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# Bio molecule

## Gist Of The Chapter

**1.Carbohydrates**- These are optically active polyhydroxy aldehydes or ketones due to presence of chiral `C' or the compounds which produce these on hydrolysis except dihydroxy acetone is not optically active.

**2. Classification-**

**(i) Monosaccharide's** – Those carbohydrates which cannot get hydrolysed e.g. glucose ,fructose, galactose etc.

**(ii) Oligosaccharides-** Those carbohydrates which give to or more monosaccharide's on hydrolysis e.g. sucrose on hydrolysis gives glucose and fructose. Raffinose on hydrolysis gives glucose, fructose and galactose.

**(iii) Polysaccharides**- Those carbohydrates which on hydrolysis give large number of monosaccharide's hydrolysis.eg starch, cellulose, glycogen.

**3. Sugar-**

**(i)Reducing Sugars-** Those which reduce Fehling's or Tollen's reagent. They have free aldehydic groups, eg , glucose, fructose , galactose

**(ii)Non Reducing Sugars-** Those which do not reduce Fehling's or Tollen's reagent. They do not have free functional group ,e.g., sucrose

**4. Glucose**- It is a monosaccharide's with molecular formula $C_6H_{12}O_6$

**5. Preparation**

**(i)From Sucrose**

$C_{12}H_{22}O_{11} + H_2O$ -------> $C_6H_{12}O_6 + C_6H_{12}O_6$ ( Only from sucrose)

**(ii)From Starch**

$(C_6H_{10}O_5)_n + nH_2O$ -------> $C_{12}H_{22}0_{11} + H_20$ ------> $2C_6H_{12}O_6$

**6.Structure**

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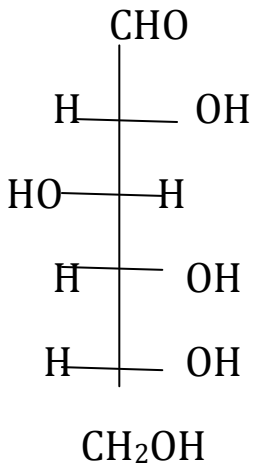
**(i)Fischer structure –**

$CHO — (CHOH)_4 — CH_2OH$

(+) Glucose has `D' configuration as shown




`D' means —OH group on first chiral `C' from the bottom is on right hand and + means it is dextro rotator, i.e, it rotates plane polarized light towards right.

**(ii) Cyclic Structure OF Glucose**: the straight chain is unable to explain the following reactions.

(a) It does not give the 2, 4-DNP test, Schiff's Test and does not form the hydrogensulphide product with $NaHSO_3$ .

(b) The pentacetate of glucose does not react with $NH_2OH$, indicating the absence of free aldehydic group.

(iii) Glucose exist in 2 different crystalline forms α and β forms. These are called anomers. They differ in optical rotation, they also differ in melting point.

**Anomers are isomers which have a different configuration across C-1 (first chiral 'C' atom).**

**7. Glycosidic Linkage:** The linkage between two monosaccharide units through oxygen is called the glycosidic linkage.

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**8. Proteins:** These are micro molecules made up of amino acids joined via a peptide link ( -(-CONH-)- is the peptide linkage). These are required for growth and development of the body.

**9. Amino Acids:** These contain an amino ($-NH_2$) and an acidic (-COOH) group and are therefore amphoteric in nature. In solution they exist in the form of zwitter ion.

**10. Classification**

| **Fibrous Protein** | **Globular Protein** |
|---|---|
| (i) Polypeptide chains run parallel or anti-parallel and held together by hydrogen and disulphide bonds. | (i) Chains of Polypeptide coil around to give a spherical shape. |
| (ii) Generally insoluble in water. e.g. Keratin, collagen,myosin,fibroin. | (ii) Usually soluble in water. e.g., insulin, thyroglobin,albumin, haemoglobin and fibrinogen gets converted into fibrous protein fibroin on clotting of blood. |

