CHAPTER › 09

Biomolecules

NEET KEY NOTES

- Although living organisms show a significant diversity among themselves, but their chemical composition and the metabolic reactions occurring in them are remarkably similar.
- Living organisms are made up of elements like carbon, hydrogen, oxygen and several others.
- All the carbon compounds that we get from living tissues can be called as **biomolecules**.
- Living tissues also contain inorganic elements and compounds. If this tissue is fully burnt, all the carbon compounds will get oxidised to gaseous form (e.g. CO_2, water vapour) and are thus removed. The remaining is called 'ash' which contains inorganic elements (like calcium, magnesium, etc).
- Water is the most abundant chemical, found in living organisms about 70-90% of total cellular mass.
- The biomolecules are of two types, i.e. small micromolecules with simple structures and large macromolecules with complex structures.

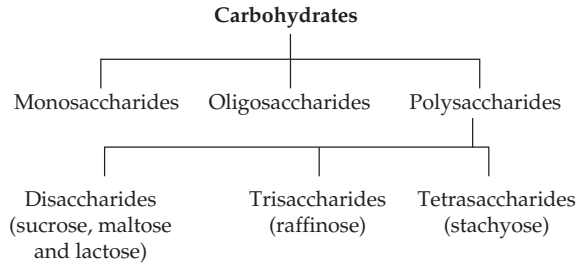
Biomicromolecules

- These are with low molecular weight (18-800 Da), highly soluble and have simple molecular conformation.
- These include inorganic compounds, i.e. water, minerals and gases, as well as organic compounds, *viz* sugars (monosaccharides and disaccharides), lipids, amino acids and nucleotides.

1. **Carbohydrates** (Saccharides)

- About 3% of the total cell content is made up of carbohydrates. These are biomolecules consisting of C, H and O atoms.
- The carbon forms chains or rings with two or more hydroxyl groups and an aldehyde or ketone group, forming aldoses or ketoses. They have a general formula, $C_nH_{2n}O_n$.

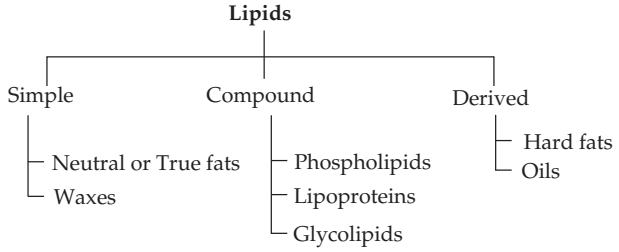
These are of following types



- Reducing sugars possess free aldehyde or ketone group and can reduce cupric ions of Benedict's or Fehling's solution to cuprous ions, e.g. lactose.
- Non-reducing sugars do not possess free aldehyde or ketone groups and cannot reduce cupric ions of Benedict's or Fehling's solution to cuprous ions, e.g. sucrose.

2. **Lipids**

- These are esters of fatty acids and alcohol, form 2% of the cell contents. Important lipids are as follows



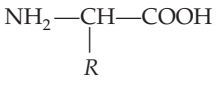
Fatty Acids

- These are water insoluble long chain hydrocarbons (4-36 carbon long) with one carboxyl (—COOH) group. These are the simplest constituents of lipids.

- There are two types of fatty acid chains as follows
  - **Saturated fatty acids** ($C_nH_{2n}O_{2n}$) These do not possess any double bond in their hydrocarbon chain and are solid at room temperature. These have high melting point, e.g. lauric acid (12 C), palmitic acid (16 C), stearic acid (18 C), arachidic acid (20 C), etc.
  - **Unsaturated fatty acids** ($C_nH_{2n-2x}O_2$) These possess one or more double bonds in their hydrocarbon chain and are liquid at room temperature due to the presence of double bond in them. These have low melting points, e.g. oleic acid (18 C), linoleic acid (18 C), etc.

3. Amino Acids

- These are organic compounds containing an amino group and an acidic group as a substituent on the same carbon, i.e. the α carbon. Hence, they are called **α-amino acids**.
- They are substituted methanes. There are four substituent groups occupying the four valency positions → hydrogen, carboxyl group, amino group and a variable group designated as *R* group.
- Based on the nature of *R* group, there are many amino acids. However, 20 amino acids occur in protein.
- General formula is



Classification of Amino Acids

Amino acids can be classified as follows

- **On the basis of synthesis in living organism**, amino acids are classified into following three categories
  - **Essential amino acids** cannot be synthesised by any organism in the body and are to be obtained from dietary sources.
  - **Non-essential amino acids** can be synthesised by an organism and thus, is not required as dietary component.
  - **Semi-essential amino acids** required essentially by an organism during particular phase of body growth and lactation period (in pregnant mothers).
- **On the basis of chemical nature**, amino acids are as follows
  - **Neutral** (contains one amino group and one carboxyl group), e.g. glycine (simple amino acid), alanine, valine, leucine and isoleucine.
  - **Acidic** (contains additional carboxylic group), e.g. aspartic acid, glutamic acid, aspargine and glutamine.
  - **Basic** (contains additional amino group), e.g. arginine and lysine.
- **On the basis of side chain**, amino acids are of following types
  - **Sulphur containing**, e.g. cysteine and methionine.
  - **Alcoholic**, e.g. threonine, tyrosine and serine.
  - **Aromatic**, e.g. phenylalanine, tryptophan and tyrosine.
  - **Heterocyclic**, e.g. histidine, proline and tryptophan.

  In a neutral solution, the amino acid molecules exist as a dipolar **zwitter ion**, i.e. a molecule containing both positive and negative ionic groups.

4. Nucleotides and Nucleosides

- These are five types of nitrogenous bases, i.e. adenine, guanine (both purines), cytosine, thymine and uracil (pyrimidines). When these bases found attached to a sugar they are called **nucleosides**. If a phosphate group is also found esterified to the sugar they are called **nucleotides**.
- Adenosine, guanosine, thymidine, uridine and cytidine are nucleosides.
- Adenylic acid, thymidylic acid, guanylic acid, uridylic acid and cytidylic acid are nucleotides. Nucleic acids like DNA and RNA consist of nucleotides only.

Primary and Secondary Metabolites

Metabolites are organic biomolecules present in cells and used in metabolic reactions.

- **Primary metabolites** These are found in animal tissue and are directly involved in normal growth, reproduction and development of animals, e.g. amino acids, proteins, etc.
- **Secondary metabolites** These are generally found in plant, fungal and microbial cells as a byproduct of major metabolic reactions, e.g. rubber, essential oils, antibiotics, etc. These are ecologically important, but role or functions of all secondary metabolites are not known yet.

Biomacromolecules

- These are large in size with higher molecular weight, i.e. above 10000 daltons.
- These molecules (i.e. polymers) are formed by linking number of micromolecules called **monomers**, e.g. proteins, polysaccharides, nucleic acids and lipids (lipids are not strictly macromolecules).

1. Proteins

- These are polypeptides. These are long chain of amino acids joined by peptide bond. Each protein is a heteropolymer of amino acids.
- In a polypeptide, the first amino acid is called as N-terminal amino acid. The last amino acid is called the C-terminal amino acid.

Some Proteins and their Functions

Proteins	Functions
Collagen	Intercellular ground substance
Trypsin	Enzyme
Insulin	Hormone
Antibody	Fight infections against
Receptors	Sensory reception (smell, taste, hormone, etc.)
GLUT-4	Enables glucose transport into cells

- Collagen is the most abundant protein in the animal world.
- Ribulose Bisphosphate Carboxylase-Oxygenase (RuBisCO), is the most abundant protein in the whole of biosphere.

Structural Level of Proteins

There are four structural levels in proteins

- **Primary structure** The sequence of amino acids, i.e. the positional information in a protein, which is the first amino acids, which is second and so on is called the primary structure.
  - Protein is imagined as a line left end represented by the first amino acid also called as **N-terminal amino acid**.
  - Right end represented by last amino acid also called as **C-terminal amino acid.**
  - A protein thread does not exist throughout as an extended rigid rod.
  - The thread is folded in the form of a helix.
  - Some portions are folded as helix.
- **Secondary structure** There are three types of secondary structures, i.e. **α-helix**, **β-pleated sheet** and **collagen helix**. The turns of helices and sheets are attached by hydrogen bond.
- **Tertiary structure** Long protein chain is folded upon itself like a hollow woolen ball, giving rise to tertiary structure. It is stabilised by several types of bonds, i.e. hydrogen bonds, ionic bonds, i.e. van der Waals interaction, covalent bonds and hydrophobic bonds. It gives 3 D conformation to protein molecule.
- **Quaternary structure** Some proteins are an assembly of more than one polypeptide or subunits. The manner in which these individuals folded polypeptides or sub-units are arranged with respect to each other is the architecture of protein, otherwise called quaternary structure of a protein.

Classification of Proteins

- On the basis of composition, proteins are classified into following two classes
  - **Fibrous proteins** formed when the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, e.g. keratin, fibroin, collagen and myosin.
  - **Globular proteins** In these, polypeptide chains are coiled about themselves which result in a spherical molecule, e.g. enzymes, hormones such as insulin and haemoglobin, etc.
- On the basis of components of molecules, proteins are classified into following three classes
  - **Simple proteins** (made up of amino acids only), e.g. collagen, albumin, etc.
  - **Conjugated proteins** (made up of protein molecules joined to non-protein part), e.g. haemoglobin, casein, etc.
  - **Derived proteins** (formed by partial breakdown of natural proteins), e.g. peptones, insulin, fibrin, etc.

2. Polysaccharides

- Polysaccharides (Gr. *Poly*–many; *saccharon*–sugar) are usually employed to polymers containing minimum of ten monosaccharide units. Polysaccharides are of following two types
  - **Homopolysaccharides or Homoglycans** They have only one type of monosaccharide units in them. Some of the better known homoglycans are starch, cellulose, chitin, etc.
  - **Heteropolysaccharides or Heteroglycans** They have at least two types of monosaccharide units in them, e.g. chitin, pectin, peptidoglycan.
- Major polysaccharides are discussed below
  - **Starch** $(C_6H_{10}O_5)_n$ It is a polymer of D-glucopyranose units linked by α-1, 4-glycosidic linkages. It consists of a mixture of **amylose** and **amylopectin**.
  - **Glycogen** About 5000-15000 glucose units make up glycogen $(C_6H_{10}O_5)_n$.
  - **Cellulose** It is a linear polymer of β-D-glucose units connected through β -1, 4-glycosidic linkage.
  - **Chitin** It is the second most abundant polysaccharide, comprising of linear unbranched structural heteropolysaccharide of β-1,4-linked chains of N-acetylglucosamine.

3. Nucleic Acids

- These are **biomacromolecules** and are **polymeric** compounds of **nucleotides,** i.e. polynucleotides.
- A nucleic acid which contains deoxyribose sugar is DNA, while that which contains ribose is called Ribonucleic Acid (RNA).
- **Deoxyribonucleic Acid** (DNA) is right-handed double helix model (structure) of two parallel polynucleotide chains given by **Watson** and **Crick** having a major and

minor groove.The outline of **Watson** and **Crick** model of DNA is as follows

- DNA molecule consists of two helically twisted strands connected together by base pairs, which align themselves in antiparallel or in opposite direction. A DNA double helix is 20Å wide and its one complete turn is 34Å wide, having 10 base pairs.
- The two strands are interwined in a clockwise direction, i.e. in the form of a right-handed helix and have antiparallel arrangement.
- Each strand consists of a backbone made up of alternating deoxyribose sugar and phosphate. The phosphate joins the two sugars through a **phosphodiester bond**.
- The nitrogenous bases are stacked inside the helix and paired with the base of the opposite strand through **hydrogen bonds** (H-bonds). There are two H-bonds between A and T and three H-bonds between G and C.

Note The right-handed form of DNA is called **B-DNA** (found in humans) and left-handed form is called **Z-DNA** (found in nucleosome).

