6. Biomolecules

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1. Choose correct option

A. Sugar, amino acids and nucleotides unite to their respective subunits to form

a. bioelements

b. micromolecules

c. macromolecules

d. all of these

B. Glycosidic bond is found in ____

a. Disaccharide

b. Nucleosides

c. Polysaccharide

d. all of theses

C. Amino acids in a polypeptide are joined by ___ bond.

a. Disulphide

b. glycosidic

c. hydrogen bond

d. none of these

D. Lipids associated with cell membrane are ___

a. Sphingomyelin

b. Isoprenoids

c. Phospolipids

d. Cholesterol

E. Linoleic, Linolenic and acids are referred as essential fatty acids since they cannot be synthesized by the body and hence must be included in daily diet.

a. Arachidonic
b. Oleic

c. Steric

d. Palmitic

F. Haemoglobin is a type of protein, which plays indispensible part in respiration.

a. simple

b. derived

C. conjugated

d. complex

G. When inorganic ions or metallo-organic molecules bind to apoenzyme, they together form----

a. isoenzyme

b. holoenzyme

c. denatured enzyme

d. none of these

H. In enzyme kinetics, Km=Vmax/2. If Km value is lower, it indicates

a. Enzyme has less affinity for substrate

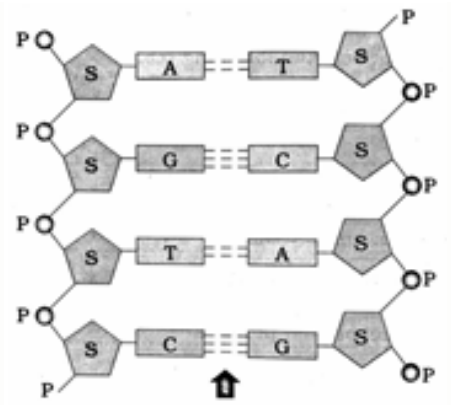
b. Enzyme has higher affinity towards substrate

c. There will be no product formation

d. All active sites of enzyme are saturated.

2. Solve the following questions:

A. Observe the following figure and name the type of bond shown by arrow in the structure.



Ans. The arrow indicates hydrogen bond. The other bonds seen in the structure are phosphor diester bond between sugar and phosphate molecule and N-glycosidic link between nitrogenous base and sugar molecule.

3. Answer the following questions:

A. What are building blocks of life?

Ans. Numerous biomolecules are building blocks of life .

B. Explain the peptide bond.

Ans. Carboxyl group of one amino acid and amino group of other amino acids are linked by condensation reaction to form a peptide bond. The peptide bonds form a protein chain by removal of water molecule.

C. How many types of polysaccharides you know?

Ans. There are two types of polysaccharides: homopolysaccharides e.g. Starch, glycogen and cellulose etc. and heteropolysaccharides e.g. hyaluronic acid, heparin, etc.

D. Enlist types of RNA.

Ans. There are 3 types of cellular RNA Messenger RNA (mRNA). Transfer RNA (TRNA) and Ribosomal RNA (r-RNA).

E. What is reducing sugar?

Ans. Monosaccharides are reducing sugars due to presence of free aldehyde or ketone group are capable of transferring hydrogen or electrons to other compounds.

F. What is the basic difference between saturated and unsaturated fatty acid?

Ans. Saturated fatty acids are without double bond in carbon atoms of hydrocarbon chain while unsaturated fatty acids are with one or more double bonds.

G. Enlist the examples of simple protein.

Ans. Histones of nucleoprotein, albumins like egg albumin, serum albumin and legumelin of pulses.

H. Explain the secondary structure of protein with examples.

Ans. (1) Proteins are molecules containing amino acids units and linear sequence of these in polypeptide chain is its primary structure.

(2) Functional proteins show three dimensional structure which is called secondary structure.

(3) Polypeptide chains are arranged in different forms like spirals or pleated sheets.

(4) Hydrogen bonds are formed in peptide chains which gives secondary structure to the
protein molecule.

(5) In structural protein keratin (hair) spiral helix is formed which is right handed (a helix) or left handed (B helix).

(6) The sequence of amino acid in polypeptide chain determines position of hydrogen bond.

(7) We notice folds and bends due to hydrogen bond formation.

(8) Linking of intermolecular peptide chains may show pattern of pleated sheet e.g. Silk fibres.

I. Explain the induced fit model for mode of enzyme action.

Ans. (1) The mechanism of enzyme action begins with the binding of the substrate to the active site of enzyme.

