Chapter-9

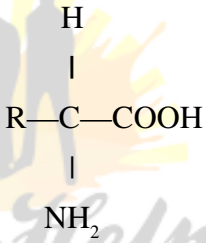
BIOMOLECULES

POINTS TO REMEMBER

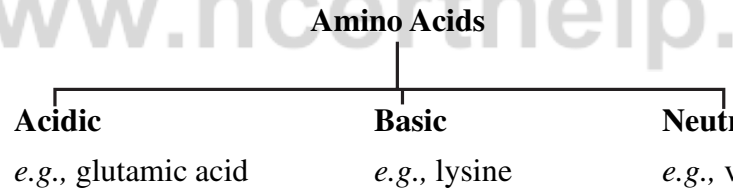
Biomolecules : All the carbon compounds that we get from living tissues.

Micromolecules : Molecules which have molecular weights less than one thousand dalton.

Amino acids : Organic compounds containing an amino group and one carboxyl group (acid group) and both these groups are attached to the same carbon atom called **α carbon**.



- Twenty types of amino acids.
- Based on number of amino and carboxyl groups, amino acids can be :



Lipids :

- Water insoluble, containing C, H, O.
- Fats on hydrolysis yield fatty acids.
- Fatty acid has a carboxyl group attached to an R group (contains 1 to 19 carbons).
- **Fatty Acids : Saturated :** With single bonds in carbon chain. *e.g.,* Palmitic acid, butyric acid.

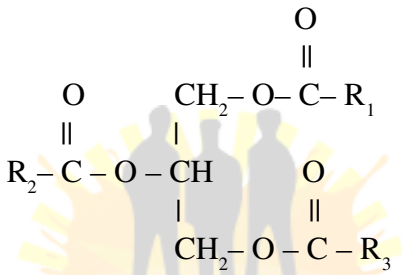
  Unsaturated : With one or more double bonds. *e.g.,* oleic acid, linoleic acid.

• **Glycerol :** A simple lipid, is trihydroxy propane.

CH_2–OH
|
CH–OH
|
CH_2–OH

• Some lipids have fatty acids esterified with glycerol.

• They can be monoglycerides, diglycerides and triglycerides.



Triglyceride (R_1, R_2, R_3 are fatty acids.)

• **Phospholipids** are compound lipids with phosphorus and a phosphorylated organic compound *e.g.,* Lecithin.

Nitrogen bases

Carbon compounds with heterocyclic rings)

Purine : Adenine, Guanine. **Pyrimidine :** Cytosine, Uracil, Thymine.

Nucleoside : Nitrogenous base + Sugar *e.g.,* Adenosine, guanosine.

Nucleotide : Nitrogenous base + Sugar + Phosphate group. *e.g.,* Adenylic acid, thymidylic acid.

Nucleic acid : Polymer of nucleotides - DNA and RNA.

Biomacromolecules : Biomolecules with molecular weights in the range of ten thousand daltons and above; found in acid insoluble fraction.

Lipids are not strictly macromolecules as their molecular weights do not exceed 800 Da but form a part of the acid insoluble pool.

Proteins :

- Are polymers of aminoacids linked by peptide bond.
- Is a heteropolymer.
- For functions of proteins refer Table 9.5, Page no. 147, NCERT, Text Book of Biology for Class XI.

Structure of Proteins

(a) **Primary structure :** Is found in the form of linear sequence of amino acids. First amino acid is called N-terminal amino acid and last amino acid is called C-terminal amino acid.

(b) **Secondary structure :** Polypeptide chain undergoes folding or coiling which is stabilized by hydrogen bonding. Right handed helices are observed. *e.g.,* fibrous protein in hair, nails.

(c) **Tertiary structure :** Long protein chain is folded upon itself like a hollow wollen ball. Gives a 3-dimensional view of protein, *e.g.,* myosin.

(d) **Quaternary structure :** Two or more polypeptides with their foldings and coilings are arranged with respect to each other. *e.g.,* Human haemoglobin molecule has 4 peptide chains - 2a and 2b subunits.

Peptide bond : Formed between the carboxyl (-COOH) group of one amino acid and the amino ($-NH_2$) group of the next amino acid with the elimination of water moeity.

Polysaccharides : Are long chain of sugars.

(a) **Starch :** Store house of energy in plant tissues. Forms helical secondary structures.

(b) **Cellulose :** Polymer of glucose.

(c) **Glycogen :** Is a branched homopolymer, found as storage polysaccharide in animals.

(d) **Insulin :** Is a polymer of fructose.

(e) **Chitin :** Chemically modified sugar (amino-sugars) N-acetyl galactosamine. Form exoskeleton of arthropods.

Anabolic pathways : Lead to formation of more complex structure from a simpler structure with the consumption of energy. *e.g.,* Protein from amino acids.

Catabolic pathway : Lead to formation of simpler structure from a complex structure. *e.g.,* Glucose → Lactic Acid.

Enzymes : Are biocatalysts.

- Almost all enzymes are proteins.
- **Ribozomes** - Nucleic acids that behave like enzymes.
- Has primary, secondary and tertiary structure.
- Active site of an enzyme is a crevice or pocket into which substrate fits.
- Enzymes get damaged at high temperatures.
- Enzymes isolated from thermophilic organisms (live under high temperatures) are thermostable.
- Enzymes accelerate the reactions many folds.
- Enzymes lower the activation energy of reactions. (Fig. 9.6, Page no. 156, NCERT Text Book of Biology for Class XI).
- $E + S \rightleftharpoons ES \rightarrow EP \rightarrow E + P$

  where E = Enzyme, S = Substrate, P = Product.

