9

Biomolecules

Multiple Choice Questions (MCQs)

Q. 1 It is said that elemental composition of living organisms and that of inanimate objects (like earth's crust) are similar in the sense that all the major elements are present in both. Then what would be the difference between these two groups? Choose a correct answer from among the following.

(a) Living organisms have more gold in them than inanimate objects
(b) Living organisms have more water in their body than inanimate objects
(c) Living organisms have more carbon, oxygen and hydrogen per unit mass than inanimate objects
(d) Living organisms have more calcium in them than inanimate objects

Ans. *(c)* All living organisms and non-living matter in our biosphere are made of similar elements and compounds. Several researches performed on plants, animals and microbes confirmed that a relative abundance of organic compound *i,e.,* carbon, hydrogen and oxygen in living organisms than in the earth's crust (non-living matter).

Whereas, the percent composition of other inorganic molecules like calcium and gold is more in earth's crust as compared to living matter.

Representation of inorganic constituents of lining tissues.

Element	% Weight in	
	Earth's Crust	Human Body
Hydrogen (H)	0.14	0.5
Carbon (C)	0.03	18.5
Oxygen (O)	46.6	65.0
Calcium (Ca)	3.6	1.5
Gold (A)		

Q. 2 Many elements are found in living organisms either free or in the form of compounds. One of the following is not found in living organisms.

(a) Silicon (b) Magnesium
(c) Iron (d) Sodium

Ans. *(a)* **Silicon** is not found freely in nature, but it does occur as oxides and silicates, whereas magnesium, iron and sodium are present in living organisms as ions. Silicon is essential to plant life but is often found in minute quantities in human body and its function is still unknown.

Magnesium is an abundant element. It is essential for a number of enzymes and their action, particularly those utilising ATP.

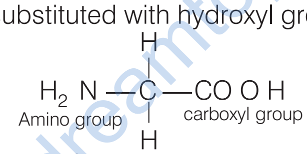
Iron is an important constituent of haemoglobin and plays a vital role by taking part in O_2 transport, and electron transport chain.

Sodium plays a vital role in animals by regulating nerve impulse transmission and altering the membrane permeability. It also has indispensable role in osmoregulation.

Q. 3 Amino acids have both an amino group and a carboxyl group in their structure. Which amongst the following is an amino acid?

(a) Formic acid (b) Glycerol
(c) Glyolic acid (d) Glycine

Ans. *(d)* **Glycine** is the **simplest amino acid** with an amino group and a carboxyl group. Whereas formic acid is the simplest carboxylic acid, glycerol is a fatty acid and glycolic acid is carboxylic acid substituted with hydroxyl group.



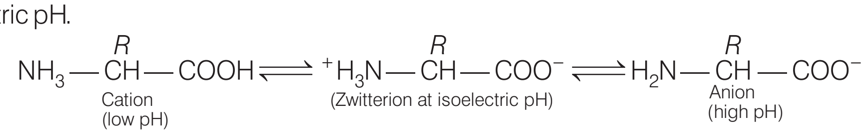
(Structure of glycine)

Q. 4 An amino acid under certain conditions have both positive and negative charges simultaneously in the same molecule. Such a form of amino acid is called

(a) acidic form (b) basic form
(c) aromatic form (d) zwitterionic form

Ans. *(d)* A zwitterion is a neutral molecule having both the cationic and anionic charges on the same molecule. Amino acids are the best known examples of zwitterion.

In acidic solution' amino group accepts a hydrogen ion to become positively charged. Whereas, in alkaline solution the carboxyl group donates a hydrogen ion to become negatively charged. The pH at which the amino acid is electrically neutral is called isoelectric pH.



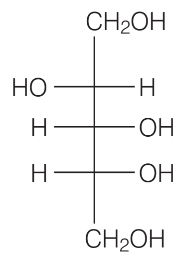
Q. 5 Which of the following sugars howe the same number of carbon as present in glucose?

(a) Fructose (b) Erythrose (c) Ribulose (d) Ribose

Thinking Process

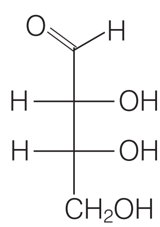
Glucose is an aldohexose. Its carbon is attached to a hydrogen atom by a single bond and to an oxygen atom by a double bond.

Ans. ***(a)*** **Fructose** is a ketohexose. Its carbon is attached to an hydrogen atom by a single bond and to an oxygen atom by a double bond.



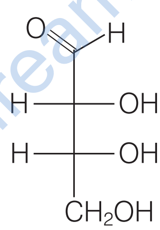
D-fructose

Erythrose is a **tetrose** carbohydrate ($C_4H_8O_4$). Its a part of tetrose family and possesses one aldehyde group.



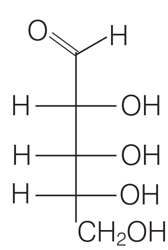
D-erythrose

Ribulose is a **ketopentose**, containing five carbon atoms and includes 'ketone' as a functional group.



D-ribulose

Ribose is a **pentose** which is a major component of DNA and RNA.