(2) Induced fit theory is proposed by Koshland.

(3) As per this theory, substrate induces conformational change in the enzyme.

(4) This theory indicates that enzymes are flexible structure.

(5) The active sites of enzyme reshape due to interaction with substrate.

(6) The substrate gets completely bound to the active site of enzyme.

(7) The products are released from the surface of enzyme.

J. What is RNA?

Ans. Ribose nucleic acid is a single stranded polynucleotide chain macromolecule mostly, non hereditary material except in few plant and animal viruses.

K. Describe the concept of metabolic pool.

Ans. (1) The reservoir of biomolecules in the cell is metabolic pool.

(2) The enzymes act on these biomolecules to produce products as required by the cell.

(3) Metabolic pool is significant because one type of biomolecules can be converted into another type. E.g. Carbohydrates can be changed to fats.

(4) Catabolic chemical reactions provide ATP energy as well as biomolecules for further synthesis of other molecules.

(5) As per the need of the cell, metabolites can be added or removed from metabolic pool.

(6) Homeostasis is maintained in the cell due to balance between catabolic and anabolic reactions.

L. How secondary metabolites are useful for mankind?

Ans. (1) Various drugs developed from secondary metabolites are useful in the treatment of Infectious diseases, cancer, hypertension and inflammation.

(2) Morphine alkaloid extracted from Papaver plant is useful as pain reliever and cough suppressant.

(3) Nicotine, cocaine and terpene cannabinol are widely used as stimulants.

(4) Secondary metabolites are used as flavouring agents.

(5) Secondary metabolites have role in defence metabolism of plants for prote from pests.

(6) For improving astringent. tannins are added to wines and chocolates.

(7) Due to antibiotic properties, secondary metabolites are used as food preservatives.

4. Solve the following questions:
A. Complete the following chart.

Protein	Physiological role
1. Collagen	1. Holding bones together
2. Actin and myosin	2. Responsible for muscle contraction
3. Immunoglobulin IgG	3. Immune response, binding to antigen
4. Mitochondrial proteins	4. Significant in respiration
5. Fibrinogen	5. Blood clotting

B. Answer the question with reference to the following figure.

1. Name the type of bond formed between two polypeptides.

Ans. The bond formed between two polypeptide chains is disulphide bond.

2. Which amino acid is involved in the formation of such bond?

Ans. Sulphur containing amino acids are involved in this type of bond formation.

3. Amongst I, II, III, and I structural level of protein, which level of structure includes such bond?

Ans. III or tertiary structure involves this type of bond formation.

C. Match the following items given in column I and II

Column I	Column II (Answers)
(1) RNA	d. Uracil
(2) Yam plant	e. Antifertility pills
(3) Koshland	a. Includes fit models

(4) Omega 3-fatty acid	b. Flax seeds
(5) Sucrase	c. Hydrolase

5. Long answer questions:
A. What are biomolecules? Explain the building blocks of life.

Ans. (1) Organic compounds in a cellular pool represent biomolecules.

(2) The cells have biomolecules which are present in protoplasm as the chemical molecules.

(3) Three basic types of macromolecules are carbohydrates, proteins and nucleic acids, while lipids are macromolecules and water insoluble component.

(4) The polysaccharides are made up of monomer monosaccharides or simplest sugar forms.

(5) The proteins or polypeptides are monomers of amino acids.
(6) Nucleic acids or polynucleotides are monomers of nucleotides.

(7) Living organisms have presence of chemical elements like carbon, hydrogen, oxygen which are prime elements and other macroelements such as nitrogen, phosphorus, potassium, sulfur, etc. with trace elements.

(8) The polysaccharides are structural components and reserved food materials which supply energy for metabolism.

(9) Proteins are important from structural as well as functional point

(10) Nucleic acids are of two types DNA and RNA which are composed of pentose sugar, a nitrogenous base and a phosphoric acid.

B. Explain the classes of carbohydrates with examples.

Ans. 1. Carbohydrates :

(1) Carbohydrates are organic compounds made up of carbon, hydrogen and oxygen atoms. The proportion of hydrogen and oxygen in carbohydrates is 2:1.

(2) The general formula is CH, for simple carbohydrates and are commonly called sugars (e.g. glucose, fructose, etc.) while the complex carbohydrates (e.g. starch, glycogen and cellulose) are storage and structural components of the cells.

