are substrate specific i.e. one enzyme catalyses only a particular substrate. Every enzyme has specific sites called active sites for the binding of substrate.

5. Only a small quantity of enzyme is capable of forming the desired product

6. Enzyme activity is sensitive to certain chemicals called inhibitors or modulators.