**11. Structure And Shape of Protein**

| **Primary Strutcure** | **Secondary Structure** | **Tertiary Structure** | **Quaternary Structure** |
|---|---|---|---|
| The specific sequence of amino acids in the polypeptide chain. Change in amino acids sequence changes the protein. They have covalent | It is the shape in which the long polypeptide chain can exist. It is of two types : α- helix and β- pleated. These structures arise due to regular folding of the backbone of the polypeptide chain | Represents overall folding of the polypeptide chain. It gives rise to the fibrous or globular molecular shapes. Forces stabilizing the $2^o$ and $3^o$ structures are | Protein can be composed of two or more polypeptide chains called sub units. The spatial arrangement of these sub units with respect to each other |

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| | | | |
|---|---|---|---|
| bonds. | due to H-bonding between the C=o and –NH- groups of the peptide bond. | hydrogen bonds, disulphide linkages, van der waal's and electrostatic forces of attraction. | quaternary structure of the protein. |

**12. Denaturaion of Protein:** The protein in native state, when subjected to a physical change like temperature, pH etc undergoes uncoiling and looses it's biological activity. The $2^{o}$ and $3^{o}$ structures are destroyed, only $1^{o}$ structure is retained.

**Renaturation of Protein:**

Some proteins regain their biological activity by reversible process it is called Renaturation of Proteins. In such a cases, when temperature in pH of a denatured proteins is brought back to conditions in which the native protein is stable, secondary and tertiary structures of proteins are restored to which leads to recovery of biological activity.

**13. Enzymes:** These are biocatalyst and generally globular proteins e.g., invertase,zymase,phenyl, alaninehydroxylase, urease etc.

**14. Vitamins:** They are organic compounds required in the diet in small amounts to perform specific biological functions for maintenance of optimum growth and health of the organism. They are classified as follows

**(i) Fat Soluble Vitamins:** Vitamin A,D,E and K. They are stored in liver and adipose tissues.

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**(ii) Water Soluble Vitamins:** B group vitamins and vitamin C. They need to supplied regularly in diet as they are excreted in urine and cannot be stored(except vitamin $B_{12}$) in our body.

Their deficiency causes diseases.

Biotin (Vit H) is however neither fat nor water soluble. It's deficiency leads to loss of hair.

**15. Nucleic Acids:** These are biomolecules which are long chain polymers of nucleotides. They are:

**(i) Deoxyribonucleic acid (DNA)**

**(ii) Ribonucleic acid (RNA)**

They are responsible for protein synthesis and transfer of genetic characteristics to offspring's.

**16. Composition of Nucleic Acid:**

They are made up of pentose sugar(β-D-2-deoxyribose in DNA and β-D-ribose in RNA), phosphoric acid and a nitrogen containing heterocyclic compound(base).

DNA- Bases present are Adenine(A), Thymine(T),Guanine(G) and Cytosine(C).

RNA- contains Adenine(A), Guanine(G), Cytosine(C) and Uracil(U).

**17. Nucleoside:** The unit formed by the attachment of a base to n1'-position of sugar (Base+Sugar).

**18. Nucleotide:** Nucleoside and phosphoric acid at 5'-position. Nucleotides are bonded by phosphodiester linkages between 5' and 3' carbon atoms of pentose sugar (Base+ Sugar+ Phosphoric Acid).

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**19.DNA :** has a double helical structure with AT and GC linked together through 2 and 3 hydrogen bonds respectively. It is responsible for transfer of genetic characteristics.

**20. RNA:** is of three types- messenger RNA(m-RNA), ribosomal RNA(r-RNA) and transfer RNA (t-RNA). RNA helps in protein synthesis.

**21. Biological Functions of Nuclei Acid:** DNA is chemical basis of hereditary and have the coded message for proteins to be synthesized in the cell. RNA carry out the protein synthesis in the cell.

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# Biomolecules

## VSA Type Questions – (1 Mark)

Q1 – Which functional groups are present in monosaccharides?

Ans - —OH and —CHO or —OH and >CO

Q2 – Name an aldopentone, aldohexone and ketohexone.

Ans – Ribose,glucose and fructose respectively.

Q3 – What is animal starch?

Ans – Glycogen.

Q4 – Which types of bonds are present in a protein molecule?

Ans – Peptide bonds, hydrogen bonds, sulphide bonds, ionic bonds etc.

Q5 – Which α-helix or β-helix is more stable?