(3) In a carbohydrate molecule there is aldehyde (CHO) or ketone (C = 0) groups and two or more hydroxyl (-OH) groups. This is a characteristic feature of

carbohydrates.

2. Classification of carbohydrates : On the basis of sugar units they contain, the carbohydrates are classified into three types, viz. monosaccharides, disaccharides and polysaccharides.

(1) **Monosaccharides :** Monosaccharides are the basic units of complex carbohydrates. These are compounds which cannot be further hydrolyzed into still smaller molecules. They are crystalline, soluble in water and sweet to taste. They have 3 to 7 carbon atoms.

(2) **Disaccharides :** When two monosaccharide units are joined by a glycosidic bond they form a disaccharide. During the process of formation of a disaccharide, one water molecule is released. Sucrose (Glucose + fructose). lactose (glucose + galactose) and maltose (glucose + glucose) are disaccharides. common They are soluble, crystalline and sweet to taste.

(3) **Polysaccharides :** Polysaccharides are complex carbohydrates formed by the condensation of monosaccharide molecules. They are amorphous. tasteless and insoluble in water. E.g. starch, glycogen, cellulose.
Polysaccharides are of two types. viz. homopolysaccharides and heteropolysaccharides. Homopolysaccharides have same type of monosaccharides while heteropolysaccharides contain different types of monosaccharides.

C. Describe the types of lipids and mention their biological significance.

Ans. There are three main types of lipids, viz. simple, compound and derived lipids.

1. Simple lipids : Simple lipids are esters of fatty acids and alcohol. They have glycerol which is a three-carbon alcohol having three OH groups. Esters are of three types, viz. monoglycerides, diglycerides and triglycerides.

(1) In monoglycerides there is one molecule of fatty acid, in diglycerides there are two molecules of fatty acids, while in triglycerides there are three molecules of fatty acids. Of these, triglycerides are neutral fats.

(2) Fatty acid is a long chain molecule of carbon atoms with carboxyl (-COOH) group at one end. Fatty acids are of two types, viz. saturated and unsaturated fatty acids.

(a) Saturated fatty acids : Fatty acids having no double bond between the carbon atoms of its chain and possessing maximum number of hydrogen atoms are called saturated fatty acids, e.g. palmitic acid, stearic acid, etc.

(b) Unsaturated fatty acids : Fatty acids containing one or more double bonds between the carbon atoms of its chain are called unsaturated fatty linoleic acid, linolenic acid, etc. These acids are not saturated with hydrogen atoms. Oils are fats containing unsaturated fatty acids. They are liquid at the room temperature. Plant fats are unsaturated while the animal fats are saturated fats.

2. Compound lipids : These have additional groups like phosphate, sugars, etc. Phospholipids and glycolipids are compound lipids.

3. Derived lipids : Sterols are composed of steroid nucleus with long hydrocarbon side chain.
significance (1) Lipids are high energy reserved food material, e.g. oil stored in oil seeds.

(2) Important component of cell membrane of eukaryotes, e.g. phospholipids.

(3) Lipids act as insulating material for heat. This function is done by subcutaneous fat.

(4) Fat deposits act as cushions for absorbing mechanical shock in case of vital organs in animals.

(5) Waxes form water insoluble coating on hair and skin of animals. In plants, waxy coating acts as waterproof layer on leaves.

(6) Cholesterol is helpful is synthesis of vitamin D and other sex hormones.

(7) Phytosterol obtained from yam plant is used in birth control pills.

D. Explain the chemical nature, structure and role of phospholipids in biological membranes.

Ans. (1) Lipids are compounds of greasy consistency containing carbon, hydrogen and oxygen.

(2) Compound lipids are esters of fatty acids and have additional groups like sugar, phosphate, nitrogenous compound, etc.

(3) The phospholipids are important component of cell membrane of eukaryotes.

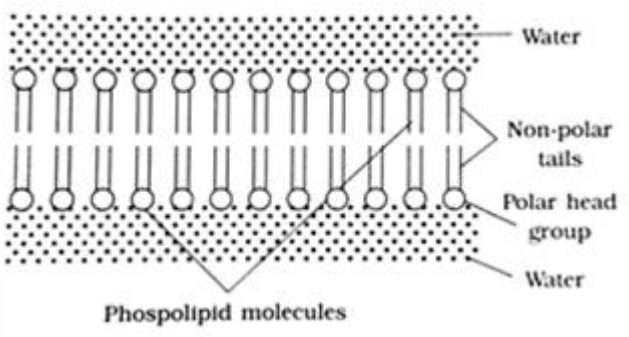
(4) Lecithin phospholipid has nitrogenous compound attached to phosphate group.