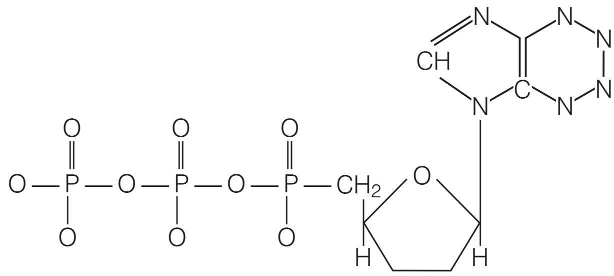
D-ribose

Q. 6 An acid soluble compound formed by phosphorylation of nucleoside is called

(a) nitrogen base
(b) adenine
(c) sugar phosphate
(d) nucleotide

Ans. ***(d)*** Each nucleoside is made up of cyclic nitrogenous base, purine or pyrimidine and a pentose sugar.

On phosphorylation, it forms a nucleotide *i.e.,* a molecule with nitrogenous base pentose sugar and three phosphate groups.



Structure of a nucleotide

Q. 7 When we homogenise any tissue in an acid, the acid soluble pool represents

(a) cytoplasm (b) cell membrane
(c) nucleus (d) mitochondria

Thinking Process

Homogenisation is achieved by a mechanical device called homogeniser. The plant/animal tissues are homogenised for cytological/biochemical studies.

Ans. *(a)* On homogenising any tissue in an acid, the acid soluble pool represents cytoplasm. Homogenisation is a process whereby a biological sample is brought to a state such that all fractions of the sample are equal in composition.

Q. 8 The most abundant chemical in living organisms could be

(a) protein (b) water (c) sugar (d) nucleic acid

Ans. *(b)* There is abundance of water in living matter. It is the only polar molecule in living organisms, that can diffuse through a cell membrane without active transport. It is vital for a number of metabolic reactions and one of the raw materials for photosynthesis.

Q. 9 A homopolymer has only one type of building block called monomer repeated '*n*' number of times. A heteropolymer has more than one type of monomer. Proteins are heteropolymers usually made of

(a) 20 types of monomers (b) 40 types of monomers
(c) 30 types of monomers (d) only one type of monomer

Ans. *(a)* Proteins are heteropolymers made of about **20 different kinds of monomer,** *i.e.,* **amino acids**. Each of these amino acids is made up of carbon, amino group, carboxyl group, hydrogen and a *R*—functional group. This variable *R*—group is what that makes each monomer different from one another.

Q. 10 Proteins perform many physiological functions. For example, some functions as enzymes. One of the following represents an additional function that some proteins discharge

(a) Antibiotics (b) Pigment conferring colour to skin
(c) Pigments making colours of flowers (d) Hormones

Ans. *(d)* Proteins can sometimes function as hormones, *i.e.,* peptide hormones such as insulin, growth hormore etc. Other compounds such as antibiotics, florigen and melanin are non-proteineceous in nature.

Q. 11 Glycogen is a homopolymer made of

(a) glucose units (b) galactose units
(c) ribose units (d) amino acids

Thinking Process

*In humans, glycogen is made and stored primarily in the cells of liver and the muscle, and functions as the secondary long term **energy storage**. Muscle glycogen is converted into glucose by muscle cells and liver glycogen is converted to glucose for entire body use including CNS, PNS and other body parts.*

Ans. *(a)* **Glycogen** is the storage polysaccharide present in animals. Glycogen consist of glucose molecule linked together with α $(1 \rightarrow 4)$ linkages with α $(1 \rightarrow 6)$ branch points occurring every 8-12 residues.

Galactose, on the other hand is a monosaccharide, and combines with glucose through condensation reaction, resulting in the formation of disaccharide, **lactose**.

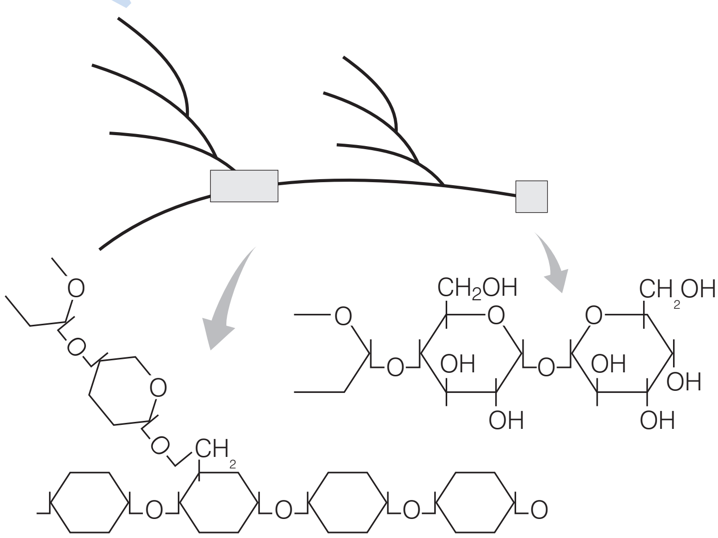
Ribose is a **pentose monosaccharide** which has all hydroxyl group on the same side in fisher projection. It forms a part of backbone in RNA and DNA. Amino acids are the monomers of proteins.