Ans – α-helix is right handed and is more stable due to intermolecular H bonding between first and fourth amino acid.

Q6 – The sequence of bases in one strand of DNA is TACGGACA. What is the sequence of bases of complementary strand of DNA.

Ans – ATGCCTGT.

Q7 – Name the vitamin whose deficiency causes rickets?

Ans – Vitamin D.

Q8 – Name the pwines present in DNA.

Ans – Adenine and guanine.

Q9 – Give an example of

(a)water soluble (b)fat soluble is

Ans – (a)Vitamin C (b)Vitamin D.

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Q10 – Name a protein which is insoluble in water.

Ans – Veratin.

## SAI Type Questions

Q1 – Name polysaccharides that make up starch and what is the difference between them.

Ans – Amylose which is linear polymer of α-glucose and amytopectin which is branched polymer of α-glucose. Amylose is water soluble where as amylopectine is water insoluble.

Q2 – What are anomers?

Ans – Monosaccharides which differ only in the orientation of the —OH group at C-1.e.g, α-glucose and β-glucose.

Q3 – Where does the water present in the egg go after boiling the egg?

Ans – On boiling during denaturation process water gets adsorbed/absorbed in the denatured proteins.

Q4 – Write two main functions of carbohydrates in plants.

Ans – (i)structural material (ii)reserved food material.

Q5 – What do you understand by glycosidic linkage?

Ans – During condensation of two monosaccharides, a water molecule given out and two monosaccharides get linked together by an oxide or ethereal linkage (—O—) called as glycosidic linkage.

Q6 – What are essential and non essential amino acid? Give two examples of each type.

Ans – Essential amino acids are those which are not produced in our body.e.g.,valine,leucine.

Non-essential amino acids are those which are produced by our body.e.g.glycine and alanine.

Q7 – How do you explain the amphoteric behavior of amino acids?

Ans – Amino acids have both acidic as well as basic group and they react both with acids as well as bases,therefore they are amphoteric in nature.

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Q8 – What is the difference between a nucleoside and a nucleotide?

Ans - Nucleoside = sugar + base

Nucleotide = sugar + base + phosphoric acid

Q9 – Define (a)Enzymes (b)Antibody

Ans – (a)Enzymes – they are biological catalyst which catalyse biochemical reactions.e.g.,

$C_{12}H_{22}0_{11} + H_20$ ----------> $C_6H_{12}0_6 + C_6H_{12}0_6$

sucrose glucose fructose

This reaction is catalysed by the enzyme investase.

(b)Antibody – they are chemical substances which destroy antigens that cause infections.e.g.,vaccination for typhoid produces antibodies in our body to prevent typhoid.

Q10 – What is invert sugar?

Ans – An equimolar aqueous solution of glucose and fructose is called invert sugar.

## SA II Type Questions –

Q1 – Give three differences between DNA and RNA.

Ans –

| DNA | RNA |
|---|---|
| 1. it has deoxyribose as sugar. | 1.it contains ribose as sugar. |
| 2. it contains thymine along with adenine, cytosine and guanine as bases. | 2.it contains uracil in place of thymine with other bases. |
| 3. it is responsible for maintaining heredity traits from generation to generation. | 3. it is responsible for protein synthesis. |

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Q2 – Difference between globular protein and fibrous protein.

Ans –

| Globular Protein | Fibrous Protein |
|---|---|
| 1. they form α-helix structure.<br>2. they are water soluble.<br>3. they involve H bonding. | 1. they have β-pleated structure.<br>2. they are water insoluble.<br>3. they have strong intermolecular forces of attraction. |

Q3 – Give reactions with support cyclic structure of glucose.

Ans – (a)Glucose does not give 2,4-DNP test, Schiff`s test and sodium hydrogen suphide test.

(b)The pentaacetate of glucose does not react with $NH_2OH$ indicating absence of free —CHO group.

(c)Glucose exists in two crystalline form α and β.