(5) Such phospholipids have hydrophilic polar group in form of phosphate and

nitrogenous group and also hydrophobic non-polar group in the form of hydrocarbon chains.

(6) The phospholipid molecules are arranged in the form of layers in membrane structure i.e. lipid bilayer.

(7) In lipid bilayer, the polar head group is towards outside and non-polar tails face each other.



E. Describe classes of proteins with their importance.

Ans. (1) Proteins are macromolecules containing amino acids joined together by peptide bonds.

(2) Proteins are classified into three types based on their structure.

(3) Simple proteins : They are composed of only amino acids. They are soluble in one or more solvents usually soluble in water e.g. histones and albumins.

(4) Conjugated proteins : These are proteins with amino acids and a non-protein part called
prosthetic group. E.g. Globin protein with haem pigment containing iron is haemoglobin which has a role of carrier protein.
Nucleoprotein has nucleic acid, glycoprotein and mucoproteins have carbohydrates, lipoprotein has lipid component. For e.g. Mucin of saliva. Heparin of blood, Conjugate protein of brain, Casein of milk.
(5) Derived proteins : These are not natural proteins but derived from native protein molecules by hydrolysis e.g. Metaproteins, peptones.

F. What are enzymes? How are they classified? Mention example of each class.

Ans. (1) Enzymes are proteinaceous macromolecules which act as biocatalysts. They are able to alter the rate of chemical reactions in the living cell.

(2) The enzymes which act within a cell in which they are synthesized are endo enzymes e.g. Enzymes in the chloroplasts but if they act outside the cell in which

they are synthesized are exo enzymes e.g. Enzymes released by fungi.

(3) The enzymes are classified based on the substrate on which it acts and type of reaction they show.

(4) Oxidoreductases : Those catalyzing reactions of oxidation reduction by transfer of hydrogen or oxygen e.g. Alcohol dehydrogenase.

(5) Transferases : Those catalyzing transfer of groups e.g. glucokinase.

(6) Hydrolases : Those catalyzing hydrolytic reactions e.g. sucrase.

(7) Lyases : Those catalyzing removal of group of atoms e.g. aldolase, decarboxylases.

(8) Isomerases : Those catalyzing structural rearrangements within a molecule e.g. epimerases, mutases.

(9) Ligase or synthase : Those catalyzing covalent linkages of molecules utilizing energy e.g. Pyruvate carboxylase for addition of CO_2 to substrate pyruvate.

G. Explain the properties of enzyme.

Ans. Properties of enzyme:

(1) Acceleration of reactions : Enzymes are capable of accelerating the reactions. However, they do not initiate the reactions.

(2) Catalytic action : Enzymes do not participate in the reaction. But they speed up the reactions. They remain unchanged at the end of the reaction. Hence they are required in small quantities.

(3) Specificity : Enzymes are specific in their action. One enzyme can react with a single type or similar group of substrate molecules.

(4) Proteinaceous nature : All enzymes are proteins.

(5) Three dimensional conformation: Enzymes have specific three dimensional conformation. Only specific part of the enzyme comes in contact with the substrate molecule. This is called an active site of the enzyme. Substrate molecule is attached at the active site of the enzyme or substrate binding site.

(6) Effect of pH : Enzymes are sensitive to pH and temperature. At optimum pH each enzyme shows highest reactivity. An increase or decrease in pH causes decline in enzyme activity.

(7) Temperature : Enzymes require optimum temperature for its action. At higher temperatures enzymes are destroyed. At lower temperatures enzymes are inactivated.

H. Describe the factors affecting enzyme action.

Ans. Factors affecting enzyme activity:

(1) Concentration of substrate : Increase in the substrate concentration gradually increases the velocity of enzyme activity within the limited range of substrate level.

(2) Enzyme concentration : The rate of an enzymatic reaction is directly proportional to the concentration of the substrate. The rate of reaction increases with increasing concentration of enzyme.

(3) Temperature : Enzymes are affected due to the changes in the temperature. Enzyme activity increases with the increase in the temperature up to 40° C. Above 60° C, the enzyme denaturation takes place. At lower temperatures enzymes are deactivated. At optimum temperature the rate of enzyme activity is enhanced.

(4) pH: Enzymes are specific to pH. The strong acid or strong base destroys the enzymes. Every enzyme has particular optimum pH value for its activity. Intercellular enzymes function best at neutral pH.