Q. 12 The number of 'ends' in a glycogen molecule would be

(a) Equal to the number of branches plus one
(b) Equal to the number of branch points
(c) One
(d) Two, one on the left side and another on the right side

Ans. *(a)* **Glycogen** is the multibranched polysaccharide of glucose units popularly known as **animal starch**, as it is chemically similar to starch. It has 30,000 glucose residues and a molecular weight of about 4.8 million. Glucose residues in glycogen are arranged in a highly branched bush like chains.

There are two main linkage patterns, observed in glycogen, *i.e.,* α 1-4 linkage in the straight part and α 1-6 linkage in the area of branching. The distance between two branching points is 10-14 glucose residues. Glycogen has as many non-reducing ends as branches plus one.



Q. 13 The primary structure of a protein molecule has

(a) two ends (b) one end (c) three ends (d) no ends

Ans. ***(a)*** The primary structure of a protien refers to a linear sequence of amino acids in polypeptide chain, held together by peptide bonds. These are two ends of a polypeptide chain, carboxyl terminus (C-terminus) and the amino terminus (N-terminus) based on the nature of the free group on each extremity.

Q. 14 Which of the following reactions is not enzyme mediated in biological system?

(a) Dissolving CO_2 in water (b) Unwinding the two strands of DNA
(c) Hydrolysis of sucrose (d) Formation of peptide bond

Ans. ***(a)*** CO_2 gets dissolved in water, a reaction which is not always catalysed by any enzyme.

Unwinding and winding of the two strands of DNA is catalysed by the enzyme **topoisomerase**. **Hydrolysis** of sucrose is regulated by **sucrase**. **Peptide bonds** are formed by the action of enzyme **peptidyl transferase**.

Very Short Answer Type Questions

Q. 1 Medicines are either man made (*i.e.*, synthetic) or obtained from living organisms like plants, bacteria, animals, etc., and hence, the latter are called natural products. Sometimes, natural products are chemically altered by man to reduce toxicity or side effects. Write against each of the following whether they were initially obtained as a natural product or as a synthetic chemical.

(a) Penicillin (b) Sulphonamide (c) Vitamin-C (d) Growth hormone

Ans. (a) **Penicillin** is a group of **antibiotics** derived from fungi *Penicillium* and was initially used as a natural product.

(b) **Sulphonamide** is a synthetic chemical. It is an antimirobial agent is the basis of several groups of drugs.

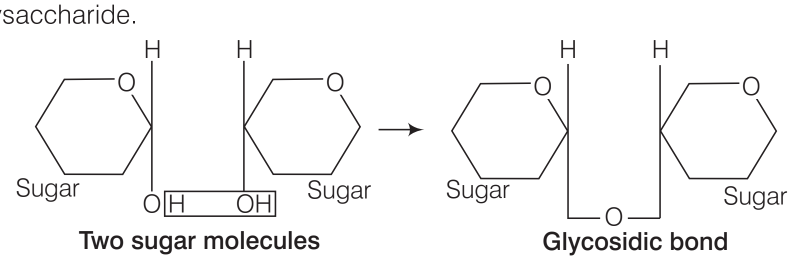
(c) Vitamin-C or L-ascorbic acid or ascorbate is a natural product and an essential nutrient for humans. It is present in citrus fruits.

(d) **Growth hormone** (GH or HGH) also known as somatotropin or somatropin is a peptide hormone occuring naturally in the body. It stimulates growth.

Q. 2 Select an appropriate chemical bond among ester bond, glycosidic bond, peptide bond and hydrogen bond and write against each of the following.

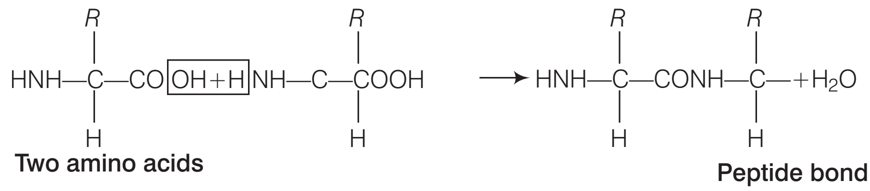
(a) Polysaccharide (b) Protein (c) Fat (d) Water

Ans. (a) **Polysaccharide** is linked by glycosidic bond. Glycosidic bond is a type of covalent bond joining simple or units carbohydrate molecules together to form a long chain polysaccharide.

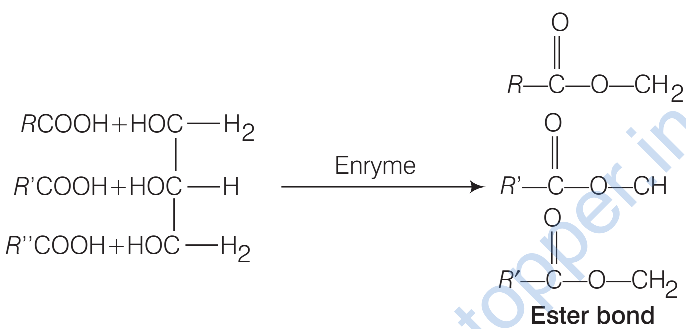


(b) **Protein are linked by peptide bonds. Peptide bond** is a covalent chemical bond formed between two amino acids when the carboxyl group of one reacts with the amino group of other causing release of water molecule. Hence, called as **dehydration synthesis reaction** (condensation reaction).