- **Ribonucleic Acid** (RNA) The other nucleic acid present in the cell is RNA, i.e. ribose nucleic acid.
- It is mostly present in single-stranded form though some viruses like retrovirus and wound tumour virus has double-stranded RNA.
- RNA can be of following three types
  - Messenger RNA or *m*RNA or template RNA
  - Ribosomal RNA or *r*RNA
  - Soluble-RNA or transfer-RNA (*s* or *t*RNA)

Nature of Bond Linking Monomers in Polymer

The polymers are formed by combination of one or more types of monomer units *via* bonds. These are

- **Peptide bonds** These are formed when the carboxyl (—COOH) group of one amino acid reacts with the amino ($—NH_2$) group of the next amino acid with the elimination of a water moiety (the process is called dehydration).
- **Glycosidic bond** This bond ions carbon atoms of two adjacent monosaccharides with the removal of water molecule.
- **Phosphodiester bond** In a nucleic acid, a phosphate moiety links the 3′-carbon of one sugar of one nucleotide to the 5′-carbon of the sugar of the succeeding nucleotide. The bond between the phosphate and hydroxyl group of sugar is an ester bond. As there is one such ester bond on either sides, it is called phosphodiester bond.

Concept of Metabolism

- All biomolecules are constantly being changed into some other biomolecules and also made from some other biomolecules, known as **turnover**.
- The making and breaking is through chemical reactions constantly occurring in living organism. Together all these chemical reactions are called **metabolism**, e.g. removal of CO_2 from amino acid forms amine.

Features of Metabolic Reactions

- Each metabolic reaction results in the transformation of biomolecules. Majority of these reactions do not occur in isolation, but are linked to some other reaction and follows a certain metabolic pathway. These pathways are either linear or circular. They also *criss-cross* to each other, i.e. there are traffic junctions.
- An important feature of metabolic reactions is that they are enzyme catalysed reactions.
  These metabolic reactions can be categorised into two types based on their metabolic pathways as follows
  - **Anabolic pathway** or **biosynthetic pathway** Formation of complex structure from a simpler structure, e.g. acetic acid becomes cholesterol.
  - **Catabolic pathway** Degradation of a complex structure to form a simpler structure, e.g. glucose becomes lactic acid in our skeletal muscles.
- **ATP** (Adenosine Triphosphate) Most important form of energy currency in living systems is the bond energy in ATP.

Enzymes

- Almost all enzymes are proteins. Some nucleic acids that behave like enzymes are called **ribozymes**.
- These are organic catalysts which catalyse biochemical reactions without being utilised themselves.
- An enzyme like any protein has the secondary and tertiary structures. This tertiary structure has backbone of the protein chain folded upon itself, also the chain *criss-crosses* itself and hence, many crevices or pockets are made. One such pocket is the **active site**.
- An active site of an enzyme is a crevice or pocket into which the substrate fits. Thus, enzymes through their active site, catalyse reactions at a high rate.

Working of Enzymes

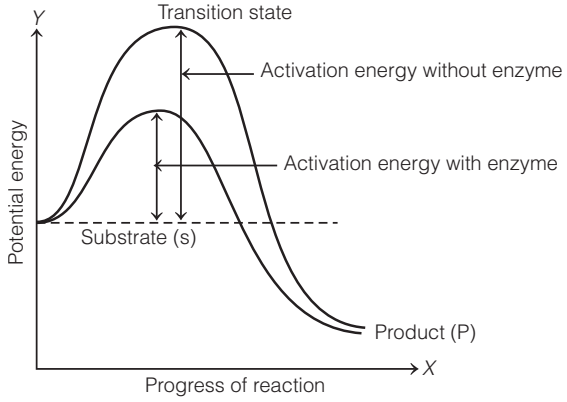
- **Substrate** (S) Chemical which is converted into a product.
- **Enzyme**, i.e. Proteins with three dimensional structures including an active site convert a **substrate** (S) into a **product** (P).

$$S \rightarrow P$$

- The substrate has to diffuse towards the 'active site'. There is thus, an obligatory formation of an 'ES' complex. This complex formation is a transient phenomenon.
- During this state, a new structure of the substrate called **transition state structure** is formed.
- After bond making/breaking is completed, the product is released from the active site.
- There could be many more 'altered structural states' between the stable substrate and the product.

Concept of Activation Energy

- Activation energy is the least possible energy required to start a chemical reaction or the amount of energy available in a chemical system for a reaction to take place.
- It can be understood with the given graph as follows



Y -axis = Potential energy

X-axis = Progression of the structural transformation or states through transition state.

- The features to notice
  - If 'P' is at a lower level than 'S', the reaction is an exothermic reaction (no supply of energy is needed to form the product).
  - The difference in average energy content of 'S' from that of the transition state is activation energy.

Nature of Enzyme Action

- Each enzyme (E) has a substrate (S) binding site in its molecule so that highly reactive enzyme-substrate complex (ES) is produced.

$$\underset{\text{Enzyme}}{E} + \underset{\text{Substrate}}{S} \rightleftharpoons \underset{\substack{\text{Enzyme -}\\ \text{Substrate}\\ \text{complex}}}{ES} \longrightarrow \underset{\substack{\text{Enzyme -}\\ \text{Product}\\ \text{complex}}}{EP} \longrightarrow \underset{\text{Enzyme}}{E} + \underset{\text{Product}}{P}$$

- The catalytic cycle of an enzyme action can be described in the following steps
  - Substrate binds to the active sites of the enzyme.
  - Binding induces enzyme to alter its shape fitting more tightly around the substrate.
  - Active site of enzyme breaks the chemical bonds of the substrate and the new enzyme-product complex is formed.
  - Enzyme releases products of the reaction and the free enzyme is ready to bind to another molecule of the substrate and run through the catalytic cycle once again.

Factors Affecting Enzyme Activity

The activity of an enzyme can be affected by a change in the conditions which can alter the tertiary structure of the protein.

- **Substrate concentration** Enzyme activity increases with increase in concentration of the substrate to a maximum and then its levels off.
- **Enzyme concentration** In general, the rate of reaction will increase with increasing enzyme concentration, due to the availability of more active sites for reaction.
- **Temperature and pH** In most of the enzymatic reactions, rise of 10°C in the temperature doubles the rate of reaction between 5-40°C. Enzymes are **denatured** (secondary and above level of structures degraded) at higher temperature due to their proteinaceous nature and rate of reaction drops.

Enzyme Inhibition

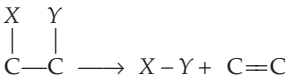
Reduction or Stoppage of enzyme activity due to the certain adverse conditions or chemicals is called **enzyme inhibition** and the chemicals which interfere or inhibit the process are called **inhibitor**.

Enzyme inhibition can be of following types

- **Competitive inhibition** It is a reversible process due to the substrate or enzyme analogue in which K_m increases, but V_{max} remains the same.
- **Non-competitive inhibition** In this, inhibitor forms a complex with enzyme other than the active site and V_{max} decreases.
- **Feedback inhibition** Where the end product or intermediates functions as temporary inhibitor which combines with a regulatory site (also known as allosteric site) of the enzyme and thus, functions as negative modulator. This is also called **allosteric modulation**.

Classification and Nomenclature of Enzymes

- **Oxidoreductases/Dehydrogenases** catalyse oxidoreduction between two substrates, i.e. S and S′, e.g. S (reduced) + S′ (oxidised) → S (oxidised) + S′ (reduced)
- **Transferases** catalyse transfer of a group G (other than hydrogen) between a pair of substrate S and S′, e.g. S – G + S′ → S + S′ – G
- **Hydrolases** catalyse hydrolysis of ester, ether peptide glycosidic C—C, C—halide or P—N.
- **Lyases** catalyse removal of groups from substrates mechanisms other than hydrolysis leaving double bonds.



- **Isomerases** catalyse inter-conversion of optical, geometric or positional isomers.
- **Ligases** catalyse linking together of two compounds, e.g. enzymes which catalyse joining of C—O, C—S, C—N, P—O, etc., bonds.

Cofactors

- In some cases, non-protein constituents called cofactors are bound to the enzyme to make enzyme catalytically active.
- Protein portion of an enzyme is called **apoenzyme**.

Types of Cofactors

These are as follows:

- **Prosthetic group** Organic compound, e.g. peroxidase and catalase and haem is the prosthetic group.
- **Coenzymes** Organic compound, but their association with the apoenzyme is only transient usually occurring during the course of catalysis, e.g. Nicotinamide Adenine Dinucleotide (NAD and NADP).
- **Metal ions**, e.g. zinc is a cofactor for the proteolytic enzyme carboxypeptidase.

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *Biomicromolecules*

1 After doing the chemical analysis of organic compounds found in living organisms, two fractions were observed namely
(a) acid soluble pool and acid insoluble pool
(b) carbon pool and hydrogen pool
(c) inorganic pool and organic pool
(d) aqueous pool and non-aqueous pool

2 Choose the element, which is negligible in living matter.
(a) Si (b) Mg (c) Ca (d) S

3 Grinding of a living tissue in trichloroacetic acid shows the presence of the inorganic compounds like sulphate, phosphate, etc., which are categorised as
(a) acid insoluble fraction
(b) acid soluble fraction
(c) not found in cellular pool
(d) Both (a) and (b)

4 Biomolecules are
(a) inorganic materials
(b) organic materials
(c) all the carbon compounds obtained from the living tissue
(d) only DNA and RNA

5 Identify the term 'ash' in terms of living tissue sample analysis from the statements given below.
(a) Organic compounds oxidised to gaseous form (CO_2 and water vapour) after burning of the tissue
(b) The material left after burning the tissue, which contains inorganic elements such as calcium, magnesium, etc
(c) Compounds removed in the form of gases
(d) Compounds which may be soluble in intracellular fluid

6 The sum total composition of acid soluble and acid insoluble fraction represents the entire composition of
(a) dead cells (b) gene pool
(c) cellular pool (d) gene library

7 Amino acids are organic compounds and are called α-amino acids. Why?
(a) Amino acids are organic compounds containing an amino group and acidic group as substituents on two different carbons
(b) Amino acids are organic compounds containing an amino group and an acidic group as substituents on the same carbon
(c) Amino acids are inorganic compounds containing an amino group and acidic group as substituents on two different carbons

(d) Amino acids are inorganic compounds containing an amino group and acidic group as substituents on the same carbon

8 Amino acids are substituted methanes. What are the four substituent groups occupying the four valency positions?

(a) Hydrogen, carboxyl group, amino group and a variable group (*R*)
(b) Two carboxyl groups, amino group and OH
(c) Two hydrogen, one carboxyl group, amino group and a variable group (*R*)
(d) Two amino groups, one hydrogen and one carboxyl group

9 Variety of amino acids are formed on the basis of

(a) position of hydroxyl group
(b) position of carboxyl group
(c) position of hydrogen
(d) nature of *R* group

10 Types of amino acids found in proteins are

(a) 21 (b) 19
(c) 20 (d) 23

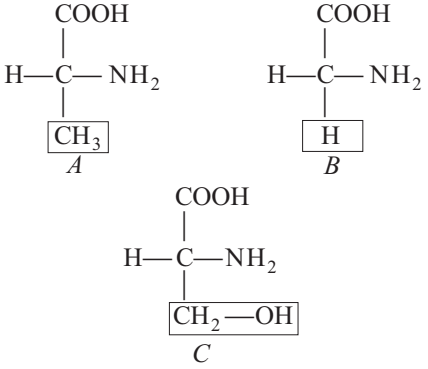
11 Based on the number of amino and carboxyl groups amino acids are classified. Choose the correct option.

	Acidic amino acid	Basic amino acid	Neutral amino acid
(a)	Glutamic acid	Lysine	Valine
(b)	Lysine	Valine	Glutamic acid
(c)	Glutamic acid	Valine	Lysine
(d)	Lysine	Glutamic acid	Valine

12 The amino acid, tryptophan is the precursor for the synthesis of ***NEET 2016***

(a) thyroxine and triiodothyronine
(b) oestrogen and progesterone
(c) cortisol and cortisone
(d) melatonin and serotonin

13 The *R*-group in proteinaceous amino acid makes them different. Name the amino acids *A*-*C* correctly according to the *R* groups given in each structure.

