CHEMISTRY (CODE – 043)

Chapter-wise Test: Biomolecules

(NCERT Class XII Chemistry, Unit 10: Biomolecules)

SOLUTIONS AND MARKING SCHEME

CLASS XII (2026-27)

Time: 1½ hours **Max. Marks: 35**

Step-by-step solutions with the distribution of marks. Marks for each step are shown in square brackets [ ]. Any other correct method or answer should be given full credit.

Quick answer key – Section A

Q.	1	2	3	4	5	6	7	8
Ans.	A	C	D	B	C	A	D	B

SECTION A

Questions 1 to 8 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions. Each question carries 1 mark.

1	**Answer: A. Sucrose** In sucrose the reducing groups of glucose (C-1) and fructose (C-2) are both involved in the glycosidic bond, so there is no free aldehyde or ketone group and it does not reduce Fehling's solution or Tollens' reagent. Maltose, lactose and glucose are reducing sugars.	1
2	**Answer: C. Row 3** Deficiency of vitamin C (ascorbic acid) causes **scurvy** (bleeding gums). Beri beri is caused by deficiency of vitamin B_1 (thiamine). Rows 1, 2 and 4 are correct.	1
3	**Answer: D. 4.07 kJ mol^{-1}** Decrease in activation energy = 6.22 − 2.15 = **4.07 kJ mol^{-1}**. Enzymes, like chemical catalysts, speed up a reaction by lowering the magnitude of the activation energy.	1
4	**Answer: B. 2 and 2** Each peptide bond (–CO–NH–) forms by the loss of one water molecule between a –COOH and an –NH_2 group. Three amino acids joined in a chain are connected by two peptide linkages, so two molecules of water are eliminated.	1
5	**Answer: C. Vitamin K** Vitamin K (sources: green leafy vegetables) is responsible for the coagulation of blood; its deficiency increases the blood clotting time. Vitamin E deficiency causes fragility of RBCs and muscular weakness; D causes rickets; C causes scurvy.	1
6	**Answer: A. Uracil** DNA contains adenine, guanine, cytosine and thymine; RNA contains adenine, guanine, cytosine and **uracil** (uracil replaces thymine).	1
7	**Answer: D. an aldehydic group** Bromine water is a mild oxidising agent. It oxidises the –CHO group to –COOH, giving a six-carbon acid (gluconic acid) with the same number of carbon atoms; this indicates that the carbonyl group in glucose is an **aldehyde**, not a ketone. The five –OH groups are shown by acetylation, and the primary –OH group by nitric acid oxidation to saccharic acid.	1
8	**Answer: B** A is true: on denaturation (change of temperature or pH) the hydrogen bonds are disturbed, the globules unfold and the helix uncoils, so the protein loses its biological activity. R is also true: only the secondary and tertiary structures are destroyed; the primary structure (the amino acid sequence) is unchanged. But R does not explain A; the loss of activity is due to the loss of the secondary and tertiary structures.	1