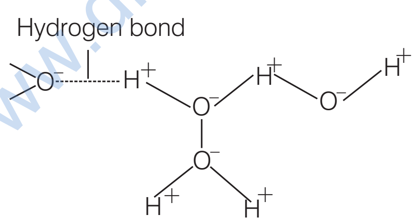
Peptide bonds between a chain of amino acids results in the formation of protein.



(c) **Ester bonds** are formed by the reaction between carboxyl group of fatty acid and hydroxyl group of triglycerols to form fat. Water is eliminated during this reaction.



(d) **Hydrogen bond** is electrovalent interaction between polar molecules in which hydrogen is bound to a highly electronegative atom, such as N, O, S, F, etc. *Water is the best known example*



Q. 3 Write the name of any one amino acid, sugar, nucleotide and fatty acid.

Ans. (a) Amino acid — Leucine (b) Sugar — Lactose

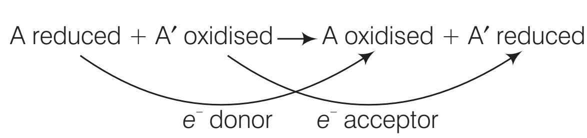
(c) Nucleotide — Adenosine triphosphate (d) Fatty acid — Palmitic acid

Q. 4 Reaction given below is catalysed by oxidoreductase between two substrates A and A′, complete the reaction.

$$\text{A reduced} + \text{A}' \text{ oxidised} \longrightarrow$$

Ans. Oxidoreductase is an enzyme that catalyses oxidation and reductions reactions. This enzyme is associated in catalysing the transfer of e^- from one molecule (the reductant), also called as electron donor, to another molecule (the oxidant), also called as electron acceptor.

The complete reaction is



Q. 5 How are prosthetic groups different from co-factors?

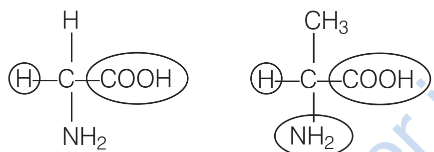
Ans. **Prosthetic groups** are organic compounds that are tightly bound to the apoenzyme, (an enzyme without cofaetor) by covalent or non-covalent forces, *e.g.,* in peroxidase and catalase, which catalyse the breakdown of hydrogen peroxide to water and oxygen, haeme is the prosthetic group and it is a part of the active site of the enzyme.

Co-factor is small, heat stable and non-protein part of conjugate enzyme. It may be inorganic or organic in nature.

Co-factors when loosely bound to a enzyme is called coenzyme and when tightly bound to apoenzyme is called prosthetic group.

Q. 6 Glycine and alanine are different with respect to one substituent on the α-carbon. What are the other common substituent groups?

Ans. In both the amino acids the common substituent groups are NH_2 COOH and H.



Glycine **Alanine**

Q. 7 Starch, cellulose, glycogen, chitin are polysaccharides found among the following. Choose the one appropriate and write against each.

Cotton fibre ....
Exoskeleton of cockroach ....
Liver ....
Peeled potato ....

Ans. (a) Cotton fibre — **Cellulose** (b) Exoskeleton of cockroach — **Chitin**
(c) Liver — **Glycogen** (d) Peeled potato — **Starch**

Cellulose is a long chain of linked glucose molecules and is the main component of plant cell walls. **Cotton** is the purest natural form of **cellulose**. the cellulose content of cotton fibre is 90%.

Chitin is a long chain polymer that forms the hard part of the outer integument or exoskeleton of crustaceans and insects such as cockroach. It is also the main component of the cell walls of fungi.

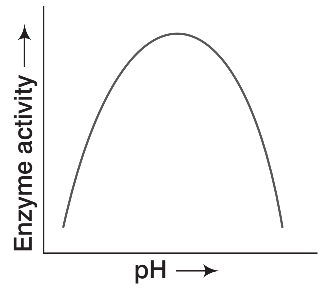
Glycogen is a multibranched polysaccharide of glucose acting as a form of stored energy in the liver of animals.It is also found in some stored fungi.

Starch is a carbohydrate consisting of along chain of glucose units joined by glycosidic bonds. This polysaccharide is produced mostly by green plants for energy storage, *e.g.,* peeled potato.

Short Answer Type Questions

Q. 1 Enzymes are proteins. Proteins are long chains of amino acids linked to each other by peptide bonds. Amino acids have many functional groups in their structure.

These functional groups are many of them at least, ionisable. As they are weak acids and bases in chemical nature, this ionisation is influenced by pH of the solution. For many enzymes, activity is influenced by surrounding pH. This is depicted in the curve below, explain briefly.



Ans. Enzymes, generally function in a narrow range of pH. Most of the enzyme shows their highest activity at a particular pH called optimum pH, and it **declines** below and above this value.

Extremely high or low pH values generally results in complete loss of activity for most enzyms. The graph above represents the maximum enzyme activity at the optimum pH.