Factors affecting enzyme activity :

(a) Temperature : Show highest activity at optimum temperature. Activity declines above and below the optimum value.

(b) pH : Enzymes function in a narrow range of pH. Highest activity at optimum pH. (Fig. 9.7, Page no. 157, NCERT, Text Book of Biology for Class XI)

(c) Concentration of substrate : The velocity of enzymatic reaction rises with increase in substrate concentration till it reaches maximum velocity (V_{max}). Further increase of substrate does not increase the rate of reaction as no free enzyme molecules are available to find with additional substrate.

Enzyme inhibition : When the binding of a chemical shuts off enzyme activity, the process is called inhibition and chemical is called **inhibitor.**

Competitive inhibition : Inhibitor closely resembles the substrate in its molecular structure and inhibits the enzyme activity. *E.g.,* inhibition of succinic dehydrogenase by malonate.

Classification of enzymes :

Oxidoreductase/dehydrogenases : Catalyse oxidoreduction between 2 substrates.

Transferases : Catalyse transfer of a group between a pair of substrates.

Hydrolases : Catalyse hydrolysis of ester, ether, peptide, glycosidic, C-C, P-N bonds.

Lyases : Catalyse removal of groups from substrates by mechanisms other than hydrolysis.

Isomerases : Catalyse inter-conversion of optical, geometric or positional isomers.

Ligases : Catalyse linking together of 2 compounds.

Cofactors : Non-protein constituents found to the enzyme to make it catalytically active. Protein portion of enzyme is called **apoenzyme.**

Cofactors : • Prosthetic groups : Are organic compounds tightly bound to apoenzyme. *E.g.,* haem in peroxydase and catalase.

• **Co-enzymes :** Organic compounds which has transient association with enzyme. *E.g.,* NAD, NADP.

• **Metal ions :** Required for enzyme activity. Form coordination bond with side chains at active site and with substrate. *E.g.,* zinc is a co-factor for enzyme carboxypeptidase.

18. Nucleic acids : Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

DNA structure (Watson and Crick Model) : DNA is a right handed, double helix of two polynucleotide chains, having a major and minor groove. The two chains are antiparallel, and held together by hydrogen bonds (two between A and T and three between C and G). The backbone is formed by sugar-phosphate-sugar chain. The nitrogen bases are projected more or less perpendicular to this backbone and face inside.

QUESTIONS

Very Short Answer Questions (1 mark each)

1. Why do generally oils remain in liquid state even in winters ?

2. Name an element found in proteins but not in lipids and carbohydrates.

3. What is the difference between RNA and DNA in terms of nitrogenous base ?

4. What does an enzyme do in terms of energy requirement of a reaction ?

5. What is the function of ATP in cell metabolism ?

6. Name the protein which form the intercellular ground substance.

Short Answer Questions-II (2 marks each)

7. Why are aminoacids also known as substituted methane ?

8. Amino acids exist as zwitter ions. Give its structure. Why is it formed ?

9. Why do starch give blue black colour with iodine ?

10. Why are starch and glycogen more suitable than glucose as a storage product ?

11. What would happed when salivary amylase which acts on starch in mouth, enter stomach ?

Short Answer Questions-I (3 marks each)

12. Explain the structure of proteins.

13. (a) What is an enzyme ?

(b) Give an example of co-enzyme.

(c) Distinguish between apoenzyme and co-enzyme.

14. Explain Watson-Crick model on DNA structure.

15. Explain peptide bond, glycosidic bond and phophodiester bond.

16. Explain competitive inhibition along with an example.

Long Answer Questions (5 marks each)

17. List the 6 classes of enzymes alongwith their functions.

ANSWERS

Very Short Answers (1 mark)

1. Oils are unsaturated lipids, hence have lower melting points.

2. Nitrogen.

3. RNA has uracil instead of thymine.

4. Lowers the activation energy of reaction.

5. Are the energy currency of cell.

6. Collagen.

Short Answers-II (2 marks)

7. The α-carbon has 4 substituted groups occupying the 4 valency positions : -H, -COOH, -NH_2 and -R group.

8.

$$H^+_3 - CH(R) - COO^-$$

Ionizable nature of $-NH_2$ and –COOH groups.

9. Starch forms helical secondary structures which can hold I_2.

10. Occupy lesser space as less bulky and can hydrolysed to glucose when required.

11. Action of amylase stops in stomach as it cannot act in an acidic medium.

Short Answers-I (3 marks)

12. Refer 'Points to Remember'.

13. (a) Are biocatalysts.

(b) NADP, NAD

(c) The enzymes which work only in the presence of co-factors as known as apoenzymes.

An organic non-protein cofactor which is easily separable from the apoenzyme is called co-enzyme.

14. Refer 'Points to Remember'.

15. Refer Page no. 151, NCERT, Text Book of Biology for Class XI.

16. Refer 'Points to Remember'.

Long Answers (5 marks)

17. Refer Page no. 158., NCERT, Text Book of Biology for Class XI.

■