(5) Cofactors : Some enzymes require cofactor to become chemically active. The cofactor is a non-protein part of the enzyme.
There are two types of cofactors, viz. organic compounds and metallic ions. Organic compounds other than proteins form the prosthetic group which is attached to the protein part of the enzyme (apoenzyme) while metallic ions are inorganic in nature.

(6) Inhibitors : Enzyme inhibitors are those substances which inhibit the enzyme action.

I. What are nucleic acids? Enlist the point of differences among DNA and RNA.

Ans. (1) I. Nucleic acids : Nucleic acids are macromolecules present in the nucleus. They are made up of monomers called nucleotides.

(2) Nucleic acids are among the largest of all molecules that are present in living organisms.
II. The differences between DNA and RNA :

(1) DNA and RNA :

DNA	RNA
1. DNA or Deoxyribose Nucleic Acid is present in nucleus.	1. RNA or Ribose Nucleic Acid is present in nucleus as well as in cytoplasm.
2. DNA is a double stranded molecule.	2. RNA is a single stranded molecule.
3. The pentose sugar present in DNA is deoxyribose.	3. The pentose sugar present in RNA is ribose.
4. The nitrogenous bases in DNA are adenine.	4. The nitrogenous bases in RNA are adenine,guanine, cytosine and uracil.
guanine, cytosine and thymine.	5. RNA is either genetic or non-genetic in nature.
5. DNA is genetic in nature.	6. Purine : Pyrimidine ratio is not 1:1.

J. What are the types of RNA? Mention the role of each class of RNA.

Ans. (1) Non-genetic RNAs are found in those organisms in which DNA is the genetic material.

(2) The non-genetic RNA is synthesized in DNA molecule. There are three types of non-genetic RNA, viz. mRNA, RNA and rRNA.

(3) mRNA : mRNA or messenger RNA is linear molecule. It is synthesized on DNA by a process called transcription. The information from the DNA in the nucleus, is carried by the mRNA to the cytoplasm. After this information reaches the cytoplasm, protein synthesis starts in ribosomes. mRNA is about 3% of the total RNA present in the cell.

(4) rRNA : TRNA or ribosomal RNA is also a linear molecule but it is folded upon itself. The complementary nitrogenous bases on the molecule form the bonding. This type of RNA is associated with ribosomes. It constitutes about 80% of the total cellular RNA.

(5) TRNA : tRNA or transfer RNA is a soluble RNA. It resembles a clover leaf. tRNA is the smallest molecule of all the RNA types. It is 10-5% of the total cellular RNA. It helps in the process of translation. Each tRNA picks up particular amino acid from cytoplasm.

K. What is metabolism? How metabolic pool is formed in the cell?

Ans. (1) The sum total of chemical reactions that occur within each cell of living organism can be described as metabolism.

(2) These reactions provide required energy for vital processes and for synthesis of new materials.

(3) The metabolic reactions involve transformations of biomolecules.

(4) There are continuous processes of breakdown and synthesis of biomolecules. These reactions are not in isolation but linked with other reactions.

(5) The metabolism involves catabolic and anabolic pathways.

(6) Catabolic pathways are those which involve breakdown of complex biomolecules releasing energy while anabolic pathways involve formation of complex biomolecules from simple structures.

(7) Reservoir of biomolecules in the cell on which enzymes can act to produce useful products as per the need of the cell is called metabolic pool.

(8) Metabolic pool allows one type of molecule to change into another type.

(9) Glycolysis and Krebs cycle provide ATP and make it available for metabolic pool of biomolecules. These are then used for synthesis of many important cellular components.

(10) The metabolites can be added or withdrawn from this pool as per the requirement of cell.

6. If double stranded DNA has 14% C (cytosine) what percent A (adenine), T (thymine) and G (guanine) would you expect?

Ans. (1) In molecule of DNA, there is complimentary base pairing of A with T and C with G.

(2) In DNA, purine : pyrimidine ratio is equal 1.e. 1:1

(3) As given C is 14% hence G is also 14% C+ G = 28%

(4) 100 - 28 = 72% which is A + T.

(5) Hence $\frac{72}{2}$ = 36, A is 36% and T is also 36%.

7. Name

i. The term that describes all the chemical reactions taking place in an organism.

Ans. Metabolism

ii. The form in which carbohydrate is transported in a plant.

Ans. Disaccharide sucrose

iii. The reagent used for testing for reducing sugar.

Ans. Benedict's reagent