Q. 2 Is rubber a primary metabolite or a secondary metabolite? Write four sentences about rubber.

Ans. Rubber (*cis* 1, 4-polyisopyrene) is a secondary metabolite. Secondary metabolites are chemicals produced by plants for which no role has been found yet in growth, photosynthess, reproduction or other primary functions.

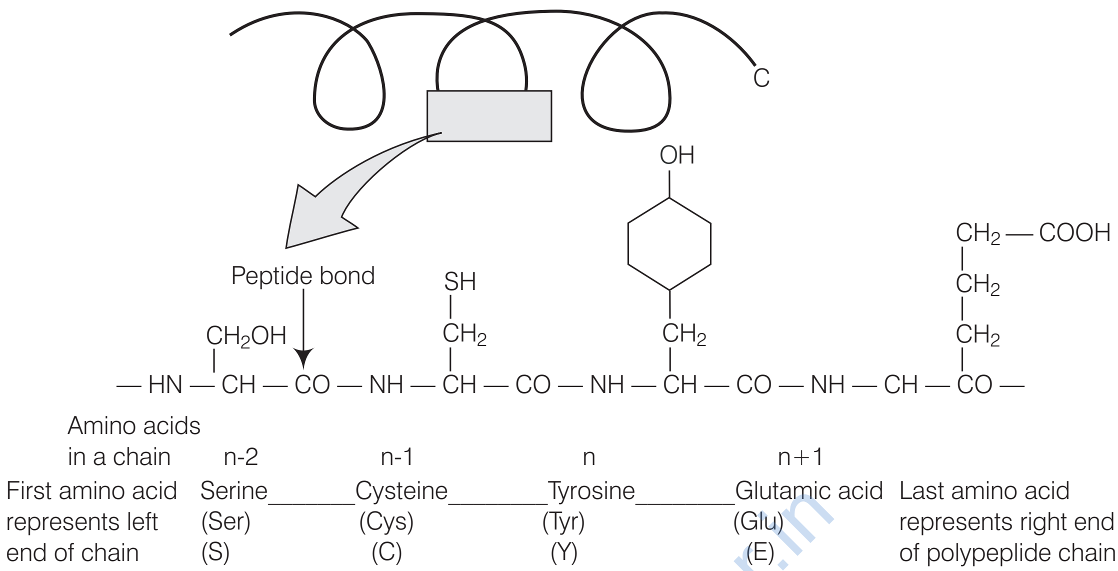
(i) Rubber is extracted from *Havea brasiliensis* (rubber tree).
(ii) It is a byproduct of the lactiferous tissue of the vessels that are in the form of latex.
(iii) It is the largest of the terpenoids because it contains over 400 isoprene units.
(iv) It is elastic, water proof and a good electrical conductor.

Q. 3 Schematically represent primary, secondary and tertiary structures of a hypothetical polymer say for example a protein.

Ans. Proteins are the large-sized, heteropolymeric macromolecules having one or more polypeptides (chains of amino acid).

Primary Structure The primary structure of a protein is the linear sequence of amino acid structural units and partially comprises its overall biomolecular structures. The amino acids are linked together in a sequence by peptide bonds.

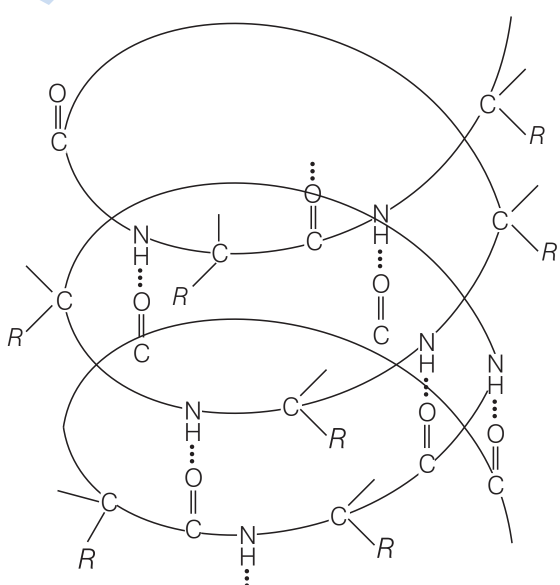
In the primary structure of protein initiate from an amino-terminal (N) to the carboxyl terminal (C) end,



Secondary Structure It is a three dimensional form of local segments of bipolymers such as proteins. Secondary structure of proteins is defined by hydrogen bonds between backbone amino and carboxyl groups. Mainly secondary structure in proteins possess two forms, *i.e.,* α-helix and β-pleated sheet.

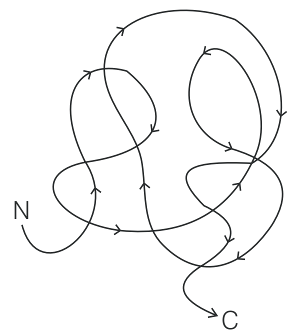
α-helix is a polypeptide chain spirally coiled to form a right handed helix. This helix may be coiled regularly at places and at some places randomly coiled. The helix is stabilised by many hydrogen bonds which are formed between —CO of one amino acid and —NH group of next fourth amino acid.