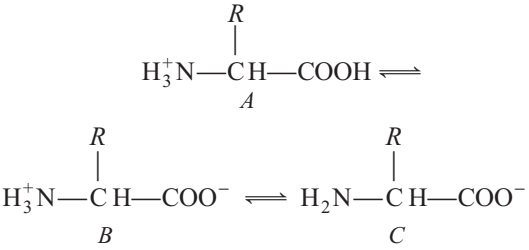


(a) A–Glycine, B–Serine, C–Alanine
(b) A–Alanine, B–Glycine, C–Serine
(c) A–Serine, B–Glycine, C–Alanine
(d) A–Serine, B–Alanine, C–Glycine

14 The aromatic amino acid (s) is/are

(a) tyrosine (b) phenylalanine
(c) tryptophan (d) All of these

15 Identify the zwitter ionic form in the given reversible reaction.



Choose the correct option.

(a) A (b) C
(c) B (d) None of these

16 A fatty acid has a carboxyl group attached to *R* group. The *R* group could be a/an

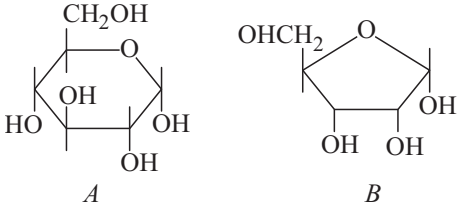
(a) methyl
(b) ethyl
(c) higher number of —CH_2 groups (1 to 19 carbons)
(d) All of the above

17 Arachidonic acid and palmitic acid have…… and …… carbon atoms, respectively including the carboxyl carbon.

Complete the given statement by filling the most appropriate option in the blank.

(a) 20, 16 (b) 22, 15
(c) 21, 4 (d) 23, 10

18 Identify the given structure and name the compound.



(a) Ribose, Glucose
(b) Deoxyribose, Ribose
(c) Glucose, Ribose
(d) Ribose, Deoxyribose

19 Saturated fatty acids possess …… bond between carbon atoms and are …… at room temperature.

(a) single, solids (b) double, solids
(c) single, liquids (d) double, liquids

20 Which of the following are not polymeric? ***NEET 2017***

(a) Nucleic acid (b) Proteins
(c) Polysaccharides (d) Lipids

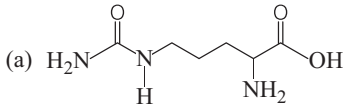
21 Omega 3 fatty acid is present in ***JIPMER 2018***

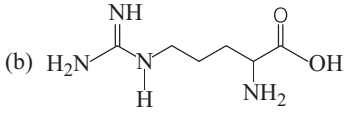
(a) sunflower oil (b) flax seed oil
(c) groundnut oil (d) butter

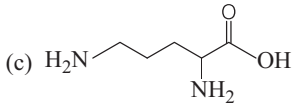
22 Which of the following is not a derivative of cholesterol? ***JIPMER 2018***

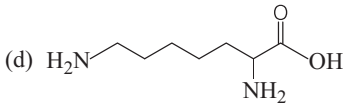
(a) Vitamin-B (b) Vitamin-D
(c) Bile salts (d) Steroid

23 Which of the following structures represent the structure of citrulline correctly? ***JIPMER 2019***

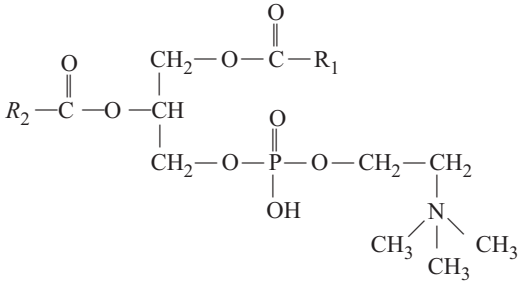
(a) 

(b) 

(c) 

(d) 

24 Choose the correct option for the molecule given below.



(a) Cholesterol – A component of animal cell membrane
(b) Lecithin – A component of cell membrane
(c) Triglyceride – An energy source
(d) Adenosine – A component of nucleic acids

25 Which of the following organic compounds is the main constituent of lecithin? ***NEET (Odisha) 2019***

(a) Arachidonic acid (b) Phospholipid
(c) Cholesterol (d) Phosphoprotein

26 Identify, in which of the following carbon compounds, heterocyclic rings can be found?

(a) Proteins (b) Amino acids
(c) Nitrogen bases (d) Lipids

27 A nucleoside having a phosphate group forms a

(a) nucleotides
(b) triglyceride
(c) lipids
(d) nitrogen bases

28 Refer to the given reactions.

I. Guanine + X $\longrightarrow$ Guanosine
II. Guanosine + Y $\longrightarrow$ Guanylic acid

Choose the correct option for X and Y.

(a) X–Phosphate group, Y–Sugar molecule
(b) X–Sugar molecule, Y–Phosphate group
(c) X–Sugar molecule, Y–Nitrogenous base
(d) X–Nitrogenous base, Y–Sugar molecule

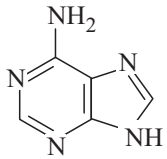
29 Choose the correct option.

(a) DNA and RNA function as genetic material
(b) Cytidine is a nucleotide
(c) Phosphate is common in both nucleotides and nucleosides
(d) DNA and RNA consist of nucleosides only

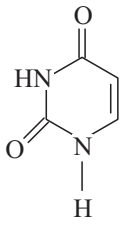
30 Adenosine, guanosine, thymidine, uridine, cytidine are all ..... but adenylic acid, guanylic acid, uridylic acid, cytidylic acid are ..... .

(a) nucleotides, nucleosides
(b) nucleosides, nucleotides
(c) nucleotides, nucleic acids
(d) nucleosides, nucleic acids

31 Identify *A* and *B*.



A



B

	A	B
(a)	Cytosine	Uracil
(b)	Adenine	Thymine
(c)	Adenine	Uracil
(d)	Guanine	Thymine

32 Name the four elements called 'Big four', which make up 95% of all elements found in a living system.

(a) C, H, O, P (b) C, H, O, N
(c) C, N, O, K (d) C, H, O, S

TOPIC 2 ~ *Primary and Secondary Metabolites*

33 Secondary metabolites can be observed in
(a) plant cells
(b) fungal cells
(c) microbial cells
(d) All of the above

34 Which of the following is/are secondary metabolites?
(a) Rubber (b) Morphine
(c) Curcumin (d) All of these

35 Primary metabolites
(a) include glucose and fructose
(b) present in all living tissues
(c) plays known roles in all physiological process
(d) All of the above

36 Which of the following secondary metabolites are used as drugs?
(a) Vinblastin and curcumin
(b) Anthocyanin
(c) Gums and cellulose
(d) Abrin and ricin

37 Choose the correct option.
(a) Pigments – Carotenoids, anthocyanins
(b) Alkaloids – Monoterpenes
(c) Toxins – Morphine
(d) Polymeric substances – Ricin

38 Concanavalin A is ***NEET (National) 2019***
(a) an essential oil (b) a lectin
(c) a pigment (d) an alkaloid

39 Select the secondary metabolites from the list given below.
I. Alkaloids II. Flavonoids
III. Rubber IV. Essential oils
V. Antibiotics VI. Coloured pigments
VII. Scents VIII. Gums
IX. Spices
Choose the correct option.
(a) I to IX (b) All except II and IX
(c) I, III, IV and VI (d) All except I and VII

TOPIC 3 ~ *Biomacromolecules and their Structure*

40 Compounds found in acid soluble pool have molecular weight ranging from
(a) 18-800 daltons (b) 100-800 daltons
(c) more than 800 daltons (d) None of these

41 Biomolecules having molecular weight less than one thousand dalton are
(a) macromolecules (b) biomacromolecules
(c) micromolecules (d) Both (a) and (b)

42 After grinding a living tissue in trichloroacetic acid and then staining it, you would obtain two fractions, i.e. acid soluble fraction and acid insoluble fraction. Acid insoluble fraction does not contain
(a) nucleic acids (b) polysaccharides
(c) lipids (d) flavonoids and alkaloids

43 Why are lipids found in the acid insoluble fraction during the analysis of chemical composition of tissues?
(a) It has very high molecular weight
(b) It is polymer
(c) It has low molecular weight
(d) On grinding, the biomembranes are broken into pieces and form insoluble vesicles

44 The least abundant chemical component in living organisms is
(a) lipids (b) ions
(c) nucleic acids (d) protein

45 Which of the following is an essential amino acids?
(a) Valine (b) Leucine
(c) Tryptophan (d) All of these

46 Non-essential amino acid is ***JIPMER 2018***
(a) valine (b) arginine
(c) histidine (d) lysine

47 Proteins are needed in diet because ***JIPMER 2018***
(a) all amino acids are not available in body
(b) during fasting, body utilises proteins
(c) proteins act as building blocks of our body
(d) All of the above

48 Which is the 21st amino acid? ***JIPMER 2018***
(a) Pyrrolysine (b) Selenocysteine
(c) Cystine (d) Histidine

49 'Ramachandran plot' is used to confirm the structure of ***NEET (Odisha) 2019***
(a) RNA (b) proteins
(c) triacylglycerides (d) DNA

50 Protein on reaction with which yields Ruhemann's purple? ***AIIMS 2019***
(a) Ninhydrin (b) Cu^{2+}
(c) H_2O_2 (d) Benedict's solution

51 Name the most abundant protein in animal world.
(a) RuBisCO (b) Carboxylase-oxygenase
(c) Collagen (d) Cellulose

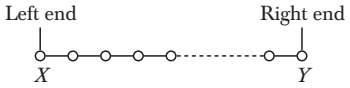
52 Which is the most abundant protein in whole of the biosphere?
(a) Collagen (b) Trypsin (c) Insulin (d) RuBisCO

53 Identify the correct pair.

	Proteins	Functions
(a)	Collagen	Hormone
(b)	Antibody	Fights infectious agents
(c)	Insulin	Intercellular ground substance
(d)	Trypsin	Enables glucose transport in cell

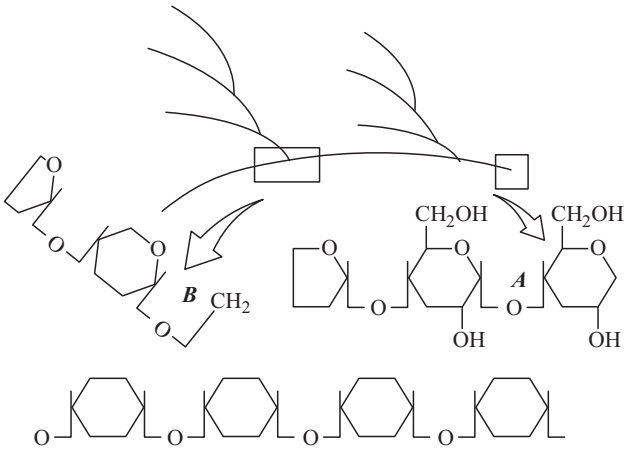
54 Which two functional groups are characteristic of sugars? ***NEET 2018***
(a) Carbonyl and phosphate (b) Carbonyl and methyl
(c) Hydroxyl and methyl (d) Carbonyl and hydroxyl

55 Name the term given to the left and right ends of a polysaccharide.



(a) Left end– N-terminal end, Right end– C-terminal end
(b) Left end–Reducing end, Right end–Non-reducing end
(c) Left end–Non-reducing end, Right end–Reducing end
(d) Left end– C-terminal end, Right end– N-terminal end

56 Identify *A* and *B* bonds in the following diagrammatic representation of a portion of glycogen.



Choose the correct option.
(a) A = 1, 6α-glycosidic bonds, B = 1, 4 α-glycosidic bonds
(b) A = 1, 1α-glycosidic bonds, B = 1, 1α-glycosidic bonds
(c) A = 1, 4 α-glycosidic bonds, B = 1, 4 α-glycosidic bonds
(d) A = 1, 4 α-glycosidic bonds, B = 1, 6α-glycosidic bonds

57 Select the correct option, which represents the homopolysaccharides made up of glucose monomers.
(a) Sucrose, lactose, maltose
(b) Chitin, glycogen, starch
(c) Starch, inulin, peptidoglycan
(d) Starch, glycogen, cellulose

58 For nucleic acids, the building block is a
(a) nucleotide (b) nucleoside
(c) polynucleotide (d) sugar

59 Name the heterocyclic compounds, which are known as nitrogenous bases.
Choose the most appropriate option.
(a) Adenine, guanine, uracil, cytosine and thymine
(b) Adenine, guanine, uracil and thymine
(c) Adenine, guanine, cytosine, uracil
(d) None of the above