Q4 – Define with example

(a)Isoelectric point (b)Mutarotation (c)Transcription

Ans –

(a)Isoelctric point – the pH at which there is no net migration of any ion towards electrode.e.g,amino acids have isoelectric point at pH = 5.5-6.3

(b)Mutarotation - it is spontaneous change in optical rotation when an optically active substance is dissolved in water.e.g, α-glucose when dissolved in water changes its optical rotation from $111^o$ to $52.5^{o.}$

(c)Transcription – it is process by which m—RNA is generated from DNA.e.g,if DNA has base sequence ATACA then m—RNA has base sequence TATCGT.

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Q5 – What happens when glucose reacts with

(a)HI (b) $HNO_3$ (c)$Br_2$ water

Ans –

(a)$C_6H_{12}0_6$ + HI ------> n-hexane $C_6H_{14}$
(b) $C_6H_{12}0_6$ + $HNO_3$ -------> saccharic acid
(c) $C_6H_{12}0_6$ +$Br_2$ water --------> gluconic acid

Q6 – Differentiate primary , secondary and tertiary structure of protein.

Ans – -In primary structure specific sequence of amino acid are present joined by covalent bonds.

-secondary structure is responsible for the shape of a protein. α-helix and β-pleated in which polypeptide chains have peptide bonds.

-tertiary structure represents overall folding of polypeptide chain and give rise to the fibrous or globular molecular shape.

Q7. Discuss the specificity and mechanism of enzyme action.

Ans. In case of enzymatic reaction the enzyme is so built that it binds to the substrate in a specific manner. Enzymatic reaction involves following steps (Lock and Key Model)-

Step (i): Binding of substrate(S) to enzyme (E) to form complex

E + S → [ES] (Enzyme substrate complex)

Step (ii): Product formation in complex

[ES] → EP (Enzyme product complex)

Step (iii): Dissociation of enzyme product complex, leaving enzyme unchanged

EP → E + P

The specificity of enzyme is due to presence of some specific regions called active site on their surface.

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Q8. Mention structural differences between amylopectin and cellulose.

Ans.

| Amylopectin | Cellulose |
|---|---|
| 1. It is linear polymer of α-glucose.<br><br>2. It consists of branched chains of α-glucose. | 1. It is linear polymer of β-glucose.<br><br>2. In cellulose, the chains are arranged to form bundles and held together by hydrogen bond between glucose and adjacent strands. |

Q9. What deficiency diseases are caused due to lack of vitamins $B_1$, $B_6$ and K in human diet.

Ans.

| Vitamins | Deficiency Disease |
|---|---|
| $B_1$ | Beri beri (loss of appetite) |
| $B_6$ | Convulsions |
| K | Increased blood clotting time |

Q10. Glucose or Sucrose are soluble in water but cyclohexane and benzene are insoluble in water. Explain.

Ans. Glucose contains five-OH groups and Sucrose contains eight-OH groups, because of this they form intermolecular hydrogen bonding, so they are soluble in water. But benzene and cyclohexane does not contain –OH groups, hence does not form intermolecular hydrogen bonding, so they are not soluble in water.

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# HOTS Questions

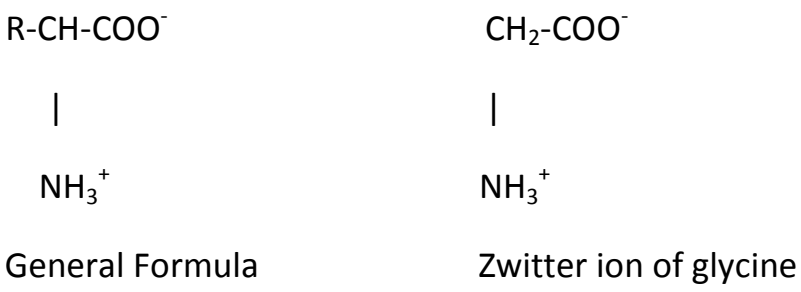
## VSA (1 Mark)

Q1. How many atoms are present in the ring of pyranose structure of glucose?

Ans. 5 Carbon atoms and one Oxygen atom.

Q2. Write the formula of Zwitter ion for Glycine.

Ans.




General Formula Zwitter ion of glycine

Q3. Which proteins possess α-Helix structure?

Ans. Keratin and myosin possess α-Helix structure.

Q4. What is the native state of protein?

Ans. The energetically most stable shape of the protein at normal pH and temperature is called native state.