β-pleated sheets two or more polypeptide chains are joined together by intermolecular hydrogen bonds to produce a sheet like structure instead of fibre as in α-helix. The polypeptide strands in a sheet may run parallel in same direction, *e.g.,* keratin or in opposite direction called antiparallel β-sheet, *e.g.,* fibroin.



α-helix (secondary structure of protein)

Tertiary structure involves interactions that are caused by the bending and folding of α-helix or β-sheets leading to the formation of rods, spheres of fibres. Such interactions are typically conferred by H-bonds, ionic bonds, covalent bonds, van der Waat's interactions and hydrophobic interactions or disulphide linkages. It gives the protein a three dimensional conformation.



Q. 4 Nucleic acids exhibit secondary structure, justify with example.

Ans. Nucleic acids are polymeric macromolecules or large biological molecules, essential for all known forms of life. The secondary structrure of a nucleic acid molecule refers to the base pairing interactions within a single molecule or set of interacting molecules.

DNA and RNA represent two main nucleic acids, however their secondary structures differ *e.g.,* the secondary structure of DNA comprises of two complementary strands of polydeoxyribonucleotide, spirally coiled on a common axis forming a helical structure.

This double helical structure of DNA is stabilised by phosphodiester bonds (between 5' of sugar of one nucleotide and 3 of sugar of another nucleotide), hydrogen bonds (between bases, *i.e.,* hydrogen of one base and nitrogen of oxygen of other base) and ionic interactioins.

Q. 5 Comment on the statement 'living state is a non-equilibrium steady state to be able to perform work'.

Ans. **Living organism** are not in equilibrium because system at equilibrium cannot **perform work**. The living organisms exist in a steady state characterised by concentration of each of the biomolecules.

These biomolecules are in a metabolic flux. Any chemical or physical process moves simultaneously to equilibrium. As living organisms work continuously, they cannot afford to reach equilibrium. Hence, the living state is in a non-equilibrium steady-state to be able to perform work. This is achieved by energy input provided lay metobolism.

Long Answer Type Questions

Q. 1 Formation of Enzyme substrate complex (ES) is the first step in the catalysed reactions. Describe the other steps till the formation of product.

Ans. Each enzyme molecule has an active site for specific binding of substrate molecules . The enzyme work by altering the activation energy of the reaction.

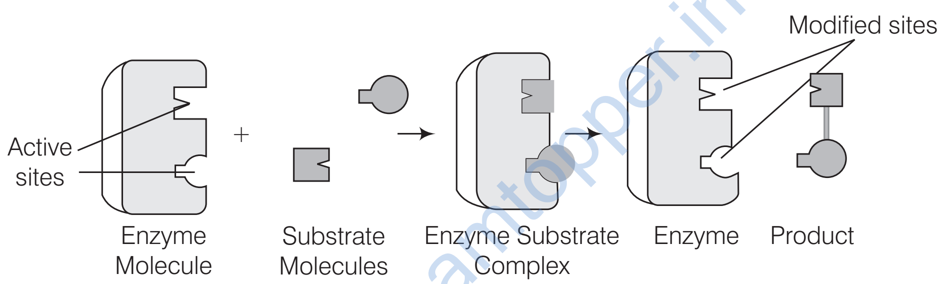
The catalytic site of an enzyme can be described as follows

(i) The substrate process to the active site of the enzyme, fitting into it.

(ii) Binding of the substrate induces the enzymes to alter its shape leading to formation of the Enzyme Substrate (ES) complex.

(iii) The active site of the enzyme, now is in close proximity with the substrate and break its chemical bonds and a **new enzyme product complex is formed**.

(iv) The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of substrate and run through the catalytic cycle once again.



Q. 2 What are different classes of enzymes? Explain any two with the type of reactions they catalyse.

Ans. Enzymes are divided into six classes each with 4-13 sub-classes and named accordingly by a four-digit number.

(i) **Oxidoreductases/dehydrogenases** These enzymes take part in oxidation and reduction or transfer of e^-.

$$\text{S (reduced)} + \text{S}' \text{ (oxidised)} \longrightarrow \text{S (oxidised)} + \text{S}' \text{ (reduced)}$$

(ii) **Transferaes** These enzymes transfer a functional group from one molecule to another (other than hydrogen). The chemical group transfer does not occur in free state.

$$\text{S-G} + \text{S}' \xrightarrow{\text{Transferase}} \text{S} + \text{S}'\text{-G}$$

(iii) **Hydrolases** These enzymes catalyse the hydrolysis of bonds like ester, ether, peptide, glycosidic C-C, C-halide, P-N etc.