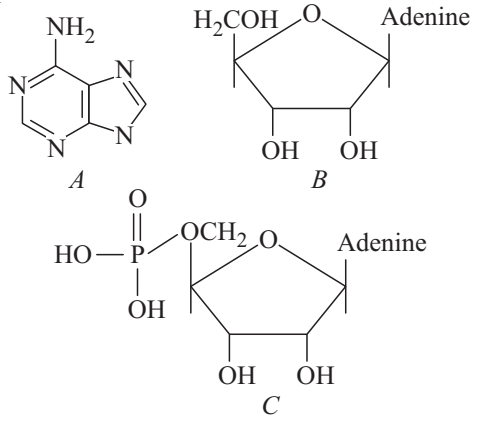
60 Select the correct pair of substituted purines.
(a) Cytosine and thymine (b) Adenine and guanine
(c) Uracil and cytosine (d) Guanine and uracil

61 A nucleotide has three chemically distinct compounds, namely, *A*, *B* and *C*.
Choose the correct option for *A*, *B* and *C*.
(a) A–Sugar, B–Carbonates, C–Chlorides
(b) A–DNA, B–Cellulose, C–Chitin
(c) A–Heterocyclic compound, B–Monosaccharide, C–Phosphate
(d) A–Phosphoric acid, B–Proteins, C–Acids

62 The sugars found in polynucleotides are

	A	B
(a)	ribose	sucrose
(b)	2′ deoxyribose	ribose
(c)	ribose	dextrose
(d)	deoxyribose	ribulose

63 Identify the structural formulae and select the correct option.



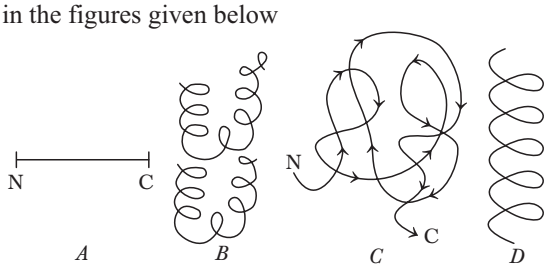
(a) A–Adenine, B–Adenosine, C–Adenylic acid
(b) A–Guanine, B–Adenosine, C–Adenylic acid
(c) A–Adenosine, B–Adenylic acid, C–Adenine
(d) A–Uracil, B–Adenosine, C–Adenylic acid

64 Which of the following is incorrect?
(a) DNA and RNA consist of nucleotides only
(b) Adenylic acid is a nucleoside
(c) Uridine is a nucleoside
(d) N-bases (A, G, C, T, U) have heterocyclic rings

65 Primary structure of proteins is due to the presence of
(a) peptide bond (b) covalent bond
(c) disulphide bond (d) ionic bonds

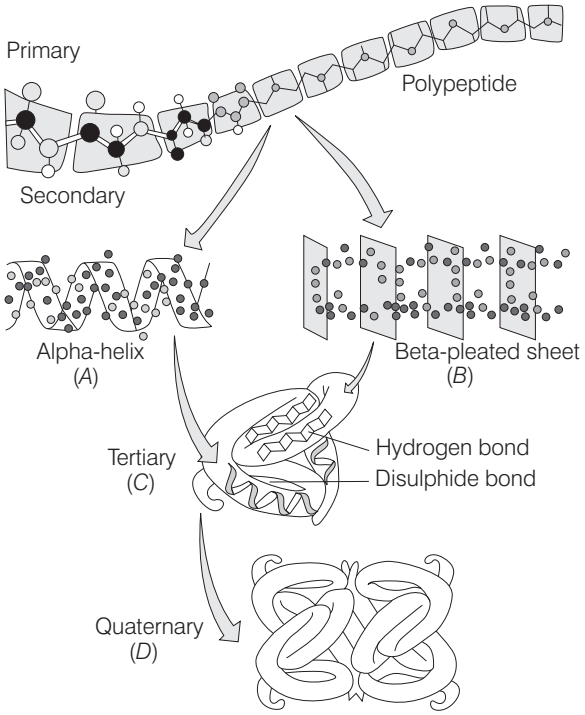
66 In a protein structure, the first amino acid and the last amino acid are respectively called as
(a) N-terminal amino acid, C-terminal amino acid
(b) C-terminal amino acid, N-terminal amino acid
(c) α-amino acid, β-amino acid
(d) β-amino acid, α-amino acid

67 Give the names of the structures of proteins as shown in the figures given below



(a) A = 1° structure, B = 2° structure, C = 3° structure, D = 4° structure
(b) A = 4° structure, B = 2° structure, C = 3° structure, D = 1° structure
(c) A = 1° structure, B = 4° structure, C = 3° structure, D = 2° structure
(d) A = 4° structure, B = 3° structure, C = 2° structure, D = 1° structure

68 Refer to the given figure of various levels of protein structure.



Formation of structures *A, B, C* and *D* is through

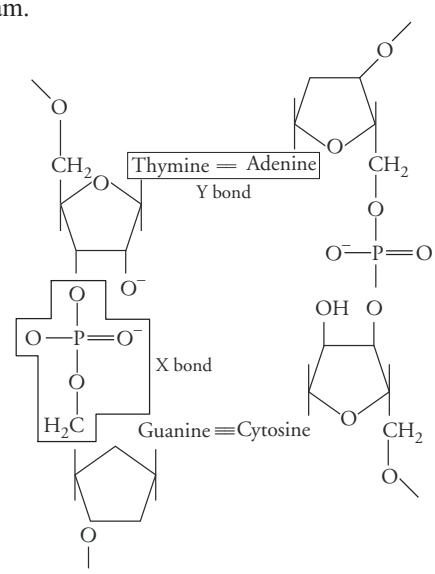
	A	B	C	D
(a)	H-bonding in single amino acid chain only	H-bonding in between two or more polypeptide chains	Further coiling in α-helix only	Both α-helix and β- sheet joined and coiled together
(b)	H-bonding in between two or more polypeptide chains	H-bonding in single amino acid chain only	Further coiling in α-helix only	Both α-helix and β- sheet joined and coiled together
(c)	H-bonding in between two or more polypeptide chains	H-bonding in single amino acid chain only	Both α-helix and β-sheet joined and coiled together	Further coiling in α-helix only
(d)	H-bonding in single amino acid chain only	H-bonding in between two or more polypeptide chains	Further folding of two or more secondary structures	Further folding of a number of tertiary structures

69 Adult human haemoglobin consists of
(a) 2 subunits (b) 2 subunits (β, β)
(c) 4 subunits (2α, 2β) (d) 3 subunits (2α, β)

70 Acidic amino acids carry two —COOH and one $—NH_2$ groups per molecule. Keeping this in mind, select the correct pair of acidic amino acid.
(a) Lysine and arginine
(b) Aspartic acid and glutamic acid
(c) Glycine and alanine
(d) Both (a) and (b)

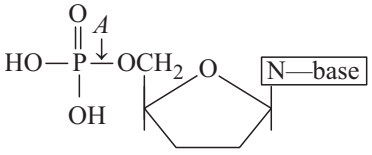
71 In a polysaccharide, the individual monosaccharides are linked by a
(a) glycosidic bond (b) peptide bond
(c) ester bond (d) phosphodiester bond

72 Which bonds are indicated by X and Y in the given diagram.



(a) X–Glycosidic bond, Y–Hydrogen bond
(b) X–Phosphodiester bond, Y–Hydrogen bond
(c) X–Glycosidic bond, Y–Phosphodiester bond
(d) X–Phosphodiester bond, Y–Glycosidic bond

73 In the given structure '*A*' represents



(a) ester bond (b) ionic bond
(c) phosphate bond (d) glycosidic bond

74 The elimination of water moiety during the formation of peptide bond is
(a) peptide hydration (b) dehydration
(c) hydration (d) reduction

75 Which of the following is the least likely to be involved in stabilising the three-dimensional (3D) folding of most proteins? ***NEET 2016***
(a) Hydrogen bonds (b) Electrostatic interaction
(c) Hydrophobic interaction (d) Ester bonds

76 In a DNA strand, nitrogenous bases pair with each other with the help of
(a) hydrogen bond
(b) van der Waals' interaction
(c) covalent bond
(d) ionic bond

77 According to Watson and Crick model of DNA
(a) DNA exists as a double helix
(b) The two strands of polynucleotide are antiparallel to each other
(c) The backbone is formed by sugar and nucleic base
(d) Both (a) and (b)

78 The form of DNA with 34Å pitch with a rise per base pair of 3.4Å is called
(a) A-DNA (b) B-DNA (c) Z-DNA (d) C-DNA

79 The pyrimidine base, which confers additional stability to DNA over RNA is
(a) adenine
(b) guanine
(c) cytosine
(d) thymine

TOPIC 4 ~ *Metabolism*

80 The term metabolism means
(a) sum of all the enzymatically catalysed chemical reactions constantly taking place in the cells and tissues of the living organisms
(b) processes that change the small molecules into larger ones
(c) processes that convert the large molecules into smaller ones
(d) None of the above

81 Choose the incorrect option.
(a) Removal of CO_2 from amino acids converts an amino acid into an amine
(b) All the biomolecules have a turnover
(c) Metabolic pathways are termed as transformation reactions
(d) Metabolic pathways always follow a linear route

82 One of the major feature of metabolic reactions is that they are … .
(a) elementary reactions
(b) non-linked reactions
(c) heat evolving reactions
(d) catalysed reactions

83 Identify, whether the given conditions are anabolic or catabolic.
I. Glucose $\longrightarrow$ Lactic acid
II. Amino acids $\longrightarrow$ Proteins
(a) I–Catabolic; II–Catabolic
(b) I–Anabolic; II–Catabolic
(c) I–Catabolic; II–Anabolic
(d) I–Anabolic; II–Anabolic

84 Catabolic and anabolic pathways are often coupled in cell because
(a) Both the paths have the same energy
(b) the free energy released from one pathway is used to drive other
(c) the intermediates of a catabolic pathway are used in the anabolic pathway
(d) their enzymes are controlled by their same activators and inhibitors

85 Biomolecules are constantly being changed into some other biomolecules and are made from … .
(a) amino acids (b) biomolecules
(c) monosaccharides (d) enzymes

86 The bond energy of which of the following chemicals is most important form of energy currency in living organisms?
(a) Adenosine Triphosphate (ATP)
(b) Nicotinamide Adenine Dinucleotide Phosphate (NADP)
(c) Flavin Adenine Dinucleotide (FAD)
(d) None of the above

87 The blood concentration of glucose and hormones in a normal healthy individual, respectively are
(a) 4.2-6.1 mM, nanograms/mL
(b) nanograms/mL, 4.5-5.0 mM
(c) 5.0-5-5 mM, nanograms/mL
(d) None of the above

88 Choose the correct option.
(a) The living state is a non-equilibrium steady state to be able to perform work
(b) The constant flow of materials for energy in and out of cell prevents the cell from reaching equilibrium
(c) Living state and metabolism are synonyms
(d) All are correct

89 Why living state cannot afford to reach equilibrium?
(a) Due to insufficiency of biomolecules
(b) To remain active all the time
(c) To save the energy
(d) None of the above

TOPIC 5 ~ *Enzymes*

90 Those nucleic acids, which behave like enzymes are known as
(a) ribozymes (b) pepzymes
(c) ribose (d) Both (a) and (b)

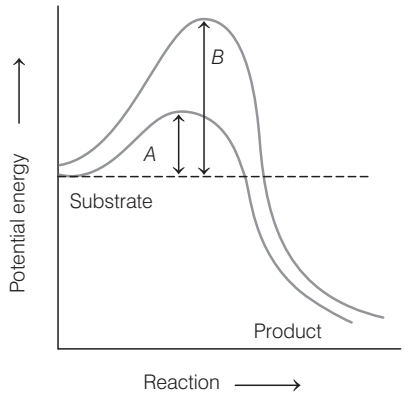
91 The crevice or pocket of an enzyme in which the substrate bind is called
(a) active site (b) inactive site
(c) allotropic site (d) Both (a) and (b)