SECTION B		
Question Nos. 9 to 11 are very short answer questions carrying 2 marks each.		
9	**(A)** (i) Lysine has two –NH_2 groups and one –COOH group (more amino than carboxyl groups), so it is a **basic** amino acid. Glutamic acid has two –COOH groups and one –NH_2 group, so it is an **acidic** amino acid. [1] (ii) **Glycine** (R = H). Its α-carbon is not asymmetric because it carries two H atoms; all the others have four different groups on the α-carbon and are optically active. [1] **(B)** (i) In aqueous solution the –COOH group loses a proton and the –NH_2 group accepts it, giving a dipolar ion with both positive and negative charges and no net charge, a zwitter ion. Glycine: $H_3N^+–CH_2–COO^-$. [1] (ii) Amino acids exist as zwitter ions, so they behave like salts (ionic, strong electrostatic attractions between molecules and strong ion–dipole interaction with water), whereas halo acids are covalent molecules. [1]	1 + 1
10	**(A)** Fibrous proteins: the polypeptide chains run parallel, held together by hydrogen and disulphide bonds, giving a fibre-like structure; generally **insoluble** in water; e.g. keratin (hair, wool, silk) or myosin. [1] Globular proteins: the polypeptide chains coil around to give a spherical shape; usually **soluble** in water; e.g. insulin or albumins. [1] **(B)** Essential amino acids are those that cannot be synthesised in the body and must be obtained through the diet. Examples: valine, leucine (also isoleucine, lysine, etc.). [1] Non-essential amino acids can be synthesised in the body. Examples: glycine, alanine (also serine, aspartic acid, etc.). [1]	1 + 1
11	**(A)** (i) The oxide (–O–) linkage formed by the loss of a water molecule that joins two monosaccharide units, e.g. in a disaccharide or polysaccharide. [1] (ii) Hydrolysis of sucrose gives an equimolar mixture of D-(+)-glucose and D-(−)-fructose. The laevorotation of fructose (−92.4°) is more than the dextrorotation of glucose (+52.5°), so the mixture is laevorotatory; the change of sign of rotation from dextro (+) to laevo (−) gives the product the name invert sugar. [1] **(B)** A nucleoside is formed by the attachment of a base to the 1′ position of a sugar (base + sugar); a nucleotide is a nucleoside linked to phosphoric acid at the 5′ position of the sugar (base + sugar + phosphate). [1] Nucleotides are joined by a **phosphodiester linkage** between the 5′ and 3′ carbon atoms of the pentose sugars. [1]	1 + 1

SECTION C		
Question Nos. 12 to 15 are short answer questions carrying 3 marks each.		
12	**(A)** (i) X = **sucrose**; Y = **maltose** (two α-D-glucose units); Z = **lactose** (β-D-galactose and β-D-glucose). [1½] (ii) **Sucrose (X)**: the reducing groups of glucose and fructose are involved in the glycosidic bond, so no free aldehyde or ketone group is left. Maltose and lactose have a free aldehyde group (at C-1 of the second glucose unit) and are reducing sugars. [1] (iii) Lactose is called milk sugar; it is found in milk. [½] **(B)** (a) Glucose does not give Schiff's test and does not form the $NaHSO_3$ addition product, though it has an –CHO group. [1] (b) The pentaacetate of glucose does not react with hydroxylamine (no free –CHO). [½] (c) Glucose exists in two crystalline forms, α (m.p. 419 K) and β (m.p. 423 K). [1] These are explained by the cyclic hemiacetal (pyranose) structure, formed by the addition of the –OH at C-5 to the –CHO group, in which the α and β forms differ at the anomeric carbon C-1. [½]	3
13	**(A)** (i) A = ***n*-hexane** ($CH_3CH_2CH_2CH_2CH_2CH_3$); B = **gluconic acid** (CHO → COOH); C = **saccharic acid** (a dicarboxylic acid). [1½] (ii) With HI: all six carbon atoms are in a straight chain. With bromine water: the carbonyl group is an aldehyde (–CHO). With HNO_3: there is a primary alcoholic (–CH_2OH) group, since both –CHO and –CH_2OH are oxidised to –COOH. [1½] **(B)** $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6$ (glucose) + $C_6H_{12}O_6$ (fructose), obtained in equal amounts. [1½] Sucrose is dextrorotatory, but the mixture is laevorotatory, because the laevorotation of fructose (−92.4°) is greater than the dextrorotation of glucose (+52.5°). The sign of rotation is inverted, so the product is called invert sugar. [1½]	3
14	**(A)** (i) Adenine pairs with thymine and cytosine pairs with guanine, so strand 2 is **T – A – C – G – A – T** (the strands are complementary). [1] (ii) The nucleotides in a strand are joined by **phosphodiester linkages** between the 5′ and 3′ carbons of the sugar. (The two strands are held together by hydrogen bonds between base pairs.) [1] (iii) **Uracil** replaces thymine in RNA. [1] **(B)** (a) The sugar in DNA is β-D-2-deoxyribose; in RNA it is β-D-ribose. [1] (b) The bases in DNA are A, G, C and T; in RNA they are A, G, C and U (uracil in place of thymine). [1] (c) DNA has a double-strand helix structure; RNA is single stranded (it may fold back on itself). [1]	3