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{Maltase}} \underset{\text{Glucose}}{2C_6H_{12}O_6}$$

(iv) **Lyases** These enzymes causes cleavage, removal of groups without hydrolysis and addition of groups to double bonds or removal of groups producing double bond.

$$\begin{matrix} X & & Y \\ | & & \| \\ C & - & C \end{matrix} \xrightarrow{\text{lyase}} X - Y + C = C$$

(v) **Isomerases** These enzymes cause rearrangement of molecular structure to effect isomeric changes. They are of three types, *i.e.,* isomerases, epimerases and mutases.

$$\text{Glucose - 6 - phosphate} \xrightarrow{\text{Isomerase}} \text{Fructose 6 - phosphate}$$

(Aldose to ketose group or *vice-versa*)

$$\text{Glucose - 6 - phosphate} \xrightarrow{\text{Mutase}} \text{Glucose-1-phosphate}$$

(Shifting the position of side group)

$$\text{Xylulose 5-phosphate} \xrightarrow{\text{Epimerase}} \text{Ribulose-5-phosphate}$$

(Change in position of one constituent or carbon group)

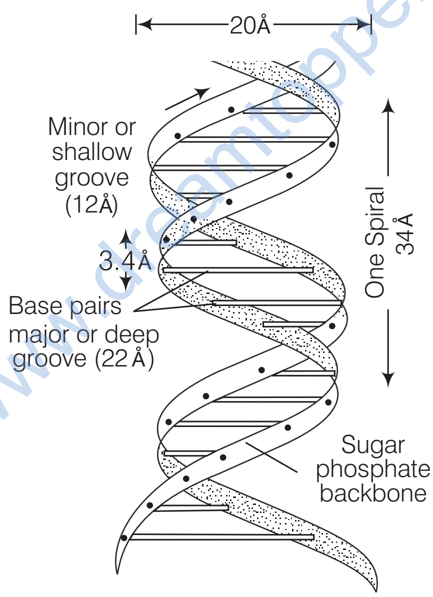
(vi) Ligases are enzymes catalysing bonding of two chemicals with the help of energy obtained from ATP resulting formation of bonds such as C — O, C — S, C — N and P — O *e.g., pyruvate carboxyl use*

$$Ab + C \longrightarrow A - C + b$$

$$\text{Pyruvic acid} + CO_2 + ATP + H_2O \underset{}{\overset{\text{pyruvate carboxylase}}{\rightleftharpoons}} \text{Oxaloacetic} + ADP + Pi -$$

Q. 3 Nucleic acids exhibit secondary structure. Describe through Watson-Crick model.

Ans. Nucleic acids are long chain macromolecules which are formed by end to end polymerisation of large number of repeated units called **nucleotides**. Nucleic acids show a wide range of secondary structures. A secondary structure is the set of interactions between bases and sugar phosphate backbone and is responsible for the shape that nucleic acid.



Double helix structure of DNA

James Watson and Francis Crick proposed a secondary structure of DNA molecules based on the crystallographic studies.

(i) **DNA or deoxyribonucleic acid** is a helically twisted double-chain polydeoxyribo-nucleotide macromolecule.

(ii) The two strands of DNA run anti-parallely to each other called as DNA duplex.

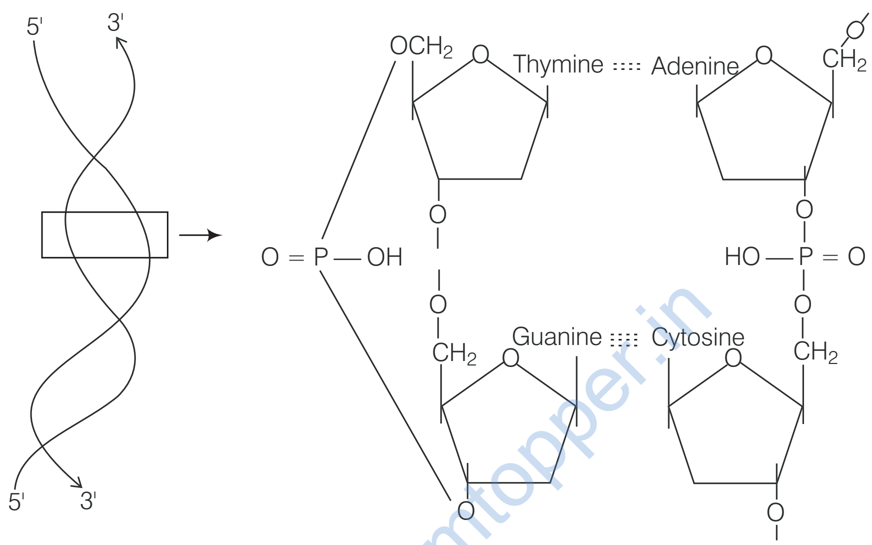
(iii) The spiral twisting of DNA has two types of alternate grooves, *i.e.,* major and minor.

(iv) One turn of 360° of the spiral has about 10 nucleotides on each strand of DNA, occupying a distance of about 3.4 nm.

(v) The nucleotides within each strand are held together by the **phosphodiester bonds** between the 5' carbon of one nucleotide and the 3' carbon of the adjacent nucleotide. These strong covalent bonds holds the sugar/phosphate backbone together.

(vi) The two strands of DNA are held together by weak **hydrogen bonds** between the nitrogenous bases. These hydrogen bonds are base specific. That is adenine forms 2 hydrogen bonds with thymine CA=T and cytosine forms 3 hydrogen bonds with guanine (C ≡ G).