92 Enzyme catalysts differ from inorganic catalysts in which way?
(a) Enzyme catalysts are smaller in size and lesser in weight in comparison to that of inorganic catalysts
(b) Inorganic catalysts can work efficiently at high temperature, but enzyme catalysts cannot (except few enzymes)
(c) Inorganic catalysts can work efficiently at high pressure, but enzyme catalysts cannot
(d) Both (b) and (c)

93 A physical change during a chemical reaction refers to
(a) change in shape without breaking of bonds
(b) change in state matter
(c) change in bond energy during the chemical reaction
(d) Both (a) and (b)

94 The rate of physical or chemical process can be defined as
(a) the amount of reactant consumed per unit time
(b) the amount of product formed per unit time
(c) the bond energy released during bond formation per unit time
(d) All of the above

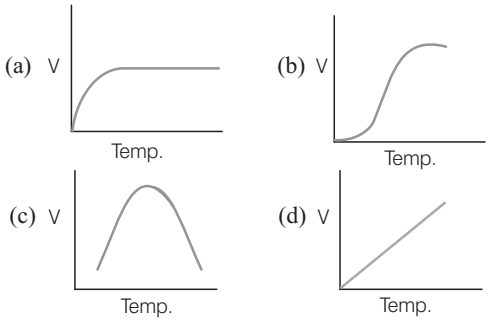
95 Which of the following describes the given graph correctly? ***NEET 2016***



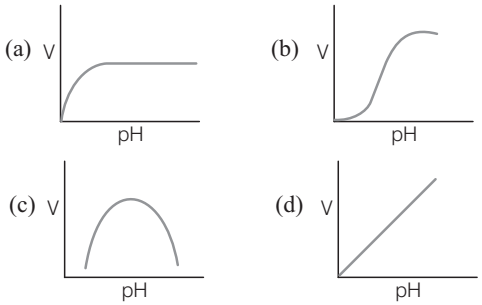
(a) Endothermic reaction with energy–A in the presence of enzyme and B in the absence of enzyme
(b) Exothermic reaction with energy–A in the presence of enzyme and B in the absence of enzyme
(c) Endothermic reaction with energy–A in the absence of enzyme and B in the presence of enzyme
(d) Exothermic reaction with energy–A in the absence of enzyme and B in the presence of enzyme

96 Choose the correct option.
(a) $E + S \longrightarrow ES \longrightarrow E + P \longrightarrow EP$
(b) $E + S \rightleftharpoons ES \longrightarrow E - P \longrightarrow E + P$
(c) $E + S \longrightarrow ES \rightleftharpoons E - P \longrightarrow E + P$
(d) $E + S \rightleftharpoons ES \rightleftharpoons E - P \rightleftharpoons E + P$

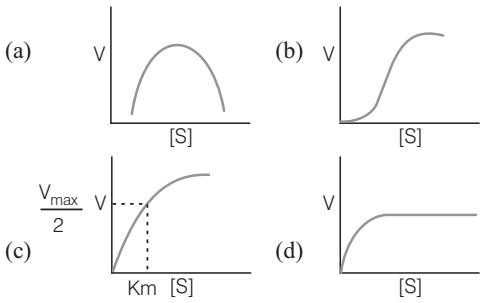
97 Select the correct graph, which shows the effect of temperature on the velocity (V) of a typical enzymatic reaction.



98 Choose the correct graph, showing the effect of pH on the velocity (V) of a typical enzymatic reaction.



99 Select the correct graph, which shows the relationship between the rate of an enzymatic activity and substrate concentration.



100 Michaelis-Menten constant (K_m) is equal to
(a) the rate of enzymatic activity
(b) the rate of reaction
(c) substrate concentration at which the rate of the reaction attains half of its maximum velocity
(d) substrate concentration at which the rate of reaction is maximum

101 When the binding of the chemical shuts off enzyme activity, the process and the chemical are respectively called as
(a) inhibition, inhibitor
(b) competition, substrate
(c) initiation, promoter
(d) None of the above

102 The inhibitor, which inhibits the enzyme activity by binding to the active site of the enzyme, due to the close resemblance to the substrate in its molecular structure is called
(a) non-competitive inhibitor (b) competitive inhibitor
(c) allosteric modulator (d) feedback inhibitor

103 Which of the following acts as a competitive inhibitor?
(a) Penicillin (b) Malonate
(c) Relenza (d) Both (b) and (c)

104 In competitive inhibition, which of the following is true?
(a) $E + I \rightleftharpoons EI$ (b) $E + I \rightleftharpoons EI + S \rightleftharpoons EIS$
(c) $S + I \rightleftharpoons SI$ (d) $ES + I \rightleftharpoons ESI$

105 How does radiation inactivate enzymes?
(a) By destroying tertiary structure
(b) By destroying primary structure
(c) By destroying secondary structure
(d) Both (a) and (b)

106 Enzymes that catalyse the removal of groups from substrates by mechanism other than hydrolysis, addition of groups to double bonds are called
(a) lyases (b) ligases
(c) hydrolases (d) dehydrogenases

107 Which enzymes catalyse the breakdown of hydrogen peroxide to water and oxygen?
(a) A carbonic anhydrase and catalase
(b) Hydrolyase and oxidase
(c) Peroxidase and catalase
(d) Hydrolase and oxidase

108 What are proenzymes?
(a) Inactive form of enzymes
(b) Active form of enzymes
(c) Neutral form of enzymes
(d) None of the above

109 Transition state structure of the substrate formed during an enzymatic reaction is ***NEET 2013***
(a) transient, but stable
(b) permanent, but unstable
(c) transient and unstable
(d) permanent and stable

110 The inhibitor, which binds to the enzyme at site other than the active site and does not resemble the substrate in structure is called
(a) activator (b) substrate analogue
(c) competitive inhibitor (d) non-competitive inhibitor

111 Enzymes that catalyse hydrolysis of ester bonds are
(a) hydrolases (b) lyases
(c) transferases (d) ligases

112 Select the option, which is not correct with respect to enzyme action. ***CBSE-AIPMT 2014***

(a) Substrate binds with enzyme at its active site
(b) Addition of a lot of succinate does not reverse the inhibition of succinic dehydrogenase by malonate
(c) A non-competitive inhibitor binds the enzyme at a site distinct from that, which binds the substrate
(d) Malonate is a competitive inhibitor of succinic dehydrogenase

113 Prosthetic groups differ from coenzymes in that ***NEET (Odisha) 2019***

(a) they require metal ions for their activity
(b) they (prosthetic groups) are tightly bound to apoenzymes
(c) their association with apoenzymes is transient
(d) they can serve as cofactors in a number of enzyme catalysed reactions

114 Which one of the following statements is correct, with reference to enzymes? ***NEET 2017***

(a) Apoenzyme = Holoenzyme + Coenzyme
(b) Holoenzyme = Apoenzyme + Coenzyme
(c) Coenzyme = Apoenzyme + Holoenzyme
(d) Holoenzyme = Coenzyme + Cofactor

115 Non-protein constituents bound to enzyme, which make enzymes catalytically more active are

(a) cofactors (b) co-ions
(c) inhibitor (d) Both (a) and (b)

116 Apoenzymes are …… portion of the enzyme.

(a) acidic (b) non-protein
(c) protein (d) basic

117 The cofactors that associate with the apoenzyme only during course of catalysis are called as

(a) cofactors (b) coenzymes
(c) metal ions (d) prosthetic group

118 Zinc is a cofactor for which enzyme?

(a) Trypsin (b) Peroxidase
(c) Carboxypeptidase (d) Apoenzyme

NEET

SPECIAL TYPES QUESTIONS

I. Assertion and Reason

■ **Direction** (Q. No. 119-128) *In each of the following questions, a statement of Assertion (A) is given followed by corresponding statement of Reason (R). Of the statements, mark the correct answer as*

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true, but R is not the correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

119 **Assertion** (A) In the solutions of different pH, structure of amino acids changes.
Reason (R) It is because of the ionisable nature of —NH_2 and —COOH groups.

120 **Assertion** (A) Eight amino acids are referred to as essential amino acids for humans.
Reason (R) These are synthesised in the human body.

121 **Assertion** (A) Zinc is an apoenzyme for carboxypeptidase.
Reason (R) A complete catalytically active enzyme together with its bound prosthetic group is called apoenzyme.

122 **Assertion** (A) Arachidic acid is an unsaturated fatty acid.
Reason (R) There are one or more variable double bonds between carbon atoms in unsaturated fatty acids.

123 **Assertion** (A) Starch is a polymer of glucose.
Reason (R) It is made of several glucose units.

124 **Assertion** (A) Coenzyme is a non-protein group without which certain enzymes are inactive or incomplete.
Reason (R) Coenzymes not only provide a point of attachment of the chemical group being transformed, but also influence the properties of the group.

125 **Assertion** (A) Competitive inhibitor is also called substrate analogue.
Reason (R) It resembles the enzymes in structure.

126 **Assertion** (A) Enzymes lower down the activation energy of the reactant molecule to make its transition into product easier.
Reason (R) Enzymes are highly substrate specific catalysts.

127 **Assertion** (A) An example of non-competitive inhibitor is cyanide.
Reason (R) Cyanide kills animals by inhibiting cytochrome oxidase.

128 **Assertion** (A) Enzymes are not divided into different classes.
Reason (R) All enzymes catalyse the different reactions.

II. Statement Based Questions

129 Which of the following option is incorrect?
(a) All the elements present in a sample of earth's crust are also present in a sample of living tissue
(b) The relative abundance of carbon and hydrogen with respect to other elements is higher in any living organism than in earth's crust
(c) The % weight of nitrogen in earth's crust is very high in comparison to human body
(d) The % weight of silicon in earth's crust is very high in comparison to human body

130 Which of the following option(s) is correct?
(a) Palmitic acid has sixteen carbon atoms including carboxyl carbon
(b) Arachidonic acid has twenty carbon atoms excluding carboxyl carbon
(c) Stearic acid has eighteen carbon atoms excluding carboxyl carbon
(d) All are correct

131 Choose the incorrect statement with respect to polysaccharides.
(a) Inulin is a heteropolysaccharide
(b) Cellulose given no colour with iodine solution
(c) Starch gives blue colour and glycogen gives red colour with iodine solution
(d) Inulin is a homopolymer of fructose

132 Select the incorrect statement.
(a) Adult haemoglobin molecule is composed of four polypeptide chains–two α-chains and two β-chains
(b) Haemoglobin is a type of quaternary protein structure
(c) Fibrinogen and thrombin are blood clotting proteins
(d) In the primary structure of a protein, the first amino acid is called C-terminal acid

133 Choose the correct statement(s) with respect to proteins.
(a) In proteins, only right handed helices are observed
(b) Proteins cannot form quaternary structures
(c) Quaternary structures of proteins always involve two polypeptide subunits
(d) All of the above

134 Choose the incorrect statement.
(a) Cholesterol is the most abundant steroid in the animal tissue
(b) Arachidonic acid has 20 carbon atoms including the carboxyl carbon
(c) Glycerides are esters of fatty acid with glycerol
(d) Prostaglandins are derived from steroids

135 Identify the correct statement from those given below.
(a) Lipids with molecular weight not exceeding 800 Da comes under acid soluble fraction
(b) The acid soluble fraction have four types of organic compounds, i.e. proteins, nucleic acids, polysaccharides and lipids
(c) The macromolecules from cytoplasm and organelles become the acid insoluble fraction
(d) The acid insoluble pool represents roughly the cytoplasmic composition of cells

136 Which one of the following statements is incorrect?
NEET 2016
(a) Cellulose is a polysaccharide
(b) Uracil is a pyrimidine
(c) Glycine is a sulphur containing amino acid
(d) Sucrose is a disaccharide

137 Which of the following statements is/are correct?
(a) Living steady state has a self-regulatory mechanism called homeostasis
(b) Energy flow and energy transformation of living system follow law of thermodynamics
(c) Metabolism is the release and gain of energy
(d) All of the above

138 Which one of the following statements is incorrect?
CBSE-AIPMT 2015
(a) A competitive inhibitor reacts reversibly with the enzyme to form an enzyme-inhibitor
(b) In competitive inhibition, the inhibitor molecule is not chemically changed by the enzyme
(c) The competitive inhibitor does not affect the rate of breakdown of the enzyme-substrate complex
(d) The presence of the competitive inhibitor decreases the K_m of the enzyme for the substrate