15	**(A)** (i) When a native protein is subjected to a physical change such as a change of temperature, or a chemical change such as a change of pH, the hydrogen bonds are disturbed, the globules unfold and the helix uncoils, and the protein loses its biological activity. Example: coagulation of egg white on boiling (or curdling of milk). [2] (ii) The secondary and tertiary structures are destroyed; the primary structure remains intact. [1] **(B)** (i) Enzymes are biocatalysts, almost all of them globular proteins, which are very specific for a particular reaction and substrate. Maltase hydrolyses maltose: $C_{12}H_{22}O_{11} + H_2O \rightarrow 2C_6H_{12}O_6$ (maltose → glucose). [2] (ii) Like chemical catalysts, they reduce the magnitude of the activation energy and are not consumed, so only a small quantity is needed. [1]	3

SECTION D

Question No. 16 is a case-based/data-based question carrying 4 marks.

16	(i) **Vitamin C**, chemically ascorbic acid; its deficiency causes **scurvy** (bleeding gums). [1] (ii) Fat soluble: vitamins **A, D and K**. Water soluble: vitamins **B_1 and C**. [1] (iii) Vitamin C is water soluble. Water soluble vitamins are readily excreted in urine and cannot be stored in the body (except B_{12}), so they must be supplied regularly in the diet. [1] **OR** (iii) Vitamins A and D are fat soluble (soluble in fats and oils, insoluble in water); they are stored in the liver and adipose (fat-storing) tissues. [1] (iv) The term “vitamine” came from vital + amine because the early compounds identified had amino groups. Later work showed that most of them do not contain amino groups, so the ‘e’ was dropped. [1] (Each of the four parts carries 1 mark; the choice is in part (iii) only.)	1 + 1 + 1 + 1

SECTION E

Question No. 17 is a long answer question carrying 5 marks.

17	**(A)** (i) $H_2N–CH_2–COOH + H_2N–CH(CH_3)–COOH \rightarrow H_2N–CH_2–CO–NH–CH(CH_3)–COOH$ (glycylalanine) + H_2O. The carboxyl group of glycine combines with the amino group of alanine, forming a **peptide linkage** (–CO–NH–), which is an amide bond. [2] (ii) Primary, secondary, tertiary and quaternary structures. [1] (iii) α-helix and β-pleated sheet; hydrogen bonding between the C=O and –NH– groups of the peptide bonds. [1] (iv) Secondary and tertiary (and the quaternary arrangement); the primary structure remains intact. [1] **(B)** (i) Starch is a polymer of α-D-glucose, whereas cellulose is a straight-chain polysaccharide of only β-D-glucose units joined by C1–C4 glycosidic linkages. [1] (ii) Amylose and amylopectin. Amylose: water soluble, about 15–20% of starch, long unbranched chain of 200–1000 α-D-glucose units (C1–C4 linkage). Amylopectin: insoluble in water, about 80–85% of starch, branched chain (branching by C1–C6 linkage). [1½] (iii) Glycogen is the form in which carbohydrates are stored in the animal body (animal starch; present in liver, muscles and brain). Its structure is similar to amylopectin but it is more highly branched. [1] (iv) Storage molecule (starch); structural material (cellulose, cell wall). [½]	5

Topic coverage of the paper

Topic (NCERT section)	Questions
Classification of carbohydrates; reducing and non-reducing sugars (10.1)	Q1, Q11 (A), Q12 (table)
Glucose: structure, reactions, cyclic structure and fructose (10.1.2)	Q7, Q13 (figure), Q12 (B)
Disaccharides and polysaccharides (10.1.3–10.1.4)	Q12 (table), Q13 (B), Q17 (B)
Amino acids and peptides (10.2.1–10.2.3)	Q4, Q9 (table), Q17 (A)
Protein structure and denaturation (10.2.3–10.2.4)	Q8, Q10, Q15 (A), Q17 (A)
Enzymes (10.3)	Q3 (figure), Q15 (B)
Vitamins (10.4)	Q2 (table), Q5, Q16 (table)
Nucleic acids (10.5)	Q6, Q11 (B), Q14 (figure)

Figure/table-based questions (7): Q2, Q3, Q9, Q12, Q13, Q14 and Q16.