Q5. Fresh tomatoes are a better source of Vitamin C that which have been stored for some time. Explain.

Ans. Vitamin C is destroyed on prolonged exposure to air due to its oxidation.

Q6. Why are carbohydrates generally active?

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Ans. It is due to the presence of Chiral Carbon atoms in their molecules.

Q7. What type of linkages hold together monomers in DNA?

Ans. Monomers in DNA are linked by phosphate linkages.

Q8. Why is cellulose not digested in human body?

Ans. It is due to the fact that human beings do not have enzymeto digest cellulose.

Q9. Name the enzyme that is used to dissolve blood clots?

Ans. Streptokinase.

Q10. Name two diseases caused due to deficiency of enzymes.

Ans. Albinism and phenylketonuria.

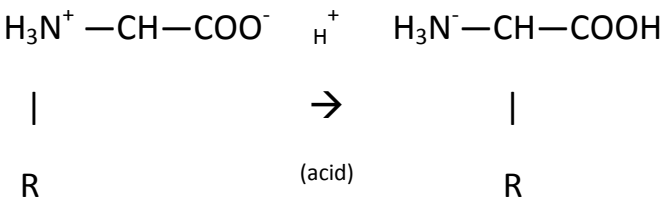
## SA Type I (2 Marks)

Q1. Give reasons for the following-

(i) On electrolysis in acidic solution amino acids migrate towards cathode, while in alkaline solution these migrate towards anode.

(ii) The monoamino monocarboxylic acids have two $pK_a$ values.

Ans. (i) In acidic solution, the carboxylate anion accept a proton and gets converted into carboxylic group resulting in the formation of positive ion.




(Zwitter ion) (Positive ion)

In presence of a base the $N^+H_3$ ion changes to $—NH_2$ group by losing a proton and this gives a negative ion.

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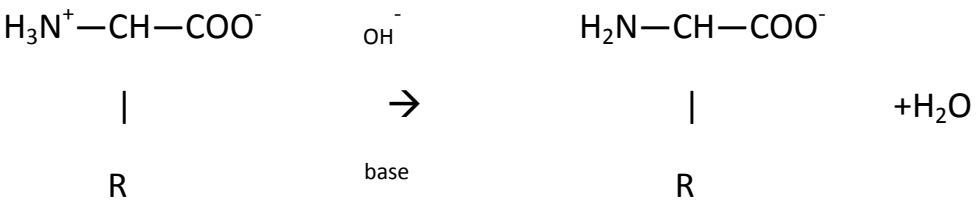
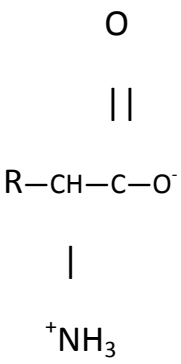


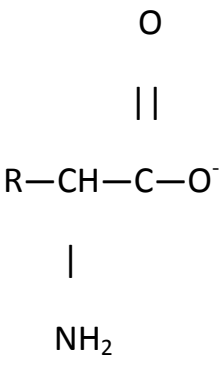

(Zwitter ion) (Negative ion)

This means that in acidic medium, the amino acid migrates towards the cathode while in alkaline solution it migrates towards anode on electrolysis.

(ii) In aqueous solution, monoamino monocarboxylic amino acid behave like salt at isoelectric point. At a pH lower than isoelectric point (i.e. in acidic medium) it shows one $pK_a$ value which corresponds to structure




and at a pH higher than isoelectric point, it shows a $pK_a$ value which corresponds to another,




Q2. Which forces are responsible for the stability of α-helix? Why is it named as $3.6_{13}$ helix?

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Ans. Hydorgen bonds between – N-H and —C=O groups of peptide bonds give stability to the structure.

It is known as $3.6_{13}$ helix, since each turn of helix has approximately 3.6 amino acid residue and a 13 member ring is formed by hydrogen bonding.

Q3. Write about the following protein synthesis-

(i) Name the location where the protein synthesis occurs?

Ans. Protein synthesis occurs at the ribosome in cytoplasm.

(ii) How do 64 codones code for only 20 amino acids?