139 Which of the following statements is/are correct?
(a) Relative abundance of carbon and hydrogen with respect to other elements is higher in any living organisms
(b) Living organisms have more nitrogen and oxygen per unit mass than inanimate objects (e.g. earth's crust)
(c) All the elements present in a sample of earth's crust are also present in a sample of living tissue
(d) All of the above

140 Choose the incorrect statement.
(a) Simple lipid is glycerol which is trihydroxy propane
(b) Many lipids have both glycerol and fatty acids
(c) Oils have high melting point
(d) Phospholipids have phosphorus and a phosphorylated organic compound in them

141 Which of the following statements is/are incorrect?
I. Left end of a polysaccharide is called non-reducing end, while right end is called reducing end.
II. Starch and glycogen are branched molecules.
III. Starch and glycogen are the reserve food materials of plants and animals, respectively.
IV. Starch can hold iodine molecules in its helical secondary structure, but cellulose being non-helical, cannot hold iodine.
(a) I and II
(b) All statements are incorrect
(c) Only IV
(d) None of the above

142 Which of the following statements is/are correct for polysaccharides?

I. The polysaccharides are found as a part of the acid insoluble pellet.

II. These are long chains of sugars.

III. They are threads containing different monosaccharides as building blocks.

IV. Cellulose is a polymeric polysaccharide consisting of only one type of monosaccharide, i.e. fructose.

V. Inulin is a polymer of fructose.

(a) All are correct (b) All are correct except IV

(c) III and IV (d) Only IV

143 Consider the following statements.

I. Haemoglobin is an example of quaternary structure of proteins.

II. Haemoglobin molecule is composed of four polypeptide chains-two α- chains and two β-chains.

(a) I is true, but II is false (b) II is true, but I is false

(c) Both I and II are true (d) Both I and II are false

144 Choose the correct statements.

I. Bond energy (ATP) is utilised for biosynthesis, osmotic and mechanical work that we perform.

II. When glucose is degraded into lactic acid in our muscles, energy is liberated.

III. Assembly of a protein from amino acid requires energy.

IV. Majority of metabolic reactions can occur in isolation.

V. There are many examples of uncatalysed metabolic reactions.

(a) IV and V (b) I and III

(c) I, II and III (d) None of these

145 Which of the following statements are correct?

I. Acetic acid can form cholesterol.

II. Flow of metabolites through metabolic pathway has a definite rate and direction. It is called dynamic state of body constituents.

III. Anabolic pathway is endergonic, while catabolic pathway is exergonic.

IV. All biomolecules have a turn over, i.e. they are constantly being changed into some other biomolecules and also made from other biomolecules.

(a) I, II, III and IV

(b) I and II

(c) III and IV

(d) Only IV

146 Which of the following statements about enzymes are correct?

I. Enzymes do not alter the overall change in free energy for a reaction.

II. Enzymes are highly specific for reactions.

III. The energy input needed to start a chemical reaction is called activation energy.

IV. Enzymes are proteins whose three dimensional shape is key to their functions.

(a) I and V (b) I, II and V

(c) II and V (d) All of these

147 Arrange the steps of catalytic action of an enzyme in order and choose the correct option.

I. The enzyme releases the products of the reaction and gets free for another substrate.

II. The active site of enzyme is in close proximity of the substrate and breaks chemical bonds of the substrate.

III. The binding of substrate induces the enzyme to alter its shape, fitting more tightly around the substrate.

IV. The substrate binds to the active sites of the enzyme, fitting into the active sites.

(a) IV $\rightarrow$ III $\rightarrow$ II $\rightarrow$ I (b) III $\rightarrow$ II $\rightarrow$ I $\rightarrow$ IV

(c) IV $\rightarrow$ II $\rightarrow$ I $\rightarrow$ III (d) II $\rightarrow$ I $\rightarrow$ IV $\rightarrow$ III

148 Consider the following statements.

I. Most of the enzymes are proteins, which catalyse biochemical reactions.

II. The enzyme itself is unchanged in the reaction, its presence allows the reaction to take place.

Choose the correct option.

(a) I is true, but II is false (b) II is true, but I is false

(c) Both I and II are true (d) Both I and II are false

149 Consider the following statements.

I. Enzymes lower the activation energy of the reaction.

II. Higher activation energy helps the molecules to react with greater rate.

Choose the correct option.

(a) I is true, but II is false (b) II is true, but I is false

(c) Both I and II are true (d) Both I and II are false

150 Consider the following statements.

I. Coenzyme or metal ion that is tightly bound to enzyme protein is called prosthetic group.

II. A complete catalytic active enzyme with its bound prosthetic group is called apoenzyme.

Choose the correct option.

(a) I is true, but II is false (b) II is true, but I is false

(c) Both I and II are true (d) Both I and II are false

151 Consider the following statements.

I. Plant cell walls are made of cellulose.

II. Plant pulp and cotton fibre are cellulosic.

III. Glucosamine and N-acetyl galactosamine are complex polysaccharides.

IV. Chitin is present in exoskeleton of arthropods.

V. Complex polysaccharides are mostly homopolymers.

Choose the correct option.

(a) I and II are true (b) II and III are true

(c) IV and V are false (d) All of these are true

152 Consider the following statements.

I. Cofactor plays a crucial role in the catalytic activity of the enzyme.

II. Catalytic activity is lost when cofactor is removed from the enzyme.

(a) I is true, but II is false (b) II is true, but I is false
(c) Both I and II are true (d) Both I and II are false

III. Matching Type Questions

153 Match the following columns.

Column I (Components)	Column II (% of the total cellular mass)
A. Water	1. 10-15
B. Proteins	2. 70-90
C. Carbohydrates	3. 5-7
D. Lipids	4. 3
E. Nucleic acids	5 . 2

Codes

	A	B	C	D	E
(a)	1	3	2	4	5
(b)	2	1	4	5	3
(c)	1	2	3	4	5
(d)	5	3	2	1	4

154 Match the following columns.

Column I		Column II
A. Fructose	1.	Protein
B. Galactose	2.	Phospholipid
C. Anticoagulant	3.	Brain sugar
D Insulin	4.	Heparin
	5.	Fruit sugar

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	4	5	(b)	5	2	4	1
(c)	5	3	4	1	(d)	1	3	5	1

155 Match the following columns.

Column I		Column II
A. Triglycerides	1.	Galactose
B. Lactose	2.	Glycerol
C. RNA	3.	Palmitic acid
D. β-pleated	4.	Uracil
E. Beeswax	5.	Secondary structure

Codes

	A	B	C	D	E
(a)	4	1	5	2	3
(b)	5	1	4	2	3
(c)	3	1	4	5	2
(d)	2	1	4	5	3

156 Match the following columns.

Column I (Categories)		Column II (Examples of secondary metabolite)
A. Alkaloids	1.	Lemon grass oil
B. Terpenoids	2.	Ricin
C. Toxins	3.	Diterpene
D. Essential oil	4.	Codeine

Codes

	A	B	C	D		A	B	C	D
(a)	4	3	2	1	(b)	1	2	3	4
(c)	3	2	4	1	(d)	2	3	1	4

157 Match the following columns.

Column I (Categories)		Column II (Features)
A. Prosthetic group	1.	Coordination bond with apoenzyme
B. Coenzyme	2.	Tightly bound to apoenzyme
C. Metal ions cofactor	3.	Transient binding with apoenzyme

Codes

	A	B	C		A	B	C
(a)	2	3	1	(b)	3	2	1
(c)	2	1	3	(d)	1	2	3

158 Match the following columns.

Column I (Categories)		Column II (Examples)
A. Prosthetic group	1.	NAD
B. Cofactor	2.	Haem
C. Coenzyme	3.	Zn ions

Codes

	A	B	C		A	B	C
(a)	2	3	1	(b)	1	2	3
(c)	3	1	2	(d)	2	1	3

159 Match the following columns.

Column I (Enzymes)		Column II (Characteristics)
A. Dehydrogenases	1.	Interconversion of optical, geometrical positional isomers
B. Ligases	2.	Group transfer
C. Isomerases	3.	Oxidoreduction between two substrates
D. Hydrolases	4.	Linking together of two bonds
E. Transferases	5.	Hydrolysis of bonds

Codes

	A	B	C	D	E
(a)	5	4	1	2	3
(b)	4	3	5	2	1
(c)	5	4	2	3	1
(d)	3	4	1	5	2

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

160 Tertiary structure in a protein
(a) defines amino acid sequence of a protein
(b) is formed by disulphide linkages and van der Waal's forces
(c) is responsible for the formation of catalytic site
(d) All of the above

161 Quantitative test for proteins includes
(a) Sudan black test
(b) Tollens test
(c) Xanthoproteic test
(d) Iodine test

162 Triglycerides are composed of
(a) glycerol
(b) ester bonds
(c) unsaturated fatty acids
(d) All of the above

163 Ribonucleic acid on rough endoplasmic reticulum shows the presence of
(a) sugar phosphate bonds on both strands
(b) *o*-glycosidic bonds
(c) phosphodiester linkages
(d) peptide bonds from $5' \rightarrow 3'$ end

164 Properties defining enzyme activity include the
(a) correct folding at primary level of organisation
(b) presence or absence of optimum temperature and pH
(c) presence of substrate concentration that increases initially and then attains V_{max}
(d) All of the above

NCERT Exemplar

165 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 the correct answer from 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

166 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

167 When we homogenise any tissue in an acid, the acid soluble pool represents
(a) cytoplasm (b) cell membrane
(c) nucleus (d) mitochondria

168 The most abundant chemical in living organisms could be
(a) protein (b) water
(c) sugar (d) nucleic acid

169 Glycogen is a homopolymer made of
(a) glucose units (b) galactose units
(c) ribose units (d) amino acids

170 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

171 Which of the following sugars have the same number of carbon as present in glucose?
(a) Fructose (b) Erythrose
(c) Ribulose (d) Ribose

172 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) Glycolic acid (d) Glycine

173 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) zwitter ion form

174 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 monomers

175 Proteins perform many physiological functions, e.g. some functions as enzyme. One of the following represents an additional function that some proteins discharge.

(a) Antibiotics

(b) Pigments conferring colour to skin

(c) Pigments making colour of flowers

(d) Hormones

176 The primary structure of a protein molecule has

(a) two ends (b) one end

(c) three ends (d) no ends

177 An acid soluble compound formed by phosphorylation of nucleoside is called

(a) nitrogen base

(b) adenine

(c) sugar phosphate

(d) nucleotide

178 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

Answers

Mastering NCERT with MCQs

1	(a)	2	(a)	3	(b)	4	(c)	5	(b)	6	(c)	7	(b)	8	(a)	9	(d)	10	(c)	11	(a)	12	(d)	13	(b)	14	(d)	15	(c)
16	(d)	17	(a)	18	(c)	19	(a)	20	(d)	21	(b)	22	(a)	23	(a)	24	(b)	25	(b)	26	(c)	27	(a)	28	(b)	29	(a)	30	(b)
31	(c)	32	(b)	33	(d)	34	(d)	35	(d)	36	(a)	37	(a)	38	(b)	39	(a)	40	(a)	41	(c)	42	(d)	43	(d)	44	(b)	45	(d)
46	(b)	47	(d)	48	(b)	49	(b)	50	(a)	51	(c)	52	(d)	53	(b)	54	(d)	55	(c)	56	(d)	57	(d)	58	(a)	59	(a)	60	(b)
61	(c)	62	(b)	63	(a)	64	(b)	65	(a)	66	(a)	67	(c)	68	(d)	69	(c)	70	(b)	71	(a)	72	(b)	73	(a)	74	(b)	75	(d)
76	(a)	77	(d)	78	(b)	79	(d)	80	(a)	81	(d)	82	(d)	83	(c)	84	(c)	85	(b)	86	(a)	87	(a)	88	(d)	89	(b)	90	(a)
91	(a)	92	(d)	93	(d)	94	(b)	95	(b)	96	(b)	97	(c)	98	(c)	99	(c)	100	(c)	101	(a)	102	(b)	103	(d)	104	(a)	105	(a)
106	(a)	107	(c)	108	(a)	109	(c)	110	(d)	111	(a)	112	(b)	113	(b)	114	(b)	115	(a)	116	(c)	117	(b)	118	(c)				

NEET Special Types Questions

119	(a)	120	(c)	121	(d)	122	(d)	123	(a)	124	(a)	125	(c)	126	(b)	127	(b)	128	(d)	129	(c)	130	(a)	131	(a)	132	(d)	133	(a)
134	(d)	135	(c)	136	(c)	137	(d)	138	(d)	139	(d)	140	(c)	141	(d)	142	(b)	143	(c)	144	(c)	145	(a)	146	(d)	147	(a)	148	(c)
149	(a)	150	(a)	151	(d)	152	(c)	153	(b)	154	(c)	155	(d)	156	(a)	157	(a)	158	(a)	159	(d)								

NCERT & NCERT Exemplar Questions

160	(d)	161	(c)	162	(d)	163	(c)	164	(d)	165	(c)	166	(a)	167	(a)	168	(b)	169	(a)	170	(a)	171	(a)	172	(d)	173	(d)	174	(a)
175	(d)	176	(a)	177	(d)	178	(a)																						

Answers & Explanations

1 (*a*) After performing the chemical analysis of organic compounds found in living organisms, two types of organic compounds were observed. They were the filtrate fraction or the acid soluble pool and the retentate fraction or the acid insoluble pool.