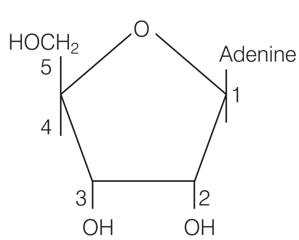
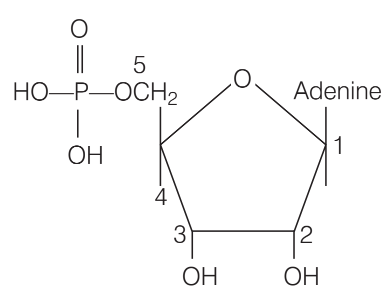
(vii) As specific and different nitrogen bases occur on two DNA chains, they are said to be complementary, *i.e.,* purine lies opposite to pyrimidine. This purine-pyrimidine pairing also contributes to the thickness of strand, *i.e.,* 2nm, and makes the two chains complementary.



Formation of bonds in double helix of DNA

Q. 4 What is the difference between a nucleotide and nucleoside? Give two examples of each with their structure.

Ans. *Difference between a nucleotide and nucleoside is as follows*

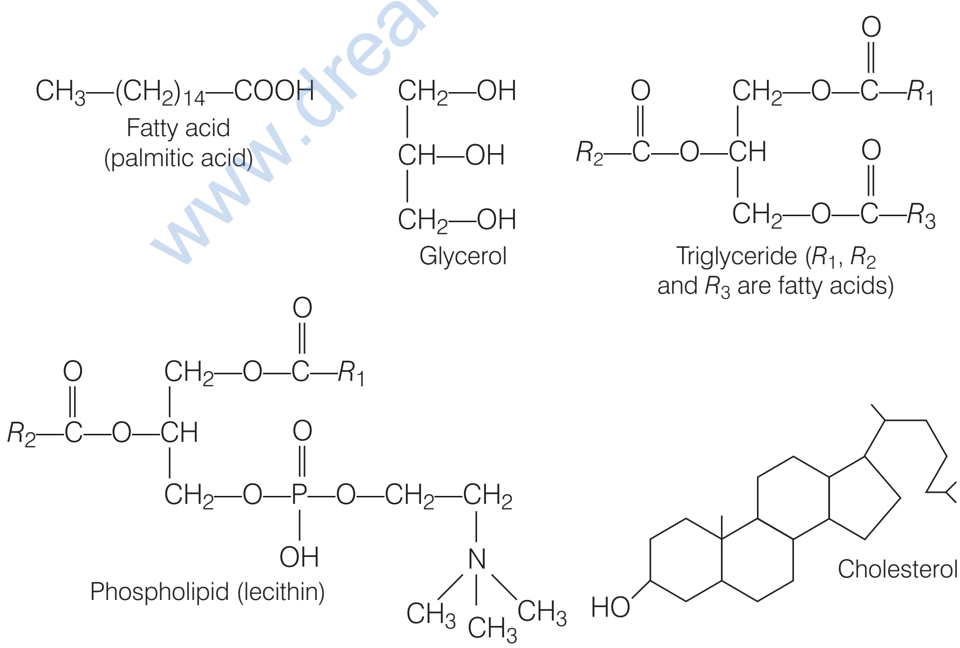
Nucleoside	Nucleotide
Nucleoside is a compound formed by the union of the nitrogenous base with a pentose sugar	Nucleotide is compound formed by union of nitrogen base, a pentose sugar and phosphate.
It is slightly basic in nature	A nucleotide is acidic in nature
It is a component of nucleotide and forms with both ribose and deoxyribose sugars.	Nucleotide is formed through phosphorylation of nucleoside
e.g., cytidine, uridine, adenosine, guanosine, thymidine and inosine.	*e.g.,* AMP, GMP, CMP, UMP, dTMP (deoxythymidine monophosphate)
 **Adenosine**	 **AMP** (Adenosine monophosphate)

Q. 5 Describe various forms of lipid with a few examples.

Ans. Lipids are the esters of higher fatty acid with alcohol, such as glycerol, etc.

These can be classified as

1. **Simple Lipids** are esters of fatty acids with alcohol. *These may be*
   (i) **Fats** These are esters of higher fatty acids with glycerol (triglycerides).
   (ii) **Waxes** These are esters of higher fatty acids with alcohol other than glycerol.
2. **Compound or conjugated lipids**, are those compounds which contain simple lipids and prosthetic (other additional) group. *They include*
   (i) **Glycerophospholipids**, also known as phospholipids in which one of the fatty acid is replaced by phosphoric acid which is linked to nitrogenous groups like choline, ethanolamine, serine etc, *e.g.,* Lecithin and cephalin, etc.
   (ii) **Sphingo lipids**, are lipides having phosphoric acid with amine alcohol 4-sphinganine or sphingosine instead of glycerol in addition to fatty acid and choline.
   (iii) **Glycolipids**, *i.e.,* those which contain spinganine with a fatty acid and a monosaccharide sugar, *e.g.,* cerebrosides and gangliosides.
3. **Steroids** are compounds with different chemical nature but similar physical properties. Their structure is based upon a 4 ring cyclopentenoperhydro phenanthrene, *e.g.,* cholesterol.
4. **Prostoglandins** are derivatives of arachidonic acid and contain 20 C-atoms. These are biologically active lipids.



Fats and oils (lipids)