Ans. The 64 codones for 20 amino acids; more than one codon can code for same amino acids, e.g., CUU and CUU both can code leucine. Proline is encoded by CCU, CCA, CCG, and CCC.

Q4. Describe the mechanism of replication of DNA.

Ans. Replication of DNA:- The process by which a DNA molecule produces two identical copies of itself is called replication of DNA. In the DNA double helix the sequence of bases in one chain is incomplemanty to the sequence in the other chain, therefore one controls the other. During all division the two strands of the DNA double helix partly unwind and each serves as the template for the synthesis of a new DNA molecule. DNA replication follows the base pairing rules by which A pairs with T and G pairs with C. Therefore, each daughter molecule is an exact replication of the parent molecule. DNA replication is semi conservative i.e. only half of the parental DNA is conserved and only one strand is synthesised. DNA replication takes place only in 5'→3' direction.

Q5. Answer the following queries about proteins-

(i) How are proteins related to amino acids?

Ans. Proteins consist of large number of amino acids linked to each other by peptide linkage, having 3- dimensional structure. Thus, proteins are biopolymers of amino acids.

(ii) When is protein said to be denatured?

Ans. When nature proteins are subjected to the action of heat, acids or alkalies, they are coagulated or precipitated. The protein in this state is said to be denatured. During

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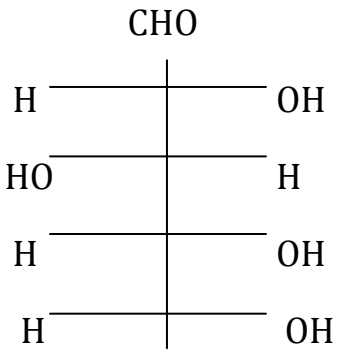
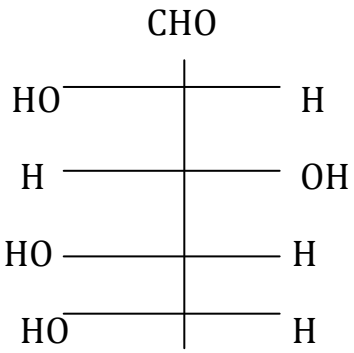
denaturation process the water soluble form of globular protein change to water insoluble fibrous protein.

**SA(II) 3 Marks**

Q6. Draw simple Fishcha projections of D and L- glucose. Are these enantiomers?




D-Glucose




L-Glucose

Yes these two fischer projections are called enatiomers.

Q7. A tripeptide on complete hydolysis gives glycine, alanine and phynylalanine using three letter symbols write down the possible sequence of tripeptide.

Ans. Each amino acid may be present at the N-terminal as well as C-terminal.

(i) Gly-Ala-Gly

(ii) Gly-Phe-Ala

(iii) Ala-Gly-Phe

(iv) Ala- Phe-Gly

(v) Phe-Ala-Gly

(vi) Phe-Gly-Ala

Q8. Glycine exists as a Zwitter ion but 0-and p-amino benzoic acids do not. Explain.

Ans. The lone pair of N-atom in O- and p-aminobenzoic acid is involved in resonance. The lone pair of N-atom in transferred towards benzene ring. This decreases the acidic character of $–NH_2$ group. Therefore these groups do not transfer and accept $H^+$ ions, respectively.

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Q9. Write short notes on-

(i) Co-enzymes

(ii) Prosthetic groups

Ans. (i) Co-enzymes:- These are usually derived from vitamins such as thaimine ,riboflamin, niacin etc. They are loosely held to the protein and can be easily separated by dialysis.

(ii) Prosthetic groups:- They are also derived from vitamins such as biotin but are tightly held to the protein molecule by covalent bonds. They can be separated only by careful hydrolysis.

Q10. The melting points and solubility in water of amino acids are generally higher than that of the corresponding halo acids. Explain.

Ans. The amino acids exists as zwitter ion ($H_3N—CHR—COO^-$). They have salt like structure. There are strong dipole-dipole and electrostatic attractions. Therefore, amino acids have high melting points. Amino acids strongly interact with water molecules and are soluble in it. The halo-acids do not have salt like structure and have low melting points. Halo-acids do not interact as strongly with water molecules as do amino acids. Therefore, solubility of amino acids in water is more than those of halo-acids.