3 (*b*) After grinding a living tissue in trichloroacetic acid the inorganic compounds like sulphate, phosphate, etc., are present in acid soluble fraction. This fraction consists of biomicromolecules (i.e. amino acids, nucleotides, etc.) and inorganic compounds. The acid insoluble fraction consists of biomacromolecules (i.e. proteins, nucleic acids, etc).

5 (*b*) After burning the dry tissue, all the organic compounds are oxidised to gaseous form (CO_2 and water vapour) and are removed. The material left which contains inorganic elements (e.g. calcium, magnesium, etc) is termed 'ash'.

7 (*b*) Amino acids are said to be organic compounds which contain an amino group and an acidic group as substituents on the same carbon, i.e. the α-carbon. Hence, these are also called α-amino acids.

8 (*a*) The four substituent groups occupying the four valency positions in an amino acids are hydrogen, carboxyl group, amino group and a variable group designated as *R*-group.

13 (*b*) The given structures are as follows

A–Alanine–*R*-group is methane.

B–Glycine–*R*-group is hydrogen.

C–Serine–*R*-group is hydroxy methane.

15 (*c*) B is the zwitter ion form because a zwitter ion is a dipolar ion with both positive and negative ion groups.

19 (*a*) Saturated fatty acids possess single bond between carbon atoms. They have a high melting point and are solid at room temperature, e.g. palmitic acid, stearic acid. Whereas unsaturated fatty acids contain one or more double bonds in between their carbon atoms. They have a low melting point and are liquid at room temperature, e.g. linoleic acid, oleic acid.

20 (*d*) Lipids are not polymeric compounds. Polymers are substances formed by the polymerisation of monomers. But the basic unit of lipids are fatty acids and glycerol molecules that do not form repetitive chains.

Instead they form triglycerides from three fatty acids and one glycerol molecule. Other options like

Proteins are polymers of amino acids, carbohydrates are polymers of monosaccharides and nucleic acids are polymers of nucleotides.

21 (*b*) Omega 3 fatty acids are present in flax seed oil. These are Polyunsaturated Fatty Acids (PUFAs). They are important for normal metabolism. Mammals are unable to synthesise omega 3 fatty acids.

22 (*a*) Vitamin-B is not a derivative of cholesterol. It is not a single vitamin, but a family of different vitamins known as B-complex. These are water soluble and are derivative of amino acids not lipids.

23 (*a*) Structure in option (a) is correct representation of citrulline. It is an α-amino acid with molecular formula $H_2NC(O)NH(CH_2)_3CH(NH_2)CO_2H$. It is the part of urea cycle taking place in the body.

25 (*b*) Phospholipids are the main constituents of lecithin. These molecules are composed of choline and inositole. It is found in all living cells and serves as a major component of cell membrane.

26 (*c*) Living organisms have a number of carbon compound in which heterocyclic rings can be found. Some of these are the nitrogen bases, i.e. adenine, guanine, cytosine, uracil and thymine.

27 (*a*) Nucleotides are formed when a phosphate group is esterified to the sugar molecule of a nucleoside. In simple words, a nucleoside with a phosphate group forms a nucleotide.

28 (*b*) Option (b) is correct and can be explained as follows

I. Guanine (Nitrogen base) + X (Sugar molecule) ⟶ Guanosine (Nucleoside)

II. Guanosine (Nucleoside) + Y (Phosphate group) ⟶ Guanylic acid (Nucleotide)

29 (*a*) Option (a) is correct. Other options are incorrect and can be corrected as

- Cytidine is a nucleoside.
- Sugar and nitrogenous base are common in both nucleotides and nucleosides.
- DNA and RNA consist of nucleotides only.

32 (*b*) The four main elements termed as the 'Big four' and are found in a living system, which make 95% of all elements are

Carbon	–	18.5%
Hydrogen	–	0.5%
Oxygen	–	65%
Nitrogen	–	3.3%

35 (*d*) Primary metabolites are present in all living tissues. These include amino acids, sugars (e.g. glucose, fructose) etc. They play a major role in different physiological processes of the body including growth, development and reproduction.

36 (*a*) Vinblastin treat cancer and curcumin (haldi) has several medicinal property. Thus, these are secondary metabolites used as drugs.

37 (*a*) Option (a) contains the correct information. Rest are incorrect and can be corrected as

- Alkaloids — Morphine
- Toxins — Abrin, ricin
- Polymeric substances — Rubber, gums, cellulose

38 (*b*) Concanavalin A is a lectin or a carbohydrate binding protein. It is a T-cell mitogen that can activate the immune system, recruit lymphocytes and elicit cytokine production. It can also induce programmed cell death *via* mitochondria-mediated apoptosis.

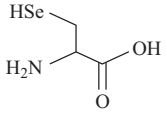
42 (*d*) Flavonoids and alkaloids are secondary metabolites. These are with very less molecular weight (i.e. less than 1000 dalton). Thus, are not found in acid insoluble fraction, as this fraction comprises of biomacromolecules.

43 (*d*) Upon grinding a tissue, cell membrane and other membranes are broken into pieces and form vesicles, which are not water soluble and get separated along with the acid insoluble pool. Since, lipids are the constituents of cell membrane and are water unsoluble, these also form vesicles and get separated in the acid insoluble pool.

47 (*d*) Option (d) is correct.

Proteins are polymers of amino acids. These are divided into two categories; essential and non-essential amino acids. Essential amino acids cannot be synthesised in the body and therefore must be included in the diet. Proteins are used as structural components of tissues and also as channels, transporters, regulatory molecules and enzymes. Proteins can also be utilised as energy sources. Normally, this is a secondary function and becomes important only when there is not enough carbohydrate and fat in the body, e.g. during fasting.

48 (*b*) Selenocysteine (Sec) is the 21st amino acid in the genetic code. This amino acid contains selenium. Its structure has been given below



49 (*b*) Ramachandran plot is used to confirm the structure of proteins. It is a plot of the angles-phi (ϕ) and psi (ψ) of amino acids found in a peptide chain. This plot was

developed by GN Ramachandran, an Indian Scientist in 1963.

50 (*a*) Protein on reaction with ninhydrin yields Ruhemann's purple which is deep blue to purple in colour. Chemically it is 2-2 dihydroxy in dane-1, 3, dion. It is used to detect ammonia, primary and secondary amines in a samples.

53 (*b*) Option (b) contains the correct match. Rest of the matches are incorrect and can be corrected as

Proteins	Functions
Collagen	Intercellular ground substance
Trypsin	Enzyme
Insulin	Hormone

54 (*d*) Sugars characteristically possess two functional groups, i.e. carbonyl and hydroxyl. Sugars are chemically carbohydrates. They are polyhydroxy aldoses, ketoses and their condensation products. Aldoses bear a terminal aldehyde or —CHO group while ketoses have an internal ketone or —CO group.

56 (*d*) A represents 1, 4α-glycosidic bonds as the glucose residues in glycogen are linked by this bond.
B represents 1, 6α-glycosidic bonds as this bond creates branches in glycogen.

57 (*d*) Homopolysaccharides are composed of monosaccharide molecules of a single type. They include three biologically important substances glycogen, starch and cellulose.

58 (*a*) For nucleic acids, the building block is a nucleotide. A nucleotide has three chemically distinct components, i.e. one is a heterocyclic nitrogenous base compound, second is a pentose monosaccharide and the third is a phosphoric acid or a phosphate group.

60 (*b*) Adenine and guanine are substituted purines, while the rest, i.e. uracil, cytosine and thymine, are substituted pyrimidines.

63 (*a*) Structure 'A' represents adenine, which is a substituted purine.
Structure 'B' represents adenosine, which is a nucleoside.
Structure 'C' represents adenylic acid, which is a nucleotide.

66 (*a*) In proteins, the left end represented by the first amino acid is termed as the N-terminal amino acid due to the presence of a free amino group. The right end represented by the last amino acid is termed as the C-terminal amino acid due to the presence of a free carboxyl group.

67 (*c*) A represents the primary structure of proteins.
B represents the quarternary structure of proteins.
C represents the tertiary structure of proteins.
D represents the secondary structure of proteins.

68 (*d*) Option (d) is correct.
- Alpha helix (A) is formed by the formation of H-bond between the NH group of one amino acid and the CO group of another amino acid located three or four residues earlier along the protein sequence.
- β-pleated sheet (B) is formed by the formation of at least two to three hydrogen bonds between two or more protein strands laterally.
- Tertiary protein structure (C) is formed by the bending and folding of two or more protein secondary structures.
- Quarternary protein structure (D) consists of an assembly of two or more polypeptides or subunits. It is formed by further folding in two or more tertiary protein structures.

72 (*b*) Given figure represents a part of DNA molecule in which bond X represents the phosphodiester bond and Y represents the hydrogen bond.

73 (*a*) In the given structure, a represents the ester bond formed by condensation reactions, involving elimination of water.

75 (*d*) Ester bond is formed between sugar and phosphate in a nucleotide and is not involved in stabilising the three dimensional (3D) folding of most proteins. The tertiary protein structure is the 3D structure of protein. It is stabilised by the use of hydrogen bond, ionic bond, van der Waals' interactions, covalent bond and hydrophobic bond.

76 (*a*) In a DNA strand, nitrogenous bases pair with each other with the help of hydrogen bonds. There are two hydrogen bonds between A and T and three hydrogen bonds between G and C.

77 (*d*) Both options (a) and (b) are correct with respect to the structure of DNA elucidated by Watson and Crick.
Option (c) is incorrect and can be corrected as
The backbone of DNA is formed by the sugar phosphate sugar chain.

78 (*b*) In one form of DNA, each DNA strand appears like a helical staircase and each step of ascent is represented by a pair of bases. At each ascent step, the pitch would be 34 Å and the rise per base pair would be 3.4 Å. This form of DNA is called the B-DNA.

79 (*d*) In DNA, thymine (5-methyl uracil) is present, which provides extra stability to DNA as it does not contain 2′—OH group like uracil, which is present in RNA in place of thymine.

81 (*d*) The option (c) is incorrect and can be corrected as
Metabolic pathways not always follow linear routes. They are circular sometimes. These pathways *criss-cross* each other.

83 (*c*) Glucose is degraded into lactic acid in skeletal muscles by a catabolic process through which energy is liberated.
Assembly of a protein from amino acids requires energy and hence, it is an anabolic process.

86 (*a*) The bond energy of Adenosine Triphosphate (ATP) is the most important form of energy currency in living organisms.
On conversion of ADP into ADP and inorganic phosphate there released 7.3 Kcal/mol of energy.

89 (*b*) To remain active all the time is the ability of living state. As a system at equilibrium cannot perform work thereby, beoming dead.

Therefore, as living organisms work continuously, they make a constant effort to prevent falling into equilibrium.

92 (*d*) Both options (b) and (c) are correct.

As inorganic catalyst works efficiently at high temperature and pressure, while enzymes gets damaged at high temperature (say above 40ºC). However few enzymes isolated from thermophilic organisms works at up to 80º-90ºC. Other incorrect statement can be corrected as

Enzyme catalysts are larger in size and higher in weight in comparison to that of inorganic catalyst.

95 (*b*) The graph shows exothermic reaction. The reaction graph depicted by A states its occurrence in the presence of enzyme as it lowers down the activation energy substantially. The B graph shows this reaction occurring in the absence of enzyme when activation energy is quite high. Thus, option (b) is correct.

96 (*b*) Each enzyme (E) has a substrate (S) binding site in its molecule, so that a highly reactive enzyme substrate complex (ES) is produced. This complex is short-lived and dissociates into its product and the unchanged enzyme with an intermediate formation of the enzyme product complex (EP).

Thus, the correct representation is

$$E + S \rightleftharpoons ES \longrightarrow E - P \longrightarrow E + P$$

98 (*c*) Each enzyme shows its maximum activity at a particular pH and temperature, known as optimum pH and optimum temperature respectively. Before and after, this optimum pH or temperature the enzyme activity is less.

Thus, graph in option (c) is correct showing the effect of pH on the velocity of a typical enzymatic reaction.

99 (*c*) When enzyme molecules are more in number than substrate molecules, a progressive increase in the substrate molecules (S), increases the rate or velocity (V) of their conversion to products.

However, eventually the rate of reaction reaches a maximum. At this stage, the active sites of all the available enzyme molecules are occupied by the substrate molecules. Therefore, the substrate molecules occupy the active sites vacated by the products and cannot increase the rate of reaction further. Thus, the graph given in option (c) is correct.

100 (*c*) Michaelis Menten constant (K_m) is equal to the substrate concentration at which the velocity of the reaction is half of the maximum velocity. It is inversely proportional to the enzyme activity.

101 (*a*) The activity of an enzyme is also sensitive to the presence of specific chemicals that bind to the enzyme. When the binding of the chemical shuts off enzyme activity, the process is called inhibition and the chemical involved is called as inhibitor.

103 (*d*) Both malonate and Relenza (synthetic drug) act as a competitive inhibitors. Whereas penicillin (antibiotic) is a non-competitive inhibitor.

105 (*a*) Radiation inactivate enzymes by destroying their tertiary structure. As mostly all enzymes are proteins and proteins are found in our biological systems are tertiary proteins. Thus, if their structure is broken down they will be become inactive and functionless.

112 (*b*) Option (b) is incorrect with respect to enzyme action and can be corrected as

Addition of a lot of succinate reverses the inhibition of succinic dehydrogenase by malonate. Inhibition of succinic dehydrogenase by malonate is an example of competitive inhibition. Thus, both enzyme and inhibitor compete for the active site of enzyme owing to structural similarity resulting in the decrease of the enzymatic activity.

Rest of the options are correct.

113 (*b*) Prosthetic groups are organic compounds and are distinguished from other cofactors in that they are tightly bound to the apoenzyme. For example, in peroxidase and catalase, which catalyse the breakdown of hydrogen peroxide to water and oxygen, haem is the prosthetic group and it is a part of the active site of the enzyme.

Co-enzymes are also organic compounds, but their association with the apoenzyme is only transient, usually occurring during the course of catalysis.

114 (*b*) Option (b) gives the correct representation.

Holoenzyme It is a conjugate complete catalytically active enzyme together with its coenzyme.

Apoenzyme The protein part of catabolically active enzyme is called apoenzyme.

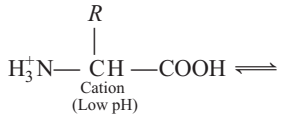
Coenzyme Some enzymes require additional organic or metallo-organic molecules for their activity. These molecules are called coenzyme.

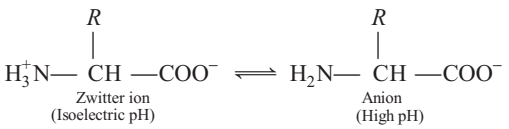
So, holoenzyme is apoenzyme together with coenzyme hence, option (b) is correct.

119 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Amino acids have a particular property, i.e. the ionisable nature of —NH_2 and —COOH groups. Hence, in solutions of different pH, the structure of amino acids changes.

In a neutral solution, the amino acid molecule exists as a dipolar ion (zwitter ion) having both positive and negative ion groups. The charge on this ion changes with the pH. In acid solutions (low pH), the amino group of amino acid picks up H^+ ions and becomes positively charged. On the other hand, in alkaline solution (high pH), the amino acid donates H^+ ions to the medium and becomes negatively charged.





120 (*c*) Assertion is true, but Reason is false and can be corrected as

Eight amino acids are referred to as the essential amino acids for humans. These must be ingested through diet, since they are not synthesised in the human body.

121 (*d*) Assertion is false, but Reason is true and Assertion can be corrected as

Zinc is the cofactor for the proteolytic enzyme, carboxypeptidase.

122 (*d*) Assertion is false, but Reason is true and Assertion can be corrected as

Arachidic acid is a saturated fatty acid found in peanut oil. It is with 20 carbon chain.

123 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Starch is a homopolysaccharide made up of several glucose monomer units.

124 (*a*) Both Assertion and Reason are true and Reason is correct explanation of Assertion.

Coenzyme is a non-protein group that activates certain enzymes. This occurs as coenzymes provide a point of attachment to the chemical group being transformed and also influences its properties.

125 (*c*) Assertion is true, but Reason is false and can be corrected as

Competitive inhibitor resembles the substrate in structure.

126 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

The correct explanation would be energy

Enzymes are able to lower the activation of the reactant molecule by binding to and placing the substrate in close proximity to other substrates and catalytic groups, so that less energy is required to enable interaction between them.

Another way is that enzymes may provide charged side groups in their amino acid structure to help stabilise transition states between the initial and final products.

127 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

The correct explanation would be

Cyanide is an example of non-competitive inhibitor as it can attach to the enzyme at a region other than the active site and inhibits its activity.

128 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Enzymes, mostly have been categorised into six different classes on the basis of the reactions they catalyse.

The six classes of enzymes are oxidoreductases, transferases, hydrolases, lyases, ligases and isomerases.

129 (*c*) The statement in option (c) is incorrect and can be corrected as

The percentage weight of nitrogen in the earth's crust is very low as compared to that in the human body.

Rest of the options are correct.

130 (*a*) The statement in option (a) is correct. Rest of the statements are incorrect and can be corrected as

- Arachidonic acid has 20 carbon atoms including the carboxyl carbon atom.
- Stearic acid has 18 carbon atoms including the carboxyl carbon atom.

131 (*a*) The statement in option (a) is incorrect with respect to polysaccharides. It can be corrected as

Insulin is a homopolysaccharide. It is a polymer of fructose.

Rest of the statements are correct.

132 (*d*) The statement in option (d) is incorrect about proteins. It can be corrected as

In the primary structure of a protein, the first amino acid is called the N-terminal amino acid. The last amino acid is termed as the C-terminal amino acid.

Rest of the statements are correct.

133 (*a*) The statement in option (a) is correct with respect to proteins. Rest of the statements are incorrect and can be corrected as

- Proteins form quarternary structures.
- Quarternary structures of proteins always involve two or more than two tertiary polypeptide units.

134 (*d*) The statement in option (d) is incorrect and can be corrected as

Prostaglandins are derived from the fatty acid, arachidonic acid.

Rest of the statements are correct.

135 (*c*) The statement in option (c) is correct. Rest of the statements are incorrect and can be corrected as

- Lipids with molecular weight not exceeding 800 Da, come under acid insoluble fraction.
- The acid insoluble fraction has four types of organic compounds, i.e. proteins, nucleic acids, polysaccharides and lipids.
- The acid soluble pool roughly represents the cytoplasmic composition of the cell.

136 (*c*) The statement in option (c) is incorrect and can be corrected as

Glycine is the simplest amino acid in which functional group '*R*' is replaced by hydrogen atom (H). It does not contain sulphur.

Rest of the statements are correct.

138 (*d*) The statement in option (d) is incorrect and can be corrected as

Competitive inhibitor resembles closely with the substrate and binds to enzyme at a site, which binds to substrate. It increases K_m constant.

Rest of the statements are correct.

140 (*c*) Only statement in option (c) is incorrect. In can be corrected as

Oils have lower melting point (e.g. gingelly oil).

Rest of the statements are correct.

142 (*b*) Only statement IV is incorrect and can be corrected as

Cellulose is a polymeric polysaccharide consisting of only one type of monosaccharide, i.e. glucose.

Rest of the statements are correct.

144 (*c*) Statements I, II and III are correct. Statements IV and V are incorrect and can be corrected as

- Majority of the metabolic reactions do not occur in isolation, they are always linked to some other reactions.
- There are many examples of catalysed metabolic reactions.

147 (*a*) Option (a) represents the correct sequence for the steps involved in catalytic action of an enzyme. The substrate binds to active sites of enzyme causing conformational change to fit properly. The enzyme breaks bonds of substrate to release the product and free itself for another molecule of substrate.

149 (*a*) Statement I is true but II is false. Correct information about statement II is as follows

Enzymes lower the activation energy of the reaction. Lower activation energy increases the rate of reaction.

150 (*a*) Statement I is true, but II is false. The correct information about statement II is as follows

A complete catalytic active enzyme with its bound prosthetic group is called holoenzyme. An apoenzyme is an inactive enzyme which gets activated by the binding of an organic or inorganic cofactor.

161 (*c*) Xanthoproteic test is used in the quantitative analysis of protein. Other options are

Sudan black test is used in the quantitative analysis of fats.

Tollen's reagent and iodine are used in the quantitative analysis test for starch.

164 (*d*) Option (d) is correct as

Enzyme activity is influenced by the presence or absence of optimum pH and temperature, substrate concentration and the folding of their protein structure. Enzyme activity increases in the presence of substrate whose concentration increases initially and then reaches V_{max} and decreases in the absence of such substrate concentration.

Further, enzyme activity is maximum at optimum pH and temperature and is minimum beyond or above the optimum value. Also, any misfolding at the primary level may generate a malfunctioning enzyme.

165 (*c*) Option (c) is correct.

All living organisms and non-living matter in our biosphere are made up of similar elements and compounds. Several researches performed on plants, animals and microbes confirmed that the relative abundance of organic compound, i.e. carbon, hydrogen and oxygen in living organisms per unit mass is more than in the earth's crust (non-living or inanimate matter).

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

166 (*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.

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

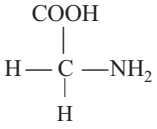
168 (*b*) The most abundant chemical in living organisms is water. It comprises of 70%-90% of the total cellular mass.

169 (*a*) Glycogen is a homopolymer made up of glucose units. It consists of glucose molecules linked together with α (1-4) linkage with α (1-6) branch points occurring every 8–12 residues.

170 (*a*) The number of 'ends' in a glycogen molecule would be equal to the number of branches plus one. This can be explained as in a glycogen there are many branches plus one main branch on which other branches arise.

171 (*a*) Fructose is a ketohexose with 6 carbons, but ketone as functional group whereas glucose is an aldohexose with 6-carbon and aldehyde as functional group. Thus, both have same number of carbon.

172 (*d*) Glycine is the simplest amino acid containing both an amino group and a carboxyl group.



Glycine

173 (*d*) The zwitter ionic of an amino acid is a neutral molecule having both the cationic and anionic charges present simultaneously on the same molecule.

174 (*a*) Proteins are heteropolymers made of about 20 different kinds of monomers, i.e. amino acids.

175 (*d*) Proteins can sometimes function as hormone, i.e. peptide hormones such as insulin.

176 (*a*) Primary structure of a protein molecule has two ends. These two ends of a polypeptide chain are C-terminal and the N-terminal, based on the nature of the free group on each extremity.

177 (*d*) Nucleoside on phosphorylation, forms a nucleotide, i.e. a molecule with nitrogenous base pentose sugar and three phosphate groups. A nucleoside is made up of cyclic nitrogenous base, purine or pyrimidine and a pentose sugar.

178 (*a*) CO_2 gets dissolved in water through a reaction which is not always catalysed by